Belize National
Spatial Data Infrastructure

Supporting Sustainable and Resilient National Development

STAKEHOLDER SITUATION UPDATE SURVEY

Discussion Draft V7

28 April 2016

GPC Group
A Global Network of Information Professionals

Belize National Spatial Data Infrastructure

STAKEHOLDER SURVEY

DISCUSSION DRAFT
Version 7.0
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Prepared for

Government of Belize
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EXECUTIVE SUMMARY

This Stakeholder Situation Update Survey report provides a compilation of information gathered about organizations that were identified as potentially important participants in the next stage of development of the Belize National Spatial Data Infrastructure (BNSDI) program. Over 80 entities were selected for this study, as being both important, interested and representative of the range of requirements in various sectors across Belize society. These were then further filtered and grouped to a total of 46 "Stakeholder Write-Ups" covering multiple sectors, including:

- >30 Units of Government
- 5 Regional Organizations
- 2 Utilities
- 2 Private Sector
- 5 Non-Profit, Non-Government Organizations
- 1 Academic and Research

For each of the above, a variety of information gathering techniques were used, including direct interviews, stakeholder information collection form responses, phone interviews and internet-based desk studies. Information was compiled to a common format covering:

- Organization and Mission
- Activity Areas
- Data Used or Generated
- Existing Software Application Systems
- Computing Infrastructure
- Other Issues, Opportunities and Constraints

Draft write-ups were returned individually to each of the subject organizations for review and comment. Comments received were then incorporated to a final version of each write-up and these were then organized and consolidated to the current compiled document.

Note: Most of the information presented in this document was collected and recorded in 2014. In late 2015 there was an election and administrative re-structuring of the government that changed the configuration of several Ministries. While some administrative structures have changed, the basic functions carried out by government remain largely the same. Since the purpose of this exercise is to reflect the aggregate requirements of representative stakeholders, the information in this report has not been reconfigured to reflect government restructuring.

1 INTRODUCTION

This Stakeholder Situation Update Survey report provides a compilation of information gathered about organizations that were identified as potentially important participants in the next stage of development of the Belize National Spatial Data Infrastructure (BNSDI) program. The objective of the current effort is to assist the Government of Belize (GoB) to review existing BNSDI policy and provide a roadmap for successful and sustainable implementation and governance of BNSDI with respect to investment programs identified under the Climate Resilient Infrastructure Project (CRIP). The BNSDI is to provide an enabling environment for the CRIP Project Preparation Facility, providing critical information infrastructure to support more effective formulation, design, development, monitoring and evaluation of targeted retrofitting, rehabilitation and reconstruction activities that are needed to strengthen the resilience of critical infrastructure to natural hazards and the anticipated impacts of climate variability. Beyond the immediate CRIP program requirements the study is also addressing a broader range of development concerns across all major sectors in Belize.

This report is one component of a structured work program for the planning, design, and implementation of the BNSDI. The position of this report relative to the entire work program is illustrated in the Figure below.

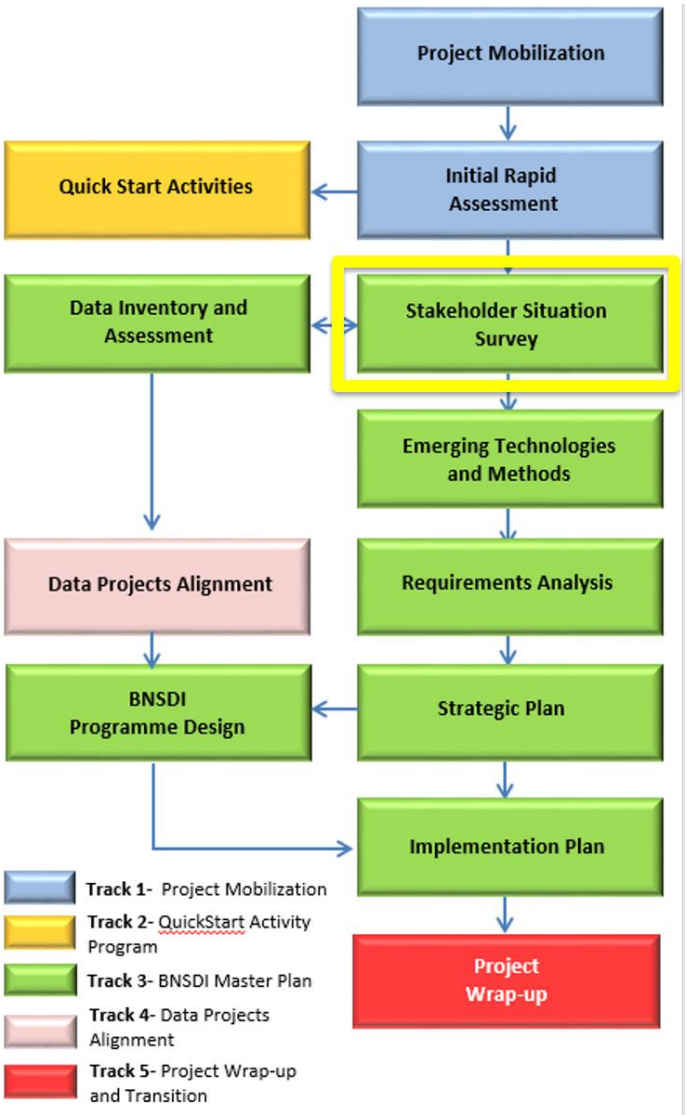

Figure 1 – Work Program Illustration

1.1 Purpose of this document

The purpose of this document is to provide a basic understanding of the current situation of GIS in Belize, an accounting of the broad range of requirements for geospatial data and services across government and other sectors of Belizean society, and a sense of the level of readiness of these organizations to participate in the next stage of BNSDI development. This foundation information is to be used to inform subsequent steps towards the formulation of a strategic plan and implementation approach for carrying the initiative forward.

The agencies identified to be contacted in this stage of BNSDI development were listed and prioritized for engagement by the Consultant, with reference to the previous stage of BNSDI development, findings of an overview rapid assessment, feedback and insights gained through a stakeholder orientation seminar and consultations with several individuals who have been active in GIS in Belize for many years.

A Stakeholder Survey packet was developed inclusive of a questionnaire requesting the following basic information about each organization:

- Agency mission and organization
- Basic functions carried out by each relevant group within the organization;
- What geographic data generated or used;
- For data used, where acquired, and in what form, scale, data resolution, etc.;
- What major geospatial or related data development programs underway now, or planned for development in the near future;
- What needs for information exchange regarding GIS and related technologies;
- What internal technical capacity maintained now, including staff skill levels, existing computerization, and data communications infrastructure;
- What existing framework of policies or regulations that would affect data sharing and related issues.
- What other issues, opportunities or constraints will need to be addressed by the BNSDI program.

Those organizations that have shown interest in the BNSDI in the past and/or who are the most likely providers of information that is needed in common by the community were targeted for direct personal interviews. Others were provided with a copy of a Stakeholder Survey packet as a guide for providing requested information. Follow-up telephone interviews were conducted with many of these organizations, while "desk study" research involving the review of existing documentation, websites, annual reports, newsletters and other sources of information were also used as reference for several organizations. In all cases, compiled survey write-ups were submitted to the involved organizations for their review and comment, and where provided this feedback has been incorporated.

1.2 Organization of this document

This document has been organized at three levels. The main chapters are defined around major government organizations with one or more departments, each of whom may be a significant participant in the BNSDI and therefore warrant an individual write-up. Other chapters represent clusters of types of organizations outside the Government of Belize (e.g. Regional Organizations, Utilities, Private Sector, Professional Associations, NGO's, and Academic and Research).

Each individual write-up is organized according to the same set of topics:

Organization and Mission. Overview of the organization and its mission;
Activity Areas. A summary of each of the major functions of each organization that have some relevance to the use of GIS and participation in the BNSDI;

Data Used or Generated. A listing of data used or generated in carrying out the organization's functions;

Existing Systems. Application software or other tools and methods used by an organization for carrying out its functions.

Computing Infrastructure. Any overview of the computing infrastructure currently being used by an organization to support its business;

Other Issues, Opportunities and Constraints. Any other issues, opportunities or constraints that should be taken into account when considering the form and function of the BNSDI and the process for undertaking its implementation.

The current document should be considered a "discussion draft" that will undergo further refinement with the help and advice of the BNSDI stakeholder community. There are a number of remaining questions that remain to be answered by some organizations. These questions and missing information have been noted and highlighted in the present document so that they can be responded to by the relevant organizations in due time, without holding up the distribution and review of the rest of the content. Corrections and additions will be compiled and incorporated into a final version of the report according to the project schedule.

Note: *Following the completion of all the interviews and information collectio but prior to the submittal of this final document there was a general election in Belize and reorganization of some units of government ensued. This is not expected to materially affect the range of requirements being expressed as nearly all the functions mentioned will continue to be carried out, albeit under different administrative structure in some cases. However, it should be noted that some of the administrative organization, staffing and staff titles implied or recorded within some sections may have been modified.*

2 MINISTRY OF NATURAL RESOURCES AND AGRICULTURE

2.1 Lands and Surveys Department - Physical Planning Unit

Person(s) Interviewed: Ms. Gina Young - Principal Planner
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Interview Date: June 9, 2014

2.1.1 Organization and Mission

The Physical Planning Section is a unit within the MNRA Lands and Surveys Department. The unit is in charge of the review and processing of land subdivisions for all private and some national land in the country, review and processing of use and construction permits for activities and constructed structures in the public coastal areas. The unit also provides advisory support to national land use planning, environmental impact assessments (EIA's), national protected areas secretariat, and other related functions.

Note: Belize encompasses a total land area of 22,960 km2 of which 5% is distributed over more than 1,060 islands. Privately held lands represent 54% (approximately 12,400 km2) of the total national territory with over 10,000 km2 distributed in rural parcels greater than 0.4 km2 (40 ha). While small private urban parcels represent less than 0.1% of the total national territory they account for most of the land transactions. Public lands account for 46% (approximately 10,560 km2) of the total land surface of Belize. These public lands are further divided into: (i) protected areas and forest reserves which represent over 30% of the total national territory; and (ii) other 'national lands' (16% of the total national territory) which are either already allocated under a government lease or unleased public land. It is estimated that there exists between 90,000 and 105,000 land parcels that can eventually form part of the national cadastre and contribute to a dynamic investment market[1].

The unit has 9 staff and is responsible for several primary activity areas that have some relevance to GIS and BNSDI, including the following:

1. Process Land Subdivision Applications
2. Process Seabed and Public Coastal Areas Use Permits
3. Support Land Use Planning Initiatives
4. Review Environmental Impact Assessments
5. Support National Protected Areas Secretariat

2.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a

[1] BELIZE Project Profile (PP), IDB Land Management Program III, Prj# BL-L1008

summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.1.2.1 Process Land Subdivision Applications

The Physical Planning Section is involved in processing land subdivision and consolidation proposals. This process is defined by the "National Guidelines for Subdivision and Consolidation of Land in Belize", May 2010 (much of the information following has been selectively extracted from the guidelines, where the functions are relevant to the current study). These procedures were developed in response to observed trends in rapid urban expansion, tourism and other development, and the resulting demand to transfer/alienate smaller portions of property and consolidation of smaller properties to facilitate development. Under the existing laws (the Land Utilization Act, Chapter 188 of the Substantive Laws of Belize, Revised Edition 2000), final subdivision approval is needed to make such land transactions legal. The land subdivision and consolidation process has been designed to assist in improving transparency and equitability of the application process and are to conform to the National Planning Framework for Belize.

The Land Subdivision and Utilization Authority is the authority which makes recommendation(s) to the Hon. Minister responsible for land for subdivision and/or consolidation of land and the creation, removal and variation of easements where road reserves are resulting from private subdivisions. This Authority was established under the Land Utilization Act, Chapter 188 of the Laws of Belize, Revised Edition 2000. The Authority meets on a monthly basis to review applications and is comprised of the following members:

a) The Commissioner of Lands (Chairperson),
b) The Chief Engineer or representative,
c) The Chief Forest Officer or representative,
d) The Chief Agricultural Officer or representative,
e) The Assistant Secretary of the Ministry of Lands (The Secretary),
f) Two other persons appointed by the Minister of Lands, and
g) The National Coordinator appointed under the Disaster Preparedness and Response Act.

The Department of Lands and Surveys through its Physical Planning Section (PPS) accepts and vets all applications for land subdivision/consolidation. Once applications are vetted, they are submitted to the Land Subdivision and Utilization Authority (The Authority) for recommendation. The PPS has the following responsibilities in reference to subdivision applications. This is not a complete listing but rather has isolated those functions and processes that have some particular relevance to the use of GIS technology and/or engagement in the BNSDI.

a) Accept applications for land subdivision and review them to ensure completeness and adherence to subdivision design requirements,
b) Open a file for each subdivision application; each file is assigned an application number and is recorded in an application and index book lodged in the office of the PPS,
c) Forward applications to the Commissioner of Lands for subdivisions which fall under Sections 18(a) or 18(b) of The Act,

Subdivision of land is obtained in two (2) main stages, namely: (1) **Provisional** approval and (2) **Final** approval.

Stage 1 – Provisional approval. Under the Provisional approval stage:

1. Application:

- The applicant submits his/her application with a sketch (drawn to scale) showing the proposed subdivision design, location plan, copy of land title, a certified copy of the land register for all lands within a declared area under the Land Registration Act, tax statement showing all taxes are paid, mortgage declaration by the land owner for all land in undeclared areas, and completed Provisional approval to subdivide application. Additional documentation may be required such as company documents, input from the local authority, and environmental clearance.
- Pays his/her application fee, according to a set and published fee structure, at the Land Revenue Section of The Ministry and provides a copy of the receipt to the Physical Planning Section.

2. The Physical Planning Section (PPS):

- Checks the application for completeness and adherence of the design to the guidelines and attaches a checklist of documents to the application.
- Places the application in a file, and assigns a reference number.
- Records the receipt of the application in the application and index books, and on the Landfolio Cadastre Application.

3. The PPS:

- Makes a determination of the complexity of the subdivision application and proceeds to submit the following directly to the Commissioner of Lands for his/her approval:
    - All simple subdivisions (3 or less parcels);
    - Subdivisions where the resulting parcel (s) are to be combined to an adjacent land owner's (18a of The Act);
    - Subdivisions where the resulting parcels are to be transferred to the land owner's wife, husband, and/or children (18b of The Act).

A series of additional administrative steps are followed to further process the application through the process.

12. The applicant:

- Submits the Provisional approval letter to a licensed surveyor to carry out a subdivision survey within one (1) year of the date of approval according to the proposed subdivision plan that was approved. Once this survey is completed, the surveyor submits the survey plan to the Mapping Section, Lands and Surveys Department for Authentication within the one (1) year stipulated time. If the applicant fails to complete the survey with the above time period, he/she must re-apply for Provisional approval.

Stage 2 – Final approval. Once an applicant has successfully completed stage 1, he/she may proceed with stage 2 of the subdivision process. Under the Final approval stage:

1. The Applicant:

- Submits his/her application plus 8 copies, within one (1) year from the date of Provisional approval, for Final approval to subdivide, along with a blue print copy of the authenticated survey plan (plus 8 regular copies), and a tax statement showing that all land taxes on the land are paid up-to-date.

2. The PPS:

- Vets the application for completeness and attaches a checklist of documents to the application. Applications that were approved under (3) in Stage 1 are submitted directly to the Commissioner of Lands for approval.

Additional administrative steps are involved in processing the application through to final approval.

Subdivision applications must adhere to certain design and development requirements, as determined in the guidelines. These include:

- Development standards for subdivisions
- Public open space contributions
- Roads and other accesses
- Access to bodies of water
- Buffer zones
- Car parking
- Utility services
- Survey plan criteria

Submitted design plans must meet certain criteria that are relevant to GIS/BNSDI, including:

- Be drawn to scale using AutoCAD or other design software compatible with AutoCAD. These drawings are georeferenced and provided in projected coordinates in Universe Transverse Mercator (UTM) format.
- Show that resulting lots are provided with consecutive numbering (no numbers on green areas, open spaces, roads or buffers),
- Show the dimensions of all parcels, roads, open spaces and buffers (length and width in feet or meters),
- Show the size of each resulting parcel (in sq. ft or acreage),
- Show all existing and proposed road accesses to each resulting parcel and the main road to the subdivision. These must be clearly labeled with road name (where applicable), road width, and labeled "existing road" or "proposed road",
- Show that road is designed to provide for adequate turning and to allow for the free flow of traffic,
- Be stamped and signed by a registered land surveyor, planner, or a registered engineer or architect,
- Be accompanied by a contour plan and have a slope no greater than 35%,
- Be compatible with and show the contours of the land (particular considerations for road design and drainage, as per Ministry if Works (MoW) standards),
- Show all existing buildings and other permanent structures on the land, the dimensions of each, and setback distances from the property boundary, adjacent buildings, and road access,
- Show the 66ft reserve and the location, outline, and extent of water features such as the Caribbean Sea, the high water mark, rivers, lagoons, creeks (whether permanent or periodical), natural drainage areas, and/or swamps within or adjacent to the property,
- Show location, outline of hills, caves, sinkholes, ancient monuments or ruins, and
- Reflect and be compatible with adjacent subdivisions (e.g. road reserves connected to maintain its functionality).

Other development standards for subdivisions that have relevance to the use of GIS and BNSDI include, for example, the following:

- Lot size and configuration standards,
- Allowed use,
- Building size and configuration standards,
- Parking allocation requirements,
- Water, sewerage and electrical service requirements,
- Public open space contributions,
- Roadway and access standards,
- Relationship to agriculturally significant soils,
- Any hazardous conditions that may impact use of the land or represent a public safety issue;
- Access to bodies of water,

- Buffer zones (from canals, roads, flooding areas, etc. as needed to protect the general public),
- For large residential and commercial developments (50 or more lots), provisions must be made for services such as potable water, electricity, and solid and liquid waste management (including sewerage).

During the approval process, the georeferenced subdivision/consolidation boundaries and related information in digital form are maintained in the Landfolio Cadastre System and accessible to all personnel in the Lands and Surveys Department. These proposed boundaries are compared to the cadastral layer and other information currently maintained by the MNRA Land Information Center (LIC), but the proposed boundaries are not posted to the LIC database until after Provisional approval has been issued.

All case information collected and compiled during the land subdivision application review and approval process is kept both in paper case files as well as stored digitally in the Landfolio system. Paper case files are organized by District, Year and a chronologically sequential number during that year (see Figure below).

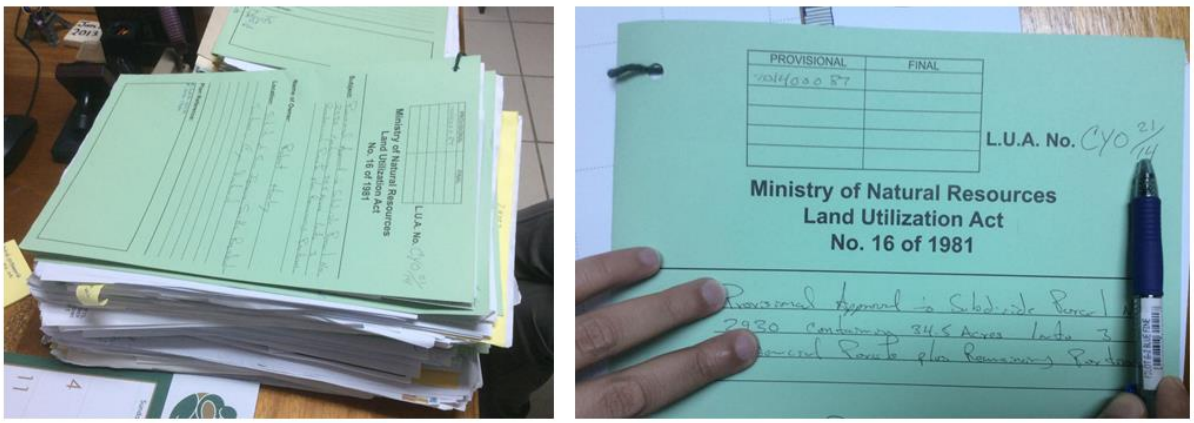

Figure 2 – Paper Land Subdivision Case Files

Section staff utilizes the LIC GIS to review the context of a subdivision application as described previously. During the approval process the subdivision information is maintained in folders via the LandFolio system. There is a desire to make selected parts of this information accessible to the community in the future.

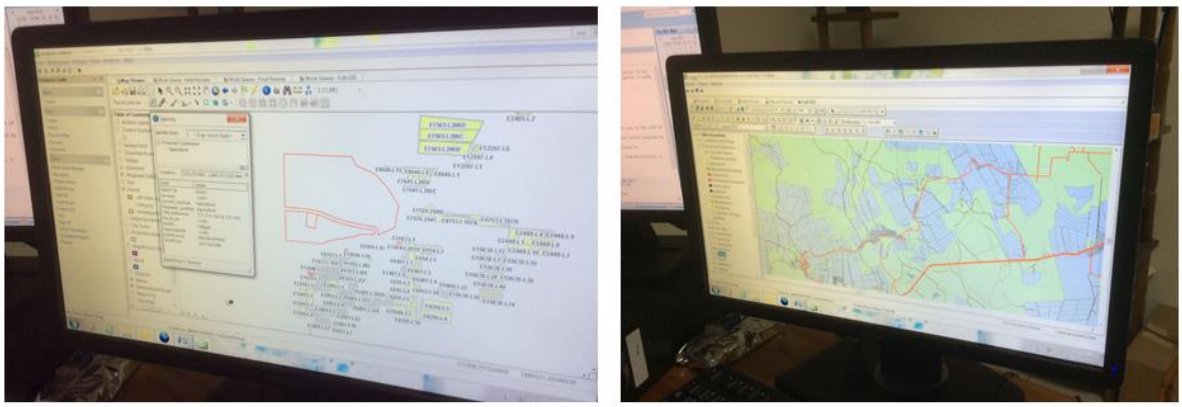

Figure 3 – Provisional Subdivision Boundaries (left) and Compilation to Integrated Cadaster Following Final Approval (right)

2.1.2.2 Process Seabed and Public Coastal Areas Use/Construction Permits

The Section is responsible for the processing and issuance of use permits for activities affecting the seabed and/or public reserve coastal areas. The seabed has traditionally been utilized for a number of purposes including the construction of piers, seawalls, groynes, and jetties. Some structures now commonly proposed include structures upon which restaurants, bars, dive shops, cabanas or other dwellings are constructed. Other uses of the seabed include land reclamation and mariculture.

Note: The 66 feet reserve adjacent to lagoons, rivers, creeks and other major water bodies is mandatory for all rural areas including areas used for agricultural, industrial and tourism purposes. The exception to this rule is for old titles, on which the reserve, for the most part, was included in the acreage. In the case of all old titles, which include the 66 feet reserve as part of the property, requests for subdivisions and subsequent new surveys must show the 66 feet reserve on the new survey entry based on the Guidelines for Subdivision and Consolidation of Land in Belize, endorsed by The Cabinet June 2010. Within developed urban-type areas, a minimum of 30 feet reserve is acceptable for small perennial or seasonal creeks and other minor water bodies. Some accepted uses of the 66 feet reserve include:

- Temporary access for mining sites;
- For placing temporary structures (tents, tables and chairs etc.);
- Beautification purposes.

Where the reserve along a waterbody has eroded over time, a landowner may apply for a licence to reclaim the reserve.

The Ministry of Natural Resources, through the Physical Planning Section of the Lands and Surveys Department, began issuing licences for use of the reserve and seabed in 1996 under the powers given to the Minister by the Private Works Construction Act of 1905. Under this act, any person intending to construct a wharf, bridge, pier, kraal or other erection upon or to enclose, stake in or fill up any land on the shore of the sea or bank of any river in any part of

Belize other than Belize City needed to apply for a licence or permit to be granted by the Minister.

In 2003 the Belize Building Act (Statutory Instrument 7 of 2003) was enacted. Under this Act any person intending to construct any structure, whether in the terrestrial or marine environ, must be granted a building permit by the Director of Building Control. The Physical Planning Section of the Lands and Surveys Department perceived it more practical and legally unambiguous to grant permission to utilize the seabed and 66 feet reserve under the National Lands Act, rather than the Private Works Construction Act.

The following general requirements that must be met when applying for licences for use of the seabed and 66 ft reserve that have some direct relevance to the use of GIS technology and the BNSDI include the following:

- Applicant must show proof of ownership of the parcel of land adjacent to the proposed site. Licences for use of the 66 feet reserve and seabed adjacent to public roads, easements, or open/public spaces are only considered if the application is made on behalf of the Government of Belize for and on behalf of Local Village, Town, or City Councils, for use by the general public.
- The applicant is required to provide a detailed plan showing the dimensions of the proposed structure or coastal works.
- The applicant is required to provide a map showing the location of the proposed construction in relation to the property and other nearby structures.
- If the proposed location is within the boundaries of a village, town, or city, the application must be accompanied by a recommendation for the proposed project by the Council Chair (if village) or Mayor (if town or city).
- In cases where input is required from other agencies, such as the Department of the Environment, Forest Department, Mining Unit of the Ministry of Natural Resources and Agriculture, or Fisheries Department, these must be provided prior to the processing of the application.
- The area of seabed and/or the 66 feet reserve that is allowed to be used cannot exceed 25% of the parcel adjacent to the area subject to the licence.
- In relation to the overwater structure the licensee will have responsibilities to take any action necessary to protect the environment.
- ‘No objection’ from Fisheries when issuing licences within a marine protected area?

It is recognized that there is a growing trend for use of the seabed and thus increasing risks for environmental degradation and other related hazards. The input of other agencies such as the Geology and Petroleum Department, the Mining Unit of the Ministry of Natural Resources, the Department of the Environment, the Fisheries Department, the Forest Department, the Belize Port Authority and other agencies is critical for the processing of these applications.
Some projects that are considered as needing input from other agencies include:

- Piers/docking facilities or marinas serving large housing and commercial development;
- Structures that house dive shops, restaurants, or bars;
- Jetties;
- Land reclamation;
- Projects involving dredging;
- Projects involving exploration for or exploitation of petroleum resources (although the method used may not necessitate use of the seabed and thus no requirement for a seabed licence);
- Projects involving clearing or alteration of mangroves;
- Marine petroleum oil rigs
- Projects near to or within protected areas, coral reefs and other environmentally sensitive areas.

Applications for new licences must be accompanied by a variety of mandatory documents, some of which have direct relevance for the GIS/BNSDI matter, including but not limited to the following:

- Land Title (Conveyance, Transfer Certificate of Title, Transfer etc.);
- Detailed drawing showing design, dimensions & materials to be used for proposed project;
- Location Map, showing the project location in relation to its immediate surroundings;
- Recommendation from Local Authority, where applicable (City/Town/Village Council);

Those parts of the license application process that have some relevance to GIS and BNSDI include the following:

- Application submittal. This must include a variety of contextual and project-specific information as indicated previously,
- Site inspection. Prior to processing of application, a site inspection must be done by the Physical Planning Section. Other agencies are included in the visit if it is foreseen that their input will be required. These include: Department of the Environment, Geology and Petroleum Department, Coastal Zone Management Authority and Institute, Fisheries Department, Forest Department, etc.;
- Approved project tracking (currently managed via Landfolio). It is recognized that maintaining a compiled record of approved projects and their status of completion and operational compliance over time would be of benefit to the Country. This would also be useful to support license renewal processes conducted by the Physical Planning Section.

2.1.2.3 Review Environmental Impact Assessments

Areas of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following, most of which are currently being handled through the Landfolio system:

- Log seabed and public coastal area use/construction permit applications geographically
- Review land tenure, administrative jurisdiction, environmental, and infrastructure context of proposed seabed and public coastal area use/construction applications (current and planned)
- Conduct semi-automated review for planning and regulatory compliance
- Determine potential current and future hazards from climate change
- Provide geographic linkage to land subdivision case files
- Produce map showing status of all pending seabed and public coastal area use/construction permit applications
- Illustrate historical seabed and public coastal area use/construction permit history

This Section is involved in the review of Environmental Impact Assessments as part of its role. The Environmental Protection Act (EPA) of Belize was enacted in 1992 and was revised 2000 and more recently amended in 2009. Over the past twelve years, Environmental Impact Assessment (EIA) has gained widespread acceptance as a planning tool for promoting environmentally sound development practices. An EIA reflects a preventative approach to environmental management as it enables decision-makers to avoid problems before they occur during the planning stage. The undertaking of an EIA is stipulated under Sections 20 to 22 of the Environmental Protection Act.

The EIA process is a procedure used to examine the environmental consequences, both beneficial and adverse, of a proposed development project and to ensure that these consequences are taken into account in project design. The EIA evaluates the expected effects on human health, ecosystems processes, ecosystems health, and the natural and cultural environment, on property, etc. as well as on local communities.

The Physical Planning Section is one of several relevant permitting agencies that coordinate with the Department of Environment in reviewing EIA's on behalf of the Commissioner of Lands and Surveys. The National Environmental Appraisal Committee (NEAC) then evaluates the EIA submitted, reviews the comments of government agencies, NGOs and the public on the EIA and recommends what action should be taken. Similarly, in the case of LLESs, key agencies evaluate the LLES, reviews comments of other stakeholders and recommend what action should be taken.

The Section uses both Landfolio and GIS to assess land tenure, agriculture resources and other issues relevant to the mandate of the MNRA in regards to each EIA.

The EIA process and broader GIS/BNSDI matters are addressed in more detail in the Ministry of Forestry, Fisheries and Sustainable Development Stakeholder Survey section of this document.

2.1.2.4 Provide Advisory Support to Other Initiatives

The Physical Planning Section provides planning advisory support to various other initiatives.

Note: In November 2011 The Cabinet endorsed the Belize National Land Use Policy for Land Resource Development. The policy attempts to incorporate all current and proposed activities undertaken by government department and ministries that are likely to have an impact on the use of land and its resources. Ministries and departments have stated their intentions and aspirations over the next few years and these statements have been translated into a first comprehensive land use policy. The document consists of a series of policy statements and policy strategies. Policy statements relate to land tenure, land administration, land tax and rent, and population growth and distribution. Specific land use strategies concern land use management for rural areas, urban development, natural resources and conservation, water resources, climate change, national infrastructure, land use planning in relation to flood risks, agricultural land use, aquaculture land use, and tourism land use.

National Environmental Appraisal Committee (NEAC). The Committee was established to review development projects in the context of the national environment. NEAC has a tabular database of information regarding the EIA's that have been addressed by the Committee. This information is not currently georeferenced, although it is intended that this feature will be added in the future;

National Protected Areas Committee (NPAC). This Committee was established to advise the government of Belize on issues concerning the national protected area system;

National Land Use Planning Task Force. This Task Force comprises stakeholders Planning Initiative within the Belize Municipal Development Project (BMDP). The objective of the BMDP is to improve access to basic municipal infrastructure and to enhance municipal management in selected town and city councils of Belize. There are three components to the project, the first component being municipal infrastructure investments. The component has two rounds of subprojects. In order to provide incentives for Town and City Councils (TCCs) to improve their management capacity, TCCs are required to meet specific eligibility criteria before subproject preparation begins. Although TCCs prioritize the investments and participate in procurement and supervision, Belize Social Investment Fund (BSIF) has overall responsibility for procuring and handling financial management arrangements of the agreed investments. The second component is the technical assistance and capacity building for TCCs, Ministry of Labor, Local Government and Rural Development, Immigration and National Emergency Management (MLLGRDINEM), and Ministry of Natural Resources and Agriculture (MNRA). Finally, the third component is the project management. Strengthening

of the operational capacity of BSIF for implementation and management of the project, to ensure compliance with fiduciary controls, supervision, monitoring and reporting, and compliance with social and environmental safeguards, through the provision of technical advisory services, training, operating costs, and acquisition of goods including vehicles. To implement the project, BSIF has put into place a small project implementation unit with technical, procurement and financial management experience. The component ensures that effective fiduciary arrangements are in place during implementation. (Note: Task Force TOR to be provided).

2.1.3 Data Used or Generated

Parcel Database. The MNRA maintains a compiled database of boundaries for all declared lands. A more detailed description of this database is provided within the MNRA – LIC stakeholder survey writeup.

Provisional Parcel Case Files. Case files are maintained for each subdivision transaction. If there are multiple transactions against the same property, then these become "projects" within the same case. All submission information as well as site inspection information, photos, correspondence and review results and comments are included in these files. The information is maintained in paper files organized by District, Year and chronological sequence number. All content in these case files is also scanned and maintained in a digital form within the Landfolio system. All information is retrievable by plot number, owner name, case file number and other identifiers.

Provisional Parcel Boundary Files. The MNRA requires the submission of boundaries for proposed subdivisions in digital form and in projected coordinates. These are included as part of the original submission according to specifications provided by the Physical Planning Section.

LIC GIS Databases. The Physical Planning Section accesses the LIC GIS database to assess a variety of contextual information regarding road access, proximity to waterbodies, locations of protected areas and many other issues.

2.1.4 Existing Systems

Landfolio. LandFolio is an application software suite originally developed by Stewart Global Systems that automates the core elements of land records management providing a complete land information management solution. The software has been built on top of the ESRI GIS platform and MS SQL Server database. This was implemented initially in 2006 and then extended through the third phase of the IDB funded Belize National Land Management Program (LMP), intended to develop a national land policy framework focusing on both private and public sector development through secure land tenure. Land Management Program III involved the expansion of the Land Information System included the expansion of the landfolio solution to the Sections of Planning, National Estate, Valuation and Land Revenue/Cashiering and is maintained and supported internally at present by the MNRA IT Department.

LIC GIS. Some members of the Section have access to the MNRA LIC GIS database through the Landfolio system.

2.1.5 Computing Infrastructure

All staff in this Unit has access to a PC and basic Office applications. Eight are trained in the use of the Landfolio system and rudimentary use of the GIS. The detailed computing infrastructure configuration is provided in the MNRA – IT Stakeholder Survey writeup.

2.1.6 Other Issues, Opportunities and Constraints

Need for detailed, comprehensive topographic information. Other than detailed site-specific topographic information that is provided as part of a subdivision application there is not comprehensive, detailed topographic basemap information available for Belize.

Need for provisional subdivision information to be generally available. These data are currently available to Lands and Surveys Department Staff. Would like to have provisional parcel boundaries posted to the central database to make others aware of these transactions.

More GIS software and training needed. The Section would like to be able to use more GIS functionality, and to have this accessible to more people trained and including training in its use.

More up to date land use data is needed. Land use data from a 2012 study (supporting the Planning Component of the BMDP).

Access to utility data becoming more important. The LUA has started requesting utility service letters confirming that approved subdivisions will be supplied with essential utility services. Staff would like to confirm the locations of nearest transformer, water point and other information.

Need for better coordination and information sharing. Need better means to coordinate and share information with others that are involved in the land subdivision process.

2.2 Lands and Surveys Department – National Estate, Registry, and Valuation Sections

Person(s) Interviewed: Gabriela Flores, National Estate, Land Officer.
Herman Castillo, Valuation Section, Chief Valuer.
Cas.values@yahoo.com
Patricia Robateau, Deputy Registrar.
Deputy.registrar@mnra.gov.bz
Ethel Gladden, Asst Registrar. Reg.gladden@mnra.gov.bz

Interview Date: June 9, 2014

2.2.1 Organization and Mission

The MNRA Lands and Surveys Department includes 6 sections with many interrelated functions required to carry out the Department's mission to efficiently manage the processes of determining, recording and disseminating all information about land, including ownership, value, its coordinates, its highest and best use for the socio-economic benefit and sustainable development of Belize. These include:

- Physical Planning
- National Estate
- Land Registry
- Survey and Mapping
- Valuation
- Land Information Center

This write-up covers National Estate, Land Registry, and Valuation. The other sections are covered in other write-ups according to interview groupings. The activities of all these sections are highly interrelated, thus a brief overview of the sections is presented in the following table.

Table 1 - MNRA Function Units Involved in Processing Land Transactions

Section	Function
Land Registration Section	Comprises the Land Registry Unit and Land Titles Unit that process and record title and related instruments and transactions for Declared and Undeclared lands respectively.
National Estate Section	The National Estate Section (NES), which is headed by the National Estate Officer (NEO), forwards Government files to the Registry for the registration of national lands which fall within the declared compulsory registration sections.
Revenue Section	The Revenue (Tax) Section is concerned with collection of land tax over lands in rural areas which fall within the declared compulsory registration sections. The Finance Officer (FO) who, heads the section, endorses that parcels are cleared of taxes for the current tax year. The tax year runs from April 1st through March 31st of each year. A new tax period commences April 1st of each year. After the calculation of stamp duties, registration fees, and late filing fees by the Registry, this section is charged with the collection of the relevant fees
Valuation Section	The Valuation Section, headed by the Chief Valuer, is responsible for validating and/or assessing the prices of parcels and the value of leasehold interest in lands which fall within the declared compulsory registration sections, which are subject to transfers submitted by the Registry
Surveys and Mapping	By virtue of the mutation process, the Surveys and Mapping

Section	Section, which is headed by the Principal Surveyor, updates the interactive map, the electronic system which supersedes the now obsolete registry index maps (RIMs) which are stored at the Registry. The Registry verifies some parcel information through records stored at the Surveys and Mapping Section
Physical Planning Section	Based on survey plans prepared by the Mapping Section, the Land Utilization Authority (LUA), a subsidiary of the Physical Planning Section, which is headed by the Physical Planner, issues provisional approvals to survey land. An approval allows an applicant to hire a surveyor to carry out survey work in accordance with the approved proposed plan and attached conditions. The survey plan precedes the production of an authenticated plan. In order to submit an application for mutation to the Registry, a copy of the final approval and an original authenticated plan (blueprint) must be provided. In order to transfer any parcel through the Registry, a copy of the final approval must be obtained from the LUA. Approvals are not issued for the mutating of national land.
Land Management Programme	The Land Management Programme (LMP), headed by the Project Manager, assumed the Land Registry's responsibility of undertaking the adjudication process. The adjudication process involved thorough investigations. Community consultations and surveys were conducted, tax records checked, and documents collected and verified before registering freehold and leasehold interests. Following this, certificates were issued to proprietors at special ceremonies. Certificates which were not issued at these ceremonies were forwarded to the Registry. These deliverables are now being distributed on a walk-in basis.

The three Sections covered in this write-up include the following:

The **National Estate Section** is responsible for processing all transactions for government owned "National Estate" lands. This includes the issuance and management of lease applications, land purchase, lease transfers, permission to mortgage, and land certificate issuance. These transactions are primarily in regards to areas on the land, but can also pertain to property in the sea in some cases.

The **Registry Section** processes all transactions and title deeds related to "declared" lands. These transactions can include the transfer of land between persons or organizations, transfer of a property lease, or the discharge of an encumbrance.

The **Valuation Section** conducts real estate property and lease valuation on behalf of the government. This is carried out for properties in both declared and undeclared areas of the

Country, to support taxation, government land purchase, sale, or lease, and expropriation of land and private treaty transactions for public benefit.

Note: The Land Laws of Belize are derived mainly from the Common Law and English Statutes of the 19th century. The Law of Property Act, Chapter 190 is similar to the Real Property Act 1925 of England in many ways. Other relevant statutes include the Registered Land Act, Chp 194 (1977). This statute governs all land transactions of Belize. There are mainly two types of Land in Belize. Which are (a) Undeclared Land & (b) Declared Land. Declared lands are those that have been fully adjudicated and for which permanent land title has been issued. Undeclared lands have not been fully adjudicated but tenure may be supported through other instruments. Transactions related to Undeclared Land in Belize are recorded at the Titles Registry. Transfers carried out for Declared Lands are to be registered at the Land registry. The Law of Property Act also allows for acquisition of property to take place in the instance that one has settled on a land for more than 30 years. The Government is in the process of re-registering all freehold lands under the Registered Land Act of 1987 to achieve an eventual uniform system of nationwide land ownership. However this process is very time taking as survey is yet not completed

At present these Sections have the following numbers of staff:

National Estate Section (Belmopan)

Second Class Clerk	2
First Class Clerk	2
Secretary II	2
Reference	1
Lands Inspector	4
Lands Officer I	1
Lands Officer II	1
Senior Lands Officer	1
Assistant Lands Officer	1
Land Information Officer	1
District Lands and Surveys Officer	1

National Estate Section (District Offices)

Cashier	3
Secretary	3
Clerk	9
Office Assistant	2
Lands Inspector	11
Assistant Lands Officer	4
Senior Lands Officer	3
District Lands and Surveys Officer	5

Registry Section

Office Assistant	1
Second Class Clerk	1
Registry Clerk	11
Senior Registry Clerk	1
Assistant Registrar II	2
Assistant Registrar I	1
Deputy Registrar	1
Registrar	1

Valuation Section

Chief Valuer	1
Senior Valuer	1
Lands Inspector	1
Reference	4

The staffs in these Sections are currently responsible for several primary activity areas that have some relevance to GIS and BNSDI including the following:

National Estate Section

1. Administer National Estate Land Leases
2. Administer National Estate Land Purchase

Land Registry Section

3. Process and Record Property Titles and Related Transactions

Valuation Section

4. Conduct Property Valuation

2.2.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.2.2.1 Administer National Estate Land Leases

The Commissioner of Lands is responsible for administering all transactions involving government lands, including grants, purchase and lease. The National Estate section acts on behalf of the Commissioner to review, condition and process all such transactions.

Applications for the lease or purchase of government owned land requires a recommendation from the appropriate elected representative and/or land caretaker. These applications are submitted to the National Estate Section and a case file is created for each in both hardcopy and entered to the ***Landfolio*** system. Among other information, the application requires a sketch map and location description of the proposed property. The Section staff reviews the application and if all in order for undeclared areas they will request a field survey from the MNRA Survey and Mapping Section, and may also conduct their own field investigation. Field investigation includes the capture of at least three GPS coordinates to establish the location of the site. All information and correspondence associated with the case are kept in the case file as well as scanned and entered to Landfolio.

Part of the application review includes evaluation of the context to ensure that the property and proposed use are not in conflict with other matters such as Protected Areas, waterbody setbacks, areas prone to flooding, vehicular access and other issues.

Fully vetted applications are forwarded to the Commissioner of Lands for final approval. Leases are for seven years but can be extended to 30 years. During this period the Section maintains an ongoing record for the property in both the hardcopy files and the Landfolio system.

Areas of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Manage inventory of all National Estate lands
- Log and track all National Estate land lease applications and leases
- Assess land tenure, environmental, infrastructure context of land lease applications
- Provide historical visualization of National Estate land leases

2.2.2.2 Administer National Estate Land Purchase

The process for purchasing national estate land is similar to leasing, however with different requirements and instruments. Typically an existing leaseholder after a certain period of time applies for a permanent title. Doing so requires that all previous lease payments are up to date and that certain investments in property development have been made such as land clearing and farming, house construction, and others. A review process similar to that applied to lease applications may be followed and all information and correspondence is entered to the property case file in both hardcopy and within the Landfolio system.

Areas of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Manage inventory of all National Estate lands
- Log and track all National Estate land sales
- Assess land tenure, environmental, infrastructure context of land sale applications
- Provide historical visualization of National Estate land sales

2.2.2.3 Process and Record Property Titles and Related Transactions

The Land Registry Section of the Lands and Survey Department is comprised of the Land Registry Unit and the Land Titles Unit. The units operate independent of each other, have different procedures in place for effecting their functions and operate under different legislations.

The Land Registry Unit provides a safe haven for records appertaining to land matters executed by the various sections. Operating under the auspices of the Registered Land Act, the Registry is responsible for the registration of land tenure, dealing, and safe-keeping of records of lands situate within the declared compulsory registration sections of Belize. The Registry provides for the unique identification of parcels of land by maintaining registers over each parcel that is privately owned or is being leased, wherein all transactions affecting those parcels are recorded. This allows for access to current information regarding the status of every registered and unregistered parcel situate in these areas. The Strata Titles Registration Act which is appurtenant to the RLA, allows for units resulting from the horizontal or vertical divisions or subdivisions of buildings on a common property, to be registered with freehold title. The dissemination of information and the issuance of instruments, land certificates, and certificates of lease prepared by the unit, as well as the issuance of the Land Management Programme's deliverables, falls under this portfolio. The Land Registry is managed by the Registrar of Lands.

The Land Title unit receives and records transactions in land that fall outside a "Declared Compulsory Registration Section" (under the Registered Land Act). The Section also records documents prepared under the Bills of Sale Act and Minister's Fiats issued under the National Lands Act. The Land Titles Unit has been recording deeds relating to land dating back to the mid 1800-s. The Land Title unit is managed by a Title Officer; other officers include a Land Inspector and two clerks.

The Belize Land Registry of the Land and Surveys Department was officially opened in May, 1978 after the enactment of the Registered Land Ordinance 1977 currently the Registered Land Act. The Registered Land Act was aimed at providing for security of land ownership or tenure and expediting the granting of leases and titles at a low cost. Transfers, accordingly becomes easier, quicker and cheaper. The Registered Land Act also provides for the declaration of compulsory registration areas, registration procedures and prescribed forms and means of dealing in registered land.

There are two types (categories) of Land in Belize. They are: (a) Undeclared Land & (b) Declared Land). The Land Registry operates under the authority of The Registered Land Act (RLA) – Chapter 194 of the Substantive Laws of Belize, Revised Edition 2000. The Strata Titles Registration Act - Chapter 196 of the Substantive Laws of Belize, Revised Edition 2000 and The General Registry Act (GRA) Chapter 327 of the Substantive Laws of Belize Revised Edition, 2000.

Under the RLA, it is responsible for the registration and dealing of all lands situated within the declared compulsory registration areas in the Country. The Strata Titles Registration Act is a follow-up to the RLA and allows for units resulting from the horizontal or vertical divisions or subdivisions of buildings on a common property, to be registered with freehold title. The General Registry Act is responsible for the registration and dealing of all that is not within the compulsory registration areas at the Land Title Unit.

Both the Land Registry Unit and the Land Titles Unit maintain ***Land Registry Case Files (Hardcopy)*** as well as maintain scanned copies of the same information in the Landfolio system.

The Land Registry Section works closely with the Surveys and Mapping Section, which updates the ***Landfolio Maps*** through the mutation system and National Estate Section in the registration of national lands which falls within these registration sections. It is the objective of the Department to eventually bring the whole country under one system i.e. under the RLA to assure more secure land tenure and a more integrated administration system.

The Land Registry guarantees title to registered estates and interests in land. It records the ownership rights of freehold properties, and leasehold properties where the lease has been granted for a term exceeding seven years.

Legally, there are two types of registrable titles being (a) absolute titles and (b) provisional titles. For absolute titles copies of documents showing proof of ownership are submitted or where persons are able to prove long undisturbed possession of their lands and do not possess deeds. Possession goes back 12 years of more. Provisional titles are granted if documents are not produced and if long undisturbed possession cannot be proved. In this case, a note must be made on the register stating the period in which provisional occupation commenced and the condition to which the titles is subject to.

The Land Registry is currently encouraging property owners whose property is not registered to make voluntary applications for registration. Although there are over 225,000 registered properties in Belize, only just over half of the land mass is registered. Much of this land is rural property in the hands of large institutional landowners.

Since December 1978, the Land Register has been open to the public. For a fee anyone can request for a copy of the Register, find out the name and address of the current owner of any registered property or obtain a copy of any registered title. This service will soon be available online.

Areas of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Manage comprehensive inventory of plot boundaries and land titles for both Declared and Undeclared lands;
- Link all property transaction case files to geographic location;

- Provide online access to land ownership information.

2.2.2.4 Conduct Property Valuation

The major functions of the MNRA Valuation Section are to execute land acquisitions, calculate land taxes, calculate purchase price, and determine rental values and the vetting of considerations/land values.[2]

The Section is also responsible for creating new tax account, the same as the National Estate Section and the Land Registry Section and the categorizing of land use. Categorization land implies that lands are grouped into categories, to differentiate its use. Examples of land use categories are beach side properties, agriculture lands, suburban lands and village lot.

Of the many functions of the section, one of the key functions is Land Acquisition. For ease of paramount management of land acquisitions, the section has introduced a ***Land Acquisition Management System (LAMS)***. One of the system's primary function is to record all relevant information such as payments and outstanding balances by the Government of Belize, for Land Acquisition for public purposes according to the Land Acquisition (Public Purposes) Act, Chapter 184 of the Laws of Belize, and Land Acquisition (Promoters) Act Chapter 183 of the Laws of Belize, Revised Edition 2000, secondly; revising the Land Acquisition Index for ease of information and thirdly, updating other records.

The Valuation Section is responsible for determining the purchase price on the sale of national land. It is responsible for the updating of the lands records in order for the Revenue Section to be able to collect its revenue smoothly. When this is not done, it results in the Department loosing revenue, as the cashiers countrywide would not be in a position to collect payment for a record that has not been updated.

The Valuation Section uses different methods and sources of information to conduct its activities. Nationwide property tax valuation is generally conducted every three to five years, at the discretion of the Government. There is no set formula for such valuation, but generally includes the types of property improvements that have been made, the character of the context, property condition, and local comparable sales. Section staffs utilize ***Landfolio*** for recent comparable sales and other cadastral reference information. They may also use available ***Aerial Photography*** or ***Google Maps*** to better understand neighborhood context. Staff have a tool to calculate the approximate area of a building, but often don't have the other supporting information that could be used for a more accurate and defensible valuation. The Section is performing approximately 500 valuations per month and does not have enough staff to physically inspect every building, so access to more detailed and up to date information from other entities through the BNSDI is seen as a very valuable future potential.

[2] http://www.mnra.gov.bz/departments/lands-and-survey/sectionsunits/valuations/what-we-do

Properties within Towns pay property tax to the local City or Town Council. These local bodies have their own valuers, and the valuation methods used are not standardized and valuation information is not shared between the City/Town Councils and the MNRA.

The Valuation Section is also involved in assessing the fair value of lands to be acquired for public benefit. There are set rates adopted by government for urban and rural lands with some additional adjustments to reflect proximity to transportation and other infrastructure and amenities, such as coast, riverbanks and other water bodies. All the standard rates are legislated.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide access to property and property improvement information
- Provide access to environmental, social and infrastructure conditions that may affect property use and value
- Provide access to comparable property sales information
- Provide access to information concerning private lands to be acquired for public purposes
- Provide access to administrative jurisdiction boundaries

2.2.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions:

Landfolio National Estate Property Case Files. Case files for all national estate property lease or purchase cases are maintained within the MNRA Landfolio system. These include all application information including property location maps, surveys, field investigation notes and photographs, correspondence and all other relevant information. All documents in the case files are also maintained in hardcopy folders at the National Estate section office.

National Estate Property Case Files. Hardcopy case files for all national estate property lease or purchase cases are maintained in folders at the MNRA. These include all application information including property location maps, surveys, field investigation notes and photographs, correspondence and all other relevant information. All documents in the case files are also scanned and maintained within the MNRA Landfolio system.

Landfolio Land Registry Case Files. Both the Land Registry Unit and the Land Titles Unit maintain Land Registry Case Files information within the Landfolio system. These include all information related to each registration case including property location maps, surveys, field investigation notes and photographs, correspondence, final title instruments and all other relevant information. All documents in the case files are also maintained in hardcopy folders by the respective Units.

Land Registry Case Files. Both the Land Registry Unit and the Land Titles Unit maintain Land Registry Case Files information in hardcopy folders. These include all information related to each registration case including property location maps, surveys, field investigation notes and photographs, correspondence, final title instruments and all other relevant information. All documents in the case files are also scanned and maintained in the MNRA Landfolio system.

Land Acquisition Management System Database. This database records all relevant information such as payments and outstanding balances by the Government of Belize, for Land Acquisition for public purposes according to the Land Acquisition (Public Purposes) Act, Chapter 184 of the Laws of Belize, and Land Acquisition (Promoters) Act Chapter 183 of the Laws of Belize, Revised Edition 2000, secondly; revising the Land Acquisition Index for ease of information and thirdly, updating other records.

Google Maps Imagery. The MNRA Property Valuations Section utilizes imagery available through Google Maps to understand the general location and context of a property or neighborhood. This interface provides imagery from several different sources including QuickBird from Digital Globe, LANDSAT, INEGI, and others.

2.2.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

Landfolio. Landfolio is an application software suite originally developed by Stewart Global Systems that automates the core elements of land records management providing a complete land information management solution. The software has been built on top of the ESRI GIS platform and MS SQL Server database. This was implemented initially in 2006 and then extended through the third phase of the IDB funded Belize National Land Management Program (LMP), intended to develop a national land policy framework focusing on both private and public sector development through secure land tenure. Land Management Program III involved the expansion of the Land Information System included the expansion of the landfolio solution to the departments of Planning, National Estates, Valuation and Inland Revenue/Cashiering. The system is maintained and supported internally at present by the MNRA IT Department.

Land Acquisition Management System (LAMS). This system is used to record all relevant information such as payments and outstanding balances by the Government of Belize, for Land Acquisition for public purposes according to the Land Acquisition (Public Purposes) Act, Chapter 184 of the Laws of Belize, and Land Acquisition (Promoters) Act Chapter 183 of the Laws of Belize, Revised Edition 2000, secondly; revising the Land Acquisition Index for ease of information and thirdly, updating other records.

2.2.5 Computing Infrastructure

All staff in these Sections have access to a PC and basic Office applications. The staffs are also trained in the use of the Landfolio system. The detailed computing infrastructure configuration is provided in the MNRA – IT Stakeholder Survey write-up.

2.2.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to these Sections:

- Landfolio is being treated as a relatively closed enterprise system. The system contains much information that could be useful for others, and likewise there is much information from other organizations (including within LIC and other parts of the MNRA) that could better support the activities being carried out by Landfolio users. Potential for more interoperability between Landfolio and other systems should be further explored.
- Many hardcopy case files are being maintained redundantly to the digital system in Landfolio. In part this is because there are legal requirements regarding authenticated original documents. Policies and techniques for digital authentication may save much paper and space in the future.

2.3 Lands and Surveys Department – Survey and Mapping Section

Person(s) Interviewed: Wilford L. William, Surveyor, LincolnWillie@yahoo.com
Jose L. Chulin, Surveyor, Jlchulin@gmail.com

Interview Date: June 9, 2014

2.3.1 Organization and Mission

The Survey and Mapping Section is a unit within the MNRA Lands and Surveys Department. The unit is in charge of the review and authentication of maps for both national and private lands, internal support for the land registry and updating of cadastral information for grants and leases, maintain the country's geodetic control network, and provide selected services and products to other agencies and the public as needed.

The Survey and Mapping Section has 13 staff, three of which are surveyors. The Section is responsible for several primary activity areas that have some relevance to GIS and BNSDI, including the following:

1. Authenticate Plans for Both National and Private Lands
2. Support Land Registry Cadastral Updating for Grants and Leases
3. Manage National Geodetic Control Network
4. Provide Survey and Mapping Products and Services to Other Agencies and the Public
5. Updating of the Landfolio information system

2.3.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in coordinating and sharing information with other stakeholders through the Belize NSDI.

2.3.2.1 Authenticate Plans for Both National and Private Lands

The Survey and Mapping Section is responsible for authenticating the survey work conducted by private surveyors on behalf of property owners. Prior to 1995 all the property survey work was conducted by government survey teams that were positioned in all Districts. Since then the policies were changed and now the majority of the work is conducted by licensed private surveyors while the government staffs have been reduced to a minimum. Persons in this Section are responsible to review and validate the submitted information to ensure that it is acceptable and according to standards. The following summarizes the basic process involved, with emphasis on those areas that are most relevant to GIS and the BNDI.

Private licensed surveyors are hired by a landowner to prepare survey maps and associated information as needed for cadastral and other property related transactions. At present there are 28 such licensed surveyors in the Country, all of whom are recorded in a ***Registered Surveyor Database***.

There is an average of about 60 plans per week processed through this office. Information is required to be submitted in a digital CAD form in real world coordinates, utilizing NAD27 projection and wherever possible tied as a closed traverse to the nearest established geodetic control point. It was indicated that the submission format requirements as stipulated in the law are not highly specific and therefore information is received in a variety of forms and often requires a significant amount of additional manual work before it is suitable for entry to the Landfolio system. A GIS ***Geodetic Survey Control Points Database*** is managed the Survey and Mapping Section and provided to surveyors and others upon request. Once a proposed subdivision is tentatively approved through the MNRA or the Land Utilization Authority, the information is submitted to the Survey and Mapping section for review and validation of the survey information.

Once received, the Section staff reviews the information to ensure it is complete and according to submission standards. The unit staff prepares a case file and reviews each plan according to a standard checklist. The ***Survey Authentication Case File*** is prepared initially in manual form to accommodate legal requirements for original signatures and related matters. Once the submission has been verified complete, it is assigned a job entry number and a

register number. The job number sequential and is used for internal tracking (as of the date of this writing there had been 15,900 jobs), and the register number identifies the licensed surveyor who has prepared the plan.

In addition to maintaining the information in the hardcopy case file, the information is also scanned and entered to the ***Landfolio*** system for quicker access and retrieval and records management. ***Proposed Parcel Boundary*** information in CAD format is part of this submission and is uploaded to the Landfolio system. It was mentioned that this information is not generally accessible to other GIS users at MNRA outside of the Landfolio system. It was also mentioned by staff within this Section that they would like to access other MNRA GIS information beyond what was accessible currently through the system. A cursory exploration of the issue with MNRA technical staff suggests that the existing system should be configurable to include additional layers, but this will need to be confirmed.

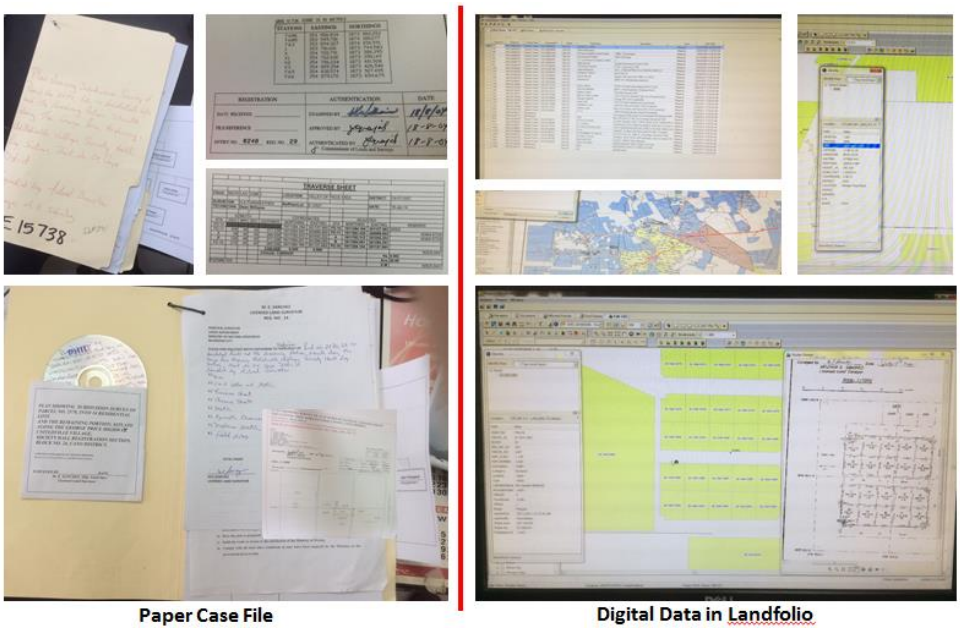

Figure 3 - Survey Authentication Information Before and After Automation

Elements of the checklist that are most relevant for GIS/BNSDI include:

- Job number;
- Surveyor and date submitted;
- Survey requested by name;
- Application to Combine/Subdivide Parcels of Land (if in Declared area);
- Letter of approval for subdivision (from appropriate local authority such as Municipal Council, etc.);
- Map scale and scale bar;
- Plotting (of grid lines);
- Distance and bearing for each boundary;
- Authentication box, standard notations and symbols;
- Boundaries of all waterways in the vicinity;
- Tie-in survey traverse information;

- All rights-of-way, easements and road reserve locations and widths;
- Geographic coordinates for centre of survey;

In some cases the reviewer will visit the site to confirm conditions and survey information presented. In such cases the reviewer will make their own field notes and this information is added to the case file.

While all the pertinent information is being entered to the Landfolio system, staff are still maintaining a parallel record of all background information and transactions in manual form, including both the before mentioned case files as well as ***Manual Survey Authentication Job Registry*** as well as a full set of ***Hardcopy Parcel Maps***. Staff indicated that this is partially due to legal requirements for maintaining certain signed or stamped original documents and to use the historical information as a reliable reference and backup.

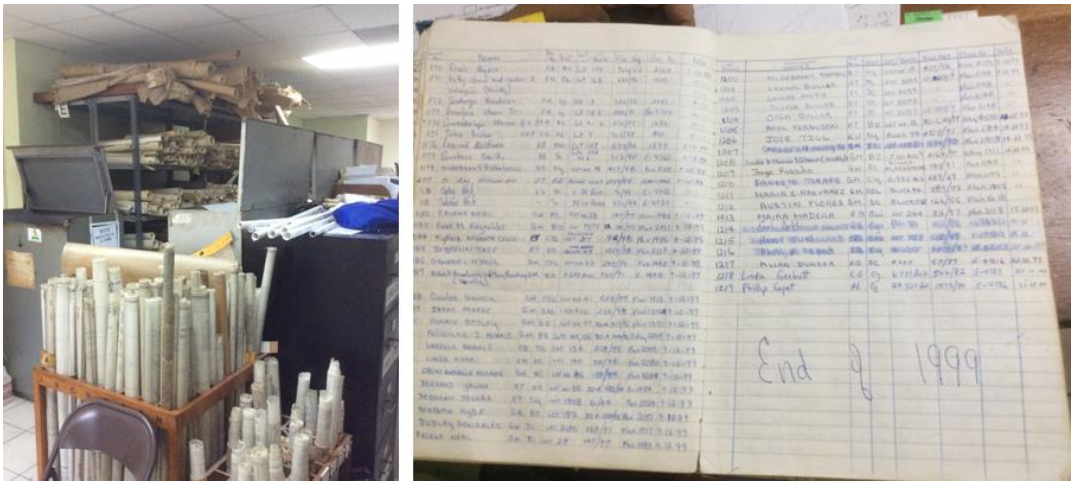

Figure 4 - Hardcopy Historical Parcel Survey Information

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Log, store and manage land survey project data
- Maintain geographically-linked database of all licensed land surveyors
- Provide tools for capturing and managing field survey information
- Provide means to visualize historical land survey activities over time

2.3.2.2 Support Land Registry Cadastral Updating for Grants and Leases

This section also supports the processing of boundary survey information for land grants and leases within National lands. In these cases the government is involved in granting or leasing land to members of the public and therefore must directly survey the land in question as part of its due diligence practice. This service may be carried out directly by the Survey and Mapping Section or by private licensed surveyors under their direction. Completed and verified ***Land Grant and Lease Surveys*** are then forwarded to the Land Registration Section for further processing.

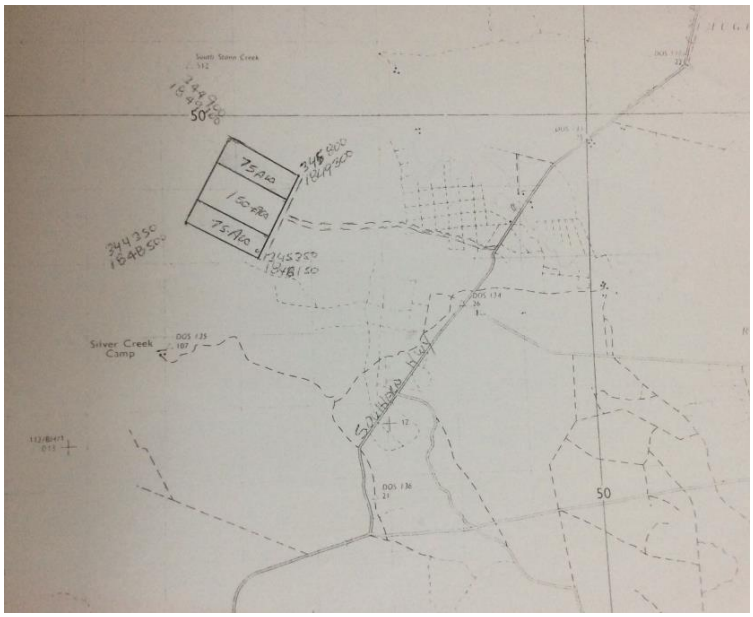

Figure 5 - Land Grant Property Location Field Notes

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Manage comprehensive land registry database for all grants and leases
- Provide tools for capture of land survey data
- Provide access to imagery and basemap information to support land survey efforts
- Geographically link land survey activity case files

2.3.2.3 Manage National Geodetic Control Network

The ***National Geodetic Control Network*** for Belize was originally established in the 1960's. At that time the Government of Belize maintained a full survey crew for the management of all survey works in the Country, including the management and continued maintenance and densification of the survey control network. The network was resurveyed in 1996 by a contractor, in advance of the Land Management Project (LMP), a multi-year, multi-phase program to modernize land management in the Country.

Today, records concerning the geodetic control network are maintained in both hardcopy and digital form. Paper records indicate the location and description of control point monuments, most of which are near highways and major works. Point coordinates have also been entered to the GIS and these are displayable along with the identification number and other basic information concerning each point.

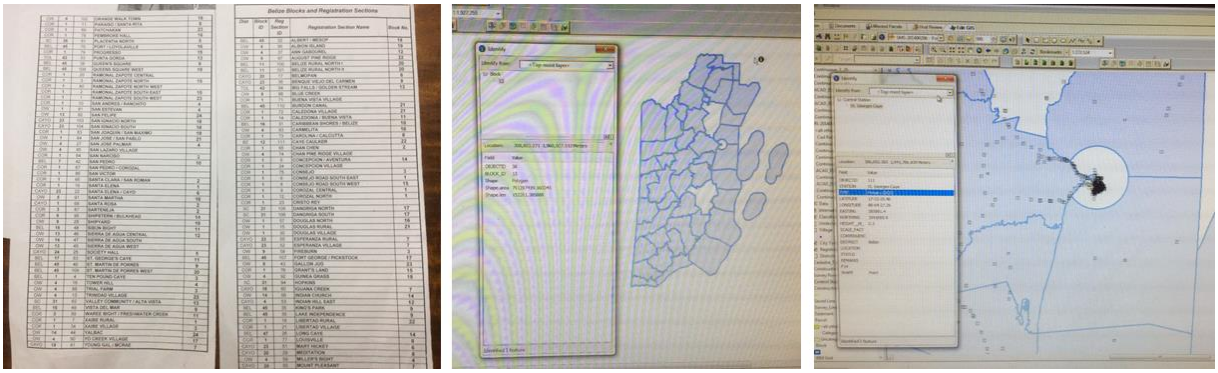

Figure 6 - Survey Blocks and Points

At present the Survey Unit has two staff that systematically maintain existing control points and occasionally adding new points for network densification. They are also replacing lost geodetic control network monuments where these are known, but it was indicated that many have been permanently lost. With the advent of highly accurate GPS technology the need for such monuments is becoming less. In addition, today's Continuously Operating Reference Station (CORS) and Real-Time Kinematic (RTK) technology provides centimeter-level accuracy. While Belize has not yet established its own CORS/RTK system, some surveyors are utilizing those available in surrounding countries. In addition, the Geology Unit now within the Ministry of Energy, Science & Technology and Public Utilities (MoESTPU) has installed a differential GPS station on the roof of the MNRA headquarters building in Belmopan and utilizes its own base station for differential correction of GPS coordinates it is collecting. The law currently requires every cadastral survey to be tied to a major or minor geodetic control point. With the advent of new survey and location finding technologies it may become necessary to update the law to reflect new realities.

The Survey Unit staff utilize Nikon brand Total Station technology for conducting their survey work.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Manage national geodetic network data
- Provide national survey services through CORS/RTK system

2.3.2.4 Provide Survey and Mapping Products and Services to Other Agencies and the Public

Although short-staffed, the Survey and Mapping section does get involved in providing selected services to other agencies and the public. Many of these requests involve establishing a coordinate location for a property or facility or production of maps in both hardcopy and digital form. In the case of coordinate location services the Section responds to such requests on a case-by-case basis. Likewise, the Section produces map products from their records to support specific requests.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide GIS and survey services to other agencies and the public
- Manage survey project data
- Produce and disseminate survey related information upon request

2.3.3 Data Used or Generated

Survey Authentication Case Files. The MNRA Lands Department, Survey and Mapping Section prepares Survey Authentication Case Files in manual form to accommodate legal requirements for original signatures and related matters. Once the submission has been verified complete, it is assigned a job number and an entry number. The job number sequential and is used for internal tracking while the entry number is the plan number (as of the date of this writing there had been 15,900 jobs), and the register number identifies the licensed surveyor who has prepared the plan. Most of this information is subsequently entered to the Landfolio system as digital data.

Registered Surveyor Database. Private licensed surveyors are hired by a landowner to prepare survey maps and associated information as needed for cadastral and other property related transactions. At present there are 28 such licensed surveyors in the Country, all of whom are recorded in a Registered Surveyor Database in MS Excel.

Landfolio Property Database. The MNRA Lands Department, Survey and Mapping Section prepares Survey Authentication Case Files in manual form that are subsequently added to the Landfolio property database, including confirmed plot boundaries in GIS form as well as scanned documents and communications associated with each case.

Proposed Parcel Boundary Files. The MNRA requires the submission of boundaries for proposed subdivisions in digital form and in real world coordinates. These are authenticated by the Lands Department, Survey and Mapping unit as part of the cadastral boundary transaction process.

Manual Survey Authentication Job Registry. The MNRA Lands Department, Survey and Mapping Section prepares Survey Authentication Case Files in manual form that are subsequently added to the Landfolio property database. Staff continue to maintain the manual Authentication Job Registry which records all transactions back to the early 90's.

Hardcopy Parcel Maps. The MNRA Lands Department, Survey and Mapping Section maintains hardcopy parcel maps for historical reference and as a backup to the Landfolio digital system that has been implemented.

Land Grant and Lease Surveys. The MNRA Lands Department, Survey and Mapping Section supports the processing of boundary survey information for land grants and leases

within National lands. In these cases the government is involved in granting or leasing land to members of the public and therefore must directly survey the land in question as part of its due diligence practice. This service may be carried out directly by the Survey and Mapping Section or by private licensed surveyors under their direction.

National Geodetic Control Network (digital). The MNRA Lands Department, Survey and Mapping Section maintains a GIS point file indicating the location, identification number and other basic information concerning each point.

2.3.4 Existing Systems

Landfolio. Landfolio is an application software suite originally developed by Stewart Global Systems that automates the core elements of land records management providing a complete land information management solution. The software has been built on top of the ESRI GIS platform and MS SQL Server database. This was implemented initially in 2006 and then extended through the third phase of the IDB funded Belize National Land Management Program (LMP), intended to develop a national land policy framework focusing on both private and public sector development through secure land tenure. Land Management Program III involved the expansion of the Land Information System included the expansion of the land folio solution to the departments of Planning, National Estates, Valuation and Inland Revenue/Cashiering. The Landfolio system is maintained and supported internally at present by the MNRA IT Department.

CORS/RTK. Continuously Operating Reference Station (CORS) and Real-Time Kinematic (RTK) technology provides centimeter-level accuracy. While Belize has not yet established its own CORS/RTK system, some surveyors are utilizing those available in surrounding countries.

Nikon Total Station. A total station is an electronic/optical instrument used in modern surveying and building construction. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to read slope distances from the instrument to a particular point. The MNRA Lands Department, Survey and Mapping Section utilizes a Nikon brand Total Station for conducting its survey works.

2.3.5 Computing Infrastructure

All staff in this Unit has access to a PC and basic Office applications. Several are trained in the use of the Landfolio system and rudimentary use of the GIS. The detailed computing infrastructure configuration is provided in the MNRA – IT Stakeholder Survey write-up.

2.3.6 Other Issues, Opportunities and Constraints

- The development and management of a permanent Continuously Operating Reference Station (CORS) by the Government of Belize could provide a valuable service

resulting in more accurate geospatial coordinate collection by government agencies and the private sector.

- Increased access to land cadaster data by other agencies and the public would save both the government and the public much time and money.

- More periodic training is required for Survey and Mapping Section staff to be able to maintain their skillsets current to technological advances and trends.

- Surveying equipment needs to be upgraded more often to take advantage of new advances. Especially GPS equipment – Rovers to be used in conjunction with the CORS site for sub-meter and centimeter accuracy

- Need to establish better standards for exchanging information with the private sector especially in regards to plot boundaries and related information submitted by licensed surveyors. This will require direct engagement with the Surveyor's Board as the current Land Surveyor Act and related policies are not specific in this regard.

- There is presently no surveying or Geomatics education program in Belize. The Government of Belize used to send students abroad for such training but that is now highly limited. This is seen as a limiting factor for improving the quality of survey services in the Country.

2.4 Lands and Surveys Department – Land Information Center

Person(s) Interviewed: Carren Williams, Principal Land Information Officer
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Elam Torres, Land Information Officer elamtorres@yahoo.com
Alfred Cal, Land Information Officer cal_alfred@yahoo.com
Kevin Gutierrez, Planning Technician
kevingutierrez49@gmail.com
Ender Jimenez, Land Information Technician
eliezer200898@hotmail.com
Rafael Lima, Statistical Officer chaflima@yahoo.com

Interview Date: June 18, 2014

2.4.1 Organization and Mission

The Land Information Centre (LIC) within the Ministry of Natural Resources (MNRA), Lands and Surveys Department is responsible for the development and dissemination of geospatial land information, products and services within the MNRA, other agencies and the public.

The Land Information Centre (LIC) was established in 1992 with the overall vision to improve integrated resource management in Belize by providing an organized and reliable geospatial information, services and a regulating and access framework for policy and decision making. In April 2005, Environmental Statistics Unit (ESU) became part of the LIC contributing to the further development of the Centre. Today the LIC has 6 permanent staff, but also hosts a number of student interns and staff from other agencies on a regular basis.

The LIC is currently responsible for several primary activity areas that have particular relevance to GIS and BNSDI including the following:

1. Develop and Disseminate GIS Data
2. Publish Environmental Statistics
3. Support Data Custodianship On Behalf of Other Organizations
4. Support Capacity Building
5. Provide Ad Hoc Technical Services
6. Facilitate the Belize NSDI

2.4.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.4.2.1 Develop and Disseminate GIS Data

The LIC is responsible for the development and dissemination of a broad variety of digital GIS data that they have developed and maintain across the Country. Major themes that the LIC manages include the following:

- Baseline Map (roads, rivers, villages, etc.);
- Cadastral Maps for towns, cities and major villages;
- Protected Areas Map;
- Land Use Map;
- Natural Vegetation Map;
- Agricultural Values Map;
- Flood Risk Map;
- Land System Map;
- Watershed Map;
- Special Development Areas Map;
- Soil Map;
- Mangrove Map;
- Topographic Map;
- Hurricane Tracking Map;

- Registration Section Map;
- Electoral Division Map;
- Poverty Map;
- San Pedro Vulnerability Assessment Map
- Satellite Imagery (Landsat, Ikonos, Aster);
- Other client specific maps

Many of the original GIS databases developed by the LIC were digitized from the 1:50K hardcopy Ordnance Survey topographic basemaps around 1997. These layers are being updated periodically as needed to support specific projects or as resources are available.

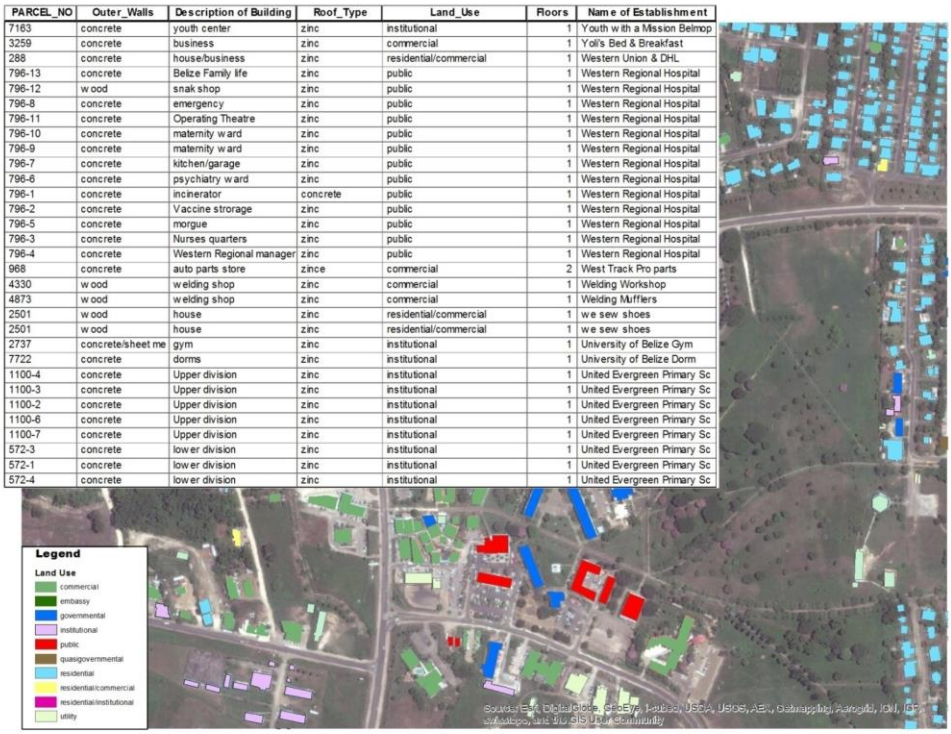
The LIC has periodically undertaken efforts to develop new databases that are perceived to be of general utility to multiple organizations. Requests for new data development may come from the Ministry executives, external organizations, the public, or may be identified by LIC staff themselves.

For example, the LIC has been working with several other agencies to develop a map database depicting built-up areas across the Country. The effort was initiated by several organizations involved in working together through the National Emergency Management Organization (NEMO) in consideration of disaster risk reduction and damage assessment requirements. Participants have included:

- Central Building Authority (CBA);
- Sustainable Tourism Program;
- Statistics Institute Belize (SIB);
- Belize Electric Ltd. (BEL);
- Belize Natural Energy Ltd. (BNE);
- San Ignacio and Santa Elena Town Council (SISE);
- Land Information Centre, Ministry of Natural Resources and Agriculture (LIC/MNRA);
- Biodiversity and Environmental Resource Data System of Belize (BERDS);
- National Emergency Management Organization (NEMO);
- Ministry of Local Government and Rural Development (MLGRD);
- Ministry of Health (MoH);
- National Association of Village Councils Organization (NAVCO);
- Coastal Zone Management Authority and Institute (CZMAI).

This effort includes both the delineation of built-up area boundaries for towns, villages and settlements as well as building footprint boundaries for every significant structure nation-wide. The requirements for the development of this database were defined by the participants. Built-up area and building footprint information is being developed based on the best available imagery and supporting collateral information for each area which ranges from detailed orthophotography for Belize City conducted in 2012 (? 18cm resolution) to QuickBird (Digital Globe) high resolution satellite data (~60cm resolution) for much of the

remainder of the Country that was accessible through Bing Maps and Google Earth. It was recognized that utilizing multiple sources would result in a database of variable accuracy. It was seen as preferable to develop this database to support current requirements and activities. In the future when more accurate boundaries are required, procedures can be applied to "conflate" attribute information to a more precise geometry.



PARCEL_NO	Outer_Walls	Description of Building	Roof_Type	Land_Use	Floors	Name of Establishment
7163	concrete	youth center	zinc	institutional	1	Youth with a Mission Belmop
3259	concrete	business	zinc	commercial	1	Yoli's Bed & Breakfast
288	concrete	house/business	zinc	residential/commercial	1	Western Union & DHL
796-13	concrete	Belize Family life	zinc	public	1	Western Regional Hospital
796-12	wood	snak shop	zinc	public	1	Western Regional Hospital
796-8	concrete	emergency	zinc	public	1	Western Regional Hospital
796-11	concrete	Operating Theatre	zinc	public	1	Western Regional Hospital
796-10	concrete	maternity ward	zinc	public	1	Western Regional Hospital
796-9	concrete	maternity ward	zinc	public	1	Western Regional Hospital
796-7	concrete	kitchen/garage	zinc	public	1	Western Regional Hospital
796-6	concrete	psychiatry ward	zinc	public	1	Western Regional Hospital
796-1	concrete	incinerator	concrete	public	1	Western Regional Hospital
796-2	concrete	Vaccine strorage	zinc	public	1	Western Regional Hospital
796-5	concrete	morgue	zinc	public	1	Western Regional Hospital
796-3	concrete	Nurses quarters	zinc	public	1	Western Regional Hospital
796-4	concrete	Western Regional manager	zinc	public	1	Western Regional Hospital
968	concrete	auto parts store	zince	commercial	2	West Track Pro parts
4330	wood	welding shop	zinc	commercial	1	Welding Workshop
4873	wood	welding shop	zinc	commercial	1	Welding Mufflers
2501	wood	house	zinc	residential/commercial	1	we sew shoes
2501	wood	house	zinc	residential/commercial	1	we sew shoes
2737	concrete/sheet me	gym	zinc	institutional	1	University of Belize Gym
7722	concrete	dorms	zinc	institutional	1	University of Belize Dorm
1100-4	concrete	Upper division	zinc	institutional	1	United Evergreen Primary Sc
1100-3	concrete	Upper division	zinc	institutional	1	United Evergreen Primary Sc
1100-2	concrete	Upper division	zinc	institutional	1	United Evergreen Primary Sc
1100-6	concrete	Upper division	zinc	institutional	1	United Evergreen Primary Sc
1100-7	concrete	Upper division	zinc	institutional	1	United Evergreen Primary Sc
572-3	concrete	lower division	zinc	institutional	1	United Evergreen Primary Sc
572-1	concrete	lower division	zinc	institutional	1	United Evergreen Primary Sc
572-4	concrete	lower division	zinc	institutional	1	United Evergreen Primary Sc

Figure 7 - Building Footprint Boundaries and Information

Field work is then conducted to confirm the boundaries on the ground and to add information regarding each building, including a photo and selected attributes including:

- Type of walls
- # of floors
- Roof type
- Land Use
- Name of building/establishment
- Description

Figure 8 - Structure Photo and Land Use Categories

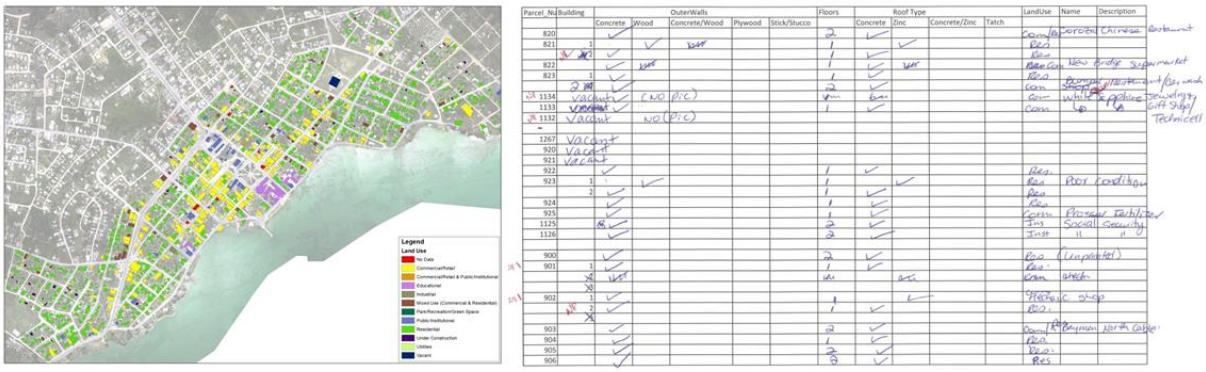


Figure 9 - Field Notes Key Entered with Building Footprints

As the date of this writing, over 23,000 buildings had been digitized in Corozal Town, Orange Walk, Benque, Punta Gorda, and Dangriga. It is expected that this database will be completed in either late 2014 or early 2015, assuming continued resource availability. Methods by which this information will be kept up to date in the future are under discussion but not yet set.

In addition to the building footprints, three organizations (LIC, BERDS and SIB) collaborated to initiate a process for developing built-up area polygons. Out of 198 official villages in Belize, only one (Santa Clara) has an established boundary. The purpose in developing a database depicting built-up areas as a land use was to provide a way to understand the location and extent of these areas and as a basis for compiling and summarizing community level statistical information. Discussions are now underway to expand this database to work with NAVCO, the MLGRD to provide more definitions of Village, Communities and Settlements, to confirm and finalize all place names according to MLGRD standards, and to update Village points and Populated Area boundaries with additional information provided by the participating organizations.

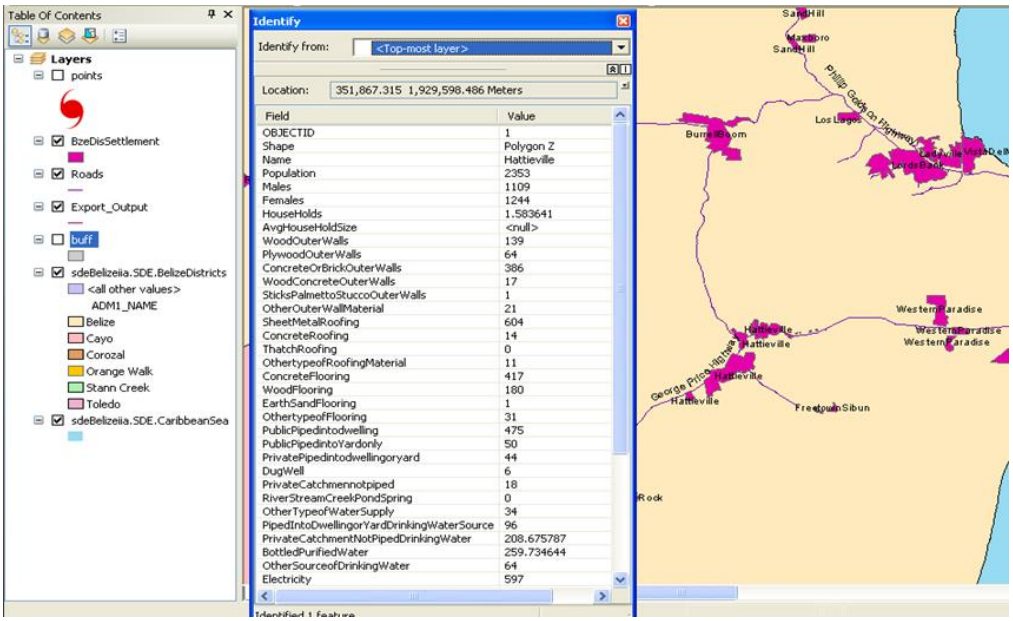


Figure 10 - Built Up Areas and Statistical Information

The LIC is utilizing ArcGIS version 10 from ESRI as its primary GIS software, and AutoCAD for managing CAD drawings and some GIS layers.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide tools for capture, management, analysis, display and dissemination of geospatial data
- Scan and geo-register paper maps
- Conduct field data collection (GPS coordinates, photos, tabular data, etc.)
- Acquire and manage satellite imagery and aerial photography
- Apply analytical processes to created derived data from original sources
- Log and manage geospatial data and service requests
- Publish geospatial data online for viewing or downloading
- Manage secure access to and use of geospatial data
- Develop geostatistical analysis map and report outputs

2.4.2.2 Publish Environmental Statistics

Since 2005 the LIC has been charged with the compilation and publishing of environmental statistical information for Belize. These statistics are now updated every three years. Statistical information is compiled from multiple other organizations through a standardized form. Data received are reviewed by LIC staff and accepted as authoritative unless large gaps or other anomalies are noticed, in which case further inquiry is made with the source organization. In addition to publishing the environmental statistics report the LIC also passes selected statistics along to the SIB.

Standard information reports that are presently distributed by the LIC include:

- "GEO Belize Report 2010", hardcopy & digital
- "Our Environment In Figures 2006" hardcopy & digital
- "Environmental Statistics For Belize 2004", hardcopy & digital
- "Environmental Statistics For Belize 2001", digital
- "Environmental Statistics For Belize 2000", digital

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide access to broad range of environmental and other relevant data
- Provide tools for geostatistical analysis, map visualization and statistical report and graphic generation
- Provide online access to environmental statistics and dashboards

2.4.2.3 Maintain Data On Behalf of Other Organizations

While the LIC has the formalized responsibility to manage and update geospatial datasets that are specific to the mandate of the MNRA, it also routinely assists other organizations in maintaining data that is their logical responsibility. In the past this included Protected Areas, Forestry and Agriculture. It is now being recognized that it is important that each organization within the Government develops its own capacity and assumes responsibility and accountability for maintaining the information that they are the logical custodian for.

One constraint that presently exists is that for many data layers there is no official custodian. This is noted as one very important issue to be addressed by the BNSDI.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide GIS services in support of other agencies
- Log and track geospatial service activities
- Manage geospatial data repository information for others
- Manage online map data and application services delivery
- Manage metadata catalog

2.4.2.4 Support Capacity Building

The LIC has been involved in assisting other organizations and students in developing their own GIS capacity. This has primarily been through on-the-job training as there is no formal GIS capacity building program in place at present.

The LIC maintains an "open door policy" in regards to staff from other agencies that would like to work temporarily within the LIC facility and to take advantage of the technical resources and staff support that are available there. Unlike more formal support and product requests these activities are not being tracked. There is recognition that there is a need for

more rigorous training and capacity building in the Country and that this might be a viable future service offering by the LIC, but this issue has not yet been fully explored.

The LIC also sponsors internships for interested students. These are primarily tertiary (Bachelor's) level student who would like to learn more about GIS and to gain some hands-on experience. There are typically 2-3 interns present at the LIC over any given period.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

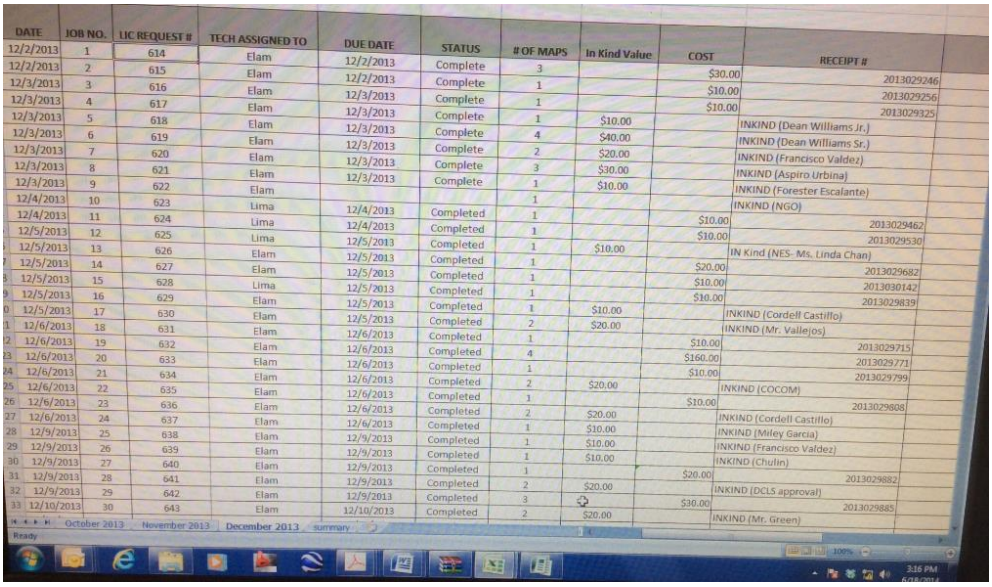
- Provide access to broad range of data for peers from other agencies, student and intern use
- Provide access to geospatial infrastructure, tools and professionals to support training efforts
- Provide technical support to peers from other agencies

2.4.2.5 Provide Ad Hoc Technical Services

The LIC provides technical services to support other agencies or the public on an as-needed basis. These include:

- Geographic Information Systems (GIS);
- Image processing & analysis;
- Environmental Information Management.

Requests can range from very simple requests for an existing map to complicated spatial analysis projects. Simple requests are accommodated without a charge, however efforts that require more staff time and resources are charged according to standard rates. Requests and status information are maintained in an ***LIC Service Requests Database*** in MS Excel. There are an average of XX requests per year that are registered in this database. The LIC charges for special services, and these amount to an average of approximately $XXXX per year. There is no specific rates structure for such services and the real cost of providing such services has not been systematically analyzed, and staff indicated this as something to be addressed in the future. The Center also charges for provision of some data. The revenue for data sales is currently less than what the Center pays for GIS licenses (approximately $50K per year).



DATE	JOB NO.	LIC REQUEST #	TECH ASSIGNED TO	DUE DATE	STATUS	# OF MAPS	In Kind Value	COST	RECEIPT #
12/2/2013	1	614	Elam	12/2/2013	Complete	3		$30.00	2013029246
12/2/2013	2	615	Elam	12/2/2013	Complete	1		$10.00	2013029256
12/3/2013	3	616	Elam	12/3/2013	Complete	1		$10.00	2013029325
12/3/2013	4	617	Elam	12/3/2013	Complete	1	$10.00		INKIND (Dean Williams Jr.)
12/3/2013	5	618	Elam	12/3/2013	Complete	4	$40.00		INKIND (Dean Williams Sr.)
12/3/2013	6	619	Elam	12/3/2013	Complete	2	$20.00		INKIND (Francisco Valdez)
12/3/2013	7	620	Elam	12/3/2013	Complete	3	$30.00		INKIND (Aspiro Urbina)
12/3/2013	8	621	Elam	12/3/2013	Complete	1	$10.00		INKIND (Forester Escalante)
12/3/2013	9	622	Elam			1			INKIND (NGO)
12/4/2013	10	623	Lima	12/4/2013	Completed	1		$10.00	2013029462
12/4/2013	11	624	Lima	12/4/2013	Completed	1		$10.00	2013029530
12/5/2013	12	625	Lima	12/5/2013	Completed	1	$10.00		IN Kind (NES- Ms. Linda Chan)
12/5/2013	13	626	Elam	12/5/2013	Completed	1		$20.00	2013029682
12/5/2013	14	627	Elam	12/5/2013	Completed	1		$10.00	2013030142
12/5/2013	15	628	Lima	12/5/2013	Completed	1		$10.00	2013029839
12/5/2013	16	629	Elam	12/5/2013	Completed	1	$10.00		INKIND (Cordell Castillo)
12/5/2013	17	630	Elam	12/5/2013	Completed	2	$20.00		INKIND (Mr. Vallejos)
12/6/2013	18	631	Elam	12/6/2013	Completed	1		$10.00	2013029715
12/6/2013	19	632	Elam	12/6/2013	Completed	4		$160.00	2013029771
12/6/2013	20	633	Elam	12/6/2013	Completed	1		$10.00	2013029799
12/6/2013	21	634	Elam	12/6/2013	Completed	2	$20.00		INKIND (COCOM)
12/6/2013	22	635	Elam	12/6/2013	Completed	1		$10.00	2013029808
12/6/2013	23	636	Elam	12/6/2013	Completed	2	$20.00		INKIND (Cordell Castillo)
12/6/2013	24	637	Elam	12/6/2013	Completed	1	$10.00		INKIND (Miley Garcia)
12/9/2013	25	638	Elam	12/9/2013	Completed	1	$10.00		INKIND (Francisco Valdez)
12/9/2013	26	639	Elam	12/9/2013	Completed	1	$10.00		INKIND (Chulin)
12/9/2013	27	640	Elam	12/9/2013	Completed	1		$20.00	2013029882
12/9/2013	28	641	Elam	12/9/2013	Completed	2	$20.00		INKIND (DCLS approval)
12/9/2013	29	642	Elam	12/9/2013	Completed	3		$30.00	2013029885
12/10/2013	30	643	Elam	12/10/2013	Completed	2	$20.00		INKIND (Mr. Green)

Figure 11 - Service Tracking Database

The LIC generates monthly reports regarding requested services.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide infrastructure for the provision of geospatial services
- Establish and maintain technical staff skillsets in step with new developments
- Log and track service requests
- Provide access to broad range of data from across government to support service requests
- Provide software tools to support broad range of analytical and visualization capabilities
- Provide products and services online
- Develop and disseminate standardized products
- Develop derived data through the manipulation and analysis of original source information
- Raise awareness through the creation of specialized products for high visibility subjects
- Develop standard products and services for public use

2.4.2.6 Facilitate Belize NSDI

Although there is no official assignment of responsibility to the MNRA to facilitate the BNSDI programme, the LIC has in fact taken a lead role in its formation. The current policy that was passed by the Cabinet in August 2012 is not specific in its assignment of responsibility, but states that "The focal Ministry leading the development of Belize's NSDI is

the Ministry responsible for Lands in collaboration with Five (5) NSDI Working Committees and various local and regional agencies".[3]

The five (5) NSDI Working Committees composed of the most technically competent spatial data practitioners in the country are as follows:

1. ***Data Quality and Data Standards*** – is the Working Committee set up to establish standards and norms for spatial data;
2. ***Data Ownership and Security Issues*** – is the Working Committee set up to ensure that ownership of data is secured and sensitive data layers are not compromised, while at the same time ensuring that equitable access to spatial data is provided;
3. ***Network Assets and System Architecture*** – is a very technical Working Committee set up to ensure that the NSDI network components are in place (hardware, software etc.)
4. ***Maintenance and Oversight*** – this Working Committee is established to ensure that best practices are followed in the development of Belize's NSDI to make certain that it is sustainable and will address issues such as the equitable sharing of expenses for the up-keep of the NSDI.
5. ***Executive Committee*** – this is a key Working Committee in ensuring that the entire NSDI process is sustained and successful. It is made up of the Chairperson and Vice-Chairperson of each of the above Working Committees (these were newly elected at the 6th October, 2011 Working Group Workshop held in Belmopan), spatial data experts, and the head of the Land Information Center (LIC). This Work Group was also formed to address the issue of inadequate communication, which was highlighted as the major factor in the discontinuation of the process back in July 2009 after the 1st NSDI Conference. This Group will also address the issue of financing for the NSDI, which was identified as the second major challenge. The above Working Committees have been established to develop Belize's NSDI. The policies and protocols that these Work Groups are responsible for developing will also directly contribute to its sustainability by putting in place policies for equitable cost-sharing for the long-term implementation of the NSDI.

Detailed terms of reference (TOR's) were developed for each of the above-mentioned Committees. However these TOR's have not been carried through due to lack of staff time to do so and nobody specifically assigned and provided the adequate resources or dedication of time require to follow up on these matters effectively.

In 2014 the LIC did receive a nominal budget to support BNSDI-specific activities, although the scope of those activities has not yet been defined. It should be noted that this is the first time that such budget specifically for BNSDI has been established in any organization across the Government of Belize.

[3] Belize National Spatial Data Infrastructure Policy, Cabinet-Confidential Memorandum No. 40 of 2012, Approved at meeting of Cabinet held 21st August, 2012.

The LIC did take the first steps in the establishment of a ***GeoNode*** geoportal, a web-based open-source application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI). It is designed to be extended and modified, and can be integrated into existing platforms. At the time of this writing, there were over 20 layers of GIS data available through the GeoNode, including the following:

- 1996 Forest Cover;
- 1992 Land Use;
- 1995 Natural Vegetation;
- Ambergris Caye Shoreline;
- Ambergris Caye Waterbodies;
- Belize Agricultural Values;
- Belize Airstrips;
- Belize City Town Boundaries;
- Belize Coastline;
- Belize Districts;
- Belize Education Centers;
- Belize Electoral Constituencies;
- Belize Flood Risk;
- Belize Protected Areas;
- Belize Registration Section;
- Belize Rivers;
- Belize Roads Coverage;
- Belize Survey Controls;
- Belize Cayes;
- Belize City Streets;
- Coastal Reserve;
- Population Estimates 2012;
- Special Development Areas.

All the layers currently available on the GeoNode are those that have been published there by the MNRA LIC. It is intended that others will publish other layers in the near future.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Establish and manage common GeoPortal node
- Develop and maintain common geospatial metadata catalog
- Maintain data repository
- Facilitate working groups for development and management of common standards
- Facilitate the development of common data sharing agreements
- Facilitate coordination of commonly needed geospatial data sets with custodians and user stakeholders
- Develop and manage BNSDI policies

- Coordinate project formulation support activities with Ministry of Finance and other project stakeholders

2.4.3 Data Used or Generated

The MNRA LIC presently maintains a repository of primary datasets that it maintains and distributed on a regular basis, inclusive of those listed in the following table:

Table 2 – List of Primary LIC Datasets

DATASET NAME	*DATE*	*SCALE*	*SOURCE*
TOPOGRAPHY/BASELINE:- • Belize Boundary • Administrative Boundary • International Boundary • Offshore Cays • Roads • Town/City Boundary • Villages/Settlements • Hypsometric Layers • Contours (20 Meter Interval) • Slopes	1992 1992 2000 1992 1992-2000 1990 2008 2000 2000 2000	50,000 50,000 50,000 250,000 50,000 50,000 10,000 350,000 350,000 350,000	• Topographic Sheets (DOS) • Topographic Sheets (DOS) • PAIGH/Topographic Sheets (DOS) • Belize Map (DOS) • Topographic Sheet (DOS)/LandSat • Statutory Instruments/LIC • LIC/Rural Development • SRTM Digital Elevation Model (NASA) • SRTM Digital Elevation Model (NASA) • SRTM Digital Elevation Model (NASA)
HYDROLOGY:- • Flood Risk • Waterways (Rivers/Creeks/Streams) • Water Bodies (Inland and Offshore Lagoons) • Watershed	1992 1992 1992 1992	250,000 50,000 50,000 250,000	• Belize Topical Forest Studies (King Et Al) • Topographic Sheets (DOS) • Topographic Sheets(DOS) • Belize Topical Forest Studies (King Et Al)
PROTECTED AREA:- • Protected Areas • Spawning Site/ Aggregation Sites • Mayan Sites • World Heritage Sites • Bird Sanctuaries • Reef	1992 - 2010 2000 - 2010 2008 1996 1992-2008 2000	50,000 50,000 50,000 50,000 50,000 100,000	• Forest Dept/Min of Agric & Fisheries/LIC • Min of Agric $ Fisheries/LIC • NICH • UNESCO/CZMAI/Min of Agric & Fisheries • Forest Department • CZMAI
LAND SYSTEMS:- • Agricultural Potential • Crop Suitability • Soils Map	1992 1992 1959	100,000 100,000 100,000	• King Et Al/NRI • King Et Al/NRI • Charles Wright et al
LAND USE/LAND COVER:- • Deforestation Cover • Land Use/Land Cover • Natural Vegetation • Land Cover (Central Belize) • Mangrove Coverage • Mangrove	1996 1994 1995 1998 1990 2010	100,000 100,000 100,000 100,000 100,000 100,00	• White Et Al • LIC/Fairweather/Gray • Iremonger/Browkaw • Zisman Et all • CATHALAC/SERVIR
SPECIAL DEVELOPMENT			

AREAS (SDA's):- • Corozal District North • Corozal District East • Orange Walk District East • Belize District Northeast • Burrell Boom/Hattieville/Ladyville • Manatee • Manatee West • Cayo District West • Mango Creek • Monkey River	1991-1992 1991-1992 1991-1992 1991-1992 1991-1992 1991-1992 1991-1992 1991-1992 1991-1992 1991-1992	50,000 50,000 50,000 50,000 50,000 50,000 50,000 50,000 50,000 50,000	• Land Utilization Authority, Lands & Surveys
Political/Electoral:- • Belize Electoral Divisions • Belize Polling Areas	2003 2003	50,000 50,000	• Election & Boundaries/LIC • Election & Boundaries/LIC
Piers:- • Placencia Piers • San Pedro/Ambergris Caye Piers • Caye Caulker Piers	2009-2010 2009-2010 2009-2010	2,500 2,500 2,500	• Land Utilization Authority, Lands & Surveys • Land Utilization Authority, Lands & Surveys • Land Utilization Authority, Lands & Surveys
Surveys/Cadastral:- • Registration Section Boundaries • Registration Section Parcel • Unregistered Areas Parcel • Survey Plans Center Points • DOS/MCP Survey Control Stations • Belize Block Nos. Database • Belize Estate Boundaries	2010 2010 2010 2010 ? ? ?	10,000 10,000 10,000 10,000 10,000 250,000 250,000	• Land Registry/Surveys & Mapping • Land Registry/ Surveys & Mapping • Surveys & Mapping/Bze Archives Dept/LIC • Surveys & Mapping • Surveys & Mapping • Surveys & Mapping • Surveys & Mapping
TOPOGRAPHY/BASELINE:- • DOS Topographic Sheets (.jpeg) • SRTM Digital Elevation Model (.img/.tiff) • ASTER Digital Elevation Model (.img/.tiff) • Slopes (.img/.tiff) • Hill Shading (.img/.tiff)	1992 2000 2006 2006 2006	50,000 350,000 30 M/P 30 M/P 30 M/P	• Ordnance Survey International (Britain) • NASA/USGS/CATHALAC • NASA/USGS/CATHALAC • ASTER DEM - NASA/USGS/CATHALAC • ASTER DEM - NASA/USGS/CATHALAC
AERIAL/ORTHO PHOTOS • Belize City (.img/.sid) • Orange Walk Town (.img/.sid) • San Ignacio/Santa Elena (.img/.sid) • Dangriga (.img/.sid) • San Ignacio Town (.bmp)	2004 2004 2004 2004 Dec 2010	4,000 4,000 4,000 4,000 25 CM/P	• Lands & Survey Department/LIC • Lands & Survey Department/LIC • Lands & Survey Department/LIC • Lands & Survey Department/LIC • Orbis Technical Services

IKONOS • San Pedro (.img/.tiff) • Caye Caulker (.img/.tiff)	 2004 2004	 3.2 M/P 3.2 M/P	 • CZMAI/NEMO • CZMAI/NEMO
ASTER • Belize & Cayes (.img/.tiff)	2000-2010	30 M/P	• NASA/USGS/CATHALAC
LANDSAT TM • Belize & Cayes (.img/.tiff)	1989 - 2010	90 M/P	• NASA/USGS/CATHALAC
DIGITALGLOBE/GOOGLE EARTH • San Pedro/Ambergris • Placencia Area • Southern Long Caye • Middle Long Caye	 2008 2008 2008 2008	 50 M/P 50 M/P 50 M/P 50 M/P	 • DigitalGlobe/Google Earth • DigitalGlobe/Google Earth • DigitalGlobe/Google Earth • DigitalGlobe/Google Earth

Relevant reports are maintained for reference, including:

NAME	*TYPE*
• Deforestation Analysis of Belize – Report • Land Use Report (1989/92) • Land Use/Land Cover - Central Belize Report (1996/98) • Land in British Honduras • 1998 Central Belize Cohune Palm Forest Report	• Digital (48 Pages) • Digital (15 Pages including 9 maps) • Digital (34 Pages including 1 maps) • Digital (185 Pages) • Digital (34 Pages Including Maps)
Environmental:-	
• GEO Belize Report 2010 • Our Environment In Figures 2006 • Environmental Statistics For Belize 2004 • Environmental Statistics For Belize 2001 • Environmental Statistics For Belize 2001	• Digital & Hardcopy • Digital & Hardcopy • Digital & Hardcopy • Digital • Digital

In addition to the above, the LIC also maintains a repository of other information that has been developed for specific projects, but that are not being maintained on a regular basis in part because the LIC is not the logical custodian for that information. The full listing of LIC data holdings at the time of this writing is as follows:

Table 3 - LIC data holdings

DOC_SET_NAME	DESCRIPTION
Belize Boundary	Boundary of Belize plus the coastline of the Country inclusive of the mainland and all the Cayes, derived from 1:50,000 topographic basemaps. This does not depict the territorial waters and is used primarily for cartographic purposes.
Administrative Boundary	This layer depicts the 6 political administrative districts of Belize, derived from 1:50,000 topographic basemaps 1994.
International Boundary	This layer depicts the international boundary line between Belize and the surrounding countries.

International Boundary Markers	This depicts the three international boundary markers provided by the Ministry of Foreign Affairs.
Offshore Cays	This layer depicts shoreline for all the Cayes based on imagery available through Google and Bing.
Roads	The Roads layer covering five classes of roadways from highways down to unpaved tracks and paths.
Town/City Boundary	This layer depicts the official boundaries for all 9 towns and cities in Belize. Each boundary includes the name of the town or city as well as both calculated and documented acreages. The documented acreage is as published in the official statutory instrument.
Villages/Settlements	The Villages/Settlements layer depicts the centerpoint for towns, villages and settlements across Belize. Each point includes the name of the place, the type of place, and the district name. District name is included to differentiate between the same community names in different districts.
Hypsometric Layers	This layer depicts elevation regimes derived from the 1:250K topographic basemaps, according to the elevation breaks shown in those maps.
Contours (20 Meter Interval)	This layer shows the 20 M contour intervals derived from 30m Aster digital elevation model data. Each line is unbroken and includes the elevation value in meters.
Slopes	This raster dataset depicts X classes of topographic slope based on 90m digital elevation model (DEM) data.
Flood Risk	The Flood Risk layer depicts the location and extent of calculated flood risk areas according to seven risk categories. This includes both areas subject to river or stream overflow as well as area flooding during times of peak rainfall, coastal inundation, swamps and mangrove forest.
Waterways (Rivers/Creeks/Streams)	The Waterways layer depicts the linear surface hydrology features digitized from the 1:50K topographic basemaps according to the classification scheme from the source maps, inclusive of river or stream names. These are used primarily for cartographic purposes.
Water Bodies (Inland and Offshore Lagoons)	The Waterways layer depicts the polygon surface hydrology features digitized from the 1:50K topographic basemaps. These polygons include water feature names and are used primarily for cartographic purposes.
Watershed	The Watershed layer shows the location and boundaries for 32 major watersheds across Belize, up to the national boundary.
Protected Areas	The Protected Areas layer shows the location and extent of all offical protected areas across Belize. The Statutory Instrument (SI's) for protected areas in Belize were compiled into a single layer covering the country. Each SI includes a textual description of the boundaries of each area, inclusive of UTM coordinates as well as other locational references. Attribute fields were added for the type of reserve, reserve name, SI number, calculated acreage, documented acreage (official), management authority, IUCN category.
Spawning Site/ Aggregation Sites	
Mayan Sites	This layer shows a point location for selected Maya archeological sites (Elam to follow up)
World Heritage Sites	This layer shows the boundaries of the World Heritage Sites designated by UNESCO in Belize.
Bird Sanctuaries	This layer shows a point location for all Bird Sanctuaries

Reef	The reef data is a line feature depicting the location of the entire reef system in Belize.
Agricultural Potential	This layers shows the areas for agricultural potential based on financial investment. This data have five classifications, with one being the most suitable for agricultural purposes.
Crop Suitability	The Crop suitability layer shows areas that are suitable for specific crops, such as sugar, corn, beans, rice, etc. It contains data such as the soil type, salinity and vegetation type.
Soils Map	This layer shows the location and extent of the different soils profile for the entire country of Belize. This include information on recent soil formations, under condition of intermittent lime enrichment, soils from under condition of continuous acid leaching immature.
1996 Deforestation Cover	This layer shows the extent of deforestation that occurred in mainland Belize between 1989/92 and 1994/96. Forest cover was mapped by computer-assisted analysis (image classification) of Landsat Thematic Mapper (TM) satellite imagery taken between 1994/1996
1989/1992Land Use/Land Cover	The land use/land cover data 1992, is a project carried out by land and surveys department of the Ministry of Natural Resources with support from the Food and Agriculture Organization FAO. This study represents the most comprehensive analysis of land use carried out for Belize.
1995 Natural Vegetation	This dataset shows the different ecosystem and vegetation type dated 1995. This data was produced as part of the Central American Ecosystems Map (Worldbank/CCAD).
1996 Land Cover (Central Belize)	This dataset was developed with a refined land use/land cover classification in a limited geographic area (Central Belize) so that the classification and methodology used could potentially be applied nationwide to update the current land use. The study area included portion of the Belize, Cayo and Stann Creek District.
1990 Magrove Dataset	The mangrove datasets shows the location and Formation of all mangrove cover for the entire coastline of Belize. The mangrove data has been classified as Tall, Medium and Dwarf, Mangrove Forest, Mangrove in Mixed Forest, mangrove savahanna and Mangrove over open water.
2010 Magrove Dataset	This data set was generate as an update to the 1990 Zisman's mangrove coverage for Belize through a partnership between the World Wildlife Fund and CATHALAC. The study involved the assessment of mangrove cover change for the period 1980-2010 based on a remote sensing-based study utilizing satellite imagery for the years 1980, 1989, 1994, 2000, 2004, and 2010
Special Development Area Corozal District North	This dataset demarcates the zonation and diversity of different types of Development regarding to mainly Agriculture, Tourism & Wildlife Reserves for the Northern Part of the Corozal District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Corozal District East	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Tourism & Wildlife Reserves for the Eastern portion of the Corozal District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003

Special Development Area Orange Walk District East	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for the Eastern portion of the Orange Walk District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Belize District Northeast	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for the Northeastern portion of the Belize District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Burrell Boom/Hattieville/Ladyville	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, Wildlife Reserves & Environmental Protection for the portion of the Belize District known as Greater Belize Area which includes Burrell Boom Village, Hattieville Village & Ladyville Village. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Manatee	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for a portion of the Belize District in the Manatee Area. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Manatee West	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for a portion of the Belize District in the Manatee West Area. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Cayo District West	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for the Western Portion of the Cayo District which includes Benque Viejo, Santa Elena and San Ignacio Areas. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Special Development Area Mango Creek	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for the Mango Creek Area in the Stann Creek District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003

Special Development Area Monkey River	This dataset demarcates the zonation and diversity of Different types of Development regarding to mainly Agriculture, Residential, Commercial, Tourism, Forestry, and Wildlife Reserves & Environmental Protection for the Monkey River Area in the Toledo District. The development plan was prepared by the Land Utilization Authority as specified on the Land Utilization Act Chapter 188 Revised Edition 2003 showing the Subsidiary Laws as at October 2003
Belize Electoral Divisions	The Electoral Division layer shows the location and extent of all official Electoral Divisions across Belize. The Statutory Instrument (SI's) for the electoral divisions in Belize were compiled into a single layer covering the country. Each SI includes a textual description of the boundaries of each area, inclusive of UTM coordinates as well as other locational references.
Belize Polling Area	The Polling Areas layer shows the location and extent of all official Polling Areas that are areas depicted within electoral divisions. Each polling area represent a voting station, there can be several of these within an electoral division The Statutory Instrument (SI's) for the polling areas in Belize were compiled into a single layer covering the country. Each SI includes a textual description of the boundaries of each area, inclusive of UTM coordinates as well as other locational references.
Piers Data	The piers data shows the location and distributions of all the piers along the coast as well as in the cayes of Belize. Popular tourist destinations such as San Pedro and Caye caulker have the most piers.
Registration Section Boundaries	The registration section boundaries dataset shows the extent of all registered areas in Belize, it is a polygon feature that outlines the boundaries of all the areas that went through an adjudication process
Registration section Parcels	The registration section parcel dataset shows the distribution of all registered parcels including residential or agricultural in Belize. The registered parcels are highly concentrated in northern Belize, These data have attributes or fields such as Parcel ID, Parcel No.'s, Registration section etc. This is a dataset that MNRA is highly dependent on to make decision, it continuously being updated by the land registry and the mapping section of MNRA.
Unregistered Areas Parcel	The unregistered parcel dataset is a compilation of all surveys that have not being registered, this data does not have any attributes or fields, and these include old government survey plans and Entries showing the distribution of Agricultural and village parcels. This data is compiled by LIC MNRA in CAD format and is then converted to shape files, it is being continuously updated and MNRA is highly dependent on this dataset.
Survey Plans Center Points	This is a point feature that contains the centeroid of all surveys done in Belize, it contains information such as the survey No. or plan No. the date of the survey and who surveyed it etc. This data is managed and updated by the surveys and mapping section of MNRA
DOS/MCP Survey Control Stations	This point feature depicts the location of major control points in the country, these are control points with a high degree of accuracy that support surveying activities in Belize, it is a network of monumented control points that provide a unified or standardize coordinate system for surveying.

DOS Topographic Sheets (.jpeg)	This is a georeferenced scan images (Directorate of Overseas Surveys/UK military) showing the topography of Belize, it consist of a total of 44 sheets that cover the entire country at a scale of 1:50,000. Most if LIC's baseline data were digitized from these images.
Aerial Photographs 2004 monochrome (Belize City, Dangriga Town, Orange Wlak town, San Ignacio/ Santa Elena Town)	These Aerial photos were acquired through the GOB Land Management Programme in April 2004. The purpose was to conduct cadastral survey rectification in these towns that would later be declared as compulsory registration section. These images have a resolution of 18 cm.
Aerial Photographs 2012 color (Placencia, San Pedro Town, Corozal town, Benque Viejo Town, Punta Gorda Town)	These Aerial photos were acquired through the GOB Land Management Programme III in march 2012. The purpose was to conduct cadastral survey rectification in these towns that would later be declared as compulsory registration section. These images have a resolution of 18 cm.
Cadastral	This folder contains maps or .mxd of all towns and cities in Belize, including street maps.
Old LIC DATA	This folder contains the shapefiles that were imported to the LIC SDE DATABASE, including the baseline data, hydrology, etc.
Protected Areas	Contains data and maps related to all protected areas in Belize including marine reserves
NEW LIC DATA	Contains new data created or produce by LIC, such as the building foot prints, build up areas and other data created by interns.
Municipal Development Project JPGs surrounding communities	
Compilations	This folder contains mostly AutoCad files of undeclared land in Belize, this data is being updated on a regular basis.
Baseline	Contains baseline maps such Baseline by country, baseline by district and which includes data such as administrative boundaries, roads, rivers and waterbodies
Mining	This folders contains all request for data or maps by the Mining Unit (MNRA)
CCCCC	Has data of projects and maps request by CCCCC. Eg. Wild cane mapping project.
Commissioner	Contains maps requested by the commissioner of lands and survey (MNRA)
Solid Waste	This folder stores all request for data and maps for Solid waste Unit (MNRA), this includes maps of disposal sites around the country.
Template	The template folder is used to store maps that is customized and prepared, this is prepared for efficiency and ready to print maps.
Jpeg Maps	This folder contains all maps exported from ArcMap to a JPEG format, they are organized by subfolders based on the type of maps.
Registration Section	Stores all maps and data regarding all registered/declared parcels in Belize, these maps are also exported as JPEG and PDF format.
BEL	Contains request made by Belize Electricity Ltd for maps and other data.
Belize River valley buildings and flood hazard areas	
Rural Development	Contains data requested by Rural development, these are spatial data of settlements/villages of their different project areas

geophysical	
Agriculture	This folder contains all data and maps related to agriculture, such as the mapping of large farms in the Cayo District and Banana farms mapping in the Stann Creek District
Roads 2012	Contains shapefile of updated roads in the Toledo, Stann Creek, and Corozal District, these data were generated from images such as Google Earth and Bing Maps, also the parcel database was used to generate the center lines of these roads.
BTB	This folder stores maps and other data pertaining to the Belize Tourist Board, these include adventure trails and other tourist attractions.
Requests	This is a folder that is constantly being used, all requests from the public, whether in the forms of maps or spatial data are stored here.
BMDP	Contains data and map documents as requested by the Belize Municipal Development Project
Belize Audubon (BAS)	Contains baseline data and areas manage by Belize Audubon Society.
BWSL	All request by Belize Water Services Ltd are stored in this folder, the data requested are parcel data in AutoCad format, and these are essential and are used to manage their distribution services.
MinistryofHealth	This folder stores maps and other data pertaining to the Ministry of Health, these include adventure trails and other tourist attractions.
FHM_Belize	This folder contains a pilot study of flood modelling of the Crooked Tree Area, Belize District. This project was carried by Japan International Cooperation Agency (JICA) through the National Emergency Management Organization (NEMO).
Forest Department	This folder contains requests, map documents & .jpg files prepared as requested by the Forest Department.
Belize City Council	Contains request for maps and spatial data for the Belize City Council, these include the updated street names, Valuation zones etc.
Belmopan City Council	Contains request for maps and spatial data for the Belmopan City Council, these include the updated street names, Valuation zones etc.
Cataloque	This folder show all the services that we provide at LIC for our customers and to the general public, these include sample maps of different areas at different scales, different file formats and images as well as reports on some projects completed, also included is a price list for maps and services.
DOE	This folder contains requests for map documents & jpg files prepared as requested by the Department of Environment
Land Use Project Mapping System 2011	This folder contains all documents, maps and spatial data related to the Land use Project Mapping System 2011. The Mapping System is an integral part of the land use planning framework. In the absence of a national zoning strategy and zoning plan it will help in the visualization and analysis of spatially enabled data to support decision making. This was done through a consultancy by Jan Meerman, Marion Cayetano and John McGill, 2011.
MOW	Contains request for maps and spatial data for the Ministry of Works, these include the updated roads, culvert and bridges data.
UB PROJECTS	This folder contains documents, maps, and spatial data regarding projects that the LIC completed for the University of Belize. These projects include the Central Jaguar corridor Land Tenure Mapping Project and the Toledo Land tenure mapping project.

urban land use data	This folder contains documents, maps and spatial data regarding the Municipal Development Plans. The Urban Land Use Project was under the direct supervision of the Physical Planning Unit of the MNRA and spearheaded by Mr. Keisha Rodrigues. Land Use data for all the Town were collected.

2.4.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

ArGIS (ESRI). The ArcGIS software by ESRI is one of the leading GIS software in the world. The LIC has been a user of ArcGIS for several years.

GeoNode. GeoNode is a web-based open-source application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI). It is designed to be extended and modified, and can be integrated into existing platforms. The platform supports users in uploading and making content available via standard OGC protocols such as Web Map Service (WMS) and Web Feature Service (WFS). Data is then available for browsing, searching, styling, and processing to generate maps which can be shared publicly or restricted to specific users only. Supported upload formats include shapefile, GeoTIFF, KML and CSV. In addition, it is possible to connect to existing external spatial databases and services. GeoNode allows the user to publish raster, vector, and tabular data; manage metadata and associated documents; securely or publicly share data; and, manage versioned geospatial data updates through the editor.

Open Data Kit (ODK). ODK is a free and open-source set of tools which help organizations author, field, and manage mobile data collection solutions. ODK provides an out-of-the-box solution for users to:

1. Build a data collection form or survey (XLSForm is recommended for larger forms);
2. Collect the data on a mobile device and send it to a server; and
3. Aggregate the collected data on a server and extract it in useful formats.

In addition to socio-economic and health surveys with GPS locations and images, ODK is being used to create decision support for clinicians and for building multimedia-rich nature mapping tools.[4]

2.4.5 Computing Infrastructure

Most staff within the LIC are well trained in the use of computers and specifically in the application of GIS and related software applications. The full details of the MNRA computing infrastructure architecture are presented in the MNRA IT Section stakeholder survey write-up.

2.4.6 Other Issues, Opportunities and Constraints

[4] https://opendatakit.org/

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the LIC:

- No permanent full time staff to support NSDI functions. At present any involvement in helping to move the BNSDI forward has to be conducted by LIC staff who are already occupied full time with MNRA support and LIC daily business.

- In the past, the LIC was involved in the review of submitted surveys and were involved in looking at proposed land subdivisions, grants, leases and other such transactions relative to protected areas and other possibly constraining factors. With the implementation of the Landfolio system the LIC is not involved in this review and likewise there are some data within the MNRA-LIC spatial data repository that could be of use to the Landfolio users but are not currently accessible from that system. As a result there has been instances of duplicate requests and approval of transactions in inappropriate locations.

- Persistent and proactive executive championship for the BNSDI needs to be established.

- Today there are many internally and externally financed projects that are formulated without a clear idea of what information is available to support the project requirements. The result has been many projects that either had to proceed with best available data (whether truly adequate for purpose or not), or to expend project resources creating new data, sometime redundantly because organizations are not aware of what each other has.

- GIS and related technologies are advancing quickly and it is difficult for LIC staff to stay fully informed of the trends and to remain up-to-date in their skillsets. Some mechanism to ensure ongoing professional development and refresh is needed to ensure staff are capable to achieve maximum value from the government's technology investments.

- Much of the LIC time is consumed in carrying out simple service requests on behalf of other agencies. There is a need to develop the capacities of those other agencies to support their own basic needs, thus freeing up the LIC staff to conduct more substantial analysis and applications development.

- At present there are many data layers for which there is no official custodian. This is noted as one very important issue to be addressed by the BNSDI

- The LIC charges for special services, and these amount to an amount that, according to the PLIO at the time, was traditionally less than the Center is paying for GIS software each year. The Center also charges for provision of some data. The revenue for data sales is currently less than what the Center pays for GIS licenses.

2.5 Central Administration – IT Department

Person(s) Interviewed: Faridi Martinez , IT Manager

Interview Date(s): June 9-12, 2014

2.5.1 Organization and Mission

The Information Technology Section within the Ministry of Natural Resources (MNRA), reports directly to the CEO of Natural Resources. There are presently 5 persons in the section supporting all IT requirements for over 300 users across the system including about 170 within the Headquarters offices in Belmopan and the remainder in the Districts.

The IT Section is currently responsible for several primary activity areas that have particular relevance to GIS and BNSDI including the following:

1. Prepare and implement IT Strategy.
2. Conduct system and database administration.
3. Provide general IT support.
4. Support application development and maintenance.
5. Develop and maintain MNRA website.
6. Maintain GeoNode portal.

2.5.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.5.2.1 Prepare and Implement IT Strategy

The Section is responsible to periodically update the organization's IT strategy, and to oversee its implementation. At the time of this writing the Strategy is under refinement. The draft document has set a range of aggressive objectives that have some relevance to the use of GIS at the MNRA and the Ministry's role in the BNSDI as outlined in the following Table.

1. IT Infrastructure: To continuously enhance and maintain an efficient and effective IT Infrastructure for improved network connectivity for the Ministry by: ▪ Ensuring connectivity between Ministry Headquarters and its remote offices ▪ Maximizing up-time and reducing downtime for existing and future services ▪ Extend and improve nationwide	A capable, stable and reliable computing infrastructure will also benefit GIS users across the MNRA. This will become especially important as different units develop their own capability to maintain and use geospatially enabled data in their day to day work. Transactional updating of this sort will also be important for communication and coordination across sectors, and to support joint operations in

network and encourage its efficient use.	emergency situations.
2. e-Governance: To use e-Governance to improve the internal processes of the Ministry through deployment of Information Technology, administrative reforms, re-engineering and modernization of systems and processes with a view to providing an efficient, responsive, transparent and cost effective Ministry; to take all necessary steps to gain the maximum advantage of resources available therein for ushering in e-Governance in the Ministry.	International experience suggests that over 80% of natural resource management sector functions relate to geographic locations in one form or another. Providing the ability to integrate location information and geographic analysis and visualization properties into eGovernment systems is an important value-add.
3. Client Services: To use IT to implement various services to the people at minimum cost on "anywhere, anytime" basis; to undertake computerization of government offices to enable them to respond to clients' electronic requests for services and information.	The growing prevalence of mobile communications and smart devices are opening many new opportunities for location based services.
4. Regulatory Issues: To devise and update appropriate legal and regulatory framework for efficient administration of IT and for the prevention of misuse of the Ministry's information systems, network resources, peripherals and equipment. To design, implement, monitor and enforce IT security policies for both the protection of Ministry assets and the rights of its users.	It will be important that the information security policies and mechanisms incorporate geospatial information as an important component for consideration.
5. Implementation and Monitoring: To build an appropriate administrative framework for the implementation and monitoring of IT activities in the Ministry. To provide for a robust and transparent methods for improved management of IT related issues, requests, changes, and inventory.	Location based services, crowd sourcing and other emerging technologies and methods that include location will become an important part of the MNRA ICT framework.
6. Capacity Building: To both expand and refresh an end-user's knowledge of the information systems and processes they work with and adhere to within the organization. To provide for improved methods of assessing and evaluating an individual's current grasp of business processes through information technology	Building spatial awareness, spatial thinking and problem solving and GIS technology utilization are critical for natural resource managers, policy and decision makers.

Other areas addressed in the Strategy that have relevance to GIS and the BNSDI include:

- Process reengineering. Development of new streamlined processes to take maximum advantage of emerging technologies and trends;
- Common standards. Develop common standards for data and technology that will help to make the MNRA information infrastructure more integrated and interoperable;
- Capacity building and change management. Embrace technology adoption, capacity building and proactive management of change as a fundamental aspect of how the Ministry operates.
- Strengthening of policies and procedures. The Strategy outlines a wide variety of policy and procedural enhancements that can be used to leverage technology to fundamentally improve the efficiency and effectiveness of MNRA operations and services to other organizations and the general public.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Include geospatial component in any Enterprise-wide system requirements analysis
- Integrate geospatial capabilities as a core technology within the MNRA's information architecture strategy
- Integrate geospatial data modeling within the MNRA enterprise data model
- Include access to BNSDI data as opportunity for optimizing MNRA use of information technology

2.5.2.2 Conduct System and Database Administration

The IT Section is responsible for administering the entire IT infrastructure for the MNRA. This includes managing all computing infrastructure within the Headquarters buildings in Belmopan as well as within several District offices and the Central Farm.

Most staffs across the Ministry have access to a PC and are regular users of standard office applications such as word processing and spreadsheets. Specific more specialized information systems include:

- ESRI Geographical Information System (GIS)
- Trimble Landfolio
- File Management System (FMS)
- Land Acquisition Management System (LAMS)
- Small Farmers Registry (under development internally)

Landfolio in particular has paved the road as a prime example of an integrated information system that has successfully integrated most of the processes and systems used by the Land and Surveys Department for land record management and geospatial information. The goal is to continue positively enhancing, integrating and evolving this system into the daily activities of the Ministry. This also serves as a good model to be applied to other areas of MNRA business by integrating IT, GIS, process optimization and other factors that can impact the effective utilization of IT technology within the Ministry.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Administer geospatial system and database
- Maintain specialized geospatial system equipment
- Manage impacts of geospatial data on the organization's networks

2.5.2.3 Provide General IT Support

The same limited staffs are responsible for providing general IT support to over 300 users in multiple locations. Some issues can be handled over the phone but others require personal onsite attention by technical support staff, sometimes requiring time-consuming travel to remote office locations.

Some units such as the LIC are capable to handle many of their own technical issues. Others such as the Project Execution Unit (PEU) could not be sufficiently accommodated at their offsite location with existing staffing so have made other arrangements to outsource a portion of their technical support requirements.

Planned upgrades to the MNRA WAN will become even more critical as the use of computerized applications generally and GIS specifically increases.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Provide specialized IT support for GIS users

2.5.2.4 Support Application Development and Maintenance

The IT Section is involved in the development of more basic application software, and providing technical support to the development of more major systems, such as the Landfolio system.
Basic application software is conducted in-house as needed to support specific users. Requests are received and IT assesses each to determine whether a need can be accommodated internally or if external support or software product is required.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Consider geospatial capability as an integral component of application software development where this can help to meet user requirements
- Incorporate GIS licensing and maintenance within enterprise configuration management program

2.5.2.5 Develop and Maintain MNRA Website and Future Portals

The IT Section has been responsible to oversee the development and maintenance of the MNRA website. There is not at present a consistent program in place to populate missing content or to maintain content on an ongoing basis. However, the Website has been implemented with the objective of providing a single point for clients to have access to the

information and services being provided by the Ministry of Natural Resources and its many departments. It is planned in the future that this will be updated periodically with up to date information and have relevant links to other Government Portals/websites. In addition to the informational services, the plan is for the website to provide access to a portal or portals that would also provide interactive and payment services to clients. The content of these Portals would be regularly updated and made available to clients.

Possible portals could include but are not limited to the following:

- Landfolio
- Farmers Registry
- Solid Waste Management Authority
- Cooperatives
- Mining Unit
- National Integrated Water Resource Authority
- National Spatial Data Infrastructure

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Maintain links to BNSDI website and GeoPortal
- Utilize MNRA website to raise geospatial awareness

2.5.2.6 Develop and Maintain BNSDI Geographic Portal

The Land and Surveys Department, through the assistance and cooperation of the Ministry's IT Unit, has successfully launched the National Spatial Data Infrastructure (NSDI) initiative for the country. This initiative has seen the construction of electronic service provision for stakeholders as it pertains to Geo-Spatial information. The current NSDI IT infrastructure comprises of a webserver, a Geoportal, an electronic forms submission service (ODK Aggregate) and a mail server.

The Ministry hopes to continue to update and evolve this portal and successfully integrate it within the processes of various stakeholders – other Ministries, private institutions, non-government organizations and international agencies by providing geospatial information through consumable web-based services. These services can be utilized for the construction of value-added services/data and for high-level decision making, ushering a new age of potential growth and development of the IT Industry for Belize.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Establish, build and maintain MNRA GeoPortal as a model system
- Link and coordinate MNRA GeoPortal with other BNSDI nodes
- Support other agencies to publish their data online through MNRA if they are not prepared to administer own GeoPortal now.

2.5.3 Data Used or Generated

The MNRA IT Section does not itself directly use data but is responsible for database administration regarding all enterprise data sets that are mentioned in all of the other MNRA stakeholder survey write-ups.

2.5.4 Existing Systems

The following systems are being supported by the IT Section:

Landfolio (Trimble). Landfolio has paved the road as a prime example of an integrated information system that has successfully integrated most of the processes and systems used by the Land and Surveys Department for land record management and geospatial information. The goal is to continue positively enhancing, integrating and evolving this system into the daily activities of the Ministry. The outlook for Landfolio is to eventually have a web-based interface that the Department's clients can utilize to:

- Access their own land record information
- Follow up on their existing lodged transactions
- View a history of any lodged transaction with the Department
- Make payments toward their land account (rent, taxes, interest)
- Make payments towards their pending applications (Instrument fees)
- Start and Submit a legally acceptable electronic application for a land process/transaction
- Purchase information that is not directly linked to any of their lodged transactions

ArGIS (ESRI). The ArcGIS software by ESRI is one of the leading GIS software in the world. The LIC has been a user of ArcGIS for several years.

SQL Server (Microsoft). The MNRA is using SQL Server as the defacto standard relational database management system within the Ministry.

File Management System (FMS). No detail provided

Land Acquisition Management System (LAMS). No detail provided

Small Farmers Registry. No detail provided.

Farmers Registry (planned). The Farmers Registry initiative is one that would integrate a portion of the processes involved within the Department of Agriculture. This system would be utilized to not only provide an accurate inventory of all existing farmers, but also elaborate on specifics such as where their agricultural parcels are, what was planted and when, what types of resources and technologies are involved for a particular field and any agricultural structures owned. Similarly, the system would also take into consideration livestock with the above

mentioned details in also. This system would then be integrated into a Geographic Information System to provide high level information for decision making purposes.

NSDI Portal. The Land and Surveys Department, through the assistance and cooperation of the Ministry's IT Unit, has successfully launched the National Spatial Data Infrastructure (NSDI) initiative for the country. This initiative has seen the construction of electronic service provision for stakeholders as it pertains to Geo-Spatial information. The current NSDI IT infrastructure comprises of a webserver, a Geoportal (see GeoNode description following), an electronic forms submission service (ODK Aggregate) and a mail server. The Ministry hopes to continue to update and evolve this portal and successfully integrate it within the processes of various stakeholders – other Ministries, private institutions, non-government organizations and international agencies by providing geospatial information through consumable web-based services. These services can be utilized for the construction of value-added services/data and for high-level decision making, ushering a new age of potential growth and development of the IT Industry for Belize.

GeoNode. GeoNode is a web-based open-source application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI). It is designed to be extended and modified, and can be integrated into existing platforms. The platform supports users in uploading and making content available via standard OGC protocols such as Web Map Service (WMS) and Web Feature Service (WFS). Data is then available for browsing, searching, styling, and processing to generate maps which can be shared publicly or restricted to specific users only. Supported upload formats include shapefile, GeoTIFF, KML and CSV. In addition, it is possible to connect to existing external spatial databases and services. GeoNode allows the user to publish raster, vector, and tabular data; manage metadata and associated documents; securely or publicly share data; and, manage versioned geospatial data updates through the editor.

2.5.5 Computing Infrastructure

The MNRA IT Section is responsible for managing the organization's entire computing infrastructure, as well as the foundation system for the Belize NSDI as indicated in the two figures following:

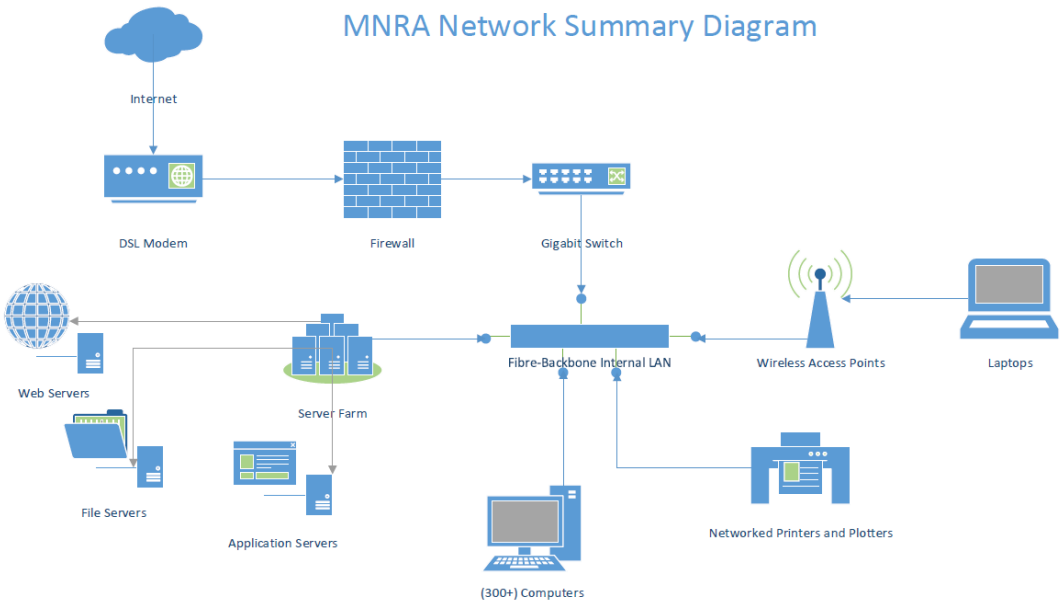


Figure 4 - Current MNRA Computing Network

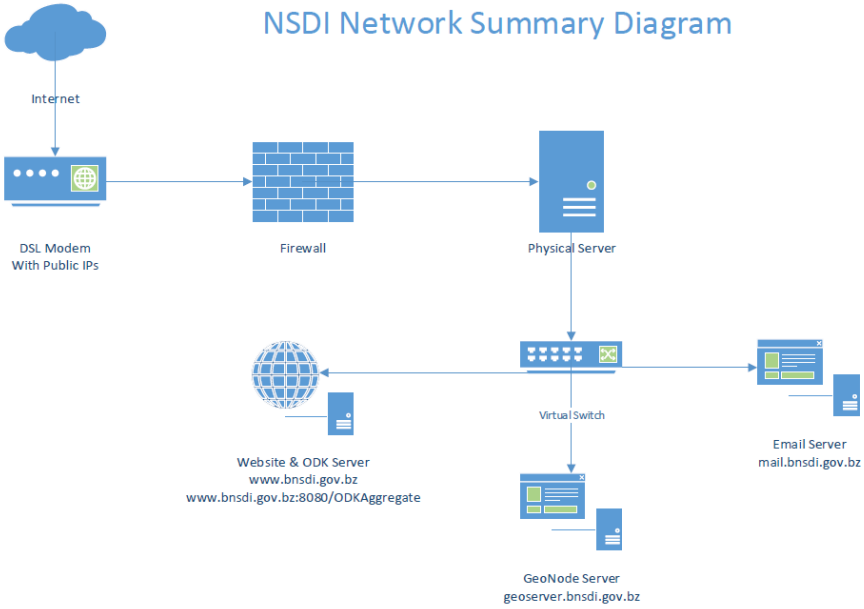
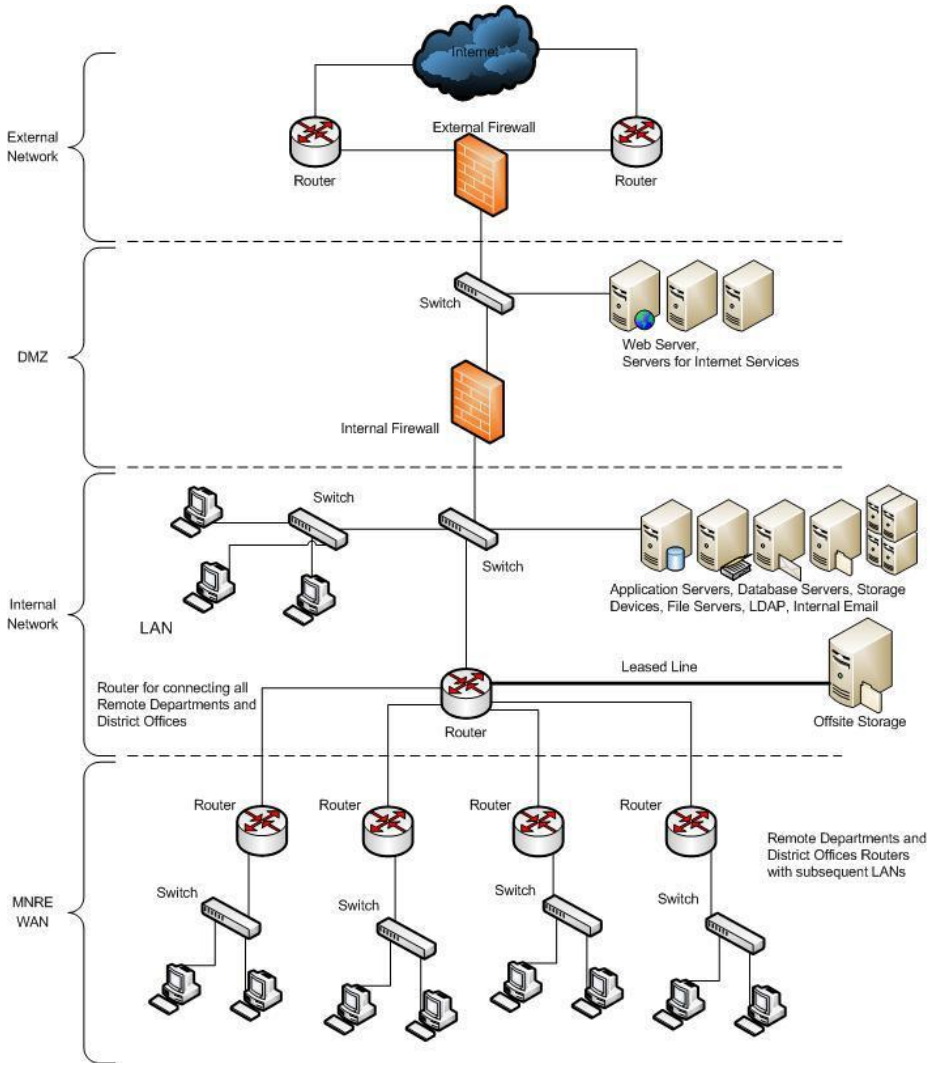


Figure 5 - Current NSDI Network

The conceptual framework for the Ministry's e-Governance architecture as defined in the draft IT Strategy is depicted in the following Figure. The IT Unit intends to provide connectivity, access and services for the various Departments within the Ministry. The MNRA WAN would be commonly used by various departments and institutions while delivering services to clients



2.5.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the MNRA IT Section:

- The IT Section is not currently staffed to provide the level of support required for full enterprise technology development within the MNRA. This will only be worsened as additional applications and the BNSDI are expanded.
- Experience has shown that the parallel development of a GeoPortal environment incorporating broad and compelling information from multiple organizations is a critical component in developing executive awareness and support for the next stages of NSDI development. It is highly recommended that information resources from other SDI stakeholders be added to the existing GeoNode as a parallel activity to this study, in a timeframe that can complement the Requirements Analysis stage. At present, both the IT Section and LIC staffs do not have sufficient time to dedicate to this function, and a

recommendation has been made to commission additional support in the near and medium term to perform this function.

- There is a need to further refine cyber-laws and policies in the Country so that a proper balance is struck between the public right to know and transparency in government and national security, intellectual property rights, privacy and related matters. Many of these policies should be set at the Federal level as an enabling environment within which Ministry-specific systems and the BNSDI can be developed.

2.6 Natural Resources Department – Mining Unit

Person(s) Interviewed: Michelle Alvarez, Geologist/ Inspector of Mines
michelle.alvarez.bz@gmail.com

Interview Date: June 10, 2014

2.6.1 Organization and Mission

The Mining Unit is responsible for managing all non-petroleum mineral resources in Belize, inclusive of any land areas, territorial sea (and beyond up to 200m depth), or in any spring, stream, river, lake of lagoon. This includes the full range of mineral resources from precious metals to industrial minerals such as clay, dolomite, granite, gypsum, limestone, sand, sandstone or salt, used for agricultural, building, roadmaking or industrial purposes, and construction minerals referring to stones, gravel, sand or clay used for constructing buildings, roads, dams, concrete structures, and similar works, or the making of blocks, bricks and tiles.

At present this office has 3 staffs who conduct several primary activity areas that have some relevance to GIS and BNSDI.

1. Conduct Mineral Resource Assessments
2. Issue Mining and Mineral Extraction Permits/Licenses
3. Monitor Mining and Mineral Extraction Operations

2.6.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.6.2.1 Conduct Mineral Resource Assessments

This Unit is involved in coordinating and compiling mineral resource assessments for the country. Several types of assessments have been conducted over the years, and today most of the assessments being conducted are for specific areas and purposes.

In the mid 1980's the UNDP conducted basic geological mapping for the entire country.

In 2003 there was an updated version of the geology map developed by Geologist Jean H. Cornec, a founding director of Belize Natural Energy (BNE), with additional updates in 2004.

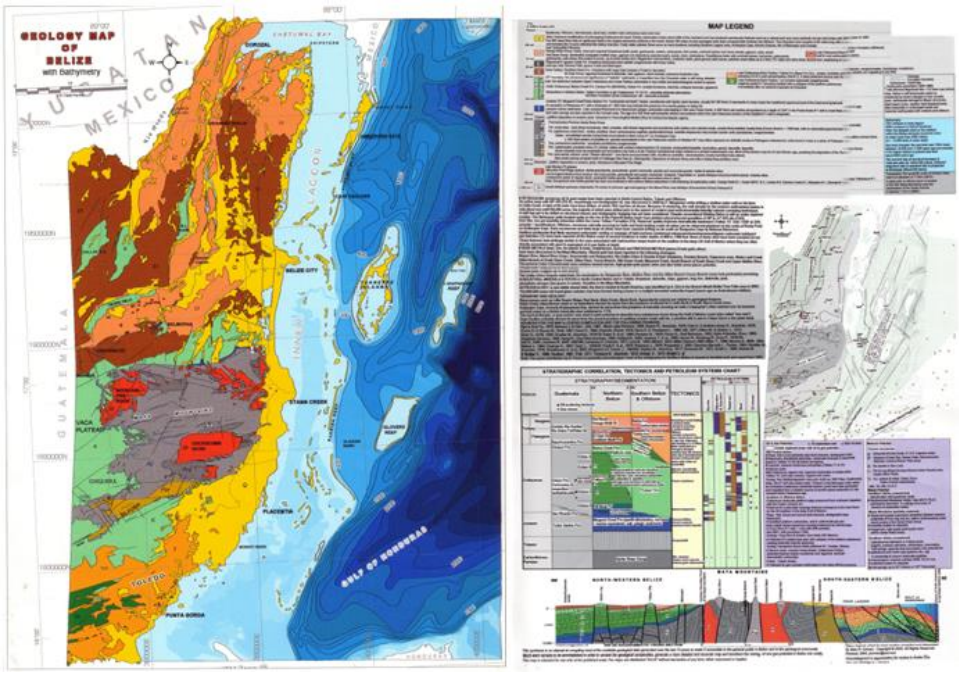


Figure 6 – Geology Map of Belize (2003-2004)

According to the author, this map represents a synthesis of the available geologic data generated over the previous 75 years.

Mineral assessments since that time have tended to be focused on a particular area and purpose. The Unit maintains a comprehensive inventory of these studies, many of which are prepared in relation to mining and mineral extraction permits. The Unit maintains a listing of these reports in MS Excel format, as well as digital copies of reports prior to 2012, and hard-copies of all the reports since. Most of these reports include site or area specific studies and maps, depending on the subject being explored. The current listing is included in Annex A to this write-up.

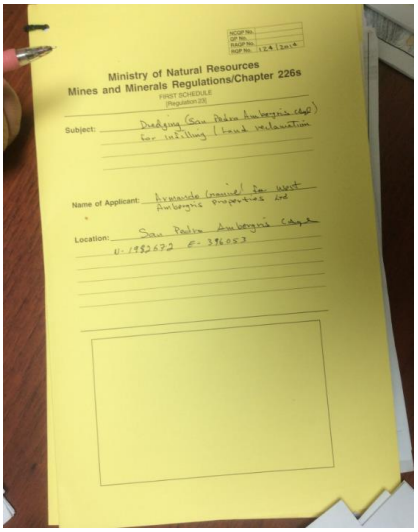
Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Log, record and track the locations of all mineral resource assessments
- Provide geographic interface for accessing mineral resource assessment data and documents

- Access geologic information from other stakeholders
- Prepare national mineral resource assessment atlas

2.6.2.2 Issue Mining and Mineral Extraction Permits

The Unit is responsible for issuing mining and mineral extraction permits. There is a set process and submission requirements associated with each permit application, depending on the type and scope of the proposed activity.



Permit applications are submitted to the Unit by the project owner, along with all supporting information. Once an application has been approved for submission a paper case file is created. Case files contain all original application information and accompanying documents and maps, as well as site visit notes, communications and any other documentation that may be generated or received associated with the particular case.

All applications include a location reference by place name, highway mileage and GPS coordinates in decimal degrees. A registry is compiled for all permit applications to an MS Excel spreadsheet for tracking purposes, inclusive of the GPS coordinates and other locational references. This information was originally used to produce GIS shapefiles illustrating the location and distribution of the cases, but this information has not been updated for 2013 or 2014.

The rate of permit applications can vary greatly each year. There has been a notable increase in small quarry permits over the past two years, with over 170 of these processed in the first half of 2014 alone. This is attributed to expanded need for aggregates for road and other construction, as well as dredging and excavation activities in associated with cruise industry related development and expansion.

The unit is then responsible for reviewing each permit, including conducting a site visit to assess site specific conditions. Site notes and photographs are recorded and added to the case file. Application processing also includes engagement with any relevant local authorities, other ministries and the National Environmental Appraisal Committee (NEAC). Many of the larger projects will require a full Environmental Impact Assessment (EIA). Any such information submitted for each case is kept on file by the Unit.

Case files are maintained largely as paper files, with some information being maintained in a file folder system. It was indicated that since the combining of the unit within the MNRA the decision making process has been streamlined by about 50%. However, the Unit does not presently have direct access to the Lands Department information resources of the MNRA.

The Unit is using GIS to make maps, using a copy of some data layers from the LIC that are maintained on the local system. Scanned and georectified images of the 1:50,000 scale Ordnance Survey topographic basemaps are used as a backdrop for other data, although these are very out of date today.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Log and track all mining and mineral extraction permit applications
- Prepare national atlas of all established mining and mineral extraction permits
- Provide map interface for accessing digital mining and mineral extraction permit case files
- Provide tools for capture of site visit information
- Provide access to environmental, social, jurisdictional and other information that is needed to assess the viability of mining and mineral extraction permit applications
- Provide a historical visualization of mining and mineral extraction activities in Belize over time

Figure 7 – Digital Projects Location Information Plotted on Scanned Basemap Image

Figure 8 – Projects Pin Map and Other Information Plotted on 1:50K Topo Map

2.6.2.3 Monitor Mining and Mineral Extraction Operations

Once a permit has been issued, there is a need to monitor activities to ensure the collection of royalties as well as compliance with operational conditions of the permit. Due to staff

shortage there is very little monitoring going on at present, but staff indicated this as a high priority for the future.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Monitor mining and mineral extraction permit reporting over time
- Prepare mineral extraction map and statistical reports and dashboards for use by policy and decision makers
- Provide historical record of mining and mineral extraction activities in Belize

2.6.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions:

Mining and Mineral Permit Case Files. Mining and mineral permit case files are maintained in paper form by the MNRA Department of Natural Resources Mining Unit. Each case file contains the original application along with all supporting documents, maps and materials and associated transactions and communications information. In addition to a vicinity map, each application includes additional locational references including place name, highway mileage number and GPS coordinates in UTM (NAD1927, zone 16Q, Central America) delineating each location or area involved.

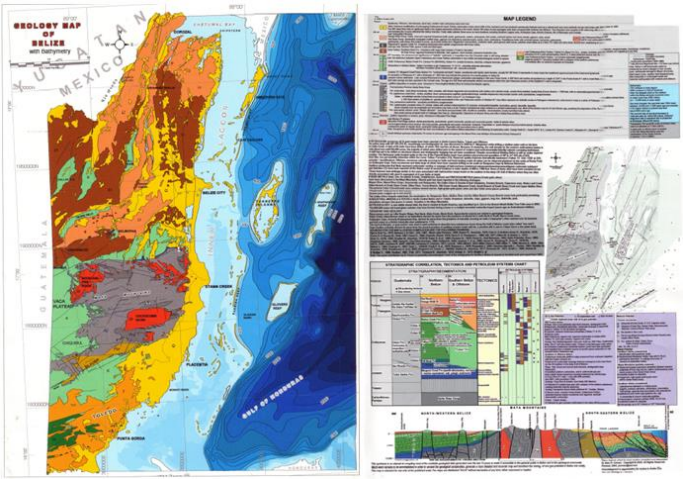
LIC GIS Data. The MNRA Department of Natural Resources Mining Unit utilizes various data layers from the MNRA Land Information Center (LIC) in conducting their daily work. Most useful for the work of this unit include roads, rivers, villages, cayes/reef, protected areas, country boundary.

1:50K Topographic Basemap Images. The MNRA Department of Natural Resources Mining Unit maintains scanned and georectified versions of the Ordnance Survey topographic map series. These include the 1:50,000 E755 topographic sheets UK Ordnance Survey, sheets 1-44 (sheets 22 & 43 are missing from the collection).

Mineral Studies Documents and Registry. The MNRA Department of Natural Resources Mining Unit maintains copies of all relevant mineral resource assessments and related studies. It also maintains a registry of these in digital MS Excel form.

Geologic Map of Belize (1980's). No detail provided.

Geologic Map of Belize (2003-04). In 2003 there was an updated version of the geology map developed by Geologist Jean H. Cornec, a founding director of Belize Natural Energy (BNE), with additional updates in 2004. According to the author, this map represents a synthesis of the available geologic data generated over the previous 75 years.



2.6.4 Existing Systems

GIS. The Unit is currently using ArcGIS to produce various maps that are needed for their work. Local copies of selected data from the LIC are used along with scanned versions of the 1:50K available small scale (1:50K +) topographic basemaps.

MS Excel. Most information concerning permits, studies and mineral rights are currently maintained in spreadsheet form.

2.6.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- More direct access to LIC geospatial data holdings as well as relevant layers maintained by others in the BNSDI community,
- Need additional staff and infrastructure to support ongoing inspection and compliance monitoring for permitted activities,
- Would like to have better tools for the analysis of volumes of deposits and extractions,
- Need better integration, alignment and data sharing with Department of Environment,
- Detailed topographic maps are needed to strengthen and streamline application assessment,
- Would like to update the case register shapefiles and to link these to the maximum permitted versus actual extraction volumes to see how things have progressed over the years.
- Would like to update the case register GIS shapefiles and to link these to maximum permitted versus actual extraction data to see how things have progressed over time.

Writeup Annex A – List of Studies

MINERAL REPORTS

FEASIBILITY STUDIES
GENERAL REPORTS

ANSCHUTZ APPENDICES REPORTS

Author	Title	Date of Publishing	No. of Copies	Brief Description of Report	Serial Number
The Anschutz Corporation	Appendix A, Statistical Processing of Bz. Data	00/00/1977	1	Belize Economic Report	12000ANSAPP
The Anschutz Corporation	Appendix B,Distrib.ofElementsinStreamSediments..	00/00/1977	1	Belize Economic Report(South Bz.)	12001ANSAPP
The Anschutz Corporation	Appendix D,Distrib.ofElementsinStreamSediments..	00/00/1977	1	BelizeEconomicReport(BladenPorphyry)	12003ANSAPP
The Anschutz Corporation	Appendix E, Analytical Values from Soil Survey of...	00/00/1977	1	Belize Economic Report (Chiquibul Area)	12004ANSAPP
The Anschutz Corporation	Appendix G, Rock Analytical Values from Surveys..	00/00/1977	1	Belize Economic Report (Chiquibul Area)	12006ANSAPP
The Anschutz Corporation	Appendix H, Photographs of the Areas containing...	00/00/1977	1	BelizeEconomicReport(BladenPorphyry)	12007ANSAPP
The Anschutz Corporation	Appendix I, Gamma Ray Spectrometer Survey of Bz	00/00/1977	1	Bz.EconomicReport(1976 Stats.&Convs)	12008ANSAPP
The Anschutz Corporation	Appendix J,Anal.ofG.R.S.Data,Bz.TrackEtch Study	00/00/1977	1	Belize Economic Report	12009ANSAPP
The Anschutz Corporation	Appendix K, Stats & Correl. Of 1977G.R.S.&Track,,	00/00/1977	1	Belize Economic Report	12010ANSAPP
The Anschutz Corporation	Appendix L,Track Etch Study-Terradex(Orig.Report)	00/00/1977	1	Belize Economic Report	12011ANSAPP
			10		

ANNUAL REPORTS

Author	Title	Date of Publishing	No. of Copies	Brief Description of Report	Serial Number
Andrews-Jones,Dr.D.A(ChiefGeologist)	The Mineral Potential of Southern Bz. Interim Report	00/00/1975	1	Report-Tables & Maps	13000ANDTHE
Andrews-Jones,Dr.D.A(ChiefGeologist)	First Annual Report for Special Exclusive Prospect...	2/3/1976	1	Annual Report-work done by Anschutz	13000ANDFIR
Andrews-Jones,Dr.D.A(ChiefGeologist)	San Luis Barite Prospect, Belize, C.A. (1976 Eval.)	00/01/1977	2	Annual Report-work done by Anschutz	13000ANDSAN
Andrews-Jones,Dr.D.A(ChiefGeologist)	1st Quarterly Report for the 3rd Licence Year No.1...	00/04/1977	2	Quarterly Report-work done by Anschutz	13000ANDFIR
Andrews-Jones,Dr.D.A(ChiefGeologist)	2nd Quarterly Report for the 3rd Licence Year No.1..	00/07/1977	3	Quarterly Report-work done by Anschutz	13020ANDSEC
Andrews-Jones,Dr.D.A(ChiefGeologist)	Second Annual Report for Special Exclusive Prosp..	00/02/1977	2	Annual Report-work done by Anschutz	13040ANDSEC
Andrews-Jones,Dr.D.A(ChiefGeologist)	3rd Quarterly Report for the 3rd Licence Year of	3/10/1977	4	Quarterly Report-work done by Anschutz	13060ANDTHI
Andrews-Jones,Dr.D.A(ChiefGeologist)	Fourth Quarterly Report for the Second Licence....	14/01/1977	2	Quarterly Report-work done by Anschutz	13080ANDFOU
Andrews-Jones,Dr.D.A(ChiefGeologist)	Second Quarterly Report for the 4th License Year...	00/06/1978	1	Quarterly Report-work done by Anschutz	13085ANDSEC
Andrews-Jones,Dr.D.A(ChiefGeologist)	Third Annual Report for Special Exclusive Prospect..	1/2/1978	1	Annual Report-work done by Anschutz	13090ANDTHI
Andrews-Jones,Dr.D.A(ChiefGeologist)	Fourth Quarterly Report for the Third Licence Year...	00/01/1978	2	Quarterly Report-work done by Anschutz	13100ANDFOU
Andrews-Jones,Dr.D.A(ChiefGeologist)	Second Quarterly Report for the 5th Licence Year....	00/07/1979	1	Quarterly Report-work done by Anschutz	13120ANDSEC
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Andrews-Jones,Dr.D.A(ChiefGeologist)	Belize Mineral Exploration Program Final Summary..	00/03/1981	2	Final Summary Report	13160ANDBEL
Anschutz Minerals Corporation	Geophysical Survey, Chiquibul Project, Bz, C.A.	00/04/1978	1	Compilation of Maps of Belize	13180ANSGEO
Anschutz Corporation	Geophysical Survey, Chiquibul Project, Bz, C.A.	00/04/1978	1	Report-Working Assessment atChiquibul	13200ANSGEO

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Bryson, R.S. (Consulting Geologist)	Regional Geology Pet. & Mineral Potential of S. Bz.	00/02/1975	1	Report-Maps	13240BRYREG
Bryson, R.S. (Consulting Geologist)	Stratigraphy Problems of Northern Belize	00/12/1975	1	Report-Maps	13260BRYSTR
Bull & Ball & Co., Inc.	PreliminaryFlotationTesting of Barite-Silica Samples	00/10/1976	2	Report-Mineral Processing & Charts	13280BULPRE
Bull & Ball & Co., Inc.	Flotation Test Work on Barite-Silica Samples	00/08/1976	2	Report-Mineral Processing & Charts	13300BULFLO
Cole, Gregory L. (Project Geologist)	Geology & Economic Evaluations Including Explor...	00/04/1979	2	Exploration Results of 1978 Field Season	13320COLGEO
Cole, Gregory L. (Project Geologist)	Exploration Results of the 1979 Field Season	00/00/1979	1	Report of the Site Visit	13340COLEXP
Druecker, Michael D.	A General Evaluation of the Bladen Volcanic....	00/11/1976	2	Report- Charts	13360DRUGEN
Druecker, Michael D.	The Geology fo the Bladen Volcanic Series, South...	5/5/1978	2	Thesis- Maps, Pictures, Charts, etc.	13380DRUTHE
Flanders, Richard William	Geology of the Chiquibul Area, Bz, C.A.	00/05/1978	1	Thesis- Maps, Pictures, Charts, etc.	13400FLAGEO
Lefond, Stanley J.& Roghani, Foad	Belize Industrial Mineral Survey	30/07/1976	2	Summer Field Season - 1976	13420LEFBEL
Muncaster,Neil	Mineral Reconnaissance of Granites in the Maya.....	00/05/1976	2	Report- Charts	13440MUNMIN
Robinson, James E.	The Geology & Mineralogy of the San Luis Barite...	00/11/1976	2	Report- Maps, Charts	13460ROBTHE
San Pedro Environmental Committee	Report on Development of Southern Ambergris Caye	13/02/1992	1	Developmental Report	13470SANREP
Shaffer, Mark E.	Final Report	00/06/1976	2	Final Report on Area Studied	13480SHAFIN
Shipley, Webster E.	The Granite of Belize: A Comparative Study	22/11/1976	3	Report on Granites in Bz.	13500SHITHE
Thoreson, Ronald F.	A PreliminaryReport on theAlteration&Mineralization	20/01/1978	2	Annual Report-Geology of Area Studied	13520THOAPR
Williams Brothers Waste Control	Ground Water Data - Rancho Dolores Well	26/05/1972	1	Results of the Subject Water Samples	13530WILGRO
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Dunham,PeterS.(Dept.of Anthropology)	The MayaMountainsArchaeological Project(MMAP):...	28/02/1993	1	A Preliminary Report of the 1992 Season	13540DUNTHE
Dunham,PeterS.(Dept.of Anthropology)	The MayaMountainsArchaeological Project(MMAP):...	8/11/1993	1	A Preliminary Report of the 1993 Season	13560DUNTHE
Dunham,PeterS.(Dept.of Anthropology)	The MayaMountainsArchaeological Project(MMAP):...	10/12/1994	1	A Preliminary Report of the 1994 Season	13580DUNTHE
Dunham,PeterS.(Dept.of Anthropology)	The MayaMountainsArchaeological Project(MMAP):...	18/03/1996	1	Field Report of Season of MMAP (1995)	13600DUNTHE
Dunham,PeterS.(Dept.of Anthropology)	The MayaMountainsArchaeological Project(MMAP):...	00/00/1996	1	Field Report of the 1996 Season	13620DUNTHE
Flores, G.	Summary Report of the Preliminary Geol. Studies...	00/03/1952	3	Geological StudiesofNorth of 17deg.N.lat.	13640FLOSUM
Geology & Petroleum Department	Terminal Report-Project UNDP/BZE/87/003	none	1	Development of the Pet.&Min.Res.Of Bz.	13660GEOTER
Halliburton Geophysical Services, Inc.	Monthly Report for Vaalco Energy Inc.(Crew:1592)	00/02/1991	2	Charts and Bar Graphs	13680HALMON
Prodere Belize (CAM/89/023)	Progress Report for Period (July-December 1991)	24/02/1992	1	Annual Report	13700PROPRO
Raju (Consultant)	Mining & Processing Granite resources of Belize	00/00/1995	2	Preliminary Investment Study	13720RAJMIN
Rosholt, Bernt (Consulting Geologist)	Follow up Survey of Granites as Source of Dimen...	none	1	Survey Report-Pictures & Maps	13740ROSFOL
Souviron, Alvaro (Consulting Geologist)	Preliminary Survey of Industrial Mineral Pot. Of Bz.	00/01/1991	1	Survey Report-Maps	13760SOUPRE
Souviron, Alvaro (Consulting Geologist)	Gold ProspectingProgramSouthern Maya Mountains	00/01/1989	1	UNDP Mission Report	13779SOUGOL
Souviron, Alvaro (Consulting Geologist)	Gold ProspectingProgramSouthern Maya Mountains	00/06/1990	4	UNDP Mission - Follow-up Report	13780SOUGOL

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Author	Title	Date of Publishing	No. of Copies	Brief Description of Report	Serial Number
Belize Granites	Preliminary Project Proposal	none	1	Feasibility Study Granite Mining in Bz.	14000BELPRE
Belize Investments, Inc.	Granite Project Preliminary Report	9/2/1994	1	Feasibility Study Granite Mining in Bz.	14020BELGRA
Belize Mining and Development Ltd.	Punta Gorda Dolomite	00/08/1990	1	MiningVenture-DolomiteFertilizerforCarib.	14040BELPUN
Cornec, J.H. (Geologist)	Gold Potentials of the Maya Mountains, Belize	00/12/1986	1	Gold Exploration in Maya Mountains	14060CORGOL
Danish Hydraulic Institute	Mining of Off-shore Material and Prevention of.....	00/11/1993	1	In association with Lanka Hydraulic.....	14070DANMIN
Duncan R. Derry Ltd.	Report on British Honduras Project Special Exclus..	22/07/1968	1	SpecialExclusiveProspectingLicenceNo.1	14080DUNREP
Duncan R. Derry Ltd.	Application for Prospecting Licence	22/07/1968	1	Reportconsisting of Application for Mining	14081DUNAPP
Gall, Daniel G. (Dept.of Geology-N.Car)	Mineral Pigments of the Trio River, S. Area of Maya..	8/4/1993	1	Maya Mounts Archeo.Proj-Pics&Samples	14100GALMIN
Gall, Daniel G. (Dept.of Geology-N.Car)	Greenstones of the Trio River,S.Maya Mountains,Bz	5/5/1993	1	Maya Mounts Archeo.Proj-Pics&Samples	14101GALGRE
Garcia, E.(National Project Director)	Report on Bladen Volcanic Series Potential for Fert..	3/2/1988	1	Feasibility Study-Fertilizer Production	14110GARREP
Garcia, E.(National Project Director)	Viable Industries in the Belize Territory	none	1	Feasibility Study- Industries in Bz.	14111GARREP
Garcia, E.L.	Proposed Pilot Project Belizean Granites Mount.....	20/05/1994	1	Geology and Petroleum Unit	14112GARPRO
Gray, David A.	A Preliminary Report on Feasibility of Establishing...	00/09/1989	1	Report to GOB on GIS in Belize	14115GRAAPR
Hibbard, D.E. & Fitton, J.C.	Supplemental Geological/Geophysical Report.....	00/06/1995	1	N.Bz-Block1A(Reg.Relns.&Hydrocar.Pot.	14120HIBSUP
Johnston, H.(Mining Engineer)	A Report on the Ciebo Chico Gold Prospect	none	2	Ceibo Chico Gold Prospect	14140JOHARE
Mahler,Robert(Consulting Engineer Ltd)	Geotechnical Report	23/05/1986	1	Voice of America Radio Relay Station..	14160MAHGEO
Masters,C.D. & Paterson, J.A.	Assessment of Conventionally Recoverable Pet.Res.	00/00/1981	1	Volga-Urals Basin, U.S.S.R.	14180MASASS
Nair, K.M.	GroundwaterPossibilityinSantaElenaFarmersCoop....	14/05/1987	2	Groundwater Prospects in Cayo	14200NAIGRO
Ramanathan, R. & Graham, Brett	Report onQuartzVeinGold Prospects in Ceibo Chico	26/05/1989	2	Report on location given Maps, and more	14220RAMREP
Tectonica Minerals, Ltd.	Executive Summary & Descriptive Report	20/11/1991	1	LookoutCopper-ZincProsp(KendallDistrict)	14240TECEXE
None	Belize Mineral Project	none	1	Business Plan	14260NONBEL

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Bateson, J.H. & Hall, I.H.	The Geology of the Maya Mountains, Belize	00/00/1977	2	Book on the Geological Formations in Bz.	15000BATTHE
Bateson, J.H. & Hall, I.H.	Revised Geologic Nomenclature for Pre-Cretaceous	00/00/1971	1	New Field data suggest that Maya &.....	15010BATGEO
Bateson, J.H. & Hall, I.H.	Reconnaissance Geochemical & Geological Invest...	00/00/1970	4	Tables, Maps, Bar Charts, Graphs, etc.	15020BATREC
Binetti Michael	Rock Fertilizer and other low-cost methods to.....	00/11/1982	1	Low cost methods to Increase Crop Field	15030BINROC
Bowden, Peter	Reconnaissance Mission to Belize on Management..	24/07/1992	1	UNDP Report-Management Development	15040BOWREC
Bryson, Richard S.	Report on Southern Belize	10/9/1974	1	Westcoast Petroleum Ltd.	15060BRYREP
Burke, Kevin	Tectonic Evolution of the Caribbean	none	1	Copy of Book on Geology of Caribbean	15080BURTEC
Choi Dong Ryong&Holmes, Charles W.	FoundationsofQuaternaryReefs inSouth-Central Bz..	00/00/1982	1	Geological Notes	15100CHOFOU
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Cornec, J.H. (Geologist)	Note on the Provisional Geological Map of Bz. At....	00/12/1985	4	A Geological Study	15140CORNOT
Dawe, Steven E.	The Geology of the Mountain Pine Ridge Area &Rel..	00/00/1984	1	Geological Study- Pics, Maps, Charts	15150DAWTHE
Dengo, Gabriel	Problems of Tectonic Relations Between C.A.& Car..	00/00/1969	1	A Geological Study of C.A.& Caribbean	15160DENPRO
Dengo, Gabriel & Bohnenberger, Otto	Structural Development of Northern Central America	24/01/1967	1	A Geological Study of Northern C.A.	15180DENSTR
Dixon, C.G. (Government Geologist)	Geology of Southern British Honduras withNotes on..	00/00/1956	5	A Geological Sudy of S.Bz.-Pictures	15200DIXGEO
Dixon, C.G. (Government Geologist)	Geology & Scenery of British Honduras	none	1	Geological Photographs & Explanation	15220DIXGEO
Estay, Domingo(Mining Engineer)	Mission Report	00/07/1986	1	United Nations Report	15230ESTMIS
Flores, Giovanni	Geology of Northern British Honduras	00/02/1952	1	Geological Notes	15240FLOGEO
Flores, Giovanni	Summary Report of the Preliminary Geological Studies	Mar-52	1	Bahamas Exploration Co.	15243FIOSUM
Gallo, Jaime E.& Mueller, Harry W.	Structural, Stratigraphic & Facies Geology of S. Bz.	00/09/1976	1	Geological Study of S. Bz. By Esso Ven.	15260GALSTR
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Garcia, Evadne	Report onSeminarSmallScale Mining in a Surficial..	00/01/1987	2	Details of Seminar-Map, List of Contacts	15300GARREP
Garcia, E.L. Wade Garcia, E.	Towards Vibrant Belize Mining Sector	00/10/1995	1	First industrial mining seminar	15310GRATOW
	Mineral Resources of Belize	31/12/1989	1	Geological Report-Maps, Bar Charts	15320GARMIN
Garcia, E.(National Project Director)	Sand Report, Dangriga	30/03/1988	2	Site Visit Report	15340GARSAN
Garcia, E.(National Project Director)	Sand Report,Carmelita Village,Orange Walk District	6/3/1988	1	Site Visit Report	15350GARSAN
Garcia, Evadne	The Lime Industry of Belize, Country Paper, Bz.C.A.	none	1	Geochemical Report	15355GARTHE
Geology & Petroleum Department	Geological Notes	none	1	Compilation-GeologicalResearchMaterial	15358GEOGEO
Geophoto Services, Inc.	Memorandum Report-Photogeologic Evaluation of a..	2/9/1958	1	PhotogeologicEvaluation-Portion Brit.Hon.	15360GEOMEM
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Harkin, Daniel A.(Tech. Adviser)	Mission Report of Mr. Daniel A. Harkin,Tech.Adviser	14/09/1979	1	Detailed Duties of the Said Author	15400HARMIS
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None	Seminar on Industrial Minerals of Belize	00/00/1988	1	The Mines and Mineral Act (No. 14 1988)	16000NONSEM
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Lietzke D.A & Whiteside E.P.	Characterization of Classification of some Belize.....	00/04/1981	1	Field study in the Coastal Plain	15430LIECHA
McGinn, Ralph	Safety, Health & Reclamation Regulations for Mines	00/01/1993	2	Legislation (Draft-3) for Mining in Belize	15440MCGSAF
Nair, K.M. & Ramanathan, R.	Sedimentology Stratigraphy & Paleogreographic....	none	1	Study of an eighty metres thick quarry	15460NAISED
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Nair, K.M. & Garcia, E.	Report on the Investigation of Silica Sands	00/03/1987	9	Report on Silica Sands in Belize	15500NAIREP
Nair, K.M. & Cho, P.A.	Report on Reconnaissance Investigation of Silica...	00/07/1986	4	PossibleExportationofSilicaSandsfromBz	15520NAIREP
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Nair, K.M.	Report on the SEPM Research Conference on Spar..	30/08/1985	2	Research Conference in Cancun	15560NAIREP
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Ower, L.H. (Government Geologist)	The Silica Lines of British Honduras	00/00/1928	1	Extract-GeologicalMagazineVol.LXV1928	15580OWETHE
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Patterson, Sam H.& Murray, Haydn H.	Kaolin, Refractory Clay, Ball Clay, & Halloysite in...	00/00/1918	1	Geological SurveyProfessionalPaper1306	15620PATKAO
Pass Robert D.	A guide To Quarry Pratice in Belize	1/10/1974	1	Quarry Pratice in Belize	15625PASAGU
Perez del Castillo, Gonzalo	Petroleum & Mineral Resources Development	14/04/1989	1	Tripartite Review Meeting	15630PERPET
Ramanathan, R.	Extraction of Sand & Gravel from North Stann Creek	25/02/1991	1	Source Rock & River Deposits	15640RAMEXT
Rao, R. Prasada	Report on the Trail from Grano de Oro to CeiboChico	00/05/1988	2	Report to GOB-Progress at Ceibo Chico	15660RAOREP
Rao, R. Prasada & Gardiner, Clinton	Geological Work in Belize	00/00/1985	3	Details on the Geology of Belize	15680RAOGEO
Robinson, James E.	Geology&Mineralogy of the SanLuis Barite Prospect	7/12/1978	1	Book on the Geology of San Luis Barite	15700ROBGEO
Schuchert, Charles	Historical Geology of the Antillean-Caribbean Region	00/00/1935	1	Chapter 25 (Honduras&Salvador) of Book	15710SCHHIS
Shipley, Webster E.	Geology,Petrology,and Geochemistry of the Mount...	24/04/1978	1	Book-Geology of Mountain Pine Ridge	15720SHIGEO
Smith, Jennifer R.	Geology & Carbonate Hydrogeochemistry of the.....	00/00/1988	1	Thesis in Geology (Master of Science)	15740SMIGEO
Smith, Fay	The Geology of a 120km Sq Area in the Mountain...	none	1	Geology-Area of Mountain Pine Ridge	15760SMITHE
Souviron, Alvaro (Consulting Geologist)	Survey of the Industrial Minerals of Belize	00/12/1991	3	Reports consisting of Maps& Sketches	15780SOUSUR
Souviron, Alvaro (Consulting Geologist)	Preliminary Survey of Industrial Mineral Pot. Of Bz.	00/01/1991	1	Mission Report including Maps	15800SOUPRE
The Planetary Society Expedition	Brief Geologic Description of Chicxulub's Ballistic....	12/1/1995	1	The Planetary Society Expedition	15820THEBRI
UN DTCD (United Nations)	Applied Finance for Natural Resources	14/12/1991	1	Report of the Interregional Seminar	15840UNDAPP
UN DTCD (United Nations)	Gold Prospecting in the Southern Maya Mountains	00/00/1991	1	Project Findings and Recommendations	15860UNDGOL
U.S. Geological Survey	Development of Mineral, Energy, & Water Resour...	00/00/1987	2	Proceedings of Workshop Circular 1006	15880USGDEV
Vargas, Adolfo (Deputy Chief)	Report on the TPR Mission to Belize	20/05/1988	1	Mission Report by UN	15900VARREP
Walrond, G.W. Phd.	Report on the Review of the Mining Legislation of Bz.	15/10/1986	2	Legislation for Mining in Belize	15920WALREP
Walrond, G.W. Phd.	Mining Regulations & Mining Contract Negotiations..	00/08/1989	1	Mission Report by UN/TCD Consultant	15940WALMIN
Walrond, G.W. Phd.	Environmental Aspects of Mineral & Energy Devel...	9/6/1989	1	Natl. Conference on Env. & Development	15960WALENV

2.7 Natural Resources Department – Policy Coordination and Planning Unit, NIWRA and Hydrology Unit

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Interview Date: June 10, 2014

2.7.1 Organization and Mission

The primary role of the Policy Coordination Unit is to bring into operations the master plan for the development of the National Integrated Water Resources Authority (NIWRA) of Belize, in addition to supporting selected special initiatives related to water resource planning in the Country. The role of the Hydrology Unit is to support the Ministry, and ultimately the NIWRA, in the gathering, management and analysis of hydrology information.

The commencement date for the NIWRA is not yet declared. However, given the importance of water management in Belize, especially in consideration of the likely climate change adaptation and mitigation challenges, it was deemed important that the future organization and its proposed functions be represented in the BNSDI planning effort. Therefore, both existing and proposed functions and requirements are accounted for in this write-up.

At present this office has 6 staff. The following summarizes the existing staff contrasted against that which is proposed for the NIWRA. This is useful for considering what is in place relative to what is actually needed to support better water management in the future.

<u>Existing</u>	
Policy Coordination and Planning Unit	3
Hydrology Unit	3
<u>Planned</u>	
Total Planned Future Staff	24

Administrative Division			Hydrology/Database/Planning Division			Water Resources Management Division		
			1	BSc.	Principal Hydrologist	1	BSc.	Water Resources Engineer
			1	BSc.	Surface Water Hydrologist	1	BSc.	Water Rights Administrator
1	BSc.	Public Awareness Officer	1	BSc.	Water Resources Planner			
1	AA	Administrator/Finance	1	BSc.	Hydro-geologist			
			3	AS	Senior Hydrological Technician	1	AS	Senior Hydrological Technician
	AS	Clerk	1	AS	Data Analyst	1	AS	Paralegal Officer
			1	AS	Draughtsman			
	HS	Reception/Clerk	2	HS	General Technician	1	HS	General Hydrological Technician
			1	AS	Computer Operator			
1	AS	Clerk/Receptionist				1	HS	Clerk/Typist
1	HS	Clerk						
1	DP	Driver Mechanic	1	DP	Driver Mechanic			
5			**13**			**6**		

Table 4: NIWRA Future Staffing[5]

The staffs in this office are currently responsible for several primary activity areas that have some relevance to GIS and BNSDI. However, the implementation of the NIWRA is a national priority thus it is also important to note the functions that the Authority is to carry out in the future. For this reason both current and planned activities are considered here for the role that GIS can play in building the capacity of the NIWRA and its current and future engagement with the BNSDI. Distinction is made between existing and planned activities in the sections following:

Existing

1. Implement NIWRA Master Plan.
2. Process Water Abstraction Permits.
3. Collect and Manage Hydrological Data.
4. Conduct Special Projects.
5. Conduct Groundwater Resource Assessment
6. Conduct Water Resource Outreach

Planned

7. Obtain, compile, store and disseminate data concerning the water resources of Belize;
8. Exercise planning functions as provided for in this Act in relation to the Master Plan and Water Quality Control Plan
9. Allocate water resources in conformity with the provisions of the Act (NIWRA);
10. Protect and control the quality of water resources in accordance with the provisions of this Act
11. Provide to any department or agency of Government, at its request, technical assistance in respect of any projects, programmes or activities which relate to the development, conservation and use of water resources;
12. Take measures designed to raise public awareness of the importance or need for the wise use of water resources

[5] *Organizational Review and Institutional Development Consultancy (National Integrated Water Resources Authority of Belize) - organizational structure and staffing requirem*ent. Rudolph S. Williams Jr, 2013.

13. Perform such other functions relating to the management, protection, conservation and use of water resources as may be assigned to it by or under this Act or any other enactment
14. Provide Technical Assistance to any Government Development, Conservation and or Water Resources Projects

2.7.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.7.2.1 Implement NIWRA Master Plan

The Policy Coordination and Planning Unit is responsible to bring the NIWRA Master Plan to reality. The following summarizes the purpose and functions of the proposed organization, and a general description of the approach that has been planned to implement it.

The Charter for NIWRA stipulates the functions, tasks and organizational structure of the National Integrated Water Resources Authority as mandated in the National Integrated Water Resources Act. The National Integrated Water Resources Authority (the Authority) is the successor to the National Pro Tempore Water Commission. The Authority is an autonomous statutory corporate body with perpetual succession, a common seal, bank accounts, and whose authority applies to control, conservation, and proper uses of water resources in Belize. Its operational expenses are from the State and any other lawful sources.

The Government of Belize in line with its approved Water Resources Strategy and Action Plan, ACTION 12: "Establish an agency to execute integrated water resources management", and after further modifications of the 2005 Cardona recommendations and in line with its policy3 decided to "Establish a permanent National Water Commission with responsibility for integrated water resources management, control and coordination, acting upon the interests of all stakeholders and adaptation measures necessary in response to climactic changes." The Purpose of the Authority is specified in subsection 15(1) of the NIWRA (The Authority) "…is to enforce the policy of the Government for the orderly and coordinated development and use of Belize's water resources, to conserve and protect such resources for the benefit of present and future generations of Belizeans, and to provide the Belizean public with a safe, adequate and reliable supply of water."

The Goal of the Authority is to coordinate its activities with any person, organization, agency, Department of Government, Local Authority, and to undertake any appropriate studies, investigations and consultations with the objective of facilitating the implementation of the water policy of the Government of Belize. The specific goals and objectives will be

established during the preparation of the National Master Water Plan. The general goals are listed in Table below.

Goal	Objective
Water Resources Development, Conservation And Use	Economic efficiency, The protection of the health, safety and welfare of persons, The promotion of a sustainable utilization of water resources The protection and enhancement of environmental values
Water Resources Assessments	Identification of water resources the occurrence, Determination of water quantity, Determination of water availability Description of quality of water Identification of current uses of water; Identification of activities which are dependent on, affected by, or related to water and its uses;
Future Water Demand Assessments	Recommendation of water development projects and programmes Control of water abstraction Control of water storage Management of water supply, distribution, drainage and disposal
The Protection of Water Resources	Management of water drainage and disposal Control of ground water Control of well drilling Establish, adopt or modify water effluent quality standards Prevention of contamination or pollution of the water Maintenance of environmental flows and safe yields of any aquifers
Develop Strategies for Integrated Water Resources Management	Proper cost analysis and budgeting, Preparation of a plan of action and timeframe, Prioritization and implementation of water uses, Coordination of water stakeholders activities Management of water rights Management of water allocations

Table 5: NIWRA Goals and Objectives[6]

In advancement of official NIWRA commencement the Policy Coordination and Planning Unit is doing what it can with its limited staff to ensure that the Ministry is prepared to undertake the transformation to a full operational Authority. This has included the continued operation and of functions described in sections following, and refinement of the procedures, criteria and record keeping in keeping with those recommended for NIWRA.

Once the NIWRA commencement has been decided, the current plan suggests a 49 month implementation that includes the following increments that are relevant to the expansion of the new Authority's GIS capabilities and its engagement with the BNSDI community.

[6] *Organizational Review and Institutional Development Consultancy (National Integrated Water Resources Authority of Belize) – Draft Organisational and Operational Charter*. Rudolph S. Williams Jr, 2013.

Activity	Timing	GIS/BNSDI Relevance
NIWRA Administration Appointed, Office staffs hired and basic administration mobilized	Month 1	Computing infrastructure will need to be designed and implemented to support the commencement process. This should include consideration of GIS and BNSDI related infrastructure that will be required.
TOR's for National Water Plan and National Water Quality Control Plan Completed	Month 1	TOR's should clearly state what relevant data and information is already available to support the planning efforts, as well as provide or require specifications for data to be developed during the planning exercises.
Hydrologist and Data Analyst staffs hired	Month 1	Computing infrastructure, including GIS and linkage to BNSDI should be established immediately to support commencement of technical activities.
General Technicians local training	Months 1 - 6	Initial computing infrastructure setup including GIS should consider expansion requirements for the first 12 months of commencement.
Funds for the two National Plans identified	Month 2	Funding should consider the utilization of existing data where possible to avoid unnecessary data collection costs.
Additional technical staffs hired	Months 2-7	Initial computing infrastructure setup including GIS should consider expansion requirements for the first 12 months of commencement.
Consultants for the two National Plans commissioned	Month 3	Consultant teams should be provided with full access to the existing data to support the planning efforts.
Two National Plans approved by Cabinet/National Assembly	Month 12	Good executive outreach opportunity to stress the significance of GIS and BNSDI to the streamlining and strengthening of the plan development process.
Two National Plans implemented	Months 13 - 49	Important to engage BNSDI stakeholder community in the process for establishing standards for data to be produced during the planning efforts.
Final technical staff added to roster	Months 25 - 30	Computing infrastructure planning should consider expansion requirements for the 2nd and 3rd years of commencement.

Table 6: NIWRA Commencement Plan and GIS/BNSDI Relevance

The development and operations of NIWRA will require close coordination and collaboration with other agencies that have mandate for some aspects of water resource management in Belize. Those institutions requiring Authority – Ministry/Department coordination include the following:

1. Land Utilization Authority
2. The Forest Department
3. Office of Mines
4. The Geology & Petroleum Department
5. The Public Health Bureau
6. Housing and Planning Department.

Table 7: Institutions requiring Authority – Ministry/Department coordination

The effective operation of NIWRA and strengthening of water resource management across Belize will require structural, operational and technical reform, coordination and alignment. The NIWRA master plan describes several recommendations for enhanced functioning of water resource entities that have specific relevance to the use of geospatial technology in the organization as well as its engagement within the BNSDI. As stated in the Plan, "Water resources management under the NIWRA was designed to ensure a holistic management approach and to facilitate the coordination of initiatives by different stakeholders. Strong motivation is required to break down what is often referred to as the silo effect, or the tendency of institutions to take decisions with regard only to their own mandates and authority, without reference to those of other organizations. The NIWRA mandates cooperation, coordination among water resources stakeholders with the view that water resources management will be more effective and efficient compared with previous approaches".

Furthermore, the Plan states "Effective resource management requires accurate information as a basis for planning, implementing and monitoring resources. However, proper water resources management demands a wide range of hydrological and related information, which may not be easily available. In order to obtain such information, water resources management institutions such as the Authority needs to establish partnerships or strategic alliances with complementary institutions".

It goes on to point out that "The Hydrology Unit, The Department of the Environment, the National Meteorological Service, the Public Utilities Commission, and the Ministry of Health maintain separate databases on water resources quantity and quality data. Such data for the most part are spatially exclusive, and generally unavailable to other water stakeholders. Combining all available data will extend the spatial coverage and expand the Authority's database. Other contributing Agencies/Institutions will be provided with the data generated by the Authority consequently, de facto backup of data across institutions and in separate locations will occur routinely."

Recommendations with specific relevance to GIS and BNSDI are listed in the following table.

Recommendation	GIS/BNSDI Relevance
The Authority should become the main repository for water resources data and the single source for comprehensive water resources data	Geospatial dimensions of hydrological data should be considered an integral component of the repository. It will be necessary to determine what specific fundamental geospatial data sets (FGDS) the NIWRA should be the primary custodian for within the BNSDI.
Standardization of the methodology removes the need for data transformations; consequently data become readily available for real-time analyses and decision making. The use of data to inform comparative analyses requires that sampling be conducted using	The need for standards that are relevant to the use of all the primary stakeholders is key. This becomes even more significant when the use

equipment with similar tolerances and resolutions. The sampling procedures and custody of samples are vital to the accuracy of analyses. Analyses procedures should be comparable if data from different sources are to be combined in one analysis. The absence of standard methodologies will require transformations to make data from multiple sources usable for analyses. Such transformation may lead to loss time in the case of emergency events and additional costs.	of the data external to the water resource sector is considered (flood control, tourism, biodiversity protection, etc.).
The methodology for data collection should be standardized across Agencies	This applies to any geospatial data as well as associated statistical information.
Institutions are bombarded by commercial providers of water resources monitoring devices, the result varying quality of water resources monitoring devices are employed across Agencies. While this situation may not be an issue if the accuracies are similar, data provided by devices with dissimilar accuracies can introduce uncertainties in water resources analyses.	This applies to any geospatial data as well as associated statistical information.
Water resources monitoring devices should, in as much as is possible, have similar accuracies. In the event that such is not the case sharing of equipment should be encouraged	Device specifications and associated information is an important metadata component within any data federation. This is not reflected in the existing geospatial metadata standards.
Various water resources institutions have their institutional directives, goals and objectives consequently, the design of monitoring networks vary accordingly. Oftentimes the monitoring sites and parameters are identical resulting in duplication of results and inefficient use of resources. Joint operation of water resources monitoring networks addresses the data consistency, reliability and accuracy issues. In addition, it removes duplications, introduces economic efficiency and expands the monitoring coverage and increases efficiencies.	Alignment of data collection projects and permanent sensor and measuring networks across special interest groups is critical to the BNSDI in all sectors, including water.
The joint operation of water resources monitoring networks is recommended.	Alignment of data collection projects and permanent sensor and measuring networks across special interest groups is critical to the BNSDI in all sectors, including water.
Water resources management and Geographic Information Systems software are prohibitively expensive and are essential to accurate water resources analyses. The joint purchasing arrangements for water resources management software provides lower acquisition, maintenance, support and update costs while providing a cadre of trained personnel across the cooperating institutions.	Technology costs can be mitigated, for example through the use of open source software or through arrangements such as the government-wide enterprise GIS licensing arrangement presently being established by CITO.
Joint purchasing arrangements for water resources management software across cooperating agencies.	Ditto above
Water resources management equipment is constantly providing greater monitoring, communication and sampling capabilities. Similarly the costs are constantly on the rise. Acquisition costs can be significantly reduced if such instruments are purchased in bulk for all cooperating institutions	Ditto above
Cooperating Institutions should make arrangement for joint purchasing of instrumentation	This principle is applicable to other sectors of the BNSDI where sensor

	network data gathering is considered.
Water resources monitoring device frequently require expensive laboratory recalibrations. Proper instrument calibration is necessary to ensure that the data collected are within the tolerances of the instrument design specifications. It reduces the likelihood of collection of erroneous data that may misinform analyses on the feasibility of development projects. Instrument calibration costs can be minimized if the cooperating institutions use the same calibration laboratories.	This principle is applicable to other sectors of the BNSDI where sensor network data gathering is considered.
Cooperating institutions should make every effort to use the same instrument calibration laboratories.	This principle is applicable to other sectors of the BNSDI where sensor network data gathering is considered.
Emergency Management Organizations are generally response mechanisms that attempt to mitigate the impact of disasters and to alleviate suffering of those who are negatively impacted. These organizations seldom operate monitoring networks for natural phenomenon, consequently the effectiveness their responses are dependent on the timing of the notice of disasters, such as floods, drought, and contamination of public water supplies.	Alignment with NEMO information and communications systems.
The Authority and the National Emergency Management Organization should establish formal structured system for the communication of flood forecasts, occurrence and severity of droughts and pollution of water resources.	Alignment with NEMO information and communications systems.
National Meteorological Services and National Hydrological Services are the major institutions that generate the bulk of water-related climate data. The Authority is legally obligated to subsume the Hydrology Unit and to assume all its functions. In the interest of accurate engineering investigations for decision making on development projects as well as for early warning systems for disaster response, a formal mechanism is required for the in real-time routine sharing of data and information between these institutions.	Alignment with Hydromet information and communications systems
The Authority and the National Meteorological Service should establish formal arrangements for routine in real-time sharing of water resources, weather, and climate data.	Alignment with Hydromet information and communications systems
The Authority has legal functions that are of primary concern. Attention to the details of the various effects of hydrological cycle on the local, national, and regional communities will seldom get a passing glance from the Authority. There is the opportunity to engage the local universities and regional organizations to partner with the Authority in the development of programs for the investigation of the changing effects of the hydrological cycle on said communities	This can impact many stakeholders across multiple sectors, and should be considered in the alignment of the BNSDI in regards to climate variability and impacts.
The Authority should approach the local universities and regional organization to foster collaborative research and development on water resources issues.	This principle is applicable to all other sectors and should include GIS and BNSDI components.
Staffing level within the water resources sector is very inadequate and lacking in expertise. Whilst some institutions have sufficient adequate amount and expertise, few if any, have excess staff and are unwilling to release any staff member. The Authority's core technical institution has the least adequate staffing level and most lacking in expertise. The contracting of consultants with the required level of expertise may be an interim solution for the staffing situation or short term secondment	This may be true for initial GIS capabilities and engagement of the early NIWRA with the BNSDI, although every effort should be made to build on existing technical capacity and capacity in the Country.

of existing staff trained in disciplines other than water resources at the required level but with training some aspects of water resources.	
The Authority should pursue short term secondment of existing staff trained in disciplines other than water resources at the required level but training but with some aspects of water resources and or contract consultants with the required level of training.	Ditto above
The Institutions that have the greatest potential to improve the efficiency of water resources Management in Belize are: a) the National Integrated Water Resources Authority, b) the Department of the Environment, c) the Department of Agriculture, d) the Forests Department Draft Organizational Review and Institutional Development Consultancy (National Integrated Water Resources Authority of Belize) e) the Public Health Bureau, f) the Public Utilities Commission, g) the National Meteorological Service, and h) the Department of Geology & Petroleum The water resources related monitoring and investigations conducted by these institutions require similar data and methodologies, common standards as well staff expertise.	There will be a need for both a special interest group to address the detailed technical data requirements across those organizations involved directly in water resource management. This group will also need to interface with others in the BNSDI community who require hydrologic data but at a less specialized level.

Table 8: NIWRA Recommendations Relevance to GIS/BNSDI

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Conduct and record a comprehensive inventory and assessment of water resources and associated infrastructure in Belize
- Maintain water rights, allocations and relevant jurisdictions database
- Establish inventory of all permitted emissions and sources of water pollution
- Establish inventory of all water abstraction and related use permits
- Establish and manage suitable hydrologic monitoring network
- Establish direct data sharing linkages with National Meteorologic Office
- Conduct and record a comprehensive inventory and assessment of current and projected demand for water resources
- Assess potential affects of climate change on water resources
- Prepare spatial masterplan for the development and sustainable management of water resources
- Identify and formulate water resource development projects

2.2.1.1 Process Water Abstraction License

The Policy Coordination and Planning Unit is currently responsible for administering the process of reviewing and issuing water abstraction license. This includes any water to be abstracted from groundwater, surface water or the sea. The current system was established three years ago under a European Union, Global Climate Change Alliance Initiative Project

implemented by the United Nations Development Program. The Unit processes each water abstraction license application and conducts an assessment along with the NIWRA Licensing Officers. This team then makes recommendations that are passed along to the Minister in order to make a final decision on license approval or refusal.

The process starts with an application being submitted by a facility or property owner or their agent. The information to be submitted in an application is set by the Ministry. Information that is most relevant to GIS/BNSDI includes:

- Owner Name,
- Owner Address (Street, City, District, Country, Region),
- Watershed Name, Stream or River Name (surface abstraction),
- Groundwater Province Name, Well Name and Well GPS Coordinates (groundwater abstraction),

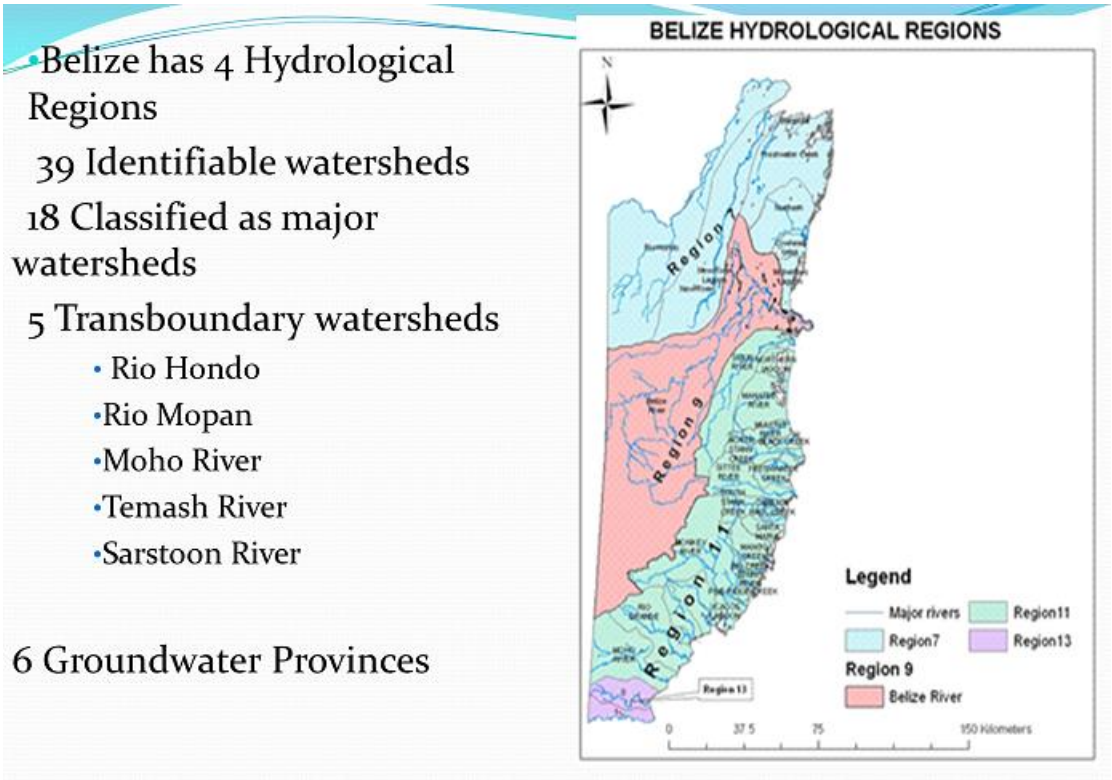


Figure 9 – Groundwater Provinces of Belize[7]

- GPS Coordinate and Location Map,
- Business Tax Number (if a business),
- Purpose,
- Method of Abstraction,
- Volume of Expected Abstraction,
- Peak Abstraction Rate,

[7] http://pdf.usaid.gov/pdf_docs/PNAAQ597.pdf.

Once an application is submitted, the Unit staff creates a paper case file that will be used to organize all subsequent transactions and communications. Each case file is identified by District, Year, and a chronologically assigned Sequence Number within that year. These are then organized to binders for each type of abstraction, as illustrated in the Figure below.

Figure 10 – Paper Water Abstraction License Case Files

Once an abstraction application has been submitted, Unit staff along with Officers from other water stakeholder ministries or organizations conduct a site visit. The site visit is based on a standard checklist to ensure uniformity of issues addressed and information collected. Those elements that are most relevant to GIS/BNSDI include:

General Information

- Site Location (GPS, address)
- Site Owner
- Site Walkover Date
- Site Topography
- Current Use of Site
- Abstraction Source (Marine, Groundwater, Surface Water)

Identification of Site Location

- Residential, Agricultural, Industrial, Reserved Area, Recharge Area, Other

Visual Inspection

- Unpleasant odor of nearby surface water
- Strange Surface Water odor
- Unpleasant odor in wells

- Stressed vegetation
- Well Casing built to specification as per regulations (height, width, etc.)
- Abandoned well (s) on site, decommissioned according to regulations (GPS coordinates)
- If No, observations open, contains garbage, possible decommission options

Study of Surroundings/Site

- Identification of any potential pathways for contamination
- Land used for agricultural or residential purposes
- Identification of potential contamination receptors (population, ecosystems, etc.

Inspection of Past/Present Installations

- Site layout plans (storage tanks, storage areas, production structures, etc.)
- Monitoring Data (including quantity & quality, well logs)
- Adequacy of existing structures
- Adequacy of new structures

Potential Pathways

- Surface Cover (hard standing, landscaped/grassed areas, rough vegetation/trees)
- Potential for Surface Water infiltration
- Underground Services (sewers, drainage systems, etc.)

SECTION A – WATER RESOURCES

Surface Water Abstractions

- Presence of Signage at the site
- Distance of Abstraction pipes from shoreline, riverbank, etc.
- Abstraction volumes affect sediment flow

Marine Water Abstractions

- Abstraction point located adequately offshore to avoid danger to recreational users
- Method of waste disposal (concentrated brine) distance from shoreline?, in deep water?
- Construction and Depth of well adequate enough to avoid salt water intrusion/contamination

Groundwater Abstractions

- Abstraction volume adequate to allow recharge, rate of abstraction
- Well construction and development in compliance with those stipulated in Act (from well logs)
- Permission to abstract water from land owner if not owned by licensee
- Well site location near possible contaminant pathways

SECTION B - ENVIRONMENT

- Activities for which water will be used requires environmental clearance.
- Abstraction activities will require the clearing of land.
- Effluents will be produced after water usage.
- If produced, effluents will be treated.
- Provide brief method to be used for water abstraction

- Describe proposed uses of water that will be abstracted
- If effluents are produced, provide description on methods for effluent treatment
- If effluent are produced, provide GPS coordinates and general description of discharge points

SECTION C - HEALTH

Distance of abstraction site from the following: (check appropriate box)

- Sewer line
- Other fecal waste disposal facility
- Septic tank
- Animal enclosures
- Latrine
- Solid waste disposal site
- Leach field
- Hazardous site
- (Underground/aboveground chemical storage tank, cemetery, effluent lagoon, wastewater injection well)
- Distance from abstraction site to inhabited area or community
- Location of other well on the site
- Location of creeks, ponds and drainage area
- Description of topographic features of area (slopes, swales, etc.)

Once the site visit has been conducted, the individual Licensing Officer submits his report to the Policy Coordination and Planning Unit who then collects all such reports in order to compile the information and their recommendation for submission to the Minister. This Committee comprises representation from the water resource management entities listed earlier, but may also require recommendation from Village, Town or City Council. So far, the Unit has licensed 6 businesses.

In the future, the Unit personnel intend to conduct operational compliance checks on approved abstraction sites, however this is not currently being done on a regular basis due to current staff shortage.

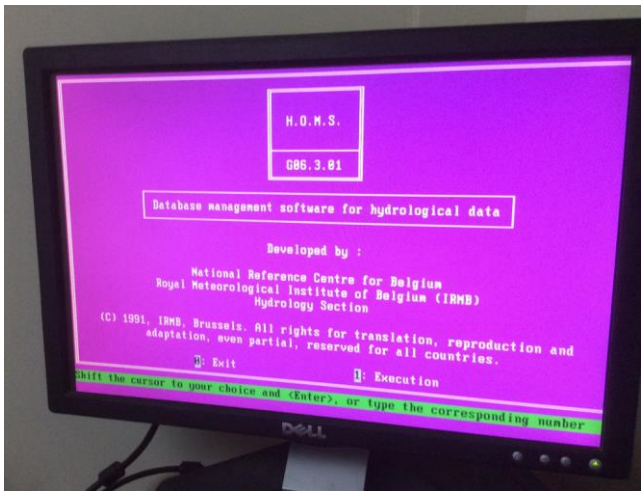
At present, all the water abstraction case files are maintained in paper files. There is a simple registry of the submitted applications maintained in an Excel spreadsheet, but this only includes a basic listing. GPS coordinates are not presently captured in a form that can be used to generate a map of the water abstraction proposed or approved locations. There is an intention to move to a digital system as part of the NIWRA commencement and Unit personnel are very interested to incorporate GIS into that process.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Define watershed boundaries at multiple levels

- Provide access to Person and Business registries for authentication purposes
- Log and manage water abstraction license applications
- Monitor and analyze water abstraction licenses and operational reports by groundwater basin, watershed and stream
- Provide access to relevant environmental, social, health, hazard and infrastructure information contextual to a water abstraction license application
- Provide map interface linkage for accessing water abstraction license case files
- Monitor and assess climate and precipitation trends and impacts on water resources

2.7.2.2 Collect and Manage Hydrological Data



The Hydrology Unit was originally established as a Unit under the National Meteorological Service of Belize and has undergone several transformations and various administrative arrangements. Currently, the Hydrology Unit is housed at the Ministry of Natural Resources. The NIWRA Act mandates that on the date of commencement the whole of the undertaking of the Hydrology Unit together with all, staff, materials, appliances, equipment and apparatus used for, by or in connection with the Hydrology Unit will be incorporated into the Authority.

In the meantime, the Hydrology Unit continues to collect and manage a variety of hydrological information for the Country. This includes the collection and management of water level and discharge information from 28 monitoring stations covering 17 of Belize's 35 rivers. 4 of the existing monitoring stations have automatic recorders but do not transmit the information and the information has to be downloaded manually at each station periodically. The other 24 stations are read manually twice a day, at 6:00 AM and 6:00 PM. Time chosen because of daylight hours and equal time intervals. Readings are taken by locally trained hydrological observers that have been trained by the Unit to make the required measurements.

The Unit also does discharge measurements to determine the stage-discharge (H-Q) relationships for points along the river. Rating curves for some stations were developed during the expansion of the monitoring network. Since the expansion, there has been an insufficient number of discharge measurements to validate and or update the existing rating curves.

All the hydrological data captured each day is being entered to the Hydrologic Operational Multipurpose System (HOMS) established by the World Meteorological Organization for the transfer of technology in hydrology and water resources. This technology includes

descriptions of hydrological instruments, technical manuals or computer programs, material which has been made available for inclusion in HOMS by the Hydrological Services of member countries of WMO from the techniques which they themselves use in their normal operations. This is an important aspect of the HOMS philosophy in that it ensures that the technology transferred is not only ready for use but also works reliably.

At present the Hydrology Unit is utilizing selected components of HOMS focused on water level and discharge levels for selected rivers. The component of HOMS being used by the Unit is a DOS-based data recording system. The coordinate locations for each monitoring station have been used by the MNRA LIC to map these locations. While the Unit is not utilizing GIS in its day to day operations, it wishes to do so in the future to be able to better assess and support water resources management in Belize.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Conduct a geographic assessment of current hydrologic monitoring network and identify requirements and gaps for additional stations, and upgrading of key stations to automated reading and data transmission
- Provide access to topographic, hydrographic, soils, land use/land cover and other information needed to understand behaviors of the hydrological systems
- Collect, manage and model hydrologic data
- Establish real-time linkage to National Meteorological Office weather data stations for active monitoring

Figure 11 – Hydrology Monitoring Point Locations in GIS

2.7.2.3 Conduct Special Projects

The Policy and Coordination Unit support special projects that fall within the thematic mandate of the future NIWRA. Currently this includes preparations for the development of a National Action Program aligned to the United Nations Convention to Combat Desertification (UNCCD) 10 Year Strategy and Reporting Process. Belize ratified the UNCCD on July 28 1987. Since then, several important efforts were made in the country towards the implementation of the Convention. However, the country still lacks a National Action Program (NAP).

Belize submitted its First National Report to UNCCD was prepared in 2000. Nevertheless, the collection of data for reporting purposes lacks homogeneity and collaboration among relevant institutions needs to be strengthened by introducing a framework system of data collection and sharing.

While over 60% of Belize's land surface is covered by forest, recent studies indicate that some 20% of the country's land is covered by cultivated land (agriculture) and human settlements. Savannah, scrubland and wetland constitute the remainder of Belize's land cover. Important mangrove ecosystems are also represented across Belize's landscape. As a part of the globally significant Mesoamerican Biological Corridor that stretches from southern Mexico to Panama, Belize's biodiversity – both marine and terrestrial – is rich, with abundant flora and fauna

The main problems related to the land degradation/destruction of soil and loss of productive agricultural lands are: (i) destruction of soil caused by exploitation of raw materials, (ii) hurricanes, (iii) construction of residential, (vi) industrial and other facilities pollution, (v) increase in soil acidity/salinity(vi) erosion, and (vii) intense and non-balanced development of certain sectors. Key barriers to achieving Sustainable Land Management in Belize are: (i) insufficient monitoring and enforcement of regulations, (ii) lack of a soil/land informational system, (iii) insufficient data management, (iv) insufficient inter-agency collaboration, (v) lack of implementation of rehabilitation and remedial measures, (vi) low level of awareness regarding the significance of soil and land for sustainable development and survival of the population, low level of land use planning, lack of land maps that would serve for better physical and land use planning, (vii) poverty.

The development of NAP to combat land degradation and its integration into the National Development Strategy, and other relevant national strategies and documents in Belize was highlighted in the First National Report on the implementation of the UNCCD, as one of the urgent measures in addressing the problem of land degradation. The project will put an emphasis on the activities aimed at supporting mainstreaming NAP recommendations into relevant national strategic documents.

The preparations of the First National Action Plan will require the setting-up of a National Coordination Body (NCB) as part of this process. The NCB will coordinate interdisciplinary and inter-ministerial efforts to run the forthcoming implementation UNCCD activities under

the National Strategies of Belize and the obligations deriving from it. The key national stakeholders which will be closely involved in the project implementation will include relevant departments of:

- Policy Coordinating and Planning Unit, Ministry of Natural Resources and Agriculture.
- Ministry of Forestry, Fisheries and Sustainable Development
- Ministry of Finance and Economic Development
- Ministry of Labour, Local Government, Rural Development, NEMO and Immigration.
- Ministry of Housing and Urban Development.
- Youth development Organizations.
- Gender empowerment organizations
- Other Non-Governmental Organization/s selected after public announcement.

Numerous other public and professional institutions will be represented in the National Coordinating Body and will therefore contribute their respective field in mainstreaming the land degradation issues and directing the process.

The following table summarizes the key activities to be conducted in this project, and the relevance to GIS and the BNSDI.

Project Activity	Relevance to GIS/BNSDI
Advocacy, awareness raising and education activities. In order to properly address the issue of land degradation, it is necessary to increase the level of awareness about anthropogenic causes of land degradation, at both local and national level.	Opportunity to utilize GIS maps and visualizations to communicate land degradation issues to the public in clear and compelling ways. In parallel it will be beneficial to highlight the technology and the BNSDI initiative and their significance in addressing these very critical national issues, in the website and media outreach. Publish compelling map and statistical reporting graph to raise awareness of water issues to policy makers and the public Conduct population demographic analysis to customize outreach to particular socioeconomic communities in specific environments
Policy framework development. The assessment of policy, institutional, financial and socio-economic drivers of land degradation and barriers to sustainable land management will be prepared within the project, along with appropriate measures to remove these barriers.	Demonstrate the policy relevance of GIS and the BNSDI through the NAP policy framework development process. Highlight this matter to national and international stakeholders and donors.
Science, technology and knowledge activities. National monitoring and vulnerability assessment on biophysical and socio-economic trends will be carried out. In order to improve knowledge on biophysical and socio-economic factors and on their interactions in affected and enable better decision-making by relevant national authorities the results of the findings	Demonstrate the application of GIS and the BNSDI to the scientific process, and in communicating the substance and results of this process to decision makers.

will be communicated to the state-level public officials, especially those dealing with the relevant sectors for sustainable land use management.	
Financing and technology transfer. Development of an integrated investment framework for leveraging national, bilateral and multilateral resources with a view to increase the effectiveness and impact of interventions. Development of a strategic plan to improve Belize's capacity to mobilize financial resources from international financial institutions, facilities and funds, including the GEF, by promoting the UNCCD/Sustainable land management (SLM) agenda within the governing bodies of these institutions.	Incorporate GIS capacity building into the process and highlight the importance of this capability to the national, bilateral and multilateral governing bodies.
Revision and validation of the NAP by national bodies. The NAP document will be submitted to the Government for adoption. In addition, all relevant documents, such as NAP, assessments, papers and policy papers will be made available through internet tools and events to be organized in the country particularly at community levels.	Leverage web-based interactive mapping to support the communication of the NAP to all levels of government and the public.
Reports preparation through participatory process. Establishment of an administrative and institutional framework and technical base line for the long term national reports preparation and elaboration. Identification, collection and analysis of data on mechanisms and activities related with the UNCCD implementation, as well as of all stakeholders that could influence the process.	Incorporate GIS as a fundamental tool for capturing, managing and assessing monitoring information relative to baseline, and communicating the results to all the stakeholders.

Table 9: UNCCD/NAP Activities and Relevance to GIS and BNSDI

Other important points to consider in how GIS and the BNSDI can support this project. There currently exists a variety of data through the MNRA LIC and others within the BNSDI community that will support the development of this project, thus avoiding some data capture costs. Also it will be important to consider how data collected to support this project can provide baseline information for NIRWA and for use by others in the BNSDI.

UNEP/GEF is the project's Implementing Agency for this project. In its role, UNEP/GEF shall provide project oversight to ensure that GEF policies and criteria are adhered to and that the project meets its objectives and achieves expected outcomes in an efficient and effective manner. Other related projects that UNEP has supported in Belize have included:

- Environmental Outlook for Belize.
- Emission Profile for Belize.
- Mesoamerican Biological Corridor project.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Utilize GIS maps and visualizations to communicate land degradation issues to the public in clear and compelling ways
- Conduct analyses in support of policy formulation and refinement processes
- Utilize geospatial data and methods for original and applied research

- Utilize geospatial data and analysis to support water resource and related development planning, design, operations, monitoring and evaluation
- Provide a map interface for the access of water resource information, plans and license information by geographic area or location
- Utilize GIS to conduct special services for government and other sectors

2.7.2.4 Conduct Groundwater Resource Assessment

In 2013 a groundwater assessment consultancy supported by the UNDP was announced, tendered and awarded. The overall objective of the consultancy is to support the Government of Belize, Ministry of Natural Resources and Agriculture in completing an assessment of Belize's groundwater resources in the southern coastal water province of Belize referred to as the Savannah Groundwater province. The Consultant is providing expertise in conducting a hydrological assessment of existing ground water resources and associated supporting water catchment grounds and to the extent possible determine the extent of ground water resources degradation based on past and current land use practices as well as provision of estimates of the ground water potential in the delineated region.

Main deliveries include the classification of the hydro-geological characteristics of the province, a definition of its boundaries, the provision of an aggregated overview of the current groundwater potential, and an integrated groundwater assessment study which is to serve as the basis for regional groundwater development master plan. Although needed for the whole Savannah Province, this assessment study is initially focusing on those areas which support growing population centers as well as those areas which are expected to support large expansions in the various developmental sectors including tourism, agriculture and aquaculture. For those areas supporting population centers a more detailed assessment of the spatial and vertical extent of the groundwater quality and quantity is required as a means of determining the feasibility of utilizing groundwater resource as an alternative for water supply options in the light of climate change.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Develop geohydrologic model for Belize
- Monitor groundwater levels, quantity and quality

- Conduct groundwater modeling and assessment
- Conduct groundwater assessments by geohydrologic basin
- Publish maps and statistical reports regarding groundwater conditions and trends

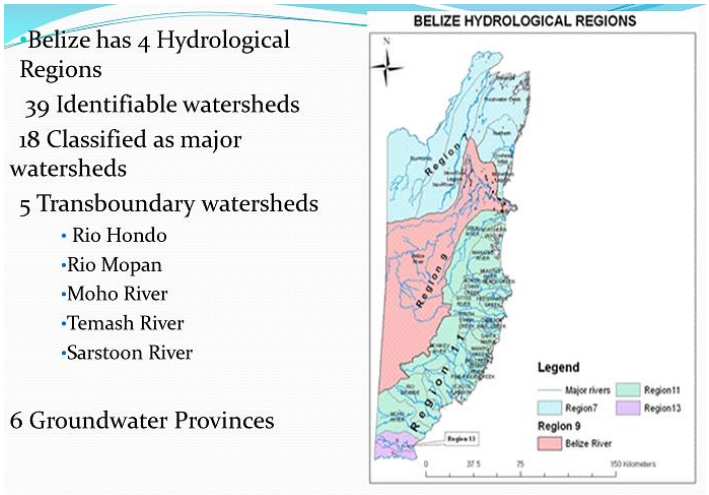
2.7.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions:

Water Abstraction Case Files. Water Abstraction Case Files are maintained by the MNRA Agriculture Department, Policy Coordination Unit. These files contain applications for water abstraction permits, as well as all supporting documentation and communications. Each case file is identified by District, Year, and a chronologically assigned Sequence Number within that year. These are then organized to binders for each type of abstraction.

The MNRA Agriculture Department Hydrology Unit is utilizing selected components of the Hydrologic Operational Multipurpose System (HOMS) recording water level and discharge information for 28 monitoring stations covering 17 of Belize's 35 rivers. 4 of the existing monitoring stations have automatic recorders but do not transmit the information and the information has to be downloaded manually at each station periodically. The other 24 stations are recorded manually twice a day, at 6:00 AM and 6:00 PM. The coordinate locations for each monitoring station have been used by the MNRA LIC to map these locations.

Hydrological Regions of Belize. The coding of the Hydrological regions of Belize conforms to the recommendations of the Central American Hydrological Project (PHCA), which is, that every main water course draining to the Atlantic Ocean gets an uneven number starting from the north.



2.7.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

Hydrological Operational Multipurpose System (HOMS). All the hydrological data captured each day is being entered to the Hydrological Operational Multipurpose System (HOMS) established by the World Meteorological Organization for the transfer of technology in hydrology and water resources. This technology includes descriptions of hydrological instruments, technical manuals or computer programs, material which has been made available for inclusion in HOMS by the Hydrological Services of member countries of WMO from the techniques which they themselves use in their normal operations. This is an important aspect of the HOMS philosophy in that it ensures that the technology transferred is not only ready for use but also works reliably. Only a selected portion of the full HOMS suite is being used in Belize presently.

All the hydrological data captured each day is being entered to the Hydrologic Operational Multipurpose System (HOMS) established by the World Meteorological Organization for the transfer of technology in hydrology and water resources. This technology includes descriptions of hydrological instruments, technical manuals or computer programs, material which has been made available for inclusion in HOMS by the Hydrological Services of member countries of WMO from the techniques which they themselves use in their normal operations. This is an important aspect of the HOMS philosophy in that it ensures that the technology transferred is not only ready for use but also works reliably.

The HOMS system being used by the MNRA Agriculture Department, Hydrology Unit was developed in MS DOS in 1991.

The HOMS system comprises a comprehensive range of components, only a few of which are being used by the Hydrology Unit today:

Policy, planning, and organisation.

A00.0.02 Hydrologists safety manual

A00.0.06 Assessment of water resources

A00.0.07 Field hydrology in tropical countries - a practical introduction

A00.0.08 Water resources management: Policies and Guidelines

Network design

B00.0.06 A hydrometrically orientated station numbering system

Instruments and equipment

SUBSECTIONS (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

C00 GENERAL

C09 SEDIMENT LOAD

C10 SUSPENDED LOAD

C12 BED LOAD

C25 GENERAL METEOROLOGICAL DATA; CLIMATE AND WEATHER STATIONS

C27 PRECIPITATIONS, MANUAL AND STORAGE GAUGES

C30 PRECIPITATIONS, RECORDING AND TELEMETERING GAUGES

C33 PRECIPITATIONS, MEASUREMENT BY RADAR

C35 AIR TEMPERATURE

C46 EVAPORATION, PANS AND TANKS

C53 SNOW, DEPTH AND WATER EQUIVALENT
C58 SOIL MOISTURE, NUCLEAR METHODS
C60 SOIL MOISTURE, ELECTRICAL METHODS
C62 SOIL MOISTURE, TENSIOMETERS
C65 GROUNDWATER, LEVEL
C67 GROUNDWATER, BOREHOLE LOGGERS
C68 GROUNDWATER, QUALITY
C71 WATER LEVEL OR STAGE
C73 STREAM DISCHARGE, FLUMES, WEIRS, ULTRASONIC AND ELECTRO-MAGNETIC METHODS
C79 WATER VELOCITY, CURRENT METERS OR FLOATS
C85 RIVER GAUGING, GENERAL
C86 RIVER GAUGING, CABLEWAYS
C88 RIVER GAUGING, CRANES, BRIDGE FRAMES, WHINCHES AND REELS

Remote sensing

- No component presently available

Methods of observations

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

E00 GENERAL
E05 WATER QUALITY
E09 SEDIMENT
E25 METEOROLOGICAL OBSERVATIONS FOR HYDROLOGY
E53 SNOW AND ICE, GLACIOLOGY
E55 SOIL MOISTURE
E65 GROUNDWATER
E70 SURFACE WATER, LEVEL AND FLOW
E71 WATER LEVEL
E73 DISCHARGE MEASUREMENT, DILUTION GAUGING
E79 VELOCITY MEASUREMENT, USE OF CURRENT METERS
E88 SURVEYING

Data transmission

F00.2.01 Telephone service water level gauge
F00.3.01 Data collection and transmission system (Ott Allgomatic)
F00.3.02 River information system
F00.3.05 ALERT data collection substation
F00.3.08 Telemetry system for data acquisition and flood forecasting
F00.3.11 Debris flow alarm system
F00.3.12 Voice response set
F00.3.13 Telemetering system

Data storage, retrieval and dissemination

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

G05 STANDARDS, MANUALS AND RECOMMENDATIONS
G06 SYSTEMS FOR STORING GENERAL HYDROLOGICAL DATA

G08 SURFACE WATER OR RIVER DATA STORAGE SYSTEMS

G10 GROUNDWATER DATA STORAGE SYSTEMS: LEVELS, WATER CHEMISTRY, WELL YIELDS AND FLOWS

G12 METOROLOGICAL DATA STORAGE SYSTEMS

G14 WATER QUALITY DATA STORAGE SYSTEMS

G20 GENERAL HYDROLOGICAL DATA TABULATION PROGRAMMES

G30 INFORMATION OR DATA DISSEMINATIONS SYSTEMS

G35 GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

G40 TRANSFER OF DATA BETWEEN AUTHORITIES, STANDARDS, RECOMMENDATIONS, MANUALS AND METHODS OF CODING

Primary data processing

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

H00 SYSTEMS PROCESSING SEVERAL TYPES OF DATA

H05 GENERAL WATER QUALITY DATA

H09 SEDIMENT TRANSPORT DATA

H25 GENERAL METEOROLOGICAL DATA FOR USE IN HYDROLOGY

H26 PRECIPITATION DATA, NON-RADAR

H39 AIR HUMIDITY DATA

H45 SOIL MOISTURE DATA

H70 SURFACE WATER (LEVEL AND FLOW) GENERAL

H71 WATER LEVEL DATA, RIVER STAGE, LAKE OR RESERVOIR LEVELS

H73 DISCHARGE DATA, ALL RANGES

H76 DERIVATION OF RATING CURVES, CONVERTING STAGE TO FLOW BY MEANS OF RATING CURVES

H79 WATER VELOCITY DATA, COMPUTING DISCHARGE FROM POINT VELOCITY MEASUREMENTS

H83 PROCESSING OF HISTORICAL FLOOD INFORMATION

Secondary data processing

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

I00 GENERAL

I05 WATER QUALITY DATA

I09 SEDIMENT TRANSPORT DATA

I26 PRECIPITATION DATA

I36 AIRBORNE POLLUTION

I45 EVAPORATION, GENERAL

I50 EVAPORATION, COMPUTATION FROM METEOROLOGICAL MEASUREMENTS

I53 SNOW DATA

I60 WATER BALANCE

I73 DISCHARGE DATA

I80 LOW FLOWS

I81 FLOODS AND FLOOD FREQUENCY ANALYSIS

Hydrological forecasting models

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

J04 FORECASTING STREAMFLOW FROM HYDROMETEOROLOGICAL DATA

J10 STREAMFLOW ROUTING FOR FORECASTING
J15 COMBINED STREAMFLOW FORECASTING AND ROUTING MODELS
J22 SEASONAL FLOW FORECASTING
J32 FORECASTING SOIL MOISTURE
J45 ICE FORECASTS
J55 FORECASTING SURFACE WATER QUALITY
J80 ANALYSIS OF MODEL PERFORMANCE

Hydrological analysis for the planning and design of engineering structures and water resource systems

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

K10 REGIONAL ANALYSIS
K15 SITE-SPECIFIC FLOOD STUDIES
K22 RAINFALL-RUNOFF SIMULATION MODELS
K35 STREAMFLOW SIMULATION AND ROUTING
K45 ROUTING THROUGH RESERVOIRS AND LAKES
K54 WATER TEMPERATURE STUDIES
K55 WATER QUALITY STUDIES
K65 SEDIMENT STUDIES
K70 DESIGN AND EVALUATION OF WATER-RESOURCE PROJECTS
K75 DESIGN AND OPERATING POLICIES OF RESERVOIRS

Groundwater

SUBSECTIONS. (Note: some subsections have additional detailed information that has been omitted here. Hyperlinks have been maintained for ease of reference).

L10 ANALYSIS OF DATA FROM WELLS AND BOREHOLES
L20 AQUIFER SIMULATION MODELS
L30 GROUNDWATER FORECASTING

Mathematical and statistical computations

X00.2.08 Hydrological, meteorological and oceanographic tables

See also subsection I81 Floods and flood frequency analysis

Training aids in operational hydrology

Y00.0.05 Statistical analysis in hydrology
Y00.0.06 On tides and storm surges
Y00.0.07 Basic hydraulic principles of open-channel flow
Y00.0.08 Study guide for beginning course in groundwater hydrology
Y00.0.09 Low-water crossing video
Y00.0.10 The hydrometric technician career development program (CDP)

2.7.5 Computing Infrastructure

All staff in this Unit has access to a PC and basic Office applications. The staff of the Hydrology Unit are trained in the use of the HOMS system. The detailed computing infrastructure configuration is provided in the MNRA – IT Stakeholder Survey write-up.

2.7.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to NIWRA:

- Would like to be able to make data available to university students for carrying out research projects,
- Would like to have a direct connection to the Hydromet meteorological data. There is a lot of information there, but has to be specifically requested to acquire,
- It would be beneficial to densify the hydrologic monitoring stations and to upgrade all stations to automated technology that can support real-time information retrieval,
- Detailed topographic basemap information needed to support many of the types of studies that need to be carried out.
- GIS usable to support wide variety of future water resource management activities including but not limited to;
    - Water classification for Potable, Agriculture, Industrial and Commercial water
    - Flood Forecasts
    - Drought Monitoring & Reporting
    - General water quantity & quality assessments
    - Protection and Conservation of water
    - Groundwater Assessment
    - Regulation of water abstractions
    - Resolution of water conflicts
    - Climate Change impacts on water resources

Data requirements include, but not limited to:

- Flood Forecasts/Drought Monitoring & Reporting
    - Greater station density in the hydro-meteorological networks
    - (more data needed – limited or no river level data in some watersheds)
    - Real or near real time reporting of rainfall and river levels (Reporting frequency in some watersheds is greater than time of concentration)
    - Algorithms to automatically convert models forecasts and radar observations to spatially referenced data for routine modeling
    - (Lumped watershed QPF, temperature, ETO, soil moisture, etc.)
    - Construction, refinement or replacement of hydrologic models
    - (Coarse or no hydrologic models for some watersheds)
    - Construction of Hydraulic models
    - (no river channel models)
- Ground Water Assessments
    - Rapid assessment of the extent and capacity of the Groundwater Provinces – satellite image Analyses? (Increasing groundwater demand; very little knowledge, no comprehensive scientific studies conducted)
    - Water Quality Assessments
    - Comprehensive program for the monitoring and reporting of surface and groundwater quality (ad hoc program in place)

- Climate Change impact on Water Resources
- Reconstruction of Historical datasets (Difficult to establish baselines due lack of historical data sets)

2.8 Natural Resources Department – Belize Solid Waste Management Authority (BSWaMA)

Person(s) Interviewed: Ms. Lumen Cayetano, Solid Waste Technician
sw.seniortech@mnra.gov.bz

Interview Date: June 23, 2014

2.8.1 Organization and Mission

The Belize Solid Waste Management Authority (BSWaMA) is a Statutory Authority governed by a Board of Directors and falling under the Ministry of Natural Resources and Agriculture (MNRA). The BSWaMA was formally established through the enactment of the Solid Waste Management Authority Act, 1991, Chapter 224 of the laws of Belize Revised Edition 2000. The Authority was established to ensure that solid waste generated in the country is managed in an environmentally sound manner.

The BSWaMA, in conjunction with Local Government bodies and other stakeholders, is responsible for the safe and environmentally sound management of solid waste in Belize. Through the application of the concept of Integrated Sustainable Solid Waste Management and working within the framework of the waste management hierarchy, the BSWaMA, will continuously strive to improve on and contribute to the protection of human health/safety and the environment, the conservation of natural resources, and the promotion of the occupational health/safety of workers in the waste sector, both formal and informal.[8]

A key role of BSWaMA has been to facilitate, plan and oversee the construction and operations of solid waste management facilities (Transfer Stations and Sanitary Landfill) constructed under the Solid Waste Management Project (SWMP). The day to day operations of the facilities is carried out by PASA Belize Limited.

Note: In Belize there are no standard waste collection vehicles. Across the country, waste is collected in various types of vehicles ranging from dump trucks, pickups, tractor trailer and compactor trucks. The BSWaMA is not directly involved in the waste collection aspect of solid waste management. The SWMP beneficiary municipalities or the Contractors to the municipalities are responsible for the collection of solid waste and subsequent haulage to the Transfer Stations.

[8] http://belizeswama.com/about/who-we-are/

The BSWaMA currently have 7 staff members, 3 of whom are employed under the current SWMP and 4 whom are government employees. The Director is presently a contract office. The office is currently responsible for the following primary activity areas that have some relevance to GIS and BNSDI:

1. Oversee execution and implementation of the Solid Waste Management Project
2. Oversee and Monitor the Operations of the Transfer Stations and Regional Sanitary Landfill.
3. Conduct public relations and outreach activities.
4. Conduct institutional strengthening and working with local municipalities to optimize their waste collection routes.

2.8.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.8.2.1 Oversee execution and implementation of the Solid Waste Management Project

Solid waste management in Belize has been recognized for over 25 years as an area requiring national attention. Inadequate waste collection systems, and improper discharge of wastes in open or partially controlled dumps lacking technical and environmental controls have persist. The inadequacy of the waste disposal practices on the offshore islands became particularly worrisome, due to their proximity to coral reefs and their importance to the eco-tourism market.

During the late nineties several Technical Co-operations were conducted to assist the government in the establishment of the Solid Waste Management Authority (SWMA), the preparation of the Solid Waste Management Plan (SWMP), and institutional and financial sustainability assessments that would pave the ground for new investments. The support included the completion of preliminary engineering designs for the a new sanitary landfill in Mile 24 and access road, to replace the deficient operations in Mile 3, including a full-fledged Environmental Impact Assessment.

In 2009 the Solid Waste Management Project, funded by the Inter-American Development Bank (IDB), OFID and the Government of Belize was initiated. The project objective has been to improve solid waste management practices, reduce environmental pollution and enhance the image of Belize in the eco-tourism market through better management of its municipal solid wastes. The project is addressing the solid waste management needs along the Western corridor (Belize City, San Ignacio and Santa Elena), and the islands of Ambergris

and Caye Caulker, and is also strengthening the overall Central Government capacity to improve solid waste management. The infrastructure investments have included: the closure of the open dump site in Mile 3 and the construction of a main waste transfer facility to facilitate waste separation and recycling, and facilitate the long haul of wastes volumes for final disposal at Mile 24; the construction of a new regional waste disposal facility at Mile 24; and the closure of open dump sites in San Pedro, Caye Caulker and San Ignacio, and the construction of transfer facilities in those sites. The institutional strengthening component is assuring that capacity within the SWMA is in place to execute the project and carry out its mandate.

The planning, design and development of the current western corridor waste management facilities involved a series of technical studies, each of which has required the analysis and consideration of geographic information. These included but are not limited to water generation and characterization study, regional site analysis and selection, an extensive environmental impact assessment, and site specific engineering studies and design. Most of the previous studies and analyses were conducted with CAD tools and manual maps. It is important to note however the activities carried out and to identify how GIS and BNSDI could have been helpful in supporting those earlier studies and how they can be helpful in the future as the solid waste requirements in the Country grow and evolve over time.

Specific areas the GIS can the BNSDI can make a difference in this activity area include the following;

Activity	**GIS and BNSDI Relevance**
Regional and community specific waste analysis and characterization	Knowing the location and characteristics of populations and businesses as a basis for understanding both local and regional, existing and projected future waste generation parameters
Transfer station siting analysis	Determine optimum location for transfer stations based on current and projected waste generation and collection conditions, land suitability and availability, impacts to local neighborhoods and other factors. Optimum siting would reduce vehicle miles and collection costs, minimize adverse impacts to traffic patterns and local communities, maximize road safety, and avoid displacing land needed for other equally important community uses.
Regional land suitability analysis	Landfill siting analysis considering environmental opportunities and constraints and the capability and suitability of alternate sites to accommodate a landfill land use. By considering the full range of environmental, social and economic factors from the beginning will optimize project costs, minimize environmental impacts, streamline the environmental review and approval process and result in a more sustainable and resilient facility and regional system in the medium to long term.
Regional transport and access analysis	Assess the location and characteristics of existing roads and highways in the planning area and their suitability and capability to accommodate solid waste transportation. Consider impacts and possible mitigations to service disruption due to seasonal flooding hazards and other such issues.

Regional socioeconomic impact assessment	Consider future growth of towns, villages, settlements, and agricultural development and assess the implications of current and future waste management scenarios and plans.
Site planning and facility design	Conduct detailed site assessment and support facility design and engineering.
Environmental impact assessment	Environmental impact assessments (EIA's) are required by law. Where environmental factors have been considered throughout the planning and design stages of facility design the process can be minimized and streamlined and the cost of mitigation measures minimized.
Ongoing monitoring and evaluation	Establish geographically based baseline information that can be monitored over time to better understand positive or negative impacts from the project operations and associated policies over time.

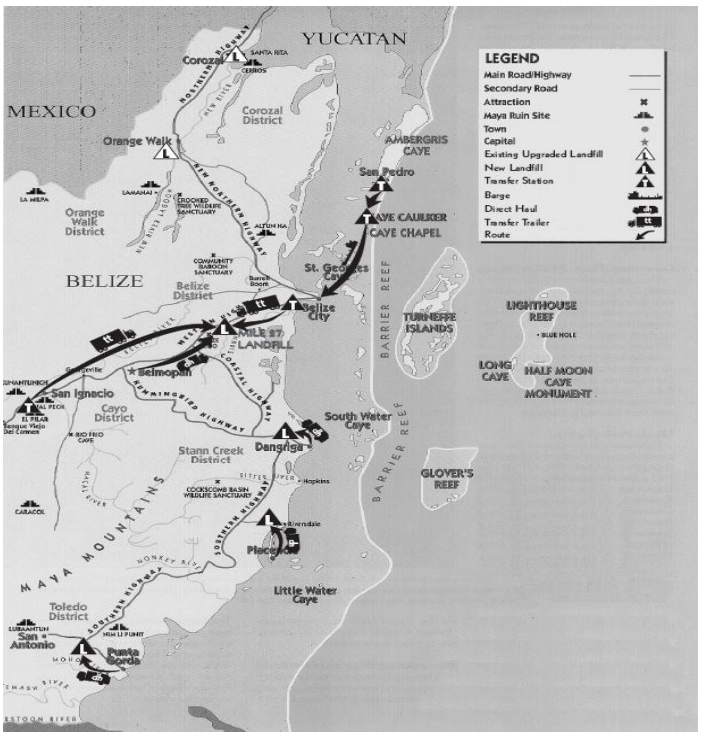


Figure 12 - Solid Waste Management Facilities and Haul Routes

Geographic and related data topics that are used in carrying out this activity, include but are not limited to the following:

- Existing waste dump sites and management practices;
- Existing waste generation sources and waste stream characteristics;
- Existing environmental impacts from current practices;
- Soils;
- Geology and hydrogeology;
- Surface hydrology and water bodies;
- Regional transportation infrastructure;
- Current and projected traffic conditions;
- Locations and socioeconomic characteristics of local villages and towns;
- Municipal and regional land use plans;

- Protected areas;
- Land ownership;
- Geophysical conditions;
- Land use and land cover;
- Topography;
- Biodiversity and ecology;
- Archeological sites.

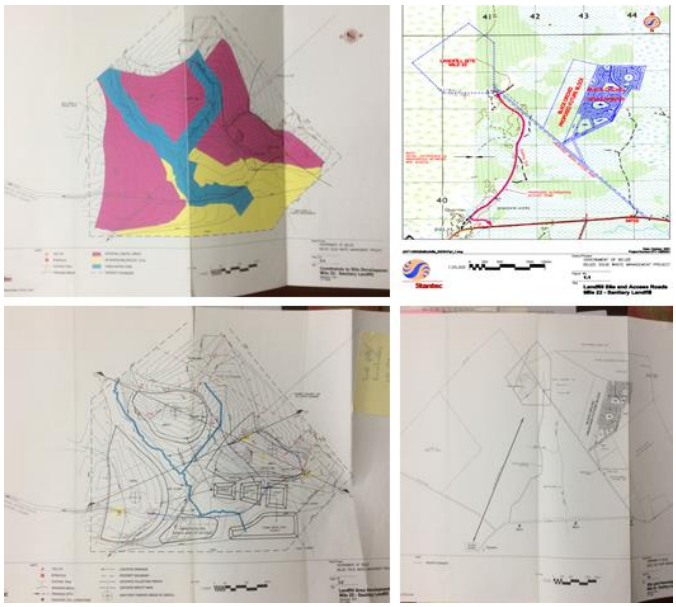


Figure 13 - Example Maps from Landfill EIA

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Conduct community specific waste analysis and characterization
- Conduct siting analysis for solid waste transfer stations
- Conduct regional siting analysis for solid waste landfill facilities
- Conduct regional solid waste transport and access analysis
- Assess future community growth and solid waste trends
- Conduct solid waste facility site planning and design
- Conduct environmental impact assessments for planned solid waste facilities
- Conduct ongoing monitoring and evaluation of solid waste management facilities and operations
- Maintain complete inventory of solid waste facilities across Belize

2.8.2.2 Oversee and Monitor the Operations of the Transfer Stations and Regional Sanitary Landfill

While the actual operations of the transfer stations and landfill are carried out by a contractor, the BSWaMA is responsible for overseeing the operations and ensuring they are compliant with best practices and permit conditions. The BSWaMA is responsible for overseeing the

operations of transfer stations in (Belize City & San Ignacio/Santa Elena) where locally collected garbage is separated and the residual consolidated for haulage to the landfill,. The Authority also oversees the operations of the sanitary landfill to which is the final disposal location for waste transported from the transfer stations.

The transfer station facilities play an important role in a community's total waste management system, serving as the link between a community's solid waste collection program and a final waste disposal facility, in this case the regional sanitary landfill located at Mile 24 George Price Highway. A transfer station provides a safe, efficient, and cost-effective means to consolidate, conduct recycle material separation, process and transfer solid waste from the waste generators to a final disposal site.

Wastes are brought to the facility by collection vehicles (garbage trucks) as well as self-haul vehicles ranging from pickup trucks to dump trucks. The waste is dumped onto a concrete floor (the "tipping" floor) inside of the transfer station. Recyclable materials such as PET bottles (soft drink and water bottles), HDPE bottles (chlorox/bleach bottles), glass bottles, aluminum and steel cans are sorted out manually and removed from the facility. The residual waste is then loaded by a front end loader into large-capacity transfer trailers and hauled to the regional sanitary landfill.

The Regional Sanitary Landfill is located at Mile 24 on the George Price Highway approximately 2 miles heading due north along a paved access road. This is the country's only Sanitary Landfill. The entire parcel of land where the landfill facility is located is 370 acres. This is the final disposal location for waste originating from municipalities in the Western Corridor (Belize City, San Ignacio/ Santa Elena – Benque Viejo, San Pedro Ambergris Caye and Caye Caulker). The first Municipal Solid Waste cell (Phase I) occupies approximately 5 acres.

The operators are responsible for maintaining accurate records regarding several issues, including:

- Weight of solid waste deposited at the transfer station;
- Weight of solid waste hauled from the transfer stations and deposited at the landfill;
- Water quality of leachate;
- Water quality in vicinity of landfill (currently 5 surface water quality monitoring points in the vicinity of the landfill);
- Gas monitoring

Flow of solid waste (METRIC TONS) from transfer stations to landfill and recyling 2013

Month	San Ignacio/SE-Benque Viejo Transfer station			Belize City, Transfer station			Total recycled	Total tonnes - to landfill	Total tonnes recycled + landfilled
	Transferred	Recycled	Sub total	Transferred	Recycled	Sub total			
Aug-13	486.4	8.54	494.92	1360.1	30.29	1,390.41	38.83	1,847	1,885
Sep-13	475.4	13.61	488.97	1482.2	30.79	1,512.99	44.40	1,958	2,002
Oct-13	510.7	7.71	518.44	1440.9	26.59	1,467.47	34.30	1,952	1,986
Nov-13	556.7	12.60	569.33	1487.8	27.07	1,514.82	39.67	2,044	2,084
Dec-13	559.4	14.40	573.81	1675.4	31.43	1,706.85	45.83	2,235	2,281
Jan-14	657.1	10.45	667.57	1378.7	35.08	1,413.82	45.53	2,036	2,081
Feb-14	602.4	13.50	615.87	1245.1	29.30	1,274.35	42.80	1,847	1,890
Totals	3,848	81	3,929	10,070	211	10,281	291.36	13,918	14,210
Avg/mon	549.7	11.5	561.3	1438.6	30.1	1,469	41.6	1,988	2,030
MSW Kg/person-day			0.70			0.80			0.77
Avg/mon	604.7	12.7	617.4	1582.5	33.1	1615.5	45.8	2187.2	2232.9
Avg/30 days	20.2	0.4	20.6	52.7	1.1	53.9	1.5	72.9	74.4
Diverted to recycling		2.1%			2.0%		2.1%		

Table 10 - Flow of Solid Waste from Transfer Station to Landfill and Recycling 2013

Influent (IN)

Parameter	Aug.	Sep.	Oct.	Nov.
Total Coliforms	2.40E+05	2.40E+05	2.40E+05	2.40E+02
Fecal Coliforms	2.40E+05	2.40E+05	2.40E+05	2.40E+02
pH	6.48	6.77	6.6	6.47
Temperature	29.6	32.6	29.1	26.5
Conductivity	1504.33	1824.33	3990.00	1564.67
Chloride	92.73	142.85	305.22	93.37
Total Hardness	393.93	306.39	1075.15	351.25
Color *	5	15	15	15
Dissolved Oxygen *	0.4	0.4	0.1	0.7
Biochemical Demand of Oxygen$_5$	505.12	211.29	1964.4	368.82
Chemical Demand of Oxygen	643	338	3435.51	634.14
Total Suspended Solids	4.05	79.67	175.09	88.63
Total Dissolved Solids	958.58	924.11	3257.60	933.47
Nitrates	< 0.10	<0.10	<0.10	<0.10
Fats and Oils	< 3.98	< 3.98	<3.98	<3.98
Ammonia Nitrogen	22.95	19.95	117.80	42.66
Total Phosphorus	< 4.00	< 4.00	5.4	< 4.00
Arsenic	0.0354	0.0288	0.0430	0.0368
Boron	0.1735	0.3826	0.5843	0.2351
Cadmium	N.D.	N.D.	N.D	N.D
Copper	N.D.	0.0103	N.D	N.D
Hexavalent Chromium	N.D.	N.D.	N.D.	N.D
Phenol				0.3926
Iron	54	19	38.03	48.67
Manganese	7	3	3.056	2.769
Mercury	0.0003	0.0001	0.0006	0.0001
Nickel	N.D.	0.0104	0.038	0.0121
Lead	N.D.	N.D.	N.D.	N.D.
Sodium	68	106	297.9	72.3
Zinc	0.0535	0.0619	0.1695	0.0498

Effluent (OUT)

Parameter	Aug.	Sep.	Oct.	Nov.
Total Coliforms	2.40E+03	< 3	2.30E+01	2.40E+01
Fecal Coliforms	< 3	< 3	2.30E+01	2.40E+01
pH	8.96	8.8	7.64	7.39
Temperature	28.6	33.9	29.7	26.2
Conductivity	172.37	235.7	398	1029.67
Chloride	10.52	16.41	32.81	74.89
Total Hardness	57.36	66.12	91.39	229.29
Color *	5	5	5	5
Dissolved Oxygen *	8.48	7.47	6.26	1.1
Biochemical Demand of Oxygen5	19.75	8.7	15.45	79.92
Chemical Demand of Oxygen	36	82	76.21	214.66
Total Suspended Solids	13	19	22	65.72
Total Dissolved Solids	113.08	170.21	236.05	565.34
Nitrates	< 0.10	< 0.10	<0.10	<0.10
Fats and Oils	< 3.98	< 3.98	<3.98	<3.98
Ammonia Nitrogen	< 0.30	< 0.30	3.95	18.59
Total Phosphorus	< 4.00	< 4.00	<4.00	<4.00
Arsenic	N.D.	N.D.	N.D.	0.0206
Boron	0.0266	0.0451	0.0679	0.1301
Cadmium	N.D.	N.D.	N.D.	N.D.
Copper	0.0045	0.01	N.D.	N.D.
Hexavalent Chromium	N.D.	N.D.	N.D.	N.D.
Phenol				0.0441
Iron	0.9586	1.68	1.843	12.97
Manganese	0.1372	0.5579	1.244	1.5
Mercury	0.0001	0.0003	0.0003	N.D.
Nickel	N.D.	N.D.	0.008	N.D.
Lead	N.D.	N.D.	N.D.	N.D.
Sodium	803.6000	23	25	58
Zinc	N.D.	0.0055	0.0121	0.0258

Table 11 - Example Water Quality Monitoring Data

Specific areas that GIS and the BNSDI can make a difference within this activity area include the following;

Activity	GIS and BNSDI Relevance
Transfer station collection	Haulers have fixed routes so theoretically it should be possible to tie all weight recordings back to the route locations to better understand quantities of solid waste coming from each area
Recycle monitoring	It would be possible to monitor and track the amount and type of materials being recycled at each transfer location and to access and view this information on a map.

Landfill intake monitoring	Track the amount of solid waste coming from each transfer station or other source.
Environmental monitoring	Provide a means to spatially depict and indicate environmental monitoring locations, conditions and trends. Also over time provide the ability to monitor other environmental conditions in areas that may be affected by the solid waste management activities.
Landfill management	Monitor the quantity and placement of solid waste within each cell over time.
Facility management	GIS can be used to record and manage all facility spaces and fixed assets.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Collection, compile and analyze transfer station and landfill operations data
- Produce transfer station and landfill operations current situation and trend statistics
- Re-calibrate waste stream analysis according to measured trends over time
- Provide new insights to solid waste policies, plans and operational procedures as needed to improve the waste management program over time
- Provide inventory of all waste management facilities and assets

2.8.2.3 Conduct public relations and outreach activities

The BSWaMA carries out various public relations and outreach activities. This is to raise awareness across the public as to the issues and challenges of solid waste management and to instill a sense of personal responsibility in reducing waste and littering. Staff attend many events and public functions wherever there is a good opportunity to reach the broadest audience. They are also trying to get parents and teacher's associations involved and are developing education programs for introduction to schools in the next academic year and investigating ways to build this issue into future school curricula.

Figure 14- BSWaMA Outreach and Public Awareness Activities

Although GIS has not been used within this functional area as yet, the technology can provide tools to record, plan, organize and visualize the location and type of PR and Outreach campaigns that are to be carried out around the Country. It can also be used to understand the location and socioeconomic characteristics of families in each community to enable programs to be customized to each new neighborhood.

Components of this functional area that have relevance to the use of GIS and participation in the BNSDI include, but are not limited to the following:

- Compile and assess community-specific surveys regarding solid waste issues
- Utilize population census information with community based surveys to understand different attitudes and issues regarding solid waste
- Link outreach programs to specific communities, schools and other channels
- Develop map visualizations and geo-statistical charts and graphs to illustrate solid waste issues and where they occur

2.8.2.4 Conduct Institutional Strengthening

BSWaMA has been undertaking a process to strengthen the institutional foundations of the organization to increase its reach and impact in improving the state of solid waste management in the Country over time. Efforts that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Nation-wide policy and planning analysis;
- Waste pickup and hauling route optimization;
- Ensure that waste management considerations and land allocation are built into municipal land use planning;
- Fleet tracking and monitoring;
- Better waste stream tracking and monitoring;
- Record and track fixed assets;
- Real-time monitoring of waste movements at transfer station and landfill locations;
- Record the location and characteristics of significant informal dump sites to support evaluation and cleanup;
- Provide foundation of information to support siting and feasibility assessment for alternative waste management scenarios, waste to energy schemes, recycling efforts, and other potential future innovations.

2.8.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions:

Solid Waste Management Plan EIA. An extensive environmental impact assessment (EIA) was developed for the SWMP in 1998. This information today exists only in hardcopy form

which can be accessed at the BSWaMA or the public library. This contains a variety of hardcopy map exhibits that depict the various environmental issues that were investigated in support of the EIA analysis and reporting.

Landfill Site Maps. The BSWaMA and the landfill operator have a series of maps depicting the landfill site, facilities, assets, leachate and surface water testing stations and borehole locations and characteristics. These are presently available only in hardcopy form.

BSWaMA Solid Waste Facilities and Hauling Routes General Map. The Authority has a very generalized map depicting the location of various waste handling facilities and the general haul routes for moving the waste.

Solid Waste Weigh Bridge Data. The solid waste operators running the transfer stations and landfill are required to collect data from every truck. This information includes the identification of each truck, its weight before and after dumping load, and the total estimated load weight. The amount of material separated for recycling at the transfer station is also measured. This information is maintained in MS Excel spreadsheets and used to generate periodic performance reports to be submitted to BSWaMA.

2.8.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

MS Excel. Weigh bridge and recycle material separation information is maintained by the solid waste transfer station and landfill operators. This information is submitted on a monthly basis in reports to BSWaMA.

Auto Cad is used to review designs and plans submitted by the BSWaMA contractor.

2.8.5 Computing Infrastructure

All staff in this Unit has access to a PC and basic Office applications. While the office has its own server, the Ministry provides general IT support. The office also runs the Government Smart Stream system so occasionally the Central Information Technology Office (CITO) provides support.

2.8.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to BSWaMA:

- Development of a GIS capability within the operators would be useful for route optimization, customer complaint management, fleet management and many other uses that can help to improve solid waste collection services at the municipal and community levels. The development of such capacity including various standards and standard operating procedures could also be facilitated by BSWaMA if such capacity was developed in-house;

- There are many informal dumpsites around the Country that can impact water quality, health and other factors. There is presently no inventory or cleanup plan for informal dumpsites;
- Future BSWaMA program development and institutional strengthening efforts could benefit from GIS capacity development, but this must be weighed against the scale of the organization, the amount of technical works carried out by external consultants, the cost of internal technical capacity building and the benefits expected from doing so.

2.9 Agriculture Department – Industries, Aquaculture and Inland Fisheries, Cooperatives, Policy and Trade (Statistics), Marketing and Project Execution Unit

Person(s) Interviewed: Roberto Harrison, Chief Agriculture Officer, Roberto.harrison@agriculture.gov.bz
Garth Murillo, Cooperatives Registrar, gmurillo.blzcoopsdept@gmail.com
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Manuel Matus, PEU Procedure and Procurement Officer, matusjr.manuel@gmail.com

Interview Date(s): June 10 - 15, 2014

2.9.1 Organization and Mission

The Ministry of Natural Resources and Agriculture, Department of Agriculture's primary role is to develop and transfer environmentally friendly technologies that will make farming more sustainable and farmers more competitive. This is being accomplished with the collaboration of other partners in development like CARDI, IICA, ROC, BAHA, BMDC, Farmers Association (CREI), among others.

The department has a number of thematic programs, all overseen by the Chief Agricultural Officer. The different programs provide vital services that include: farm visits, breeding stock, breeding services of all major livestock species, grafted and non-grafted fruit tree seedlings, hard wood seedlings, identify markets and conduct market studies, development of new value-added products, carrying out training for farmers and the development of technical materials, carry out research and other developmental activities, organize agriculture fairs/shows, liaise with other extension services within the country, and implement the programs and policies of the Ministry. The Ministry is also collaborating with the Ministry of Health in the pilot School Feeding Program which supplies lunches for needy children in selected locations.[9]

[9]Derived from information provided at http://www.agriculture.gov.bz/Agriculture_Dept.html

Note: Agriculture currently provides some 71% of the country's total foreign exchange earnings, and employs approximately 29% of the total labour force. Although about 1,998,230 acres or 38% of the total land area are considered potentially suitable for agricultural use, only perhaps 10 to 15% is in use in any one year. About half of this is under pasture, with the remainder in a variety of permanent and annual crops

The functions of the Agriculture Department were formerly under the Ministry of Agriculture and Fisheries. The Department seeks to continue to develop the agriculture sector as the economic pillar of Belize, ensuring food security, generating income and foreign exchange, creating employment, and conserving natural resources, in order to grow the economy, reduce poverty and empower the local population for sustainable development. Specific purpose of the Department includes:

- To create the enabling and favorable environment to increase the efficiency, productivity, profitability and competitiveness of the agriculture, inland fisheries and cooperative sectors.
- Accelerate the diversification in production, processing and exports. Improve and conserve the natural and productive resource base to ensure long-term sustainable productivity and viability.
- Improve access to productive resources and services and create economic opportunities for small/young farmers, women and indigenous people, particularly in poor, marginal areas.
- Strengthen the institutional capacities to provide effective support in marketing and trade, research and extension, as well as relevant education and training.
- Increasing food production, enhance food security and improve the nutritional status of the population as well as increasing farm incomes.
- Strengthen inter-sectoral linkages, in particular with the social sectors of health and education, as well as with the strategy and action plan for poverty eradication.

This stakeholder survey write-up covers a majority of the units within the Agriculture Department outside of the Central Farm, which is covered separately. The current units and essential functions that have some relevance to GIS and the BNSDI include the following:

<u>Industries</u>

1. Participate in and support agricultural industry associations
2. Testing for livestock disease as part of trade agreements

<u>Aquaculture and Inland Fisheries</u>

3. Support the promotion and development of aquaculture and inland fisheries

<u>Cooperatives</u>

4. Promote and support agricultural cooperatives

<u>Marketing</u>

5. Promote and support agricultural market development

<u>Projects Execution Unit</u>

6. Administer, monitor and support projects execution

Policy and Trade – Statistics

7. Develop and disseminate agricultural statistics and information

2.9.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.9.2.1 Participate in and Support Agricultural Industries

The Ministry has a responsibility by legislative acts to participate as members of industry "Commissions" in the major agricultural industry producer groups in the areas of Citrus, Sugar, Bananas and Livestock.

The purpose of such participation is to ensure government oversight in areas of agricultural production that are most critical to the interests of the Country, and to facilitate and support government intervention where needed to overcome any issues. For example the government has intervened in the case of the citrus greening disease, a bacterial infection that impedes fruit production that can have serious and widespread impact on the citrus industry in Belize if not managed properly.

Some of the basic objectives of the government involvement in the agricultural industries area that have specific relevance to GIS and BNSDI are represented in the following table:

Objective	**GIS and BNSDI Relevance**
To promote, foster and encourage the development of the industry and the export of products.	▪ Inventory of the location and characteristics of farms, farmers and production statistics; ▪ Crop capability and suitability mapping; ▪ Access to markets and export infrastructure analysis; ▪ Climate change risk and vulnerability assessment and mitigation planning;
To promote the interests and efficiency of the industry by regulating and controlling production, marketing and exporting.	▪ Monitor geographically specific agricultural production and utilize statistics and geospatial analysis for the refinement of production forecasting; ▪ Monitor prices in local markets and export destinations; ▪ Disaster damage assessment and recovery planning;

To engage in the production of agricultural products.	▪ Farm ownership tracking; ▪ Production and forecasting tracking; ▪ GIS supported precision farming; ▪ Crop capability and suitability mapping.
To purchase, sell or export agricultural products.	▪ Market specific price monitoring; ▪ Production and forecasting tracking; ▪ Extension service for optimizing marketing and production focus;
To supply finance for the development of the industry.	▪ Farm feasibility assessment and planning; ▪ Production and forecasting tracking; ▪ Monitor area-specific production statistics
To acquire, develop, improve land for production of agricultural products.	▪ Farm ownership tracking; ▪ Production and forecasting tracking; ▪ GIS supported precision farming; ▪ Crop capability and suitability mapping.

At present the government role in the various agricultural trade commissions and associations is focused primarily on political, legislative and administrative support. The associations themselves are actively engaged in the development of their own geospatial and statistical information as needed to support the respective industries and their members. For example, it was indicated that the Sugar Industry Resource Development Institute (SIRDI) recently paid around $1M for detailed soils mapping within their area of interest (***SIRDI Soils Maps***). Likewise, the Belize Livestock Producers Association (BLPA) has been involved in the development of a ***Cattle Sweep Inventory*** that is being structured into a digital database along with GPS coordinates. (See Agriculture Cooperatives stakeholder survey write-ups for more specific information).

The MNRA did in 2010-2011 develop an ***Agricultural Census of Belize*** inclusive of all the key agricultural production sectors. However, the information from the census has not yet been released due to issues with the collected data that require substantial checking and resolving prior to publishing for public use. It should be noted that location reference information was collected as descriptive text fields that will limit how easily the information can be visualized and analyzed geographically in a GIS.

In addition to the above, the Agriculture Department does maintain a regular ***Agriculture Products Market Price Index*** database that is updated on a weekly basis. This information is used regularly by the agriculture sector community.

Although GIS is not currently being used systematically to support this function, ways that GIS/BNSDI could be useful include but would not be limited to:

- Inventory of the location and characteristics of farm properties, farmers, and production statistics;

- Inventory of the location and characteristics of processing plants and other agriculture related infrastructure;
- Crop production forecasting;
- Land capability and suitability mapping;
- Local and export market analysis;
- Access to markets and export infrastructure analysis;
- Farm feasibility assessment and planning;
- Market location price monitoring and product sources;
- Production and forecasting tracking;
- Climate change agriculture risk and vulnerability assessment and mitigation planning;
- Disaster damage assessment and recovery planning;
- Provide trade associations with access to government geospatial resources to support their planning and operations;
- Monitor and evaluate the status and effectiveness of government agricultural policies and intervention actions over time.

2.9.2.2 Promotion and Support for Development of Sustainable Aquaculture Industry

The purpose of the sustainable aquaculture and inland fisheries program is to guide the development of a competitive aquaculture industry while at the same time maintaining the viability of the environment and providing responsible stewardship for inland fisheries resources of the nation as well as the ecosystems that supports them, in order to provide sustainable benefits for Belizeans of present and future Generations.

There was no separate interview conducted at MNRA HQ for this functional area, however the topic was discussed with the Aquaculture Technical Monitoring Unit at the Central Farm, and that information is re-presented here for completeness.

The Aquaculture Technical Monitoring Unit is a relatively new unit responsible for promoting and supporting sustainable, small scale aquaculture for rural communities, primarily for local consumption. This includes building awareness of the requirements and benefits of sustainable aquaculture, supporting technology and best practice transfer to farmers, providing training and extension support. The Unit also maintains hatcheries in two districts for fish stock development.

When assessing whether a site is suitable for aquaculture, the Unit considers a variety of factors, including but not limited to:

- Good and accessible water supply;
- Good clay (for bottom sealing);
- Access to markets;

The Unit recently conducted an inventory of aquaculture facilities in Cayo District. This included recording GPS locations for 60-70 aquaculture locations. Additional information

about each location is being added to an Excel spreadsheet, including the farmer name, fingerlings count, total fish produced and other such information (***Inland Aquaculture Farm Inventory***).

Ways that GIS/BNSDI could be useful to this unit include but would not be limited to:

- Continue geocoding aquaculture farm locations to track their distribution on a map;
- Suitability analysis (soils, slope, water access, market and transport access, etc.);
- Access protected areas and other information to ensure proposed aquaculture can be carried out within regulatory directives;
- Access land ownership information to confirm service requestor is land owner;
- Monitor and evaluate outcomes and effectiveness of aquaculture promotion and support programs over time.

2.9.2.3 Promote and Support Agricultural Cooperatives

The Co-operatives unit, consisting of approximately 14 staff, is the primary government body responsible to monitor and support all cooperative enterprises in Belize. The majority of these are agricultural cooperatives however not exclusively so, and also includes private transportation cooperatives, tourism cooperatives, pottery cooperatives, fisherman cooperatives and many others. The Cooperatives unit is committed to the strategic management of human, technical, financial and other resources for the sustainable development of co-operatives as business-oriented units in the socio economic development of Belize. The Unit's overall objective is to provide the highest quality of service in the most economic, efficient, and effective manner within the resources available.

Some of the basic objectives of the government involvement in the agricultural cooperatives area that have specific relevance to GIS and BNSDI are represented in the following table:

Objective	**GIS and BNSDI Relevance**
Registration and regulation of co-operatives societies in Belize	▪ Inventory of the location and characteristics of cooperative members, their facility locations and productive output;
Providing expert and authoritative advice for societies requesting, or in need of assistance	▪ Provide market analysis, facility siting and land capability and suitability analysis for use by cooperatives; ▪ Provide access to government data for market assessment and planning purposes; ▪ Disaster damage assessment and recovery planning;
Promotion of sound projects for co-operatives to ensure proper financial stability of all registered societies	▪ De-risk agricultural and other investments through agricultural land capability and suitability and feasibility analysis mapping, infrastructure adequacy assessment and other such geographic analyses;

	▪ Provide market assessment and forecasting information;
Collection and maintenance of accurate and reliable statistics and other information on all societies for the benefit of their members and/or the general public	▪ Maintain and disseminate comprehensive, geospatially enabled data for use by cooperatives.
Training and Education in a most, to ensure continuity and more productive co-operative organizations	▪ Providing training in best practice application of GIS to cooperatives subjects of interest
Ensuring that societies benefit from the legal and other advantages of being registered	▪ Provide cooperatives with full access to government geospatial and statistical data holdings where these can be of benefit for planning and operations support purposes.

The Cooperatives Unit presently maintains a database of all 265 registered cooperatives in an MS Excel spreadsheet (***Belize Cooperatives Register***), and there is an intention to import this information to an MS Access database in the future. There is also a need to update and cull the information, as only about 56 of the Cooperatives registered are actually active and functioning. Information maintained in the spreadsheet includes the name, date of association, area of operation, number of members, activities they are engaged in and other basic information. In April an effort was started to record and monitor program budgeting baseline and performance indicators.

The relevance of area of operation information is different for each type of cooperative. Although not in use by the Unit currently, the significance and potential benefits of GIS are being recognized in several areas, including but not limited to:

- Cooperative office locations and boundaries of areas of interest;
- Market analysis and projections;
- Training in the use of ICT and GIS to support Cooperative business;
- Use of cell phones and other mobile devices for Cooperative community crowd sourcing of various information;
- Special geospatial analysis projects (e.g. analysis of pesticide use in Papaya fields adjacent to declining honey bee production area);
- Web based training and information dissemination;
- Monitoring and assessment of Cooperative policies and programs over time.

2.9.2.4 Promote and Support Agricultural Market Development

The Agriculture Department Marketing Unit is responsible for carrying out certain activities to support and market Belize agricultural products. The Unit has two staff but also relies on extension officers in 6 Districts to support marketing efforts within their areas. This function includes the collection and dissemination of agricultural product price information,

monitoring and disseminating regional price information from Central America and the Caribbean, working with farmers to strategize best times and methods for bringing products to market to achieve best prices, and helping them to prepare presentations and other channels for marketing their products.

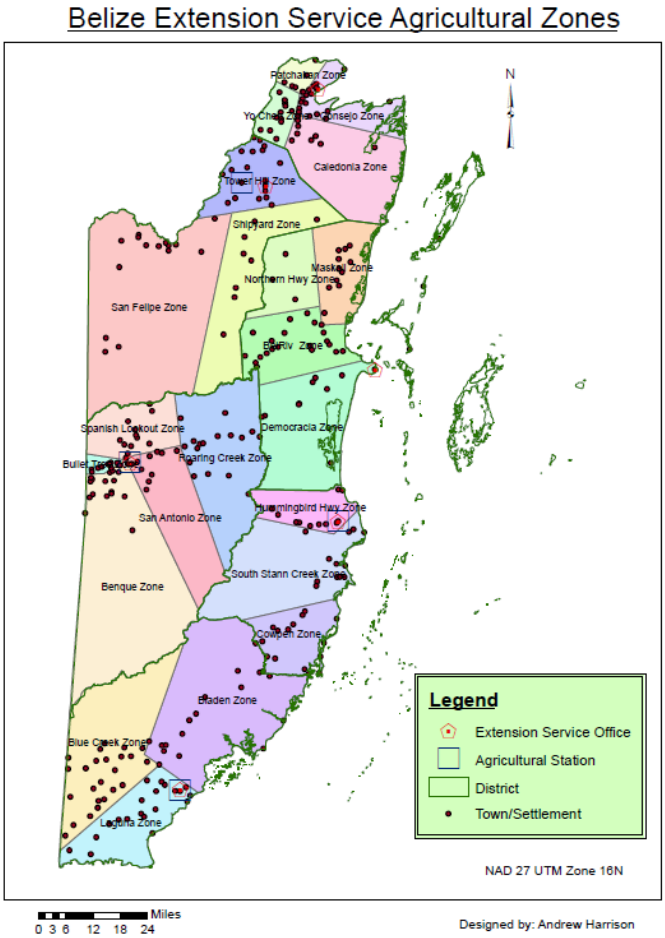

Figure 15 - Agricultural Extension Service Areas

The Unit has developed a GIS ***Agricultural Extensions Service Areas*** database indicating the location of agriculture extension offices and the boundaries of the service area for each, as illustrated in the figure above.

The MNRA Agriculture Department Marketing Unit collects agricultural product price information for approximately 48 commodities from 7 market locations in the Country (***Agriculture Products Market Price Index***). These reports are compiled in a spreadsheet form but only distributed in PDF reports. This information has been collected in the present form since 2010. For 15 year previous to this, selected price statistics were being collected but it was not consistent and was compiled only in paper form. It is planned to make this information available in digital form over the web in the future. The price information is also used to produce trend reports.

Price Collected on: June 6th-7th 2014

Product	Unit of Sale	North		Central			South		Average Price Today	Average Price last week	Tendency
		Corozal	O/Walk	Belmopan	San Ignacio	Belize	Dangriga	Punta Gorda			
		Belize Dollars (BZD)									
BASIC GRAINS											
Rice	lb	1.10	1.25	1.25	1.10	1.20	1.15	1.15	1.17	1.18	↓
Rk Beans	lb	2.00	2.50	2.25	2.25	1.75	2.50	2.00	2.18	2.22	↓
Black Beans	lb	1.50	2.25	1.75	1.50	1.75	2.00	2.00	1.82	1.79	↑
White Corn	lb	0.50	0.50	0.40	0.50	0.40	0.60	0.40	0.47	0.46	↑
Yellow corn	lb	0.50	0.50	0.40	0.40	0.40	0.60	0.40	0.46	0.47	↓
VEGETABLES											
Celery	lb	2.50	3.00	2.50	2.00	2.50	3.00	2.50	2.57	2.71	↓
Brocolli	lb	2.50	3.00	2.50	2.75	2.50	3.50	3.00	2.82	2.93	↓
Yellow onion	lb	1.50	1.75	1.50	1.75	1.25	2.00	1.75	1.64	1.64	=
White onion	lb	2.00	1.75	2.50	2.50	2.00	3.50	3.50	2.54	2.46	↑
Habanero pepper	lb	1.50	2.25	2.00	2.75	1.00	2.50	3.50	2.21	2.61	↓
Sweet Pepper	lb	2.00	1.75	2.00	1.50	2.00	3.50	4.50	2.46	2.50	↓
Head Lettuce	Head	4.00	3.00	3.50	3.50	N/A	4.00	2.50	3.42	3.42	=
Leaf Lettuce	Head	2.00	2.50	N/A	2.50	N/A	N/A	N/A	2.33	2.33	=
Potato (clean)	lb	1.50	1.75	1.50	1.75	1.50	1.75	2.00	1.68	1.64	↑
Potato (unwashed)	lb	2.00	1.25	1.25	1.50	1.25	N/A	N/A	1.45	1.46	↓
Cucumber	lb	0.50	1.00	0.75	0.75	0.75	1.00	1.00	0.82	0.85	↓
Cabbage	lb	2.00	1.00	1.50	1.50	1.00	1.50	1.75	1.46	1.46	=
Tomato (Table)	lb	2.00	1.25	2.00	2.50	0.75	2.50	3.00	2.00	1.89	↑
Tomato (Roma)	lb	2.00	1.00	1.50	2.00	0.75	N/A	N/A	1.45	1.40	↑
Carrots	lb	1.50	1.25	1.50	1.75	1.00	1.50	2.00	1.50	1.46	↑
FRUITS											
Banana	Unit	0.12	0.13	0.13	0.10	0.10	0.10	0.13	0.12	0.11	↑
Banana (Apple)	Unit	0.10	0.13	0.08	0.10	0.10	0.10	0.13	0.11	0.10	↑
Coconut (dry)	Unit	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	=
Lime	Unit	0.25	0.50	0.20	0.25	0.25	0.33	0.25	0.29	0.38	↓
Orange	Unit	0.12	0.13	0.13	0.08	0.12	0.13	0.17	0.13	0.12	↑
Papaya (Tainong)	Unit	2.00	2.50	1.00	2.50	2.00	2.50	3.00	2.21	2.36	↓
Pineapple	Unit	3.50	3.50	2.00	2.50	2.50	3.00	2.50	2.79	2.86	↓
Plantain (green)	Unit	0.33	0.33	0.33	0.33	0.25	0.25	0.25	0.30	0.30	=
Plantain (ripe)	Unit	0.50	0.33	0.33	0.33	0.33	0.33	0.33	0.35	0.37	↓
ROOTCROPS											
Cassava	lb	1.00	1.25	0.50	1.00	1.00	0.75	1.00	0.93	0.96	↓
Coco yam	lb	1.50	3.00	1.50	0.75	1.50	1.50	1.50	1.61	1.54	↑
Sweet potato	lb	1.00	1.25	1.50	1.00	1.25	1.00	1.00	1.14	1.11	↑
MEATS											
Whole Chicken	lb	2.45	2.75	2.95	2.75	2.90	2.90	2.80	2.79	2.79	=
Whole Fish	lb	6.00	5.00	6.00	6.00	6.00	5.00	5.00	5.57	5.71	↓
Egg	Dozen	3.00	3.50	3.75	4.00	4.00	4.00	3.75	3.71	3.79	↓
Honey	Quart	12.00	12.00	12.00	12.00	16.00	14.00	20.00	14.00	14.00	=

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Symbol: (↑)Increase, (↓)decrease , (=) Stable in prices
Exchange rate: 1 USD = 2 BZD
n/a - Not Available

Source: Belize Agri-Price Information System
Phone: 822-2241, Fax: 802-2333

The information in the report is believed to be accurate but is not warranted. Published data is subject to revision at any time. Please send an e-mail to info@agriculture.gov.bz

Table 12- Example Weekly Agricultural Price Report

While the Unit is not using GIS extensively at present, there are several areas that it would like to support in the future, including but not limited to:

- Analyze farm locations relative to markets where commodities are being sold;
- Monitor weather forecasts and other information to strategize best times to bring products to market;
- Assess how climate change may affect some commodities in geographic locations around the Country so that remedial action can be taken;
- Move towards more real-time treatment of market price information (e.g. Trinidad example utilizing smart phones equipped with GPS;
- Add supermarket prices to the market price tracking;
- Build a GIS unit to accommodate the variety of geospatial analyses that can be conceived to support the marketing of agricultural products in Belize.

2.9.2.5 Administer, Monitor and Support Projects Execution

The MNRA Agriculture Department Project Execution Unit (PEU) is theoretically responsible for administering, monitoring and supporting the management of projects being carried out by the MNRA. In reality, the 8 person Unit has developed expertise that is in demand and today is supporting this function on behalf of other government organizations as well, especially where these involve funding from the European Union (EU) and the Inter-American Development Bank (IDB).

Each project overseen by the PEU goes through a series of development stages. Projects are typically initiated by a government entity with a concept note, often prepared in collaboration with a donor. Projects are proposed through the Ministry of Finance and Economic Development, where they are reviewed in the context of national plans and priorities. If a project is acceptable, a Strategy Paper will be developed to further articulate the scope, costs and benefits of the proposed project. The Strategy Paper is reviewed by a Steering Committee that is chaired by the MNRA Agriculture CEO. Once a project is fully vetted and approved, then a process is initiated to set up the project, finalize funding arrangements, secure support resources and other related matters, at which time the PEU gets involved. As illustrated in the following figure, paper ***Project Execution Case Files*** are set up for each project and all information concerning each project is thereafter maintained within these files.

Figure 16 - PEU Project Case Files

The PEU conducts primarily contractual and administrative oversight and support to projects and is not involved in most technical considerations. Staff indicated that one constraint that is particularly relevant to GIS and the BNSDI has been a lack of assessment of what data are available to support specific projects. This issue has been reinforced by the MNRA LIC who have indicated that project consultants will often visit their office to collect data that they expected to be available to support projects only to find it not available and therefore resorting to best available information or original data collection which may not have been accounted for in the project budgeting.

While all the staff at the PEU have access to a PC, these are not networked and they are not connected to the MNRA enterprise systems at the HQ.

While the PEU is not currently using GIS, there is recognition that the technology and the BNSDI could provide useful capabilities to strengthen project formulation and management in the future, including but not limited to the following:

- Provide project location and characteristics information throughout the lifecycle of the project;
- Provide access to contextual information that can assist in project formulation and feasibility assessment;
- Provide better coordination and alignment among projects from different sectors planned for the same area;
- Allow the government to monitor and geographically track all relevant projects across all sectors (essentially adding a geographic element to the existing Public Investment Strategy Programme (PSIP) managed by the Ministry of Finance and Economic Development);

2.9.2.6 Develop and Disseminate Agricultural Statistics and Information

The MNRA Agriculture Department Policy and Trade unit is responsible for compiling, analyzing and distributing agricultural statistical information to policy makers, special interest groups and the public. The following data resources are not covered in detail in other BNSDI Stakeholder survey write-ups:

2001 Agricultural Census. Following the change in Government in 1998, the Ministry of Agriculture, and Fisheries & Cooperatives (MAFC) began a five stage programme to stimulate development in the agriculture sector. The broad objective of the effort was to establish a sustainable registry of farms (farmers) and a system of periodic surveys for updating the registry through the introduction of appropriate data collection and statistical methodologies. Outputs were to include:

- A Belize Farm registry that contains basic information about all farms (and farmers) in Belize;
- A set of supply utilization accounts and food balance sheets;
- A sampling frame that can be used to select farmers as respondents for specialized surveys;
- A methodology, questionnaire and training material that can be used for periodic sample surveys that would be used to estimate crop production and livestock inventories;
- An agricultural statistics database accessible in the Ministry and its six district offices;
- An assemblance of adequate and reliable statistics on most aspects of agriculture so as to enable agriculture production of gear itself to the changing development in agriculture in the global environment;
- An agriculture statistics database that can be quickly and efficiently retrieved on a continuous basis;
- To make available specific statistics on Belizean agriculture to overseas parties;
- To forecast the country's main agriculture produce on a periodic basis;

2010 Agriculture Census. Another agricultural census was conducted in 2010 and 2011. The census was based on a 16 page questionnaire that covers a broad range of topics. Those that are most relevant to the GIS and BNSDI matter include the following:

- **Farm and Farmer Identification**
  - Location by District-Zone, Village/Community and Textual description;
  - Farmer Name and Address;
  - Farmer Age, Sex, Ethnicity;
  - Types of Farm Activities Conducted;
  - Legal Status of the Farm;
- **Total Land and Land Tenure of Farm by Parcel**
  - Total Size of Farm
  - Number of Parcels On Farm
  - Farming System Used
  - Land Use on Farm Today
- **Actual Land Use of Farm – Perennial Crops on Day of Interview**
  - Area and Age by Crop Type
  - Production Information
  - Extension and Financial Services Used
- **Actual Land Use of Farm – Temporary Crops**
  - Area and Age by Crop Type
  - Production Information
  - Extension and Financial Services Used
  - Irrigation used
- **Livestock on the Farm Today**
  - Livestock Type, Number, Sex and Purpose
  - Acres of Pasture
  - Numbers of Hives and Bee Boxes
  - Honey Production
  - Poultry Type, Number, Sex and Purpose
  - Aquaculture Type and Production
- **Farm Implements and Equipment**
  - Type, Owned/Rented, Support Requirements
- **Agroforestry**
  - Type, Area, Age and Inputs
- **Household Members**
  - Members and Involvement in Agricultural Tasks
- **Farm and Farm Household Activities**
  - Major Issues and Needs
  - What Major Sources of Information and What Info Most Useful
  - Food Shortage and Cause
  - Access to Information Technology and Media
  - Water Source
  - Sources of Credit
  - What Export Products of Interest
  - What Inputs Required for Export Products
  - Percentage of Household Income Attributable to Farming

The agricultural census was intended to be a 100% coverage of existing farms in the Country. The data were entered to a digital database, however there have been a number of challenges with data quality faced and MNRA staff are carrying out a data scrubbing exercise to correct this information as much as possible before publishing. There is no committed date for when this corrective activity will be completed and concern has been expressed that since a number of years has passed since the census was taken that this information is becoming out of date which will impact its utility. Another issue has been that with the method of location reference used, the information can only be geo-located to the Village level.

Ways that GIS/BNSDI could be useful to support this functional area include but would not be limited to:

- Provide a geographically based, comprehensive national farms registry
- Conduct geographically linked farmer surveys
- Conduct geostatistical analysis of farms inventory data
- Produce a national agricultural census maps and statistics
- Prepare and publish national agriculture maps and statistical reports
- Assess farms vulnerability to climate change projections
- Access geographic data from other BNSDI stakeholders
- Monitor agricultural trends over time
- Perform food security analysis
- Assess trends and provide information and recommendations to policy makers

2.9.3 Data Used or Generated

The following GIS and BNSDI related data sources have been used in carrying out the functions of the Agriculture Department:

SIRDI Soils Maps. Sugar Industry Resource Development Institute (SIRDI) commissioned the preparation of detailed soils mapping within their area of interest (See Stakeholder Survey write-up containing SIRDI information).

Cattle Sweep Inventory. Belize Livestock Producers Association (BLPA) has been involved in the development of a Cattle Sweep Inventory that is being structured into a digital database along with GPS coordinates. (See Stakeholder Survey write-up containing BLPA information).

Inland Aquaculture Farm Inventory. The Aquaculture Technical Monitoring Unit conducted an inventory of aquaculture facilities in Cayo District. This included recording GPS locations for 60-70 aquaculture locations. Additional information about each location is being added to an Excel spreadsheet, including the farmer name, fingerlings count, total fish produced and other such information.

Belize Cooperatives Register. The MNRA Agriculture Department Cooperatives Unit presently maintains a database of all 265 registered cooperatives in an MS Excel spreadsheet and there is an intention to import this information to an MS Access database in the future.

There is also a need to update and cull the information, as only about 56 of the Cooperatives registered are actually active and functioning. Information maintained in the spreadsheet includes the name, date of association, area of operation, number of members, activities they are engaged in and other basic information. In April an effort was started to record and monitor program budgeting baseline and performance indicators which are to be added to the database in the future.

Agricultural Extensions Service Areas. The MNRA Agriculture Department Marketing Unit has developed a GIS-based Agricultural Extensions Service Areas database indicating the location of agriculture extension offices and the boundaries of the service area for each.

2001 Agricultural Census. Following the change in Government in 1998, the Ministry of Agriculture, and Fisheries & Cooperatives (MAFC) began a five stage programme to stimulate development in the agriculture sector. The broad objective of the effort was to establish a sustainable registry of farms (farmers) and a system of periodic surveys for updating the registry through the introduction of appropriate data collection and statistical methodologies. Outputs were to include:

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- A sampling frame that can be used to select framers as respondents for specialized surveys;
- A methodology, questionnaire and training material that can be used for periodic sample surveys that would be used to estimate crop production and livestock inventories;
- An agricultural statistics database accessible in the Ministry and its six district offices;
- An assemblance of adequate and reliable statistics on most aspects of agriculture so as to enable agriculture production of gear itself to the changing development in agriculture in the global environment;
- An agriculture statistics database that can be quickly and efficiently retrieved on a continuous basis;
- To make available specific statistics on Belizean agriculture to overseas parties;
- To forecast the country's main agriculture produce on a periodic basis;

2011 Agricultural Census. The Belize Agricultural Census (BAC) was conducted in 2011. The objectives of the BAC were to A) provide reliable and objective baseline data on the structure of the agricultural sector of Belize and an inventory of agricultural resources; B) to provide reliable data on the agricultural sector that will enable the users at the Ministry of Agriculture and Fisheries and other public, private and international institutions to make better decisions; and C) to use the results of the BAC to establish an agricultural statistics system to measure the development of this sector on a regular and continuing basis. As of June 2014 this data has not been released and is still undergoing some level of quality checking and data cleansing.

Another agricultural census was conducted in 2010 and 2011. The census was based on a 16 page questionnaire that covers a broad range of topics. Those that are most relevant to the GIS and BNSDI matter include the following:

- **Farm and Farmer Identification**
  - Location by District-Zone, Village/Community and Textual description;
  - Farmer Name and Address;
  - Farmer Age, Sex, Ethnicity;
  - Types of Farm Activities Conducted;
  - Legal Status of the Farm;
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  - Farming System Used
  - Land Use on Farm Today
- **Actual Land Use of Farm – Perennial Crops on Day of Interview**
  - Area and Age by Crop Type
  - Production Information
  - Extension and Financial Services Used
- **Actual Land Use of Farm – Temporary Crops**
  - Area and Age by Crop Type
  - Production Information
  - Extension and Financial Services Used
  - Irrigation used
- **Livestock on the Farm Today**
  - Livestock Type, Number, Sex and Purpose
  - Acres of Pasture
  - Numbers of Hives and Bee Boxes
  - Honey Production
  - Poultry Type, Number, Sex and Purpose
  - Aquaculture Type and Production
- **Farm Implements and Equipment**
  - Type, Owned/Rented, Support Requirements
- **Agroforestry**
  - Type, Area, Age and Inputs
- **Household Members**
  - Members and Involvement in Agricultural Tasks
- **Farm and Farm Household Activities**
  - Major Issues and Needs
  - What Major Sources of Information and What Info Most Useful
  - Food Shortage and Cause
  - Access to Information Technology and Media
  - Water Source
  - Sources of Credit
  - What Export Products of Interest
  - What Inputs Required for Export Products
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The agricultural census was intended to be a 100% coverage of existing farms in the Country. The data were entered to a digital database, however there have been a number of challenges with data quality faced and MNRA staff are carrying out a data scrubbing exercise to correct this information as much as possible before publishing. There is no committed date for when this corrective activity will be completed and concern has been expressed that since a number of years has passed since the census was taken that this information is becoming out of date which will impact its utility. Another issue has been that with the method of location reference used, the information can only be geo-located to the Village level.

Agriculture Products Market Price Index. The MNRA Agriculture Department Marketing Unit collects agricultural product price information for approximately 48 commodities from 7 market locations in the Country. These reports are compiled in a spreadsheet form but only distributed in PDF reports. This information has been collected in the present form since 2010. For 15 year previous to this, selected price statistics were being collected but it was not consistent and was compiled only in paper form. It is planned to make this information available in digital form over the web in the future. The price information is also used to produce trend reports.

Project Execution Case Files. The MNRA Agriculture Department Project Execution Unit maintains paper case files for each project or program that they administer and all information concerning each project is maintained within these files. These include projects being carried out by the MNRA as well as other Ministries and especially those financed by the European Union (EU) and the Inter-American Development Bank (IDB).

Livestock Registry. The Belize Livestock Producers Association in 2009 initiated the development of a comprehensive registry of all livestock farms in Belize as one component to complement the $12.2M National Cattle Sanitary plan project, a joint effort between the Government of Belize and the European Union. The national livestock registry was developed to support the exportation of cattle to Mexico and other countries by establishing compliance with the (OIE) World Organization for Animal Health requirements for bovine, animal health and the requirements established by Mexico, for the export of live cattle under formal agreement between Mexico and Belize. This database contains information regarding each farm as well as each animal from destination to origin as is required in international trading.

2.9.4 Existing Systems

Existing systems in use by these units within the Agriculture Department include the following:

MS Excel Spreadsheets. MS Excel spreadsheets are used to manage registry, inventory and market price database information.

IBM SPSS. Selected staff within the MNRA Agriculture Department are using the IBM SPSS statistical software for basic statistical analysis and visualization.

ArcView. ArcView GIS software has been used on a limited basis to develop databases to indicate the location and extent of extension offices and agricultural extension service area boundaries.

2.9.5 Computing Infrastructure

With the exception of the PEU, the IT infrastructure of the MNRA Agriculture Department is managed and supported by the MNRA IT Department. More detail concerning the organization and operations of this function are included in another Stakeholder Survey write-up.

The PEU computing infrastructure today includes PC's for all relevant staff, however these are not networked internally nor to the MNRA HQ. Also technical support is acquired from outside services on an as-needed basis.

2.9.6 Other Issues, Opportunities and Constraints

There is a very significant opportunity to increase the use of GIS within the agricultural sector of the MNRA. The following summarizes issues, opportunities and constraints that need to be considered in the formulation of future plans in this area:

Develop a capacity for GIS-enabled agriculture management information systems. It is recognized that there are many existing and emerging information and geospatial technologies that could greatly benefit the Agriculture Sector in Belize. There is an interest to explore and strengthen this capability within the MNRA Agriculture Department to increase these technologies and methods to the agricultural sector and to promote and support the integration and building of this capacity where it can do the most good.

Develop standards for capture of agriculture data. There is currently lacking any guidelines or standards for the capture of agriculture data in Belize. Development of such a framework would help to ensure that all agriculture data that is collected will be interoperable across all the programs and units.

Develop more awareness of the potential of GIS and the BNSDI across Agriculture Department programs and especially with the extension officers. It is recognized that for GIS and the BNSDI to be embraced by Agriculture Department staff as well as in the Districts there is a need to raise awareness about what it is and how it can benefit specific requirements.

Introduce GIS and BNSDI concepts and practices within the agricultural programs at the University. The next generation will be important in bringing new technologies and methods into the agricultural sector. Integrating these tools into agriculture curricula will help to equip young agricultural professionals to take this modernization process forward.

Explore how to use cell phones and other mobile devices to take advantage of more two-way information exchange with the farming community. Many people even in remote rural areas are now using cell phones. There is an opportunity to tap into this trend both to improve and streamline the provision of information and services to farmers as well as to collect input and information from the farming community. Cell phones are increasingly location-aware, thus providing the opportunity to reference this feedback geographically.

Strengthen capacity for conducting agricultural surveys. There is currently little staff within the Agriculture Department with full training in the planning, design, and management of surveys, nor in the design, development and statistical analysis of the resulting data. Building additional capacity in this area could greatly increase the utility and impact of agricultural information for decision making.

2.10 Agriculture Department – Central Farm

Person(s) Interviewed: Fay Garnett, District Agriculture Coordinator
Fay.garnett@agriculture.gov.bz
Javier Quiroz, (TITLE AND EMAIL?)
Anna Howe, Extension Section, Extension Officer
howe_anna@yahoo.com
Oscar Salazar, Research Section, Researcher-Covered Structures.
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Manual Trujillo, Crops Section, Crops Coordinator.
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Bernadette Cob, Livestock Section, Livestock Technician.
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Neri Bol. Aquaculture and Inland Fisheries Section, Aquaculture Coordinator.
Neri.bol@agriculture.bz

Interview Date: June 11, 2014

2.10.1 Organization and Mission

The Central Farm Research, Development and Innovation Center is a 1500 acre centralized station comprised of five main sections: Administration, Livestock, Crops, Agro-processing, and Agriculture Engineering. The Center serves as a research and demonstration center which provides services and training to students, farmers, farmer groups, cooperatives, extension agents and NGO's, primarily focused on small to medium sized farmers. Central Farm is supported by its partners in development – TTM-ROC, BAHA, CARDI, PCP and the University of Belize.

There are over 100 persons working at Central Farm. Meetings were held at the facility to cover the Sections and GIS and BNSDI relevant functions listed below:

Agriculture Engineering

1. Provide Mechanical and Land Preparation Services

Aquaculture and Inland fisheries.

2. Promotion and Support for Development of Sustainable Aquaculture Industry

Agro-processing

3. Promote and Support Agro-Processing in Belize

Crops

4. Promote and Support Crop Development

Livestock.

5. Promote and Support Livestock Production

Extension.

6. Provide Extension Services to Small to Medium Sized Farmers

Research.

7. Conduct Special Agriculture Research Studies
8. Provide Facilities and Infrastructure for Agricultural Research and Development

2.10.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

2.10.2.1 Provide Mechanical and Land Preparations Services

The Central Farm Agriculture Engineering Section provides mechanical and land preparation services to the general public and farmers at reasonable prices. The mechanization services that the section provides includes bush hogging, ploughing, harrowing, rototilling, cultivating, drain digging, bedding/ridging and trailer transportation.

The above services are conducted both within Central Farm as well as provided as a paid service to farmers within Cayo District. The Unit has 8 tractors, but at any given time there will be an average of 6 that are operational.

Requests for service are coordinated by the Tractor Coordinator. Tractor Service Requests are tracked manually. The Coordinator tries to group the requests according to geographic locations, type of service requested and timeframes in order to minimize tractor transport and increase efficiencies. Recently the Unit has been providing approximately 300 hours of service to 20-25 requests each quarter. The demand has been growing so the Unit is interested to increase equipment and manpower to accommodate it. Preventive, routine maintenance is lacking and most maintenance is carried out only when there is a breakdown.

Although no GIS is being used for this function currently, ways that GIS/BNSDI could be useful include but would not be limited to:

- Geocode service requests, providing ability to track current and past projects geographically;
- Access agricultural census and farmer registries and associated information to help build awareness and market the tractor services;
- Access protected areas and other information to ensure requested work can be carried out within regulatory directives;
- Access land ownership information to confirm service requestor is land owner;
- Keep track of tractor locations;
- Monitor and evaluate outcomes and cost effectiveness of tractor service program over time.

2.10.2.2 Promotion and Support for Development of Sustainable Aquaculture Industry

The Aquaculture Technical Monitoring Unit is a relatively new unit responsible for promoting and supporting sustainable, small scale aquaculture for rural communities, primarily for local consumption. This includes building awareness of the requirements and benefits of sustainable aquaculture, supporting technology and best practice transfer to farmers, providing training and extension support. The Unit also maintains hatcheries in two districts for fish stock development.

When assessing whether a site is suitable for aquaculture, the Unit considers a variety of factors, including but not limited to:

- Good and accessible water supply;
- Good clay (for bottom sealing);
- Access to markets;

The Unit recently conducted an inventory of aquaculture facilities in Cayo District. This included recording GPS locations for 60-70 aquaculture locations. Additional information about each location is being added to an Excel spreadsheet, including the farmer name, fingerlings count, total fish produced and other such information.

Ways that GIS/BNSDI could be useful to this unit include but would not be limited to:

- Continue geocoding aquaculture farm locations to track their distribution on a map;
- Suitability analysis (soils, slope, water access, market and transport access, etc.);
- Access protected areas and other information to ensure proposed aquaculture can be carried out within regulatory directives;
- Access land ownership information to confirm service requestor is land owner;
- Monitor and evaluate outcomes and effectiveness of aquaculture promotion and support programs over time.

2.10.2.3 Promote and Support Agro-Processing in Belize

The main objective of the Agro-Processing unit are to a) Contribute to income generation and food security in Belize, b) Facilitate technical training, technology transfer and product research and development to small and medium food processors, and c) Contribute to primary schools through the school feeding program.

Although no GIS is being used for this function currently, ways that GIS/BNSDI could be useful include but would not be limited to:

- Record and track the location and characteristics of farmers that are involved in agro-processing;
- Access environmental, infrastructure and other information that would support or hinder agro-processing development around each rural community;
- Based on the above, assess needs and develop program responses that are suitable for each geographic area;
- Track school locations and their participation in school feeding program;
- Monitor and evaluate outcomes and effectiveness of agro-processing promotion and support programs over time.

2.10.2.4 Promote and Support Crop Development

The Crops Unit is responsible for promoting and supporting the strengthening of agricultural crop development in Belize, both to support economic development and contribute to food security in the Country. Focus is place on priority commodities that have highest potential to meeting program objectives, which currently includes selected grains, coconuts, bananas, plantain, fruit trees, rice and pineapples.

ESTIMATED COST OF PRODUCTION FOR ONE ACRE CORN FOR SEED PRODUCTION					
Planting System:	Mechanized/Commercial Production				
Av. Yield - lbs/acre:	4000				**Central Farm Estimates**
Date:	May 27, 2014				
Activity	**Unit**	**Quantity**	**Unit Cost $**	**Cost 1 acre**	
Ploughing	acre	1	$ 60.00	$ 60.00	1 pass
Harrowing	acre	1	56.00	$ 56.00	2 passess@$28.00/pass
Planting/Fertilizing/Sidedressing	acre	1	45.00	$ 45.00	
Herbicide Application	acre	2	10.00	$ 20.00	2 if necessary
Insecticide application	acre	2	10.00	$ 20.00	
Subtotal				**$ 201.00**	
Inputs					
Seeds - Variety CARDI Y001	lbs	25	$ 2.00	$ 50.00	seed already treated
Fertilizer - 14-36-12	110-lb bag	1.5	$ 64.50	$ 96.75	Fertilizer is applied at planting
Urea	110-lb bag	1	$ 57.50	$ 57.50	Fertilizer is applied 5 weeks after planting
Round-up	Liter	1	$ 14.00	$ 14.00	Broad spectrum herbicide (if necessary)
Prowl	liter	1	$ 32.00	$ 32.00	Pre-emergent herbicide
Primero (herbicide)	pk	0.5	$ 45.00	$ 22.50	Selective, post-emergent herbicide (36 g pk)
Cypermethrin 25EC	liter	0.5	$ 30.00	$ 15.00	control of armyworms
Surfactant	liter	0.5	$ 8.72	$ 4.36	Spreader sticker
Subtotal				**$ 292.11**	
Harvesting/Post-Harvest					
Harvesting (Combine)	bags	40	$ 3.00	$ 120.00	
Drying	bags	40	$ 3.00	$ 120.00	
Storage (phostoxin treatment)	tube	6	$ 3.50	$ 21.00	
Mechanical cleaning	lbs	4000	$ 0.10	$ 400.00	
Bags	lbs	50	$ 1.00	$ 50.00	
Subtotal				**$ 711.00**	
Total				**1,204.11**	
Cost Benefit Analysis					
Dry Weight Corn	Av. Yield/Ac	Price/lb	Total		
	4000	$ 1.50	$ 6,000.00		
Cost of production from planting to storage			$ 1,204.11		
Net Profit			**$ 4,795.89**		
Cost of Production for 10 acres	**12,041.10**				
Net Profit for 10 acres	**47,958.90**				

Figure 17 – Crop Production Cost Estimation

The Unit has developed a database of the growers and processors that they engage with. The locational reference for each stakeholder is general, although the staff indicated a desire to add a GPS location for each farmer and processor in the future.

The Unit works closely with regional partners in terms of technology, introduction of productive hybrids, disease treatments and other related matters. It is important to track where these interventions have taken place to be able to track their effectiveness in the future.

There are currently 48 acres at Central Farm dedicated to Coconut breeding. Seedlings are being made available to the public at a very inexpensive rate. It is estimated that there are about 9800 acres of commercial coconut in about 100 groves in the Country. There is currently no map of these locations but staff indicated this is definitely needed.

Database of Coconut Producers in Belize 2013

Name	Location	Variety	Non-bearing	Bearing	Total	Contact #	e-mail	Remarks
	Stann Creek		Acres	Acres	Acreages			
Richard Pollack owner/ Jacqueline Haylock - Manager	Silk Grass	Chectumal, Colima		390		5223408	jacquelinehaylock@gmail.com	Mexican hybrids
Said Flores	Big Creek	Maypan		7				abandoned
Sittte River Coop	Sittee River	Maypan		14				
Marie Sharp Ltd.	Melinda	Assorted		21				need to confirm
Bowman		Maypan		15				need to confirm
Arden Usher		Maypan		20				need to confirm
Henry Cantun		Maypan		30				need to confirm
Kwaney Reynolds	Sittee River	Maypan		20		607-0740	kwarney@hotmail.com	Maypan hybrids
Agricuture Station	Melinda	Panama Tall		1				Hybrid
Steve Christiansen	Placenca	Maypan		12				need to check
Darrell Cutkelvin	Sittee River	Assorted		5				need to check
Francisco Villafranco	Hope Creek	Maypan		1.5		6645139		
Clement Martinez	Hope Creek	Assorted		20		6689517		
Augustine Sabal		Assorted		10		6014848		
Emilio Almendarez	Hope Creek		20			6284326		
Quincey Coleman		Maypan		5		6690449		
Gaspar Martinez				1.5		6624961		
Genovivo Salam						6789976		
Stanley Murillo		Assorted		0.5				
Gustavo Lopez	Steadfast	Assorted		8				
Roberto Morriera	Steadfast	Assorted		10				
Mr. Edward Bardalez	Steadfast	Assorted		10				
Freshwater Creek Farms	Silk Grass	Maypan		6		6677279		Fernando Majil - Farm Manager
Aurora Manzanero	Alta Vista	Assorted		8				
Paul's Guest House				10				
Raymond Mejia	Sarawee	Assorted		1				
Cyril Sabal	Sarawee	Assorted		5				
Dickie Castillo	Hope Creek	Assorted	5					
TexBel	Silk Grass	In progress						Plans to plant 1,000 acres
Ricardo Montero	Silk Grass	Mexican varieties		3				
Wilbert Ramclam		Maypan		4				
Rainforest Realty	Hummingbird Hwy Mile 3	Assorted		15				

Figure 18 – Coconut Producers Database

In addition, the Nursery is involved in propagation for other species including various fruit trees, mahogany, teak and cedar. There is a database of agroforestry plantations but this is not on a map and there is not precise description of locations in the database.

Production of grains in Belize is a $60m - $70m per year business, inclusive of corn, beans, rice, soy beans, black eye beans and others. There was an agricultural census conducted in 2010 but the data from that study is not yet available.

Many people and organizations are investigating potential investment in Belize agriculture. There is a need to support investment by showing areas that are suitable for certain types of agricultural development.

Pineapple is being developed on a smaller scale, primarily in Cayo District and some areas in the north of the country.

Although no GIS is being used for this function currently, ways that GIS/BNSDI could be useful include but would not be limited to:

- Record and track the location and characteristics of various farms, their crops and outputs nationally;
- Conduct agricultural crop suitability assessment (soils, rainfall, access to supplemental water supply, access to markets and transportation, outside of protected areas, etc.). Calibrate this over time with crop production information from farms producing certain crops within various ecotypes;

- Identify high potential areas for investment and make this information available to potential investors;
- Monitor and evaluate outcomes and effectiveness of crop promotion, development and support programs over time.

2.10.2.5 Promote and Support Livestock Production

The Livestock Program is responsible to promote and provide technical support for the improvement and growth of the livestock production capacity of small to medium sized farmers in Belize. This is accomplished through genetic improvement programs, providing breeding stocks, extension services, promoting technological approaches for supplemental feeding and controlled breeding and production programs.

There are 250 acres of land at the Central Farm dedicated to the livestock program, focused on cattle. Besides the breeding program and selling of young breeding bulls, the facility also includes a milk production facility. There are persons in the other District offices who take orders for breeding stock. Extension services from this location are only for Cayo District.

There is a Belize Livestock Producers Association representing the interests of the farmers. The MNRA coordinates with the Association. It is required that cattle are branded, and all farmers who are members register their brand with the Association for tracking purposes.

In the past, the Ministry used to do a livestock survey ever 2-3 years. This included cattle as well as pigs and sheep. Staff was not sure what the status of this data collection program is today.

Although no GIS is being used for this function currently, ways that GIS/BNSDI could be useful include but would not be limited to:

- Record and track livestock farmers;
- Record and track services to livestock farmers;
- Identify areas suitable for livestock development;
- Monitor livestock development and production;
- Monitor and evaluate outcomes and effectiveness of livestock development and support programs over time.

2.10.2.6 Provide Extension Services to Small to Medium Sized Farmers

The Central Farm provides agricultural extension services across the Cayo District, in all sectors. Extension officers maintain contact with farmers and provide a liaison between various research tracks at Central Farm and ensuring that innovations, technologies and best practices are disseminated to the small and medium sized farming community.

The extension officers maintain records about the farmers they deal with but this is currently not done in mapped form. Also, the extension officers are interested to utilize the outputs of the 2010 agricultural census that was conducted by the MNRA, but this data has not yet been made available and there is concern that this information is already becoming out of date, further impacting its usefulness.

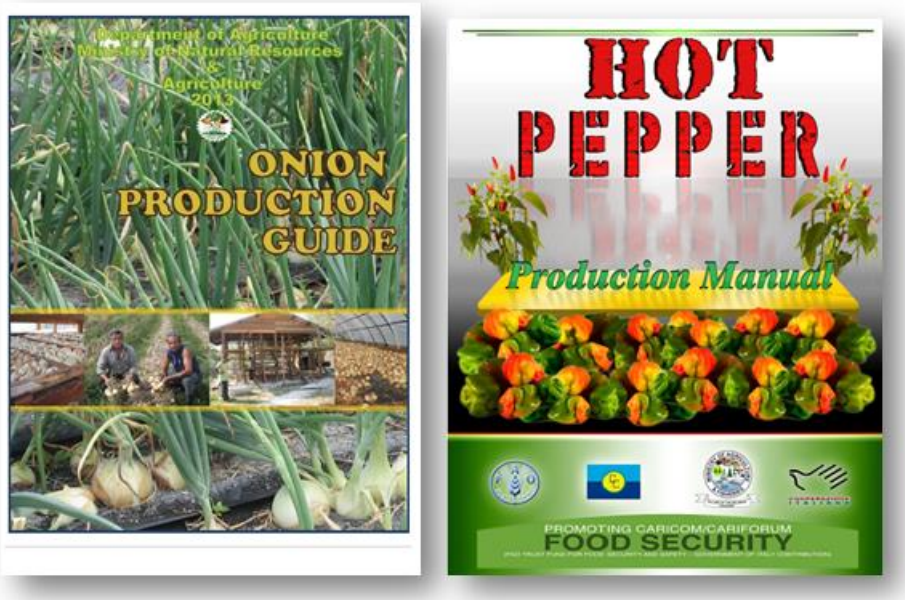

Figure 19 – Example of Production Literature Provided to Farmers

Although no GIS is being used for this function currently, ways that GIS/BNSDI could be useful include but would not be limited to:

- Record and track all farms and farmers;
- Spatially enable the agricultural census for a complete geographically based picture of the agricultural sector across the Country;
- Track agricultural census extension services;
- Monitor agricultural output across all sectors;
- Monitor and evaluate outcomes and effectiveness of agricultural extension programs over time.

2.10.2.7 Conduct Special Agriculture Research Studies

The Agricultural Research Studies Unit is involved in conducting special studies in various areas of agricultural technologies and production methods. The Unit currently has 6 people that run 4 sections. One section is a horticultural demonstration center that is a showcase for good farming practices and technologies. A second section is focused on rice seed production. One section is researching the use of covered structures (greenhouses, etc.) technologies and their application across the Country, and one section is dealing with organic production research.

The horticulture demonstration area is also used for trials, for example to test the effectiveness of various fertilizers and other inputs. They also conduct research in the districts in certain crop such as onions, potatoes, carrots and lettuce.

The rice program focuses on evaluation of various strains and in the production of seed for sale to the farmers.

A small urban gardening program has been established focused on small space urban area food growing with some emphasis on organic gardening.

In 2011 the Unit conducted a survey of covered agricultural structures across the country. This included the mapping of approximately 95% of the structures. This exercise included some assessment of what information was needed to monitor and assess the production advantages and capacities of this area of technology, however the resulting database has not been routinely updated and it is known that many additional structures have been built since then. It is suspected that the extension officers have the best sense of where new structures have been built, but there is currently no standard operating procedure in place for this information to be updated through that channel.

Tracking of crop diseases and pest outbreaks is very important. Some of these can have catastrophic impact on certain crops and in turn the economy of Belize. This is especially an issue for small to medium-sized farms that do not have access to the infrastructure required for mechanized treatment. Having the ability to identify potential threats early and to respond in a timely manner to constrain spread of a disease or pest is critical to the agricultural sector in Belize.

Although all areas of research and extension are concerned with the location of farmers and it is generally known where the major producers are located, these are not recorded on a map and the intelligence is held by individuals in their heads. There is some danger that all this experience and knowledge will be lost if the record keeping and mapping of collective knowledge and experience intelligence is not recorded for future use.

Ways that GIS/BNSDI could be useful to support the functions of this unit at the Farm include but would not be limited to:

- Record and track all locations and characteristics of special studies;
- Agricultural study formulation and feasibility assessment;
- Monitor and evaluate outcomes and effectiveness of research programs over time.

2.10.2.8 Provide Facilities and Infrastructure for Agricultural Research and Development

The Central Farm primary mission is to provide the facilities and knowledgeable personnel to support the effective agricultural research and development functions that are needed to grow and evolve the agricultural sector in Belize. This includes the original and applied research needed to monitor and assess worldwide technologies and trends and to adapt them to the Belize context. It also includes the dissemination of this information in ways that will directly benefit the farming community.

It is recognized that the extension officers play a key role in this latter function, and that the effectiveness of extension services is also dependent upon the engagement with and receptivity of farmers to use this information.

Belize is committed to certain international treaties and conventions, some of which related directly to agricultural programs and trade. For example, the Country is committed to reporting its production statistics for grains to CARICOM. Extension officers and the active cooperation of the farming community is key acquiring and reporting accurate information

Another important consideration is the potential impact of climate change and variability on the agriculture sector in Belize. The implications are far-reaching, affecting the livelihood of thousands of families across the Country and impacting the national economy, the Country's food security, poverty alleviation, environmental sustainability and many other related issues. Monitoring the impacts of climate change and providing the research support needed to mitigate and adapt to a changing climate context over time is going to be critical to the agricultural sector in the Country in the coming years.

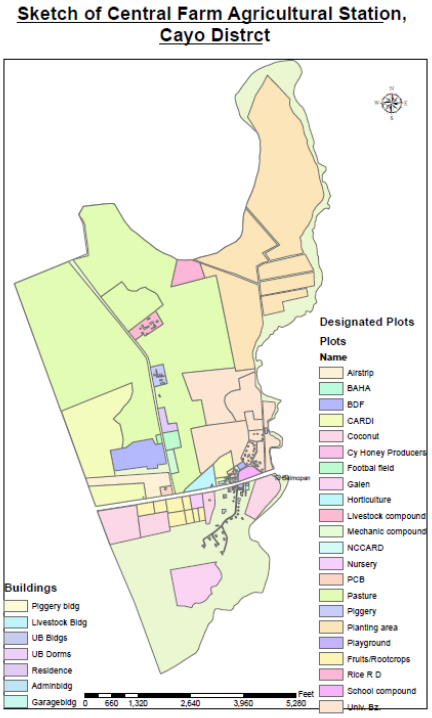

Figure 20 – Central Farm GIS Basemap

The management of all the lands and assets of Central Farm is also a topic of interest across the board. A University team in 2012 developed an initial basemap showing the location of the various areas on the farm, roads and buildings (See Figure above). This was created in an ArcGIS shapefile format, but this is not generally accessible and has not been updated. There is the potential to expand on this database to develop a more complete asset, land and program management system for Central Farm.

The Research Unit has its own office and through a recent project funded by the IDB was able to acquire 8 PC's and a Server. There is a desire to build an information library for the Central Farm that can be used as a common resource across the agricultural research community. It is known that over the years there has been much research information generated at the Central Farm that has been lost because it was maintained by individual researchers or programs, and has since been lost. There is an interest to explore the establishment of a central facility at the Farm to facilitate, promote and support the capture, management and dissemination of research data and information, including making this information available to the various agricultural trade associations, farmers and the public. Developing such a capability at Central Farm will be highly dependent on management awareness and support to ensure that as a policy all units should cooperate and share information across administrative boundaries.

The above matter is not isolated to Central Farm and extends to the whole MNRA organization and especially the District offices where the direct contact with the farming community takes place.

Ways that GIS and the BNSDI could be useful to support this functional area include but are not limited to the following:

- Provide geospatial computing infrastructure, facilities, data and technical support to support applied research activities in the agriculture sector
- Support student internships and international exchange program
- Conduct special studies in support of communities and business

2.10.3 Data Used or Generated

The following GIS and BNSDI related data sources have been used in carrying out the functions of the Central Farm:

Tractor Service Requests. The MNRA Central Farm Engineering Section maintains a tracking record for mechanical and land preparation services that are conducted for farmers and others. This includes recording of the farmer name, location, tractor and staff mobilized to provide the service. There are about 20-25 requests per quarter, representing about 300 hours of service provided throughout Cayo District. These services are tracked manually now, but there is desire to do this in digital/GIS form in the future.

Aquaculture Inventory. The Aquaculture Technical Monitoring Unit conducted an inventory of aquaculture facilities in Cayo District. This included recording GPS locations for 60-70 aquaculture locations. Additional information about each location is being added to an Excel spreadsheet, including the farmer name, fingerlings count, total fish produced and other such information.

Agricultural Census. The Belize Agricultural Census (BAC) was conducted in 2011. The objectives of the BAC were to A) provide reliable and objective baseline data on the structure of the agricultural sector of Belize and an inventory of agricultural resources; B) to provide reliable data on the agricultural sector that will enable the users at the Ministry of Agriculture and Fisheries and other public, private and international institutions to make better decisions; and C) to use the results of the BAC to establish an agricultural statistics system to measure the development of this sector on a regular and continuing basis. As of June 2014 this data has not been released and is still undergoing some level of quality checking and data cleansing.

Crop Production Cost Estimates. The MNRA Central Farm maintains various crop production estimates for key crops. This information is developed from statistics that are compiled at the Central Farm as well as input from farmers in various areas. In the future it may be desirable to track the location and characteristics of the farms and plots from where these costs are derived to provide a basis for refining and calibrating these to reflect a variety of conditions and practices.

Crop Growers and Processors Database. The MNRA Central Farm Crops Unit has developed a database of the growers and processors that it engages with in an Excel spreadsheet form. The locational reference for each stakeholder is general, although the staff indicated a desire to add a GPS location for each farmer and processor in the future so that this information can be displayed and accessed in a GIS.

Livestock Registry. The Belize Livestock Producers Association in 2009 initiated the development of a comprehensive registry of all livestock farms in Belize as one component to complement the $12.2M National Cattle Sanitary plan project, a joint effort between the Government of Belize and the European Union. The national livestock registry was developed to support the exportation of cattle to Mexico and other countries by establishing compliance with the (OIE) World Organization for Animal Health requirements for bovine, animal health and the requirements established by Mexico, for the export of live cattle under formal agreement between Mexico and Belize. This database contains information regarding each farm as well as each animal from destination to origin as is required in international trading.

Belize Farm Registry. In the first quarter of 2001, the Ministry of Fisheries and Agriculture, with technical and financial support of the FAO commenced the development of a Belize Farm Registry, with a limited agricultural census. The purpose of the Registry was to

establish a sustainable registry of farms (farmers) and a system of periodic surveys for updating the registry through the introduction of appropriate data collection and statistical methodologies. Any more information regarding this survey available?

MNRA Livestock Survey. In the past, the MNRA used to do a livestock survey ever 2-3 years. This included cattle as well as pigs and sheep. Staff of the Central Farm was not sure what the status of this data collection program is today.

Farmer Extension Services Database. The extension officers at Central Farm maintain records about the farmers they deal with but this is currently not done in mapped form and is not consolidated. There is a desire to track the location of all farmers and extension services provided in the future.

Covered Agricultural Structure Inventory. In 2011 the Unit conducted a survey of covered agricultural structures across the country. This included the mapping of approximately 95% of the structures. This exercise included some assessment of what information was needed to monitor and assess the production advantages and capacities of this area of technology, however the resulting database has not been routinely updated and it is known that many additional structures have been built since then. It is suspected that the extension officers have the best sense of where new structures have been built, but there is currently no standard operating procedure in place for this information to be updated through that channel.

Central Farm Facility Database. A University team in 2012 developed an initial basemap showing the location of the various areas on the farm, roads and buildings. This was created in an ArcGIS shapefile format, but this is not generally accessible and has not been updated. There is the potential to expand on this database to develop a more complete asset, land and program management system for Central Farm.

2.10.4 Existing Systems

Most digital information at Central Farm is utilizing generic word processing and spreadsheet applications. There were no application software systems surfaced in this interview.

2.10.5 Computing Infrastructure

All professional staff at the Central Farm has access to a PC and basic Office applications. The detailed computing infrastructure configuration is provided in the MNRA – IT Stakeholder Survey write-up.

2.10.6 Other Issues, Opportunities and Constraints

There is a very significant opportunity to increase the use of GIS for agricultural research and development in very practical ways that will directly benefit farmers, the agricultural sector, and its contribution to economic and sustainable/resilient development in Belize. The

following summarizes issues, opportunities and constraints that need to be considered in the formulation of future plans in this area:

Develop a capacity for GIS-enabled agriculture management information systems. It is recognized that there are many existing and emerging information and geospatial technologies that could greatly benefit the Agriculture Sector in Belize. There is an interest to explore the establishment of a function at Central Farm to introduce these technologies and methods to the agricultural sector and to promote and support the integration and building of this capacity where it can do the most good.

Develop standards for capture of agriculture data. There is currently lacking any guidelines or standards for the capture of agriculture data in Belize. Development of such a framework would help to ensure that all agriculture data that is collected will be interoperable across all the programs and units.

Develop more awareness of the potential of GIS and the BNSDI across Central Farm programs and especially with the extension officers. It is recognized that for GIS and the BNSDI to be embraced by Central Farm staff as well as in the Districts there is a need to raise awareness about what it is and how it can benefit specific requirements.

Introduce GIS and BNSDI concepts and practices within the agricultural programs at the University. The next generation will be important in bringing new technologies and methods into the agricultural sector. Integrating these tools into agriculture curricula will help to equip young agricultural professionals to take this modernization process forward.

Explore how to use cell phones and other mobile devices to take advantage of more two-way information exchange with the farming community. Many people even in remote rural areas are now using cell phones. There is an opportunity to tap into this trend both to improve and streamline the provision of information and services to farmers as well as to collect input and information from the farming community. Cell phones are increasingly location-aware, thus providing the opportunity to reference this feedback geographically.

3 MINISTRY OF WORKS AND TRANSPORT

3.1 Works Department and Transport Department

Person(s) Interviewed: Simeon Herrera, Works Department, Engineer, simeonherrera@gmail.com
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Garson Ramnarace, System Administrator sys.admin@mow.gov.bz
Lennox Bradley, Works Department, Chief Engineer chief.engineer@mow.gov.bz
Crispin Jeffries, Chief Transport Officer, commander_ed_Police@yahoo.com

Interview Date(s): June 16 & June 24, 2014

3.1.1 Organization and Mission

The Ministry of Works and Transport (MoWT) has over 320 staff and is divided to two major Departments, including Works Department and the Transport Department.

The Works Department is responsible for maintaining all national assets comprising the transportation network, such as roadways, bridges, culverts, drainage channels and safety appurtenances with a view to provide good riding quality, all weather road upgrading, appropriate user safety and general access to enable transit activity, urbanization, agricultural and commercial development. This charge includes the preservation of civic buildings, sea defense structures and other municipal chattel.

The Transport Department is responsible for the oversight and regulation of all public transportation in the country and to ensure traffic safety along all roadways under the jurisdiction of the MoWT.

The MoWT conducts several functions that relate most directly to GIS and the BNSDI, including the following:

1. Support transportation planning
2. Manage materials lab.
3. Oversee road design and construction.
4. Maintain roads infrastructure.
5. Maintain other civil infrastructure
6. Manage road safety

7. Administer driver and vehicle licensing registration
8. Conduct transit planning.
9. Manage and regulate public and private transit and operate terminals.
10. Conduct traffic enforcement.
11. Monitor and manage road safety.
12. Participate in emergency planning and response.

3.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

3.1.2.1 Support Transportation Planning

The MoWT is involved in supporting the planning and design of all major roadways under their jurisdiction throughout the country. This activity generally happens within the context of specific transportation development projects financed externally through the international finance institutions. In 2013 the Government of Belize enlisted the technical support of the South Korean Government in preparing a National Transportation Master Plan. The Master Plan, prepared by the Korea Development Institute, the University of Seoul and the TESO Engineering Company of South Korea also included consultation with key government ministries including the MoWT. The Plan is largely driven by the transport needs of the Tourism and Agriculture sectors, improving access to key touristic attractions and connecting agricultural farms with processing and export facilities and markets. It also considers linkages to air and water transport within the country and internationally. The development of the plan was arranged through the Ministry of Foreign Affairs and coordinated by the Ministry of Energy, Science & Technology and Public Utilities.

BZ$20 million has already been earmarked for key projects within the Master Plan. They include $6.0 million from the OPEC Fund, Kuwait Fund and CABEI for the continuation of the upgrading of the Southern Highway; $5.0 million from CDB for the new Macal River Crossing (in Cayo District, including upgrading roads to the new bridge site); $3.0 million from CABEI for the new Corozal Border Crossing Reconstruction Project to upgrade facilities and infrastructure at the second Belize/Mexico Bridge; and $6.0 million from the World Bank for the Belize Municipal Development Project to improve access to basic municipal infrastructure and to enhance municipal management in selected towns and city councils.

The National Transportation Master Plan is divided in three phases: 1st phase: 2014-2020; 2nd phase: 2021-2030; and 3rd phase: post-2030.

- Phase 1 includes works on the Altun Ha road and the Augustine Pine Ridge Municipal airstrip.
- Phase 2 includes road investment for boosting major industries, refinements to the Caracol Road and the widening and expansion of the taxiway for airstrips in Corozal, San Pedro, Caye Caulker, Dangriga, Placencia, and Punta Gorda.
- Phase 3 will entail the establishment of industrial infrastructure for long-term economic development and improvements to enhance the connectivity between northern and western regions, among other plans.[10]

The MoWT who will be responsible for the execution of the Plan was one of several other entities that were consulted in its development. Several areas that GIS and the BNSDI can support in this planning exercise include but are not limited to:

- Inventory and assessment of existing transportation infrastructure;
- Inventory and assessment of high priority trip origination and destination points and areas;
- Traffic modeling and monitoring;
- Transport optimum corridor selection based on cumulative social, environmental and engineering issues, opportunities and constraints, including consideration of potential future climate change issues;
- Roadway conceptual design;
- Cost, value engineering and feasibility assessment;
- Environmental impact assessment;
- Right of way acquisition assessment and planning;
- Stakeholder engagement and coordination;
- Public outreach and communications.

One issue raised by MoWT Transport Department staff is that the current Municipal Development Project that is laying future land use plans for the major population centers is not considering transit requirements such as bus routes and stops, station locations and areas for transit vehicles to park when not in use. Staff would like to see more attention given to this matter in future planning efforts.

3.1.2.2 Manage Materials Lab

The MoWT materials lab is responsible for review roadway engineering geotechnical studies, testing of roadway construction materials and related matters. Today the locations of ***geotechnical testing boreholes and sampling sites*** is not standardized. Some site samples and data have precise GPS-derived geographic coordinates while others may reference a sketch location on a plan. Standardization of the geolocation information would add value in the incremental compilation of a repository of accurately located testing information over time.

[10] http://amandala.com.bz/news/belize-developing-multimillion-dollar-national-transportation-master-plan/

Ways that GIS and the BNSDI would be of relevance to this functional area includes but is not limited to the following:

- Link borehole, geotechnical and material lab test results to geographic locations
- Publish selected test results by geographic location for use by engineers

3.1.2.3 Oversee Roads Design and Construction

The MoWT is involved in overseeing roadway design and construction works. These are conducted in accordance with national standards. The foundation of standards was developed in 1999 and evolved with minor adjustments since that time. Key areas addressed by the standards include:

- Pedestrian crossings;
- Speed bumps;
- Road markings;
- Catseyes (Roadstuds);
- Road and bridge standards;
- Markers and reflectors;
- Traffic signs;
- Maintenance and construction signs;
- Aggregates;
- Surface dressing;
- Concrete;
- Intervention levels of road maintenance;
- Explosives;
- Vegetation control;
- Premix MACADAM.

Many of the above listed standards include spatial considerations for placement and juxtaposition.

Detailed road design and construction are usually carried out by private sector firms through competitively bid contracts. The MoWT oversees these activities to ensure compliance with standards and to maximize the value of the public investment in this infrastructure.

There are currently three different Project Execution Units (PEU's) administering the externally financed projects of the MoWT, one for each of the primary finance institutions including the IDB, European Union and OPIC. Each has different procedures, conventions and information management procedures depending upon the requirements of the funding entity. ***MoWT Project Case Files*** in paper form are compiled and maintained for all projects, but these are not integrated across the three PEU's.

Several areas that GIS and the BNSDI can support in road design and construction activities include but are not limited to:

- Basemap and inventory of existing conditions (topography, soils, slope, surficial geology, land use, land cover, land ownership, existing infrastructure and structures, protected areas, administrative boundaries, etc.);
- Planning and management of temporary traffic diversions and signage during construction;
- Asset takeoff and as-built inventory for roadway and associated appurtenances;
- Construction oversight status reporting;
- Management of as-built records for roads, georeferenced to location;
- Public awareness and outreach (maps for newspaper and television, etc.);

3.1.2.4 Maintain Roads Infrastructure

The Ministry previously developed and had maintained a roadway inventory system for pavement, bridges and culverts. This information was maintained in the ***Routine Maintenance Planning System software (ROMAPS),*** an off-the-shelf commercial application software that was developed originally in the 1980's by Roughton International. The program was designed to meet the needs of practicing maintenance engineers in real situations. It was reputed to encourage good practice and acknowledge the value of local maintenance experience. ROMAPS specifies methods and procedures for:

- Inventorying Assets
- Recording asset conditions
- Identifying appropriate repair strategies
- Estimating the annual cost of such strategies
- Providing supporting bid documentation
- Calculating prioritized work programs based on approved allocations
- Organizing, implementing and recording the work done

ROMAPS captured roadway pavement, appurtenances and activities in a tabular database as point or line events within a linear referencing scheme that identified events in kilometer reference to a point of beginning at designated locations. Geographic coordinates were captured for bridges, but not for culverts. The system had no GIS component therefore there was no mechanism for visualizing this information on a map or conducting geospatial analysis. The ROMAPS system has been maintained whenever data is collected and presented, but it has not been updated to the latest version and is to be replaced by the currently ongoing RMSI roadway inventory.

The Ministry of Works in 2011 undertook a project to map over three hundred miles of paved roads in Belize. The purpose of the survey, supported by the International Road Assessment Program (iRAP) was to determine the state of the nation's roadways and to prioritize a capital investment program for road safety infrastructure improvements. The survey was carried out by a specially equipped vehicle which recorded images of the major highways from Corozal to Toledo and selected paved roads in between. The survey was carried out by the

International Road Assessment Program, a London-based not-for-profit organization dedicated to saving lives through safer roads. This program resulted in the capture of road condition information including geo-referenced video imagery every 10m (**IRAP Road Assessment Database**). The GPS coordinates captured for all roadways surveyed, except for the Toledo District, were provided to the MNRA LIC in 2011

Figure 21 - IRAP Road Condition Survey Vehicle

The Ministry is currently undertaking a major project to prepare a complete inventory and assessment of the entire existing road network. The RMSI company was commissioned to carry out this project.

As follow-on project is under preparation for the strengthening of the road maintenance program for all the roadways under the jurisdiction of the MoWT.

The Ministry used to maintain as-built drawings for all road works conducted in the past. However most of this information has been lost over time and there is currently no actively maintained repository for as-built information.

Aspects of this function that can be supported by GIS and the BNSDI include but is not limited to:

- Maintain complete and up to date inventory of road assets nationwide;
- Provide geographic basis for understanding road network asset conditions and maintenance priorities;
- Spatial representation of preventive maintenance priorities and schedules;
- Link to other utilities and infrastructure entities with assets within the road right of way;
- Monitor and track reactive maintenance activities to identify repeat visit areas that may need more proactive remedial treatment;
- Maintenance fleet management;
- Integrate MoWT roads with roads administered by others for a complete picture of the transportation network. This could also be used as the basis for a complete and accurate navigable road database to support car navigation;

- Link traffic violations and accidents to roadway conditions as a reference for future maintenance and enhancements;
- Maintain geo-referenced repository of roadway as-built records;
- Monitor and assess the effectiveness of road maintenance programs over time.

3.1.2.5 Maintain Other Civil Infrastructure

The MoWT is also responsible for maintaining other selected civil works including inland waterways and public buildings. In the case of inland waterways, the Ministry is responsible to ensure that natural and manmade waterways are kept free of debris that would constrict flow and cause flooding issues. The Ministry is also responsible for implementing major repairs to government buildings, which is primarily carried out on an as-needed, reactive basis when major problems arise.

Aspects of this function that can be supported by GIS and the BNSDI include but is not limited to:

- Complete inventory and assessment of inland waterways;
- Development of preventive inspection and maintenance schedules for inland waterways;
- Plan, track and monitor reactive maintenance activities to resolve inland waterway issues;
- Utilize geospatially enabled social media and crowd-sourcing to help identify existing and potential inland waterway issues;
- Complete inventory and assessment of government buildings;
- Development of preventive inspection and maintenance schedules for government buildings;
- Plan, track and monitor reactive maintenance activities to resolve inland government building issues;
- Utilize geospatially enabled social media and crowd-sourcing with government staff to help identify issues with government building maintenance.

3.1.2.6 Manage Road Safety

The MoWT has a road safety unit that is responsible for inspecting and providing technical advice in regards to line marking, signage and maintenance of the standards manual. These staff are also the primary liaison for coordination with the utilities, with the support of the zone engineers. Whenever utility trenching and other works are required these are coordinated with the zone engineer and road safety staff to ensure that the work is properly supervised and that road safety is not compromised. This group also maintains a record of traffic accidents in paper form. The form includes a highway milestone number. This is based on a common road reference system established by the Joint Intelligence Command Service (JICS) coordinated by the Police Department. This information is also collected by the Police and Ministry of Health, but there is presently no basis for coordination or sharing information among the three entities.

The MoWT is required to review and approve all signs, buildings and utility corridors that will in some way impact highway right of way or safety. At one time the Ministry maintained a ***Highway Sign Inventory***, but that information has not been maintained for many years.

Aspects of this function that can be supported by GIS and the BNSDI include but is not limited to:

- Complete inventory of street markings and signage;
- Tracking and analysis of traffic accidents and causative factors;
- Maintain common road linear referencing scheme;
- Provide common operational picture in support of the JICS.

3.1.2.7 Administer Driver and Vehicle Licensing and Registration

The Transport Department is responsible for driver licensing and vehicle registration for people and businesses within communities outside of the municipalities. The municipalities carry out this function for residents and businesses within their jurisdiction. The Department role in this is carried out by staff in 7 locations across the country. Private driver license issuance requires written and driving skills testing and there is no further licensing or testing required for commercial drivers. Vehicles are inspected to ensure all the safety components are operational. There is not emissions testing beyond visible smoke. Licensing and vehicle registration is carried out by several administrative jurisdictions and there is no central coordination or repository of this information.

The Department has collaborated with CITO in the development of a concept paper for a proposed Belize Motor Vehicle Registration and Licensing System (BMVRALS). This system is intended to accomplish several objectives that are relevant to GIS/BNSDI including:

- Enable countrywide real-time data sharing
- Functions/standards to enhance efficiency in service delivery;
- Develop interconnectivity with other supporting agencies (public and private);
- Allow transparency in the acquisition of services/permits rendered by the Department;
- Allow the implementation of new functions (e.g. national violation ticket system);
- Enable the public to process information for needed documents via an electronic system.

There has been some interest in supporting some aspects of the BMVRALS by international donors, however this is dependent on related agencies and the central government fully backing the plan as a priority.

Aspects of this function that can be supported by GIS and the BNSDI include but is not limited to:

- Validate which jurisdiction a person is in to determine the responsible agency for licensing.

- Track violation locations countrywide, including linkages to municipality-issued tickets;
- Geocode licensed drivers and vehicles to visualize distribution and level of transactions in various areas over time.

3.1.2.8 Conduct Transit Planning

The Department of Transport is involved in overseeing, monitoring and regulating public and private transit in Belize. At present there is no formal mechanism for transit planning in the Country, but staff have indicated that this is needed for the future. The GIS and BNSDI could support such an effort in the following ways:

- Current transit situation assessment and modeling (existing and planned demand and supply);
- Assess the transit implications of existing and planned land use;
- Socioeconomic data and public transit rider profile assessment (current and projected);
- Existing roads and road conditions;
- Existing public and private transit routes and carrier information;
- Existing and planned terminals and stops;
- Multi-modal connections and flow modeling.

3.1.2.9 Manage and Regulate Public and Private Transit and Operate Terminals

Most Belizeans travel the country using public buses as their primary form of transportation. In the larger towns and cities, such as Belize City or Belmopan, there are bus terminals. In smaller places, there are bus stops. However, the most common way of catching a bus is by flagging it down on the road. On the Northern and George Price Highways, bus service is more frequent than on smaller highways and other roads. In some locations, like small towns, buses may run only once a day. Buses are classified as either Regular runs (usual prices) or Express runs (faster, for slightly higher prices).

A new zoning system was implemented in 2008 including the Northern (highway/rural), Southern (highway/rural), Western (highway/rural). Bus providers are restricted to assigned zones. [11]

The Transport Department is responsible for issuing operating permits for commercial carriers of more than 8 passengers. The Department establishes zone designations for each carrier and tracks the carrier routes. While there is currently information available online in regards to air and water transportation, there is nothing provided in regards to land transit. This is an area that staff have indicated will be important for the future,

The Department is also responsible for the management of the bus terminals. There are currently 124 people carrying out this function in 6 locations in 4 Districts. There is no ticketing system and people pay when they get on the bus, based on the distance to their

[11] http://en.wikipedia.org/wiki/Transport_in_Belize

destination and a pre-set rate set by the government. Operators have indicated that the current rate is not sufficient to cover operating and maintenance costs and that this causes deferred maintenance. Also the poor condition of some roads also increases operating and maintenance costs.

The GIS and BNSDI could support this function in the following ways:

- Maintain accurate and up to date bus route information;
- Monitor ridership on each route and bus terminal throughput;
- Track and monitor public and private buses (location, ridership, compliance with speed limits, stops, schedule performance, etc.);
- Terminal asset management and security;

3.1.2.9 Conduct Traffic Enforcement

The Transport Department is responsible for carrying out traffic law enforcement outside of the municipalities. There are a total of 28 enforcement officers who patrol the country's highways. They are responsible for issuing traffic, equipment and other safety violation tickets and identifying drivers who may be driving under the influence of alcohol or drugs. In addition, the enforcement officers also inspect buses at terminals. The officers issue approximately 250 tickets each month. Each ticket includes the home address or community name of the offender and the approximate location of the offense, by address, street or intersection name, and highway milepost or landmark reference. The Department would like to upgrade the approach in the future to include automating the ticket system and establishing a more precise way to record geographic locations.

The GIS and BNSDI could support this function in the following ways:

- Geocode violators and violation locations and provide the basis for analyzing and visualizing this information over time;
- Provide a means for enforcement officers to identify and communicate road safety and maintenance issues to the Department by geographic location;
- Monitor patrols and support computer aided dispatch;
- Allow traffic violation information to be retrieved by location on a map;
- Monitor traffic violations over time, assess patterns and determine need for remedial measures.

3.1.2.10 Participate in Emergency Planning and Response

The MoWT is a key member of the National Emergency Management Organization (NEMO) team. The Ministry participates in disaster vulnerability assessment, contingency planning, and emergency response and recovery activities.

The GIS and BNSDI could support this function in the following ways:

- Identify hazards and vulnerabilities of public works and transportation infrastructure (e.g. flooding and probable storm-related damages);

- Identify vulnerable populations, responder ingress/egress and population evacuation routes;
- Identify alternative routes for carrying relief supplies;
- Prepare and record transport component of emergency contingency plans;
- Inventory location and characteristics of MoWT equipment that can be used to support emergency response;
- Monitor and coordinate emergency response logistics;
- Plan and execute disaster recovery measures.

3.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting MoWT functions:

Geotechnical and Material Testing Sites. Today the locations of geotechnical testing boreholes and sampling sites is not standardized. Some site samples and data have precise GPS-derived geographic coordinates while others may reference a sketch location on a plan. Standardization of the geolocation information would add value in the incremental compilation of a repository of accurately located testing information over time.

Roadway As-Built Records. Historical as-built records for roadway and bridge construction projects were maintained centrally in the past by the MoWT, but this function is no longer being carried out.

MoWT Project Case Files. There are currently three different Project Execution Units (PEU's) administering the externally financed projects of the MoWT, one for each of the primary finance institutions including the IDB, European Union and OPIC. Each has different procedures, conventions and information management procedures depending upon the requirements of the funding entity. Case Files in paper form are compiled and maintained for all projects, but these are not integrated across the three PEU's. These contain contracts, plans, status reports, site visit notes, correspondence and other relevant reference information for each project.

Routine Maintenance Planning System (ROMAPS) Database. The Ministry previously developed and had maintained a roadway inventory system for pavement, bridges and culverts. This information was maintained in the Routine Maintenance Planning System software (ROMAPS), an off-the-shelf commercial application software that was developed originally in the 1980's by Roughton International. ROMAPS captured roadway pavement, appurtenances and activities in a tabular database as point or line events within a linear referencing scheme that identified events in kilometer reference to a point of beginning at designated locations. Geographic coordinates were captured for bridges, but not for culverts. The system had no GIS component therefore there was no mechanism for visualizing this

information on a map or conducting geospatial analysis. The ROMAPS system has been maintained whenever data is collected and presented, it has not been updated to the latest version and is to be replaced by the currently ongoing RMSI roadway inventory.

IRAP Road Assessment Database. The Ministry of Works in 2011undertook a project to map over three hundred miles of paved roads in Belize. The purpose of the survey, supported by the International Road Assessment Program (iRAP) was to determine the state of the nation's roadways and to prioritize a capital investment program for road safety infrastructure improvements. The survey was carried out by a specially equipped vehicle which recorded images of the major highways from Corozal to Toledo and selected paved roads in between. The survey was carried out by the International Road Assessment Program, a London-based not-for-profit organization dedicated to saving lives through safer roads. This program resulted in the capture of road condition information including geo-referenced video imagery every 10m (**IRAP Road Assessment Database**). The GPS coordinates captured for all roadways surveyed, except for the Toledo District, were provided to the MNRA LIC in 2011.

RMSI Road Inventory Database. No detail provided. When completed, this database is to be made generally available to the BNSDI GeoNode portal.

Utility Coordination Records. The MoWT currently maintains a manual record of all utility trenching and works requests. Each case file includes the original request and any collateral information such as the original request, no objection letters, site visit notes and correspondence. At present this is the only record of an installed utility maintained by the MoWT and there is no compiled version of this information to indicate the locations of all the utilities within the highway right of way.

Traffic Accident Records. The MoWT currently maintains a manual record of all traffic accidents that it learns of. The form includes a highway milestone number. This is based on a common road reference system established by the Joint Intelligence Command Service (JICS) coordinated by the Police Department. This information is also collected by the Police and Ministry of Health, but there is presently no basis for coordination or sharing information among the three entities.

Highway Sign Inventory. The MoWT at one time maintained an inventory of all the major advertising signs situated along the highways. The Ministry is required to review and approve such signage. The database was included in the ROMAPS system but has not been maintained for a few years and is not being recorded in the RMSI system that will replace ROMAPS.

Driver's License Database. The MoWT maintains a database of all the driver's licenses issued by the Ministry. This includes basic information about the driver including home address or location descriptive information. The MoWT is only responsible for carrying out this function outside of the municipalities. Each municipality is responsible for issuing

drivers licenses to persons residing within their jurisdiction, and there is no coordination or integrated repository of this information nationally.

Vehicle Registration Database. The MoWT maintains a database of all the vehicle registrations issued by the Ministry. This includes basic information about the vehicle owner including home address or location descriptive information. The MoWT is only responsible for carrying out this function outside of the municipalities. Each municipality is responsible for issuing vehicle registrations to persons residing within their jurisdiction, and there is no coordination or integrated repository of this information nationally.

Transit Zones and Routes. The MoWT Transport Department has in the past maintained a paper map of transit zones, routes and terminal locations. This information is not maintained on a regular basis although staff have indicated they would like to do this in a GIS format in the future and make this information available for use by the transit riding public.

Traffic Tickets. The MoWT Transport Department is responsible for carrying out traffic law enforcement outside of the municipalities. There are a total of 28 enforcement officers who patrol the country's highways. They are responsible for issuing traffic, equipment and other safety violation tickets and identifying drivers who may be driving under the influence of alcohol or drugs. In addition, the enforcement officers also inspect buses at terminals. The officers issue approximately 250 tickets each month. Each ticket includes the home address or community name of the offender and the approximate location of the offense, by address, street or intersection name, and highway milepost or landmark reference. The Department would like to upgrade the approach in the future to include automating the ticket system and establishing a more precise way to record geographic locations.

3.1.4 Existing Systems

The MoWT currently uses the following computerized systems in carrying out its functions:

Routine Maintenance Planning System software (ROMAPS). The Ministry previously developed and had maintained a roadway inventory system for pavement, bridges and culverts. ROMAPS is an off-the-shelf commercial application software that was developed originally in the 1980's by Roughton International. The program was designed to meet the needs of practicing maintenance engineers in real situations. It was reputed to encourage good practice and acknowledge the value of local maintenance experience. ROMAPS specifies methods and procedures for:

- Inventorying Assets
- Recording asset conditions
- Identifying appropriate repair strategies
- Estimating the annual cost of such strategies
- Providing supporting bid documentation
- Calculating prioritized work programs based on approved allocations
- Organizing, implementing and recording the work done

ROMAPS captured roadway pavement, appurtenances and activities in a tabular database as point or line events within a linear referencing scheme that identified events in kilometer reference to a point of beginning at designated locations. Geographic coordinates were captured for bridges, but not for culverts. The system had no GIS component therefore there was no mechanism for visualizing this information on a map or conducting geospatial analysis. The ROMAPS system has been maintained whenever data is collected and presented, it has not been updated to the latest version and is to be replaced by the currently ongoing RMSI roadway inventory.

The Transport Department presently has PC's for many of its staff, but these are not networked together and do not have access to the Ministry's servers.

3.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- The MoWT is interested to expand the use of GIS within the Ministry, but has been constrained by cost. The Ministry is included in the list of entities coming under the ESRI enterprise license arrangement being negotiated by CITO, but staff are not sure of the scope or status of that negotiation.
- One issue raised by MoWT Transport Department staff is that the current Municipal Development Project that is laying future land use plans for the major population centers is not considering transit requirements such as bus routes and stops, station locations and areas for transit vehicles to park when not in use. Staff would like to see more attention given to this matter in future planning efforts.
- Staff have indicated that there is currently no online information available for public and private transit schedules and would like to improve this in the future.

4 MINISTRY OF LABOUR, LOCAL GOVERNMENT, RURAL DEVELOPMENT, NEMO AND IMMIGRATION AND NATIONALITY

4.1 Local Government and Rural Development

Person(s) Interviewed: Desk study with agency review:
Mr. Eugene Palacio, Director Local Government,
dir.local.gov@labour.gov.bz
Mr. Ernest Banner, Coordinator Rural Development,
earnest.banner@gmail.com

Interview Date(s): August 18, 2014

4.1.1 Organization and Mission

Belize has two levels of government: a state government and a single-tier local government. Over the last several years, local councils have been formally established and the trend has been towards greater decentralization and autonomy. Direct election of mayors was introduced in 2000. The Ministry of Labour, Local Government and Rural Development is responsible for local government. Local government is provided by two city councils; seven town councils; 181 village councils; and 12 community councils. Local elections are held every three years.

There are four types of councils in Belize: city councils, town councils, village councils and community councils. There are also Water Boards for selected areas that will also have GIS needs but are not specifically addressed in the current study. The two city councils—Belize and Belmopan—plus the seven town councils cover the urban population in the six administrative districts of the country. The 181 village and 12 community councils cover the rural population across the districts. In the Toledo District and Maya Mopan there is an alcalde system that operates alongside village councils.

Urban authorities are responsible for street maintenance, drains, refuse collection and public cemeteries. They also have responsibility over other services including infrastructure, parks and playgrounds, markets and slaughter-houses, public libraries, public buildings and the amenities of the city or town. All urban councils must set up a Utility Coordination Unit to coordinate the activities of the bodies providing electricity, water and sewerage, gas, telephone and other utility services.

Village councils encourage and assist cooperation on economic and social development and general welfare. They run community centres, and assist villagers in making representations

to other agencies when there are problems with particular services such as school supplies, primary healthcare, and the provision of agricultural extension services.

The local authorities are funded by central government but can derive further revenue from licence fees and fines; urban authorities can also raise revenue from Property Evaluation Fees.

The Mayors' Association of Belize represents the the city and town councils. Membership is automatic and is funded by members' contributions and the Ministry of Local Government. The association is a forum for discussing issues of common concern, promotes dialogue with the government and is recognized by the government.

Under the Village Councils Act, village councils are required to have a District Association of Village Councils office in each district. The six district associations together form the National Association of Village Councils. The District and National Associations may represent a village or group of villages at any forum. These are also funded by members' contributions and the Ministry of Local Government. The Toledo Alcaldes Association (TAA), set up in 1992, promotes the alcaldes, establish lay magistrates, lobby for indigenous rights, addresses issues of concern, and campaigns for recognition of the TAA by governments internationally.

The Ministry is has oversight responsibility over several entities that have some relevance to this study, including:

- Reconstruction and Development Corporation (RECONDEV) RECONDEV is responsible for managing the lands that they own, including some lands in Belmopan and a housing stack primarily outside of Belmopan., ;
- National Association of Village Councils;
- Corozal District Association of Village Councils;
- Orange Walk District Association of Village Councils;
- Belize District Association of Village Councils;
- Cayo District Association of Village Councils;
- Stann Creek District Association of Village Councils;
- Toledo District Association of Village Councils;
- Rural Development.
- Municipalities, including
    - Corozal
    - Orange Walk
    - Belize City
    - San Pedro
    - Belmopan
    - San Ignacio
    - Benque
    - Dangriga
    - Punta Gorda

The local authorities listed above carry out a variety of functions that relate most directly to GIS and the BNSDI, as outlined below. The District and National Associations help to monitor and support the Village Councils in carrying out their duties through policy, regulatory, and financial oversight and support functions:

1. Develop and administer municipal development plans and land use zoning (municipal function)
2. Issue development permits
3. License and inspect petrol stations and garages (GoB)
4. Maintain streets and street lighting (GoB)
5. Facilitate utility coordination
6. Facilitate and support community services coordination
7. Maintain storm drainage system
8. Manage refuse
9. Issue littering tickets
10. Manage parks and recreation areas
11. Manage public slaughterhouse facilities
12. License, rent and inspect market facilities
13. Manage local cemetery
14. Manage local property taxation
15. Manage licensing of motor vehicles, liquor and trade
16. Manage swing bridge operations
17. Manage public water closets and latrines
18. License billboards and banners

4.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

4.1.2.1 Develop and Administer Municipal Development Plans and Land Use Zoning

A major Municipal Development Project has been carried out to improve access to basic municipal infrastructure and to enhance municipal management in selected town and city councils of Belize. This project was funded by the World Bank/IBRD, administered through the Belize Social Investment Fund (BSIF) and technically coordinated through the Ministry of Natural Resources and Agriculture (MNRA) Physical Planning Unit.

There are three components to the project, the first component being municipal infrastructure investments. The component will have two rounds of subprojects. In order to provide

incentives for Town and City Councils (TCCs) to improve their management capacity, TCCs were required to meet specific eligibility criteria before subproject preparation were initiated. Although TCCs were responsible to prioritize the investments and participated directly in procurement and supervision, Belize Social Investment Fund (BSIF) was assigned the overall responsibility for procuring and handling financial management arrangements of the agreed investments.

The second component is the technical assistance and capacity building for TCCs, Ministry of Labour, Local Government and Rural Development (MLLGRD), and Ministry of Natural Resources and Agriculture (MNRA).

Finally, the third component is the project management, strengthening of the operational capacity of BSIF for implementation and management of the project, to ensure compliance with fiduciary controls, supervision, monitoring and reporting, and compliance with social and environmental safeguards, through the provision of technical advisory services, training, operating costs, and acquisition of goods including vehicles. To implement the project, BSIF will put into place a small project implementation unit with technical, procurement and financial management experience. The component will ensure that effective fiduciary arrangements are in place during implementation.

GIS technology and mapping has been utilized to support the planning process in each of the chosen communities. The following summary is derived from the Dangriga Municipal Development Plan, but is representative of the other several plans prepared as well.

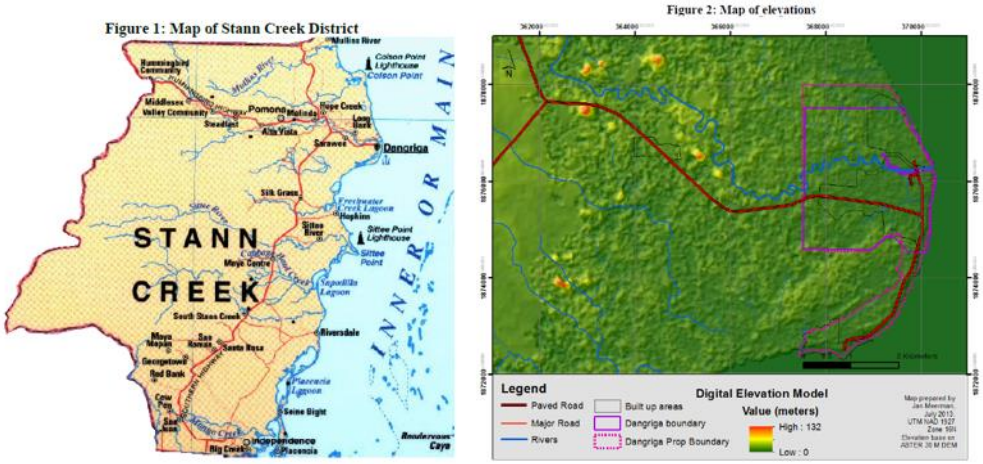

Figure 22 - GIS Maps Depicting District Wide Context

Assessment of Existing Conditions at the district scale is conducted to understand the context and regional setting and conditions that need to be considered in the development of the municipal plan. This normally includes a review of the:

- Physical setting;
- Environmental and natural assets;
- Cultural and historical assets;
- Inter-region transportation links.

The development of a plan also involves developing an understanding of the municipal level setting, existing and historical conditions. These topics may typically cover:

- History and culture;
- Population;
- Households;
- Age and sex distribution;
- Migration;
- Ethnicity;
- Education;

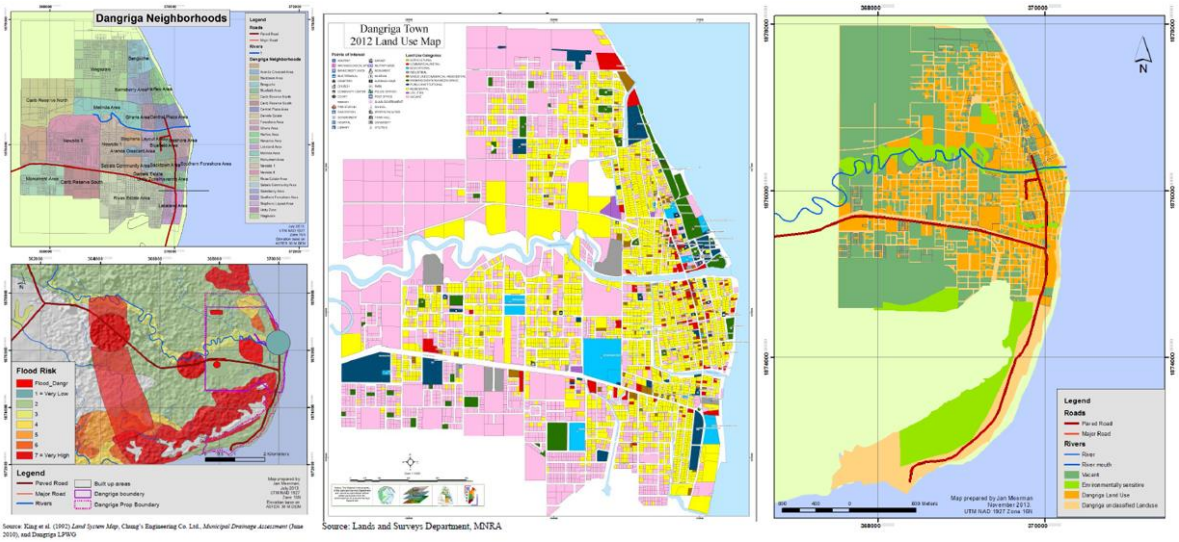

Figure 23 - GIS Planning Maps – Existing Conditions

- Economy and labor force;
- Current land area;
- Spatial development pattern, land and land use;
- Neighborhoods;
- Growth pattern;
- Urban planning boundary;
- Cost of land;
- Land use;
- Vacant land;
- Urbanized area size;
- Environmental areas and public open space;
- Public spaces;
- Cultural and historic assets and sites;
- Recreation facilities;
- Transportation and accessibility;
- Priority Investments and future projects;
- Climate change related hazards, risks and disaster preparedness;

Planners utilize the understanding of existing conditions and trends as a foundation of understanding to work with local communities in envisioning alternative futures and the

development of a final plan. This process often includes the following issues and data themes, often for one or more scenarios:

- Vision for an alternative future;
- Population projections and growth scenarios;
- Estimation of future land use needs;
- Tourism development potential;
- Economic development potential;
- Land use plans;
- Infrastructure and municipal services;
- Public and open space;
- Promotion of culture, arts and civic activities;
- Buildings, landmarks and urban design;
- Sports and recreation;
- Education facilities and programs;
- Municipal government facilities and activities;

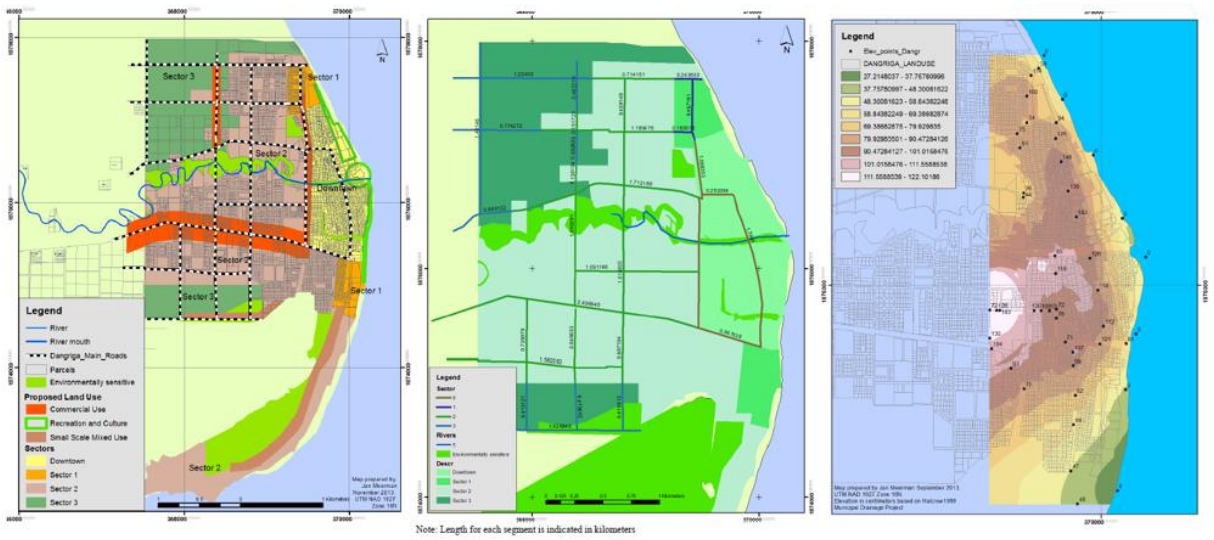

Figure 24 - GIS Planning Maps – Future Plans

Once plans are finalized and adopted, then these are implemented through various mechanisms over a number of years. GIS and the BNSDI are useful during this stage to:

- Monitor changes in the urban and natural landscape;
- Conduct development proposal review and conditioning;
- Track building and infrastructure development;
- Monitor and evaluate plan effectiveness over time;
- Develop plan refinements and adaptation over time based on evolving conditions and requirements.

4.1.2.2 Issue Development Permits

The local building authorities are involved in the review and approval process for development and building permits. This is carried out in collaboration with other organizations such as the Central Building Authority. Aspects of this function that are relevant to GIS and the BNSDI include:

- Review development proposals relative to municipal development plans;
- Track and monitor development projects and building permits;
- Evaluate development trends and impacts over time.

4.1.2.3 Facilitate Utility Coordination

The local councils are responsible to communicate and coordinate with all utility and infrastructure entities that have activities within the council's jurisdiction. This includes coordination of utility extension and refurbishment activities, and coordination of excavations to ensure that utilities are not damaged and other such activities.
Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of the location and characteristics of all utilities and infrastructure (data provided by those utilities);
- Track utility and infrastructure projects planned, or under construction within the jurisdiction;
- Provide one-stop coordination for site clearance for underground trenching.

4.1.2.4 Facilitate and Support Community Services Coordination

The Councils are responsible to ensure that both municipal community services as well as those from other government entities and non-government organizations are coordinated together for the benefit of the community. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of the location and characteristics of local community facilities and services;
- Identify gaps in community service provision and promote the appropriate government and non-government organizations to get involved;
- Maintain spatially enabled system for citizen reporting regarding community services.

4.1.2.5 Maintain Storm Drainage System

The Councils are responsible for managing storm drainage systems within their jurisdiction. This includes the identification of areas susceptible to flooding and other drainage related issues, identification of any populations or infrastructure at risk, preparation of plans for improvement of the storm drainage system, management of construction efforts, conducting periodic drain cleaning and other preventive maintenance measures, and emergency response support during a storm emergency. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of existing storm drainage systems;
- Identify areas susceptible to flooding;
- Prepare storm drainage improvement plans;
- Manage storm drainage improvement construction activities;
- Maintain storm drain system preventive maintenance schedule;
- Participate in preparation of emergency response plans;
- Participate in emergence response activities.

4.1.2.6 Manage Refuse

Municipal Councils are responsible for refuse management within the area of their jurisdiction in coordination with the Solid Waste Management Authority through the Western and Southern Corridors. In some cases this involves the management of formalized, regular trash collection and disposal activities. In the villages and communities this may involve the establishment and management of a landfill area and encouragement of the local population to utilize this facility rather than random dumping and creating unsanitary conditions within neighborhoods. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of local waste stream;
- Manage garbage collection activities and contracts;
- Plan, build and maintain landfill facilities;
- Monitor and record random dumping incidents;
- Raise awareness regarding the reduction, reusing and recycling of waste material.

4.1.2.7 Issue Littering Tickets

Related to the refuse management function outlined previously, the local Councils also issue tickets for littering. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of ticket issuance locations;
- Maintain inventory of observed illegal trash dumping;
- Provide social media platform for citizen reporting of illegal littering and trash dumping;
- Monitor littering and illegal trash dumping and identify neighborhood “hotspots” for focused awareness building and education.

4.1.2.8 Manage Parks and Recreation Areas

Local councils are responsible for managing public parks and recreation areas within their jurisdiction. Councils are to ensure that recreation is considered in any local land use planning exercises, maintaining park facilities and grounds, and managing various types of organized activities that are carried out in parks and recreations areas. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of existing park locations and facilities;
- Conduct place-based surveys regarding community attitudes about local park and recreation assets and programs;

- Plan and track park maintenance;
- Integrate park and recreation areas into local land use planning;
- Incorporate park and recreation concerns into new development review and conditioning.

4.1.2.9 Manage Public Slaughterhouse Facilities

The local Council is responsible for the management of public slaughterhouse facilities on behalf of the community. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of existing public slaughterhouse facilities;
- Track, record and report slaughterhouse operational statistics and revenues;
- Conduct siting analysis for new facilities;

4.1.2.10 License, Rent and Inspect Market Facilities

Local Councils manage market facilities, inclusive of both permanent full time markets as well as weekly markets. All markets must be licensed and all are inspected regularly to ensure compliance with public health and safety regulations and standards. In some cases the market property is owned by the local government and spaces may be rented out by the local Council for a fee. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain inventory of existing permanent and weekly markets;
- Manage market leases by location and specific space;
- Plan and carry out market inspections;
- Track market inspection infractions;
- Monitor market activities and make plans for market expansion and new markets.

4.1.2.11 Manage Local Cemetery

Management of the local cemetery in each community is the responsibility of the local Council. Space is reserved for cemetery use, and a staff is maintained or commissioned to perform cemetery operations and maintenance. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain an inventory of cemetery locations and plots, name and family connections of the interred and related information;
- Plan and implement cemetery maintenance activities;
- Plan for cemetery extension and new cemetery areas.

4.1.2.15 Manage Local Property Taxation

The Council in each community is responsible for collecting local property evaluation fees. Property valuation is based on site value, in the case of Belmopan; and on the annual rental value in the case of the other municipalities, and is administered by the local councils. In the

rural areas, valuation is based on a set formula developed by the government and administered by the MNRA. The local Council in urban areas ensures that property tax bills are paid by the land owners. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain a geographically based inventory of all properties being taxed;
- Monitor status of property tax payments;
- Monitor property tax non-payment and plan follow-up;
- Track and report property tax revenue geographically over time.

4.1.2.16 Manage Licensing of Motor Vehicles, Non-Motor Carriages, Liquor and Trade

The local Councils are responsible for the licensing of motor vehicles and non-motorized carriages. They also handle the issuance of trade and liquor licenses. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain a geographically based inventory of the registration addresses for all vehicle licenses (motorized and non-motorized);
- Maintain a geographically based inventory for all trade and liquor licenses;
- Plan and conduct trade establishment inspections;
- Track trade and liquor license renewals and payments;
- Publish trade license business locations on the web as a community resource;
- Provide trade license business location information for use in car navigation and other consumer and government applications;

4.1.2.17 Manage Swing Bridge Operations

Swing bridges allowing boat traffic on rivers and canals to pass through low lying bridge locations are operated by the local Council. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain a geographically based inventory of swing bridge locations;
- Maintain schedule for planned bridge swing operations and fees paid;
- Maintain record of ad hoc bridge swing requests and fees;
- Monitor and report swing bridge operational trends over time.

4.1.2.18 Manage Public Water Closets and Latrines

The rural Councils and Water Boards manage public water closets and latrines. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain a geographically based inventory of public water closet and latrine facilities;
- Prepare and implement maintenance schedules for public water closet and latrine facilities
- Provide location-aware social media for public to comment on water closet and latrine facilities;

- Monitor trends and complaints as input to the planning for the expansion of existing latrine facilities and planning of new ones.

4.1.2.19 License Billboards and Banners

Local Councils are responsible for the licensing of advertising billboards and banners within the area of their jurisdiction. Areas of this function that are relevant to GIS and the BNSDI include:

- Maintain a geographically based inventory of billboard and banner locations;
- Issue and track billboard and banner licenses;
- Monitor and track billboard and banner license payments;
- Prepare and maintain plans for future billboard and banner locations;
- Provide location-aware social media for public to comment on billboard and banner issues.

4.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting local Council functions at present (also see Belize City Council write-up).

No information provided.

4.1.4 Existing Systems

No information provided.

4.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Areas served by RWS and sanitation

4.2 Belize City Council

Person(s) Interviewed: Troy Smith, Valuation Manager troyvalman@yahoo.com
Carla Patnett, City Planner, archpatnett@yahoo.com
Marilyn Gentle Garvin, Internal Audit
financedirector@belizecitycouncil.org
Marilyn Ordonez, BCC-Director of Finance
Kevan Jenkins, Traffic Manager, Kevanjenkins39@yahoo.com
Norman Benjamin, IT Manager, mis@belizecitycouncil.org

Interview Date: June 23, 2014

4.2.1 Organization and Mission

Local government in Belize consists of four types of local authorities: city councils, town councils, village councils and community councils. Some rural communities also have an alcalde, a local magistrate who performs both administrative and judicial functions. There are two city councils (Belize City and Belmopan) and seven town councils in Belize. As of 2000, the seven town councils were Benque Viejo del Carmen, Corozal Town, Dangriga, Orange Walk Town, Punta Gorda, San Ignacio, and San Pedro.

Belize City Council is the government entity responsible for the management and conduct of local government functions in Belize City. The Council consists of a mayor and a number of councilors (ten in Belize City). Mayors and councilors are directly elected to three-year terms.

The Belize City Council has a wide range of functions. According to the Government of Belize website, "urban authorities are responsible for street maintenance and lighting, drains, refuse collection and public cemeteries. They also have discretionary powers over other services including infrastructure, parks and playgrounds, markets and slaughter-houses, public libraries, public buildings and the amenities of the city or town centre."

This stakeholder survey write-up was developed based on two in-person interviews with groups of representatives of the Belize City Council as well as desk study information derived from the organization's website and other available documentation.

The Belize City Council is organized to a number of sections, several of which have particular relevance to GIS and the BNSDI. The sections that are especially relevant to this study include the following:

- Public Health Unit
- Tourism Unit
- Traffic Department
- Works Department
- City Planning Department
- Sanitation Department
- Security Department
- City Emergency Management Office
- Valuation Department
- Revenue Department
- MIS Unit

The above sections carry out the following activities that are relevant to the use of GIS and the Council's participation in the BNSDI:

1. Manage local public health;
2. Manage local tourism:
3. Manage city traffic and licensing;
4. Manage public works;
5. Conduct city planning activities;
6. Manage environmental sanitation;
7. Manage Municipal facility security;

8. Conduct emergency planning and response;
9. Conduct property valuation;
10. Collect and monitor city revenues;
11. Manage city council information systems.

4.2.2 Activity Areas

Each of the abovementioned units carries out business activities as further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

4.2.2.1 Manage Local Public Health

The Council's Public Health Unit works hand in hand with Central Government's Public Health Department. The unit's primary functions include: the inspection of overgrown properties within the City, the inspection of food vendors and the education of city residents on safety tips and best health practices.

The Public Health Unit meets with the Ministry of Health, the Public Health Department and other governmental and non-governmental organizations to analyze and address principal health related issues affecting Belize City throughout each year. The Public Health Unit also serves as an indirect link for city residents to many other Healthcare partners that offer a wide range of services throughout the City and the Country.[12]

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Provide map base for planning, conducting and tracking weed abatement inspections and infractions;
- Monitor weed abatement repeat offenses and patterns over time;
- Record and maintain locations and information for food vendors;
- Record and track food vendor inspection activities;
- Record locations and abatement activities related to environmental health hazards;
- Share information with other departments and organizations regarding mutually relevant subjects (pest vector control, solid waste, food poisoning cases, etc.).

4.2.2.2 Manage Local Tourism

The Council's Tourism Unit is a nontraditional extension of the Council organizational structure, which has been working aggressively to promote and sustain an environment that encourages the growth of the Tourism industry in the City. With the City being the main port

[12] http://belizecitycouncil.org/public-health-unit

of entry for Cruise Tourism, newly created opportunities are surfacing which call for entrepreneurial activity, and which can significantly increase the level of commercial activity in the City.

The Council's Tourism Unit works very closely with the Belize Tourism Board (BTB) which is the organization that concentrates on tourism on a national level. The Council's Tourism Unit's primary responsibilities include: the monitoring of vendors and various operations that occur within the Fort Street Tourism Area, communicating with the Tourism Police Unit to address the safety of visitors and vendors in the area, and working with the Belize tourism Board to continuously assess and develop the City's Tourism industry.[13]

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Monitor and track crime incidents and patterns in and around tourism areas;
- Track and analyze tourist complaints;
- Develop online tourism support services, maps and guides;
- Develop and maintain tourism maps of Belize City;
- Utilize location-aware social media for engagement with the tourist community;
- Record and monitor tourism-oriented facilities and activities;

4.2.2.3 Manage City Traffic

The Belize City Council Traffic Department is one of the largest subdivisions of the Council's Organizational formation. The principal function of the Traffic Department is to enforce the Motor Vehicle and Road Traffic Laws of Belize. The Department is mindful of all forms of Traffic activities that occur within the City, and is determined to manage these types of activities to promote and secure the wellbeing of all citizens and visitors.

The Traffic Department works very closely with the Police department, Transport Board and the Ministry of Transport to continuously enforce, review and assess all its duties and responsibilities given under the law. The Department is responsible for a wide range of functions that are traffic related, some of which are as follows:

- The Issuing and renewal of drivers' license and vehicle license for all individuals and vehicles registered in Belize City.
- The Inspection of all modes of transportation that require a license under the law to traffic on any street.
- The monitoring and supervision of all parades, funerals and similar activities which impede the normal flow of Traffic.
- The regulation of Parking and all activities related to parking within the City.
- The strategic placement of appropriate traffic signs throughout the City.
- Public education on basic Traffic Laws.[14]

[13] http://belizecitycouncil.org/tourism-unit
[14] http://belizecitycouncil.org/traffic-department

The Traffic Department issues and renews driver's licenses for all individuals and vehicles registered in Belize City. The system is used to record information and transactions across several related subject areas including:

- Vehicle licenses;
- Driver licenses;
- Traffic tickets;
- Invoices;
- Receipts;
- Customers;
- Information requests;
- Transactions;
- Statistics.

The Traffic Department operates under the same regulatory framework as the Ministry of Works and Transport and carries out many of the same functions, only within the City jurisdiction. The Department includes 14 office staff and 28 traffic officers.

Location references in all records include either a street address, landmark or textual description. These are manually entered as there is currently no master address registry. This results in different spellings for street names, entry of invalid address numbers and other issues that will constrain automated address matching to locations.

At present, the City's traffic and licensing information is standalone within the City network and not integrated with the Ministry of Works and Transport or other Cities and Towns that likewise carry out these functions within their jurisdiction. As a result there is no way to link these systems to identify where people have duplicate licenses or vehicle registration, multiple traffic tickets in multiple jurisdictions and other issues. There is no universal registry of personal identification in Belize, thus the Traffic Department requires a utility bill as a means of authenticating a person and their address. The limitations of these issues are well recognized, as is the need for a nationally integrated system in the future.

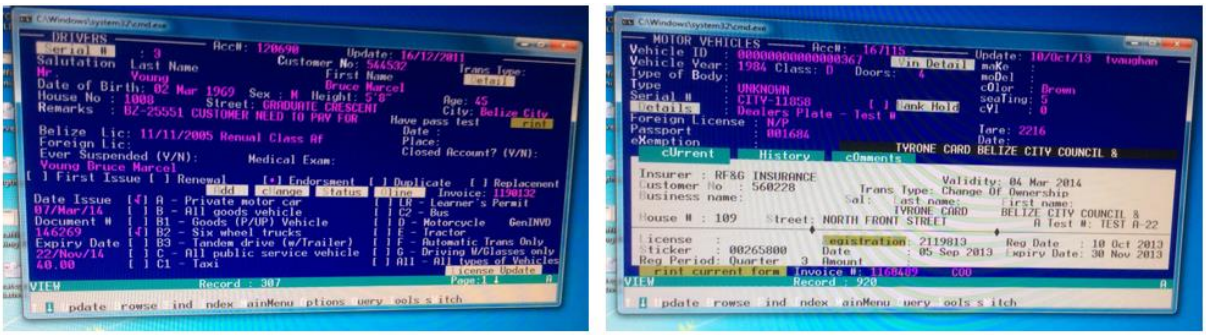

Figure 25 – Driver's License and Vehicle Registration Data Management Screens

Traffic violation information has been captured digitally for nearly 20 years. There is different information collected for moving violations versus parking. In both cases, location is referenced only by a street name or textual description, thus there is no way to tie this

information to specific geographic locations. The Traffic Department staff are using manual ticket books. Information from the ticket books is entered on a daily basis and paper copies are provide to the Police for their reference. There is no digital connection between the systems at the City Council and the Police Department at present.

Figure 26 - Traffic and Licensing Information Official Records Also Maintained in Manual Files

The Traffic Department also tracks bus routes and monitors compliance with the routes to avoid any unplanned impacts to traffic within the City limits. The delineation of the routes are maintained on a manual map, but there is an intention to convert that to a digital GIS form in the future.

Figure 27 - Belize City Bus Route Map

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Geocode driver licenses, vehicle registration and traffic tickets information to addresses or other discrete location reference, thus providing a basis for understanding the geographic distribution of drivers, vehicles and traffic/parking infractions;
- Record and maintain bus routes;
- Share integrated information with other partner agencies (Ministry of Works and Transport, Police Department, etc.);

4.2.2.4 Manage Public Works

The Belize City Council Department of Works is responsible to conduct various technical services on behalf of the Council. The responsibilities of the department are as follows:

- Rehabilitation of city streets
- Maintenance of city streets
- Expansion of city streets
- Maintenance of city infrastructural drains
- Construction of city drains
- Installation of culverts
- Maintenance of city bridges
- Construction of drainage
- Maintenance of manholes
- Construction of manhole covers
- Maintenance of Parks
- Maintenance of Council owned buildings
- Maintenance of Council owned vehicles

The Works Department works closely with the Ministry of Works to collaborate new construction and resurfacing of streets within the City of Belize.

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Maintain accurate inventory and condition assessment for municipal assets (streets, parks, buildings, drainage system, bridges, etc.);
- Provide foundation information for street furniture and pavement management;
- Provide foundation information of storm drainage system management;
- Provide foundation information for park management;
- Provide foundation information for municipal building maintenance and space planning;
- Provide foundation information for municipal vehicle fleet management;
- Provide asset register as the basis for municipal asset financial management;
- Provide geographically-based asset register to support preventive and as-needed maintenance planning and response;

- Provide linkage to maintenance management system to track maintenance activities over time;
- Track maintenance performance indicators;

4.2.2.5 Conduct City Planning Activities

The Belize City Town Planning department prepares land use plans and processes development applications. The development application is used by the Belize City Council as an administrative tool, to control and regulate development within Belize City. It is through these applications that residents of the City make known their intentions to development a portion of land, and state the desired purpose, whether for commercial, residential, industrial or other uses.

Town planning dealt primarily with the regulation of land use and the physical arrangement of city structures, as guided by architectural, engineering, and land-development criteria. It then broadened to include the comprehensive guidance of the physical, economic, and social environment of a community. Elements characteristic of town planning include:

- General plans that summarize the objectives of (and restraints on) land development;
- Zoning and subdivision controls that specify permissible land uses, densities, and requirements for streets, utility services, and other improvements;
- Plans for traffic flow and public transportation;
- Strategies for economic revitalization of depressed urban and rural areas;
- Strategies for supportive action to help disadvantaged social groups; and
- Guidelines for environmental protection and preservation of scarce resources.[15]

Specific areas that GIS and the BNSDI can support within this functional area includes, but is not limited to the following:

- Access and utilize data from other organizations (population census, natural resources, land ownership, business locations, community facilities, utilities, etc.)
- Prepare general plans, including information and tools for:
- Population forecasting and future needs assessment;
- Natural hazard and vulnerability mapping (flood prone areas, storm surge, sea level rise);
- Alternative future scenario development and visualization;
- Land use requirement and siting assessment;
- Traffic analysis;
- Infrastructure requirement and siting assessment;
- Community facility and service requirements and siting analyses;
- Support community engagement and visualization of future plans and planning issues;
- Develop general plan and zoning map databases;
- Provide public online access to planning and zoning information;
- Monitor plan build-out and variations;
- Provide tools for plan revision and refinement based on changing conditions over time.

[15] http://belizecitycouncil.org/city-planning-department

4.2.2.6 Manage Environmental Sanitation

The Sanitation Department is responsible for:

- The cleaning of loose garbage including hotspots;
- Culvert cleaning and dig out;
- Supervising the cutting/cleaning and weeding of lots/abandoned or empty (owner in the states, or can't be located);
- Derelict vehicles (Section 6 of the Summary Jurisdiction (Offences) Act;
- Monitoring of the schedule that is sent to us from Belize Maintenance Limited and Belize Waste Control;
- Landfill (located at 3 ½ mls. Western Highway).

In addition to these the City Council has Enforcement Officer and Sanitation Inspectors who monitor hot spots (an illegal area where residents or businesses dispose of their garbage). The Enforcement Officers are authorized to issue littering tickets to those who are caught committing any littering offences. (Please include section of the law). The Sanitation department and Works department are currently involved in an Infrastructure drainage project. In respect to the Solid Waste Agreement, one of our Enforcement Officer is working along an employee of Belize Waste Control to sign on businesses for their garbage to be removed which is in keeping with the Trade Licensing (Amendment) Act (No. 22 of 2009).[16]

Specific areas that GIS and the BNSDI can support within this functional area include, but are not limited to the following:

- Use location-enabled mobile phone reporting of loose garbage or hotspot locations by the public, as well as any other environmental sanitation complaints;
- Track culvert blockages and cleaning activities;
- Track lot cleaning and weeding activities;
- Track derelict vehicle reports and removal activities;
- Monitor trash pickup routes, schedules and performance;
- Record and manage landfill assets and operations.

4.2.2.7 Manage Municipal Facility Security

The Belize City Council's Security Department is responsible for providing guard services to selected priority locations including City Hall - Main Office, Traffic Department, 4½ mls. Western Highway, Commercial Center, Landfill, and Queens Square Market. The main responsibilities of the Department are to:

- Report all incidents immediately to respective Supervisors;
- Report any illegal transactions at the various workstations;
- Maintain a good working relationship with members of staff, and the general public;
- Ensure that law and order is maintained;
- Ensure proper handing over and taking over of duties;

[16] http://www.belizecitycouncil.org/sanitation-department

- Ensure proper logging/recording of entries in the Security Log Book;
- Radio checks must be made every hour to posts within the organization and respective Supervisors;
- Ensure that all buildings are secured at the end of each work day.
- Ensure proper care of all Council's equipment i.e. Handheld Radios, Base Radios, etc.
- Ensure that all guard booth/workstations are clean before and after handing over.

The Department presently employs a total of forty (40) employees. These employees consist of a Security Manager, Secretary, four (4) Senior Security Officers-Supervisors, an Office Assistant and thirty-three (33) Security Officers.

Specific areas that GIS and the BNSDI can support within this functional area include, but are not limited to the following:

- Provide contextual base mapping for security planning;
- Tie all incidents and reports to geographic locations;
- Record and access building floor plans;
- Provide online secure access to security cameras from map interface.

4.2.2.8 Conduct Emergency Planning and Response

The City Emergency Management Organization (CEMO) is the City's unit for the planning and coordination of emergency response activities. This unit is an important part of the National Emergency Management Organization (NEMO) and coordinates closely with the NEMO headquarters in Belmopan.

Specific areas that GIS and the BNSDI can support within this functional area include, but are not limited to the following:

- Hazard and vulnerability assessment (flooding, storm surge, high winds, etc.);
- Resources at risk analysis (settlements, infrastructure, environmental resources, etc.);
- Record and describe the locations of emergency response assets;
- Identify emergency staging areas;
- Preparation and dissemination of emergency response contingency plans;
- Provide common operating picture for emergency response;
- Provide common operating picture for post-emergency damage assessment, recovery planning and activities.

4.2.2.9 Conduct Property Valuation

The role of the Valuation Department under the Belize City Council is to generate income by ensuring that all properties/ establishments be assessed on the respective Valuation Role in a timely efficient manner. The word "Valuation" relates to the method of assessing and computing the current value of building and property as the basis for determining the amount of tax that the owner will pay. The size, type, use, and location of building or property are factors taken into consideration when calculating the value.

The property tax revenue obtained is used to provide the annual budget of the Belize City Council. It enables the Council to carry out their work program, which includes the repairing of streets, drains, bridges, lighting of streets, garbage collections, etc. There is also a Fire Rate charged under the fire Brigade Ordinance and this is 4%, which is included in the property tax.

Before a property is valued, there are Referencers (Valuation Officers) who undertake an on the site inspection of each property. A working list is prepared, with the name of the Street, House and Lot numbers, and the name of the owner of the property. During the Referencer's inspection he will make notes on his working list indicating whether or not the building is occupied or unfit for habitation. The purpose for which the building is used is also indicated: e.g. Dwelling, Shop, and Dwelling, Ware house, Club, Office etc. Information is collected concerning the following areas:

- Accommodation - Dwelling, shop, restaurant, warehouse, hotel, boarding house etc.;
- Construction - i.e. – timber, concrete and timber, concrete blocks plastered, Architecture design;
- Roof - Corrugated iron sheeting, roofing, concrete roofing shingles, Fibre concrete roof tile, asbestos free (rod roofing);
- Condition and Age - very good, good, fair, poor, bad, very bad, dilapidated;
- Site Condition - Lot or yard, whether wholly filled, part filled or Low-lying;
- Building sketch Plan measurements - An outline plan of each floor plan has to be prepared showing approximately the dividing walls and all outside measurements to the nearest feet. (3") letters of the alphabets are used to identify each subdivision of a building, and or any outdoor buildings e.g. store room, kitchen etc. and type of material used for the construction of the building;
- Rental Information - Inspecting officers are expected to find out the rent paid for the accommodation or if the building is owner occupied. Information is also obtained concerning the amount of building space available and how it is allocated by use.

All of the above information is entered into a field book and then transferred to the proper files, in manual form. This information is then used by the Valuation Officers to calculate the property tax based on pre-set criteria and formulas.

The Valuation Department is also responsible for managing trade licenses. "*Trade*" means any business in the course of which any goods, wares, merchandise or provisions are sold and includes a business in which produce or goods of any sort are exported from Belize and any vocation as defined in the municipal codes. The annual license fee payable in respect of the carrying on of any trade is an amount equal to the annual License fee payable in respect of the carrying on of any trade in an amount equal to one-fourth of the annual value of the premises in which the business is carried on. Valuation Officers determine the value of the premises based on site inspection and preset criteria and formulas.

Any person who has a valid Trade License and wishes to move his business to a new location or desires to cease operation of his business must inform the board in writing. He must give proper address of the new location so as to enable the Trade License to carry out his assessment of the new location.

Specific areas that GIS and the BNSDI can support within this functional area include, but are not limited to the following:

- Maintain property boundary maps;
- Link valuation data to lot features in GIS;
- Plan and track property valuation activities;
- Develop and maintain inventory of trade establishments.
- Track trade licenses and associated information by location;
- Prepare and disseminate property valuation maps;
- Track property tax payments and delinquencies (Finance Department?).

4.2.3.1 Collect and Monitor City Revenues

The Belize City Council Revenue Department is responsible for the collection and monitoring of the councils income. This includes income from sources such as property taxes, trade licenses, liquor licenses, auctioneers license fees, building fees, cemetery fees, market fees, garbage fees from landfill, peddlers & vendors fees, rental of parking, street use permits, rental of parks, fees for swinging of bridges, fees for ads on billboards and banners as well as the enforcement of the laws of City Council or relating to City Council.

The Department is responsible to the delivery of the property tax bills. The Bills are prepared by the Valuation Department which sets the assessment.

The Department also collects for the trade licenses approved by the Trade Licenses Board as approved each year. This includes activities to:

- Check business premises to make sure they have a trade license.
- To ensure that the certificate is properly displayed.
- If they do not have a trade license, they are given a trade licensing application and are giving one week to apply. If they do not apply, the business will be closed down.
- Anyone operating a business without a Trade license the officers will then issue a magistrate summons for that person to appear in magistrate court.

Various activities for which the Revenue Department collects fees include:

- ***Trade License Files***. No detailed information provided.
- ***Liquor License Files***. No detailed information provided.
- ***Auctioneer License Fee Files***. No detailed information provided.
- ***Building Permit Fee Files***. No detailed information provided.
- ***Cemetery Fee File***. No detailed information provided.
- ***Market Fee File***. No detailed information provided.
- ***Peddlers and Vendor Fee File***. No detailed information provided.

- ***Parking Rental File***. No detailed information provided.
- ***Street Use Fee File***. No detailed information provided.

The Department also processes building plans. It is accepted, recoded and forwarded to the planning department for inspection and final approval from the local building authority.

Another responsibility of the department is to maintain records of deaths and location of deceased at the cemetery as well as issuing spaces for burial.

Specific areas that GIS and the BNSDI can support within this functional area include, but are not limited to the following:

- Develop and manage a geographically based inventory of all properties, facilities, trade establishments and activities that pay fees to the City;
- Link fee data to locations and produce map-based revenue visualization and reporting information;
- Track and monitor fee-paying activities and facilities;
- Utilize location-based social media for monitoring public comments or complaints regarding fee-paying facilities and activities;
- Produce maps illustrating historical City revenue generation and trends;
- Produce maps illustrating future City revenue projections.

4.2.3.2 Manage City Council Information Systems

The Management Information Systems Department (MIS) is responsible for managing the citywide computing and information infrastructure. The Department includes 3 full time staff and one consultant who carry out the following duties:

- Ensure that the proper systems/ procedures and controls are in place and correctly implemented by employees;
- Design/ implemented revised and/ or new procedures to support operations/production changes;
- Ensure timely and accurate generation and execution of all MIS operation. Identify and recommend improvements to established procedures, forms and workflows;
- Prepare monthly volume statistical report example (attendance, phone etc.);
- Directly assist users by answering technical questions concerning operating and software systems;
- Ascertain line, network, and software characteristics desirable for the applications of company systems;
- Analyze and test alternative equipment and software configurations and recommend appropriate alternative to management;
- Provide technical expertise to guide employees in the execution of their roles;
- Maintain and monitor employee attendance records;
- Evaluate and repair personal computers;
- Install person computer operating systems and software;
- Connect computers to local area network;

- Install UTP cables and connector for LAN systems;
- Troubleshoot PC for problems;
- Order and pick up materials needed, operate and perform maintenance equipment;
- Estimate time, material and equipment required to assigned job; maintain records of work performed and parts used, to the MIS Manager/Supervisor etc.

4.2.4 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting Belize City Council functions:

Driver's License Database. Belize City Council Traffic Department maintains a database of all driver's licenses issued by the Department within the jurisdiction of Belize City. This includes all relevant information about each driver, including home address. This information is not linked with other jurisdictions, therefore there is no complete, centralized recording of driver's licenses nationally.

Vehicle Registration Database. Belize City Council Traffic Department maintains a database of all vehicle licenses issued by the Department. This includes all relevant information about each vehicle and its owner, including home address. This information is not linked with other jurisdictions, therefore there is no complete, centralized recording of vehicle licenses nationally.

Traffic Ticket Database. Belize City Council Traffic Department maintains a database of all traffic violation tickets issued by the Department. This includes all relevant information about each offending vehicle and its owner, including home address. Each ticket also includes a reference to location, which might be by street address, street name or other textual description. Tickets are issued in hardcopy in the field, and later key entered at the Traffic Department office. Copies of the paper ticket books are shared with the Police Department, however there is not sharing of the digital ticket information therefore there is no complete, integrated record of issued traffic tickets nationally.

Property Valuation Files. No detailed information provided.

Trade License Files. No detailed information provided..

Liquor License Files. No detailed information provided.

Auctioneer License Fee Files. No detailed information provided.

Building Permit Fee Files. No detailed information provided.

Cemetery Fee File. No detailed information provided.

Market Fee File. No detailed information provided.

Peddlers and Vendor Fee File. No detailed information provided.

Parking Rental File. No detailed information provided.

Street Use Fee File. No detailed information provided.

4.2.5 Existing Systems

No detailed information provided.

Traffic Information Management System. The Traffic Department issues and renews driver's licenses for all individuals and vehicles registered in Belize City. The system is used to record information and transactions across several related subject areas including:

- Vehicle licenses;
- Driver licenses;
- Traffic tickets;
- Invoices;
- Receipts;
- Customers;
- Information requests;
- Transactions;
- Statistics.

4.2.6 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- City Council staff have indicated that the current street addressing system in Belize City needs revamping and updating;
- There is currently no integrated enterprise information strategy for the City;
- Information connectivity to other agencies with whom the City coordinates is lacking (Police, NEMO and others);

4.3 National Emergency Management Organization (NEMO)

Person(s) Interviewed: Andrew Wade, ICT Manager,

Interview Date(s): June 13, 2014

4.3.1 Organization and Mission

The National Emergency Management Organization (NEMO) in cooperation with the respective Emergency Management Committees, and all Public and Private agencies, is established to preserve life and property throughout the country of Belize in the event of an emergency, threatened or real, and to mitigate the impact on the country and its people.

The NEMO comprises the Cabinet, with the Prime Minister as the Chairperson, the Cabinet Secretary, as Secretary, the NEMO Secretariat and the 10 Operational Committees (chaired by Permanent Secretaries).

The ten Operational Committees are as follows:

- Education, Communication and Warning;
- Medical and Relief Measures;
- Housing and Shelter;
- Search, Rescue and Initial Clearance;
- Collection Control and Distribution of Food and Material;
- Assessment and Evaluation of Damage;
- Foreign Assistance;
- Transport;
- Environment and Utilities.

The other permanent members are the Belize Red Cross, the Belize Teachers Union, the Chief Meteorological Officer, the Commandant BDF and the Commissioner of Police. Integral to NEMO are its 9 District Emergency Committees (chaired by the senior Minister in each District) representing Belize, Corozal, Orange Walk, Cayo, Stann Creek, Toledo, Belmopan, San Pedro and Caye Caulker.[17]

NEMO Headquarters has 8 staff who are responsible to run the Center and coordinate among all the participating organizations. There is also one coordinator for each District and one regional coordinator for each of the three zones. The 10 Committees are chaired by the CEO's of the participating organizations and staffed as needed with personnel from those organizations.

The NEMO conducts several functions that relate most directly to GIS and the BNSDI, including the following:

1. Hazard and vulnerability assessment
2. Disaster contingency planning
3. Emergency response
4. Disaster recovery
5. Disaster reduction and mitigation

[17] http://site.nemo.org.bz/

4.3.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

4.3.2.1 Hazard and Vulnerability Assessment

NEMO is responsible for identifying potential hazards and threats to the country and to determine the vulnerability of the Country's population and infrastructure to those threats. Major focus is placed on storm and hurricane relate hazards that are most prevalent in Belize. Specific storm and hurricane related hazards that are considered include destructive wind action, flooding and tidal surges. These storm-related physical processes have a variety of secondary and tertiary socioeconomic and environmental impacts may also have to be dealt with during and following a disaster event.

There have been a variety of activities undertaken to better understand natural hazards and vulnerabilities in Belize, including the following:

Red Cross Hazard and Vulnerability Study. The Belize Red Cross Society conducted a Vulnerability and Capacity Assessment (VCA) for the Country. VCA is a participatory investigative process designed to assess the risks that people face in their locality, their vulnerability to those risks, and the capacities they possess to cope with a hazard and recover from it when it strikes. Through VCA, National Societies like the Belize Red Cross Society can work with vulnerable communities to identify the risks and take steps to reduce them by drawing on their own skills, knowledge and initiative (See Red Cross of Belize write-up).

Belize Flood Hazard Assessment. NEMO collaborated with CATHALAC in the development of ***Flood Susceptibility Maps for Belize***. These maps were prepared for NEMO by the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) based on data from the following sources:

- Flood susceptibility estimates by the Bruce King et al (1986-1992);
- Settlement maps by Jan Meerman/Belize Tropical Forest Studies (2012);
- Land Cover mapping by CATHALAC (2013).

The flood susceptibility data were modified and re-classified. The topographic contours and shading on the resulting map products were generated through topographic modeling conducted by CATHALAC using the ***Ordnance Survey E755 topographic maps***, in addition to ***elevation data from ASTER***, ***Intermap Star3i***, ***SRTM*** and the University of the West Indies' Centre for Geospatial Studies (UWI-CGS).

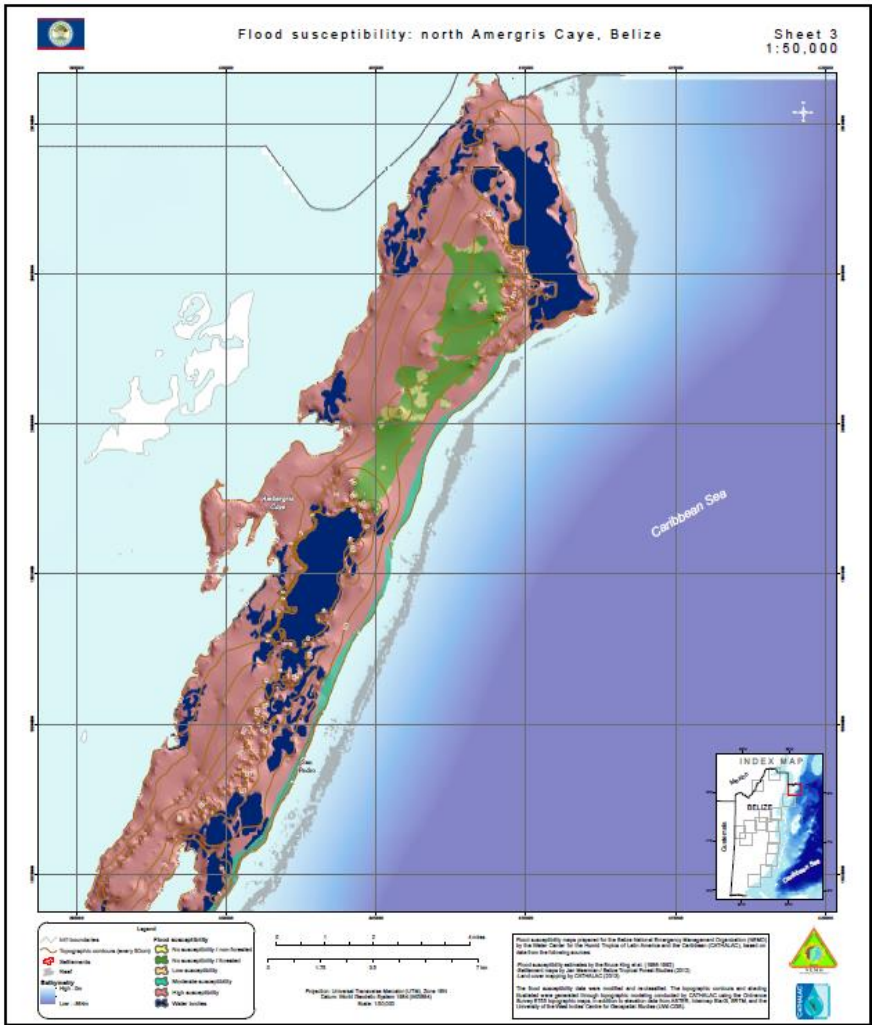

Figure 28 - Example Flood Susceptibility Map Generated by CATHALAC

Belize River Flood Susceptibility Assessment. In 1996, the Caribbean Disaster Mitigation Project (CDMP) completed a coastal storm hazard assessment for Belize. The goal of this project was to provide the Government of Belize the capability to predict river water levels based on rainfall rates. This capability would allow the Belize Meteorology and Hydrology offices (now Hydrology Unit within the Ministry of Natural Resources and Agriculture/ NIWRA program) to create floodplain maps for the country and to provide a flood early warning system for emergency response. The flood hazard maps were created through a flood hazard model integrated into a geographic information system (GIS).

The flood hazard model developed for the Belize River can be applied to river basins elsewhere in the country. Datasets required to run the model, such as land cover, river routing and rainfall estimates have been developed for the study area. This database can be updated with new information, as it becomes available.

The flood hazard assessment model for the Belize River was completed. A number of hydrologic models were tested before selecting a final model. The lack of spatially distributed rainfall data and the size and complexity of the basin caused instability in the traditional HEC model. Other models tested included a finite element model of the US Army Corps of Engineers and the University of Oklahoma, and a newer, fully distributed version, CAS2D,

also developed by the USACOE. The CDMP organized a review by hydrology experts in both the United States and Belize of this model as applied in Belize. The model uses the Geographic Resource Analysis Support System (GRASS), which can run on IBM-compatible personal computers using Linux, a public-domain version of the UNIX operating system. GRASS was in use by the Belize Hydro-Met Service at that time.

The flood model requires land cover, river routing and profile information and rainfall data. Land cover information was derived from satellite imagery provided by the Belize Land Information Unit. River route maps were created by combining information from maps provided by Belize with Digital Chart of the World base data. River profiles were provided by the Belize Meteorology and Hydrology office. Rainfall estimates were derived by combining existing rainfall gauge data with satellite-based rainfall estimates and model estimates for mountainous areas.

In September 1999, the results of the Belize River flood assessment were presented to the collaborating technical agencies in Belize. Around forty representatives of public sector agencies and private sector interests participated in a half-day workshop. The assessment methodology was presented and applications of the information and database were discussed with the participants. The final report outlines the next steps that can be taken once high resolution digital elevation data is available for the Belize river basin.

Note: Although the results of the CDMP study described above have not been used in the current NEMO assessment of flood susceptibility, the methods used may be worth revisiting at some point in the future, with the inclusion of more detailed topographic and land use/land cover information available today.

Belize Emergency Management Database (BEM INFO). BEM INFO is a database management system to record and assess information about each community that is relevant for disaster reduction and response. The BEM INFO framework has been developed based on the Development Information System (DevInfo) is a database system for monitoring human development. It is a tool for organizing, storing and presenting data in a uniform way to facilitate data sharing at the country, regional and global levels across government departments, United Nations (UN) organizations, civil society organizations and development partners. DevInfo has features that produce tables, graphs and maps for inclusion in reports, presentations and advocacy materials. The software supports both standard indicators, including indicators for the Millennium Development Goals (MDGs) and user-defined indicators. DevInfo can operate both as a desktop and a web-based application. A consultant has worked with the NEMO team to use the DevINFO database administration tools to develop a BEM INFO framework of community based information. The major categories of information now being populated into the BEM INFO system includes the following sectors:

- Demography;
- Education, Information, Communication and Warning;
- Housing and Shelter;
- Human Resource Management;
- Transport and Evacuation;
- Water Resource Management;
- Relief and Supplied Management;

- Search and Rescue;
- Damage Assessment and Needs Analysis;
- Restoration of Utilities and Access;
- Medical Care and Public Health;
- Foreign Assistance;
- Access, Works and Mitigation;
- Recovery.

The above sector information is being collected for each community across Belize. This information is being compiled based on the information and experience of the various member agencies and organizations, and their knowledge of the each community involved. In the future it is expected that much of this information could be derived using GIS and access to the BNSDI data network.

NEMO is also conducting its own pilot for ***Community Level Vulnerability Assessment***. This includes a limited and focused questionnaire that is submitted to representatives of some of the most vulnerable communities in the Country. This is using a random sampling technique that was initiated in several communities since April 2014. The results of this pilot are to be evaluated to determine the utility and feasibility for scaling up this technique for periodic nationwide application.

Geospatial operations that are relevant to this functional area include, but are not limited to the following:

- Provide access to a broad variety of geospatial information from multiple custodians
- Identify the location, extent and potential severity of various natural hazard conditions (e.g. flooding, wind damage, storm surge, coastal erosion, etc.)
- Identify vulnerable populations, community and government facilities and infrastructure
- Conduct vulnerability assessment

4.3.2.2 Disaster Contingency Planning

NEMO has developed a number of contingency plans for different emergencies at multiple levels. The plans identify:

- Locations of hazards and those populations and infrastructure assets that may be at risk;
- Locations of shelters (GPS points and basic information concerning each structure – see Figure below)
    - Type of material of walls, floors and roof;
    - Number of stories;
    - Capacity;
    - Picture of structure;
    - Points of concern for remediation or repair.

- Locations of staging areas (churches, schools, parks, etc.);
- Locations and capacity of fuel stations (presently maintained in Excel spreadsheet)
- Locations of Ministry of Works and Transport assets that are usable for emergency response;
    - Vessels;
    - Buses and other public transport
    - Tractors;
- Locations of warehouses
- Preset actions, priorities and lines of authority for various response scenarios;

Contingency plans are currently maintained in digital documents and printed paper form. These are not currently maintained in GIS although it is intended to do so in the future.

SHELTER REPORT SHEET 2013

DISTRICT: _____

Contact Person:_____ Number:_____

DATE: _____ Number of Buildings: _____ Storeys:_____

SHELTER NAME:
LOCATION: Coordinates:
BUILDING CONDITION: ROOF.....Galvalume( ) Concrete ( ) Zinc ( ) Other_____ CEILING .....Sheetrock ( ) Celotex ( ) None ( ) Concrete ( ) Other_____ BEAMS ..... E VG F P WALLS .....Concrete ( ) Wooden ( ) Plycem ( ) Other_____ WINDOWS ...Metal ( ) Glass ( ) Wooden ( ) Burglar Bared ( ) DOORS .....Metal ( ) Wooden ( ) Other _____ TOILETS .....Attached ( ) Unattached ( ) Acceptable (yes) (no) FLOOR .....Concrete ( ) Tiled ( ) Wooden ( ) Other _____ ELECTRICITY ....BEL ( ) None ( ) Generator ( ) Other _____ WATER .....BWSL ( ) Vat ( ) Well ( ) Other _____ GROUNDS ..... E VG F P
DATE OF LAST INSPECTION:
COMMENTS: Bldg size: Usable size:

Figure 29 - Shelter Inventory and Assessment Form

GIS and BNSDI operations that have relevance to this functional area include the following:

- Identification and assessment of vulnerable populations, facilities and infrastructure
- Conduct impact assessment based on plausible scenarios
- Prepare a geographically-based inventory of response equipment and people
- Identify and characterize staging areas and evacuation routes
- Prepare and maintain geographically based inventory of shelter

4.3.2.3 Emergency Response

NEMO coordinates various levels of emergency response, depending on the type and magnitude of disaster. During an emergency event the various NEMO teams coordinate communications through direct interaction at the headquarters situation room, the various agency headquarters and regional offices and through mobile telephony and radio.

Figure 30 - NEMO Headquarters Situation Room

Each of the 10 operational committees is responsible for carrying out activities within its specific thematic area, per contingency plan provisions and areas of expertise.

Geospatial functions that could support this functional area include but are not limited to the following:

- Provide a "common operating picture" based on data and inputs from all involved sectors
- Provide real-time monitoring of disaster impacts and near-term projections
- Support damage assessment
- Track the deployment of human, vehicle and equipment response assets
- Monitor disaster response status

4.4.2.2 Disaster Recovery

NEMO coordinates various levels of disaster recovery activities, depending on the type and magnitude of disaster. Each of the 10 operational committees is responsible for carrying out activities within its specific thematic area, per disaster recovery contingency plan provisions and areas of expertise.

Geospatial functions that could support this functional area include but are not limited to the following:

- Conduct post-disaster damage assessment
- Conduct recovery planning and prioritization
- Coordinate and monitor recovery actions (social, community facilities, infrastructure, etc.)

4.4.2.3 Disaster Reduction and Mitigation

NEMO and all the participating agencies and institutions are increasingly considering the incorporation of disaster reduction and mitigation planning into their policies, regulations and procedures. Climate change is likely to cause increased number and strength of storms, storm surge, flooding, sea level rise and other impacts that will make this increasing important in the future.

Ways that GIS can be used to support each of the 10 thematic areas of NEMO throughout each stage of the disaster management cycle outlined above includes but is not limited to the following:

Education, Communication and Warning;

- Identify vulnerable communities for pre-disaster planning awareness and emergency alert early focus;
- Provide geographically based information concerning the location and nature of possible natural disasters;
- Early place-specific warning analysis based on current and near-term projected storm and associated impact modeling (e.g. national hazard atlas, with neighborhood specific maps for high vulnerability areas;
- Collaborate with urban planning, land administration, utilities, insurance companies and other relevant entities to ensure that hazards are taken into consideration in any future plans and mitigation measures;
- Include place-based community communications measures within contingency plans;
- Organize and monitor post-disaster communications and community outreach;
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

Medical and Relief Measures;

- Record precise locations for medical and relief material;
- Record work and home locations for medical and relief personnel;
- Identify and manage medical and relief staging areas;
- Track flow of people and material during emergency response (smart phones, and tracking devices on major equipment);
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

Housing and Shelter;

- Pre-identify specific neighborhoods and structures that are likely to be damaged in major events. Work this information into contingency and response plans;
- Record staging areas and facilities for temporary housing and shelter accommodation post disaster;
- Manage housing and shelter status information during response;
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

Search, Rescue and Initial Clearance;

- Pre-identify specific neighborhoods, structures and infrastructure that are likely to be damaged in major events. Work this information into contingency and response plans;
- Track and manage field staff activities during response;
- Post event damage assessment and clearance planning;
- Track and monitor status of initial clearance activities;
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

Collection, Control and Distribution of Food and Material;

- Pre-identify specific neighborhoods, structures and infrastructure that are likely to be damaged in major events. Work this information into contingency and response plans;
- Identify precise locations of food and material storage facilities and enterprises;
- Track and manage field staff activities during response and recovery operations;
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

Assessment and Evaluation of Damage;

- Pre-identify vulnerable populations, structures and infrastructure. Maintain accurate inventory and valuation of assets;
- Collaborate with insurance industry and government to develop financial mitigation and recovery measures;
- Conduct post-event damage assessment and losses;
- Manage and track damage repair and mitigation activities;

Foreign Assistance;

- Identify hazardous conditions and ensure that settlement and infrastructure projects avoid these areas;
- Pre-identify vulnerable populations, structures and infrastructure. Establish disaster mitigation and post-event recovery assistance strategies;

Transport;

- Pre-identify vulnerable populations, structures and infrastructure. Identify transportation routes that should remain viable for emergency response, evacuation and relief supply provision purposes;
- Consider natural disaster hazard conditions for the planning and design of new highways;
- Identify transportation infrastructure that may be impacted by natural disaster events and develop mitigation plans for protection and recovery;

Environment and Utilities

- Pre-identify vulnerable infrastructure and environmental resources.
- Consider natural disaster hazard conditions for the planning and design of new utilities;
- Identify transportation infrastructure that may be impacted by natural disaster events and develop mitigation plans for protection and recovery;

4.3.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting NEMO functions at present:

Belize Flood Hazard Assessment (2014). NEMO collaborated with CATHALAC in the development of ***Flood Susceptibility Maps for Belize***. These maps were prepared for NEMO by the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) based on data from the following sources:

- Flood susceptibility estimates by the Bruce King et al (1986-1992);
- Settlement maps by Jan Meerman/Belize Tropical Forest Studies (2012);
- Land Cover mapping by CATHALAC (2013).

The flood susceptibility data were modified and re-classified. The topographic contours and shading on the resulting map products were generated through topographic modeling conducted by CATHALAC using the ***Ordnance Survey E755 topographic maps***. In addition to ***elevation data from ASTER***, ***Intermap Star3i***, ***SRTM*** and the University of the West Indies' Centre for Geospatial Studies (UWI-CGS).

Belize Flood Susceptibility Estimates. Bruce King et al (1986-1992). No detailed information provided.

Settlement Maps. Jan Meerman/Belize Tropical Forest Studies (2012). (See Writeup for BERDS).

Belize Land Cover Map. CATHALAC (2013). (See Writeup for CATHALAC).

Ordnance Survey E755 Topographic Maps. (See Writeup for MNRA/LIC)

SRTM30. SRTM30 is a near-global digital elevation model (DEM) comprising a combination of data from the Shuttle Radar Topography Mission, flown in February, 2000 and the U.S. Geological Survey's GTOPO30 data set. It can be considered to be either an SRTM data set enhanced with GTOPO30, or as an upgrade to GTOPO30. The SRTM data resulted from a collaborative effort by the National Aeronautics and Space Administration (NASA) and the National Geospatial-Intelligence Agency (NGA, formerly NIMA), as well as the participation of the German and Italian space agencies, to generate a near-global digital elevation model

(DEM) of the Earth using radar interferometry. SRTM was the primary payload on the STS-99 mission of the Space Shuttle Endeavour, which launched February 11, 2000 and flew for 11 days. Following several hours for instrument deployment, activation and checkout, systematic interferometric data were collected for 222.4 consecutive hours.

ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer). ASTER is a Japanese sensor which is one of five remote sensory devices on board the Terra satellite launched into Earth orbit by NASA in 1999. The instrument has been collecting superficial data since February 2000. ASTER provides high-resolution images of the planet Earth in 14 different bands of the electromagnetic spectrum, ranging from visible to thermal infrared light. The resolution of images ranges between 15 to 90 meters. ASTER data are used to create detailed maps of surface temperature of land, emissivity, reflectance, and elevation.

ASTER Global Digital Elevation Model. On 29 June 2009, the Global Digital Elevation Model (GDEM) was released to the public. A joint operation between NASA and Japan's Ministry of Economy, Trade and Industry (METI), the Global Digital Elevation Model is the most complete mapping of the earth ever made, covering 99% of its surface. The previous most comprehensive map, NASA's Shuttle Radar Topography Mission, covered approximately 80% of the Earth's surface, with a global resolution of 90 meters, and a resolution of 30 meters over the USA. The GDEM covers the planet from 83 degrees North to 83 degrees South (surpassing SRTM's coverage of 56 °S to 60 °N), becoming the first earth mapping system that provides comprehensive coverage of the polar-regions. It was created by compiling 1.3 million VNIR images taken by ASTER using single-pass stereoscopic correlation techniques, with terrain elevation measurements taken globally at 30 meter (98 ft) intervals. In October 2011 version 2 of the GDEM was released to the public with improved horizontal and vertical accuracy.[18]

Red Cross Hazard and Vulnerability Study Database. (NEED INFORMATION FROM RED CROSS) Xxx

Belize River Flood Susceptibility Assessment (1996). In 1996, the Caribbean Disaster Mitigation Project (CDMP) completed a coastal storm hazard assessment for Belize. The goal of this project was to provide the Government of Belize the capability to predict river water levels based on rainfall rates. This capability would allow the Belize Meteorology and Hydrology offices (now Hydrology Unit within the Ministry of Natural Resources and Agriculture/ NIWRA program) to create floodplain maps for the country and to provide a flood early warning system for emergency response. The flood hazard maps were created through a flood hazard model integrated into a geographic information system (GIS). (NO ADDITIONAL INFORMATION REGARDING FOLLOWUP FOUND YET)

Belize Emergency Management Database (BEM INFO). BEM INFO is a database management system to record and assess information about each community that is relevant

[18] http://en.wikipedia.org/wiki/ASTER_GDEM#ASTER_Global_Digital_Elevation_Model

for disaster reduction and response. The BEM INFO framework has been developed based on the Development Information System (DevInfo) is a database system for monitoring human development. It is a tool for organizing, storing and presenting data in a uniform way to facilitate data sharing at the country, regional and global levels across government departments, United Nations (UN) organizations, civil society organizations and development partners. DevInfo has features that produce tables, graphs and maps for inclusion in reports, presentations and advocacy materials. The software supports both standard indicators, including indicators for the Millennium Development Goals (MDGs) and user-defined indicators. DevInfo can operate both as a desktop and a web-based application. A consultant has worked with the NEMO team to use the DevINFO database administration tools to develop a BEM INFO framework of community based information. The major categories of information now being populated into the BEM INFO system includes the following sectors:

- Demography;
- Education, Information, Communication and Warning;
- Housing and Shelter;
- Human Resource Management;
- Transport and Evacuation;
- Water Resource Management;
- Relief and Supplied Management;
- Search and Rescue;
- Damage Assessment and Needs Analysis;
- Restoration of Utilities and Access;
- Medical Care and Public Health;
- Foreign Assistance;
- Access, Works and Mitigation;
- Recovery.

Community Level Vulnerability Assessment. NEMO is also conducting its own pilot for Community Level Vulnerability Assessment. This includes a limited and focused questionnaire that is submitted to representatives of some of the most vulnerable communities in the Country. This is using a random sampling technique that was initiated in several communities since April 2014. The results of this pilot are to be evaluated to determine the utility and feasibility for scaling up this technique for periodic nationwide application.

Disaster Response Contingency Plans. NEMO. No detailed information provided.

4.3.4 Existing Systems

NEMO maintains servers and a number of PC's throughout the headquarters building and including the situation room.

Two persons currently manage the NEMO ICT infrastructure and communications systems. NEMO maintains connectivity to the Ministry of Natural Resources and Agriculture (MNRA)

through VPN for backup. Connectivity to the district offices is over the Internet. VHF radio and mobile phones are used for communications.

4.3.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- A large number of agencies and institutions are participating in NEMO activities, yet these are not connected to expedite data and information sharing;
- There is currently no GIS support within NEMO, and the organization relies heavily on the MNRA Land Information Center (LIC) for this support.
- There is currently no provision for remote field access to NEMO information resources. Such provision would assist in both outreach and response activities and could also be used to establish two way, location-aware information exchange with mobile phone users before, during and after disaster events.

4.4 Belize National Meteorological Office - Hydromet

Person(s) Interviewed: Ronald Gordon, Meteorologist, rgordon@hydromet.gov.bz
Frank Tench, Weather Forecaster, ftench@hydromet.gov.bz

Interview Date: June 27, 2014

4.4.1 Organization and Mission

The National Meteorological Office of Belize is the leading governmental authority on weather and climate. It provides meteorological and climate-based products and services to the Belizean public through systematic and accurate monitoring and data collection, reliable data analyses and timely dissemination of user-friendly information on regular and emergency events and processes. This is undertaken in order to contribute to the safety and well-being of the people of Belize and the sustainable development of the nation. To fulfil this mission, the Department maintains a network of meteorological observing stations, a Doppler radar, and an upper air observing station. The Weather Forecasting section of the Office is equipped with telecommunication equipment, data analysis and display workstations and satellite receiving equipment.

The National Meteorological Office is responsible for providing aviation weather information and forecasts, and specialized weather forecasts for agriculture, forestry, marine, military, and tourism. It also provides public weather forecasts for the media, which then distributes via newspapers, radio and television. Forecasts are also distributed by the Meteorological Office by facsimile, e-mail, the Department's website and recorded telephone messages.

The Chief Meteorologist serves on the National Emergency Management Organization (NEMO) and provides advice on hurricanes, floods and other forms of severe weather conditions, which could provoke a national emergency. All phases of the National Hurricane

Emergency Plan are declared by NEMO, on the advice of the Chief Meteorologist.

The National Meteorological Office is the National Focal Point for Belize on the Intergovernmental Panel on Climate Change. The IPCC is a scientific body whose function is to review the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. The Office also has representation on several national committees including the National Environmental Appraisal Committee (NEAC) which reviews Environmental Impact Assessments (EIAs). The Office also has representation on the Belize National Climate Change Committee.

Belize is a member of the World Meteorological Organization (WMO) particularly the Regional Association IV of WMO. The Chief meteorologist serves as Permanent Representative of Belize with the WMO. Through the National Meteorological Office Belize is also a member of the Caribbean Meteorological Organization (CMO) and the Comité Regional de Recursos Hidráulicos (CRRH) an arm of la Sistema de la Integracion de Centroamerica (SICA).

The Office now has 27 staff members. The senior staff includes 4 Meteorologists trained at the BSc level or higher and 2 Electronic Technicians. In addition, there are 3 Forecasters who prepare and disseminate the daily weather forecasts. The remaining personnel (Meteorological and Electronic Technicians along with Administrative and Maintenance staff) provide varying and invaluable duties to assist the Office in providing the public with best product available in order to fulfil the mission of the National Meteorological Office of Belize.[19]

The Office carries out certain functions that have relevance to GIS and the BNSDI, as outlined below:

1. Conduct weather monitoring
2. Analyze and report weather information
3. Prepare and disseminate weather forecasts.
4. Analyze weather and prepare agro meteorology reports for the agricultural sector.
5. Monitor and report hurricanes
6. Participate in emergency preparedness and response

4.4.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

4.4.2.1 Conduct Weather Monitoring

[19] http://www.hydromet.gov.bz/about-us/history

The Office monitors weather both through a network of weather stations as well as weather satellite information and models from international sources.

The Office is responsible for managing a network of 21 weather stations across Belize, as illustrated in the ***Weather Station Locations Map*** following. Some of the 36 stations listed in this map are not operating, although data for these is maintained through the last known date of observation. The locations of all currently operating stations is depicted in the next ***Weather Station Locations Map (2013)***. Data is collected manually from each station, every 6 hours at the airport and once per day elsewhere.

The Office was originally entering weather monitoring information to ***CLICOM***, a program for standardized weather data compilation and management prepared by the World Meteorological Organization, World Climate Data and Monitoring Programme (WCDMP). This program developed a standard for weather database management and involved the installation of PC-based climate database software, hardware and a comprehensive training

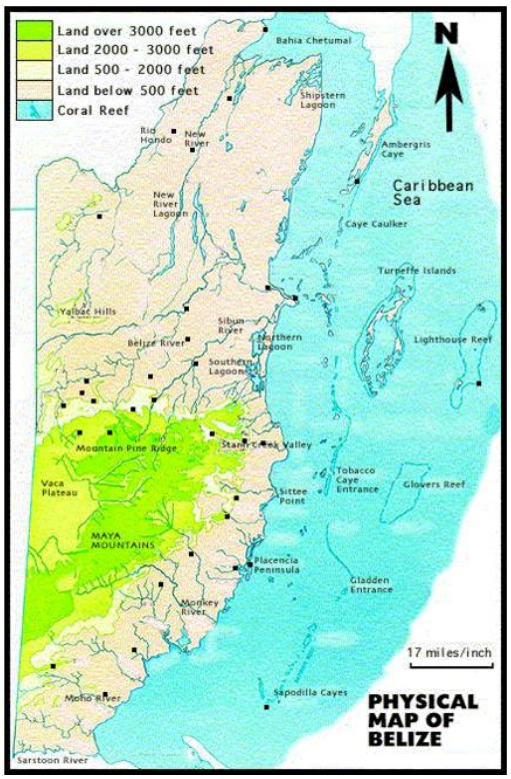

Figure 31 - Weather Station Locations

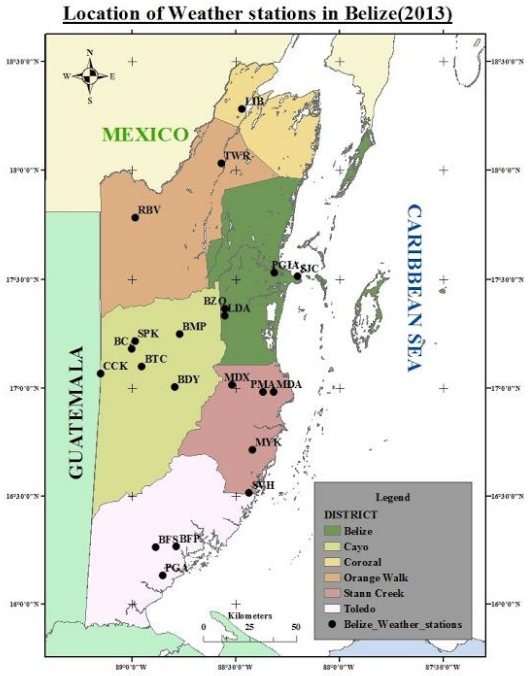

Figure 32 - Weather Station Locations (2013)

program in more than 100 national meteorological organizations around the world. The project provided the foundations for demonstrable improvements in climate services, applications and research in these countries. In the late 1990s, the WCDMP initiated a Climate Database Management System (CDMS) project to replace CLICOM and take advantage of the latest computer technologies to meet the varied and growing data management needs. The new CDMSs offered improved data access and security and much greater utility for users.[20] The Office ran into issues with the CLICOM system and is now in the process of developing a new database, although staff continue to use the system for data entry (see Figure below). As part of the upgrade process the Office is also looking to install nine new automated stations.

Information collected at each of the weather station locations includes, but is not limited to:

- Air temperature
- Wind speed and direction
- Relative humidity
- Pressure
- Precipitation
- Evaporation
- Sunshine duration

[20] http://www.wmo.int/pages/themes/climate/climate_data_management_exchange.php

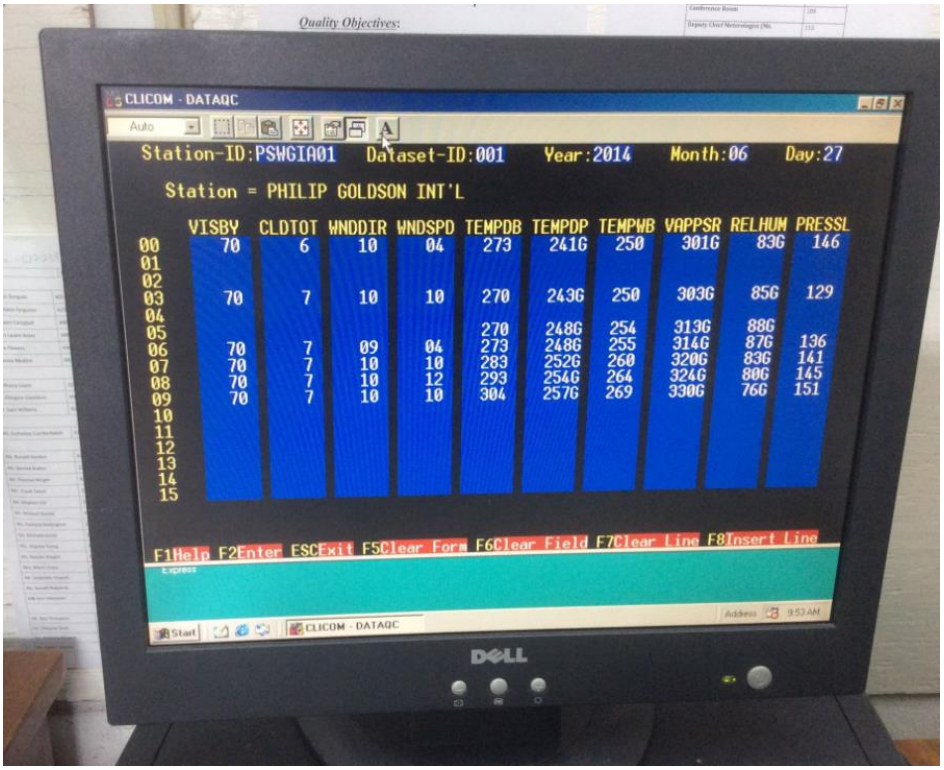

Figure 33 - CLICOM Data Entry Screen

The Office launches a weather balloon from the Philip Goldson International Airport. This is launched daily to measure wind speed and direction, lapse rate, temperature and other factors to determine atmospheric stability and other conditions at different elevations. The balloon is tracked in terms of its geographic location and elevation. After about one hour and once the balloon reaches a certain elevation it bursts and the data recorder is collected and fed into a Weather Balloon Database and transmitted to the University of Wyoming. That information has not been used in other systems to visualize the track and recorded information, but staff indicated this would be a useful GIS application for the future.

In addition to the weather monitoring station network and balloon measurements, the Office also maintains a single ***Weather Radar Station***, located at the Philip Goldson International Airport. The Rainbow 5 system by Gematronik Weather Radar Systems. Rainbow® 5 is a comprehensive, state-of-the-art sensor management system for multi-radar network management, data analysis and display. It fulfills needs in the fields of radar management, weather monitoring/nowcasting, hydrology, aviation and research. The system includes platform independent graphical user interfaces and client-server architecture. The TCP/IP based communication concept supports heterogeneous multi radar environments. The system can support a single or multi radar networks and provides a full range of more than 50 different meteorological products. It has data analysis, research and display application Rainbow® DART embedding product generation and cartographic image projections

(PROJ4) and supports 3D display and 3D cross sections. It also has the ability to interface with GIS in both vector and raster formats and supports export to Google Earth.[21]

The Office also accesses and utilizes a variety of information from satellites and global and regional models from international sources, including but not limited to the following:

CIMSS Weather Data Products. The Cooperative Institute for Meteorological Satellite Studies (CIMSS) is a Cooperative Institute formed through a Memorandum of Understanding between the University of Wisconsin-Madison (UW-Madison), the National Oceanic and Atmospheric

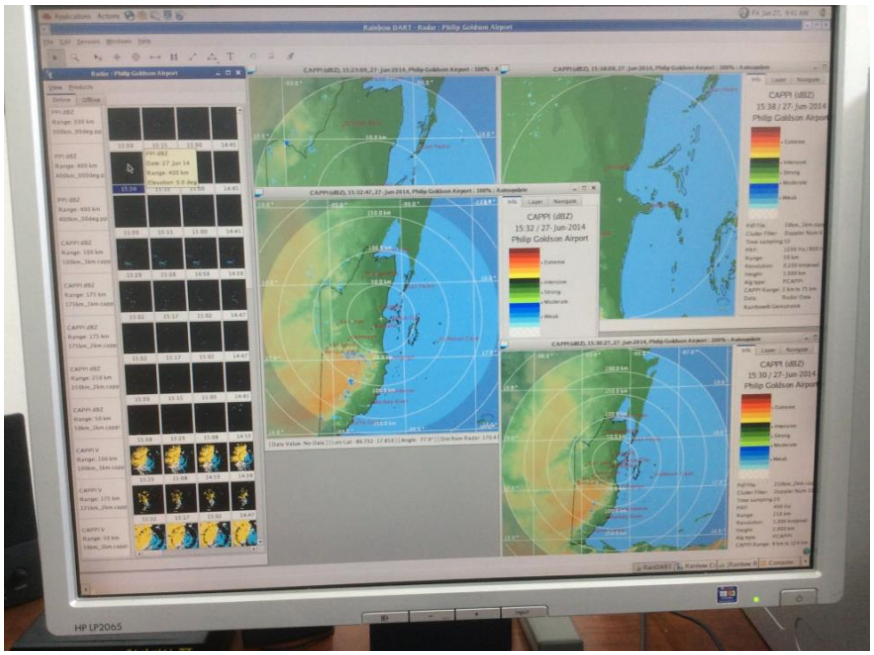

Figure 34 - Weather Radar System

Administration (NOAA), and the National Aeronautics and Space Administration (NASA) in 1980. CIMSS operates as an institute within the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison. CIMSS scientists conduct research using remote sensing systems for meteorological and surface-based applications and provide a variety of products and online services for general use by the public and other meteorological organizations worldwide. The Belize National Meteorological Office utilizes many of the real-time, near real-time, historical and predictive CIMSS products.

National Hurricane Center Storm Tracking. The Belize National Meteorological Office utilizes data products from the National Oceanic and Atmospheric Administration (NOAA), U.S. National Weather Office, National Hurricane Center (NHC). The NHC is a component of the National Centers for Environmental Prediction (NCEP) located at Florida International University in Miami, Florida. The NHC mission is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts, and analyses of

[21] http://www.gematronik.com/fileadmin/media/pdf/product-information/Datenblatt.RAINBOW.13.engl.pdf

hazardous tropical weather and by increasing understanding of these hazards. To meet its mission, the NHC is composed of several units. The Hurricane Specialist Unit (HSU) maintains a continuous watch on tropical cyclones and areas of disturbed weather within the North Atlantic and eastern North Pacific basins. The HSU prepares and issues analyses and forecasts in the form of text advisories and graphical products. The HSU issues coastal tropical cyclone watches and warnings for the United States and its Caribbean territories and provides watch and warning recommendations to other World Meteorological Organization (WMO) Region IV meteorological services. The HSU also conducts an extensive outreach and education program, training U.S. emergency managers and representatives from many other countries affected by tropical cyclones.[22]

Geostationary Satellite System (GOES). The Geostationary Satellite system (GOES), operated by the United States National Environmental Satellite, Data, and Information Office (NESDIS), supports weather forecasting, severe storm tracking, and meteorology research. Spacecraft and ground-based elements of the system work together to provide a continuous stream of environmental data. The National Weather Office (NWS) uses the GOES system for its United States weather monitoring and forecasting operations, and scientific researchers use the data to better understand land, atmosphere, ocean, and climate interactions. Designed to operate to geostationary orbit, 35,790 km (22,240 statute miles) above the earth, thereby remaining stationary with respect to a point on the ground, the advanced GOES I–M spacecraft continuously view the continental United States, neighboring environs of the Pacific and Atlantic Oceans, and Central, South America and southern Canada. The three-axis, body-stabilized spacecraft design enables the sensors to "stare" at the earth and thus more frequently image clouds, monitor earth's surface temperature and water vapour fields, and sound the atmosphere for its vertical thermal and vapor structures. Thus the evolution of atmospheric phenomena can be followed, ensuring real-time coverage of short-lived dynamic events, especially severe local storms and tropical cyclones—two meteorological events that directly affect public safety, protection of property, and ultimately, economic health and development.[23] The Belize National Meteorological Office utilizes data products from the GOES/NESDIS.

Aspects of this functional area that can be most directly supported by GIS and the BNSDI include the following:

- Develop and manage inventory of meteorological stations
- Provide map interface for accessing meteorological data
- Conduct geographic analysis to determine need and feasibility for more monitoring stations based on multiple stakeholder requirements
- Cooperate with other organizations in weather data collection (e.g. estimate of precipitation via cellular telephony signal analysis between towers)
- Provide geographic interface for recording and visualizing weather balloon readings

[22] http://www.nhc.noaa.gov/aboutintro.shtml
[23] http://en.wikipedia.org/wiki/Geostationary_Operational_Environmental_Satellite

- Provide geospatial tools to support combination of radar, meteorological station, satellite and other related information for improved weather monitoring
- Link local GIS with regional weather model outputs

4.4.2.2 Analyze and Report Weather Information and Forecasts

As mentioned above, the Office is utilizing both in situ observations as well as data products from a variety of international sources to gain a picture of the historical, current and forecasted weather conditions to provide useful information and advisory services across many sectors in Belize. This information is interpreted and refined by Office staff using their own local knowledge. There is also the opportunity to feed more localized information regarding weather, topography, land cover and other information to refine the available models. All of the information collected is further compiled, synthesized and analyzed by Office staff for distribution to the public (radio, television and print media) and key stakeholders in aviation, agriculture, transportation and others.

The Office relies heavily on forecasting information through the United States **National Centers for Environmental Prediction** (**NCEP**) which delivers national and global weather, water, climate and space weather guidance, forecasts, warnings and analyses to its Partners and External User Communities. These products and services are based on a service-science legacy and respond to user needs to protect life and property, enhance that nation's economy and support the nation's growing need for environmental information. The centers form part of the National Weather Office.

There are nine centers:

1. Aviation Weather Center provides aviation warnings and forecasts of hazardous flight conditions at all levels within domestic and international air space.
2. Climate Prediction Center monitors and forecasts short-term climate fluctuations and provides information on the effects climate patterns can have on the nation.
3. Environmental Modeling Center develops and improves numerical weather, climate, hydrological and ocean prediction through a broad program in partnership with the research community.
4. National Hurricane Center provides forecasts of the movement and strength of tropical weather systems and issues watches and warnings for the North Atlantic and the Eastern Pacific ocean.
5. NCEP Central Operations sustains and executes the operational suite of numerical analyses and forecast models and prepares NCEP products for dissemination.
6. Ocean Prediction Center issues weather warnings and forecasts out to five days for the Atlantic and Pacific Oceans north of 30 degrees north.
7. Space Weather Prediction Center provides space weather alerts and warnings for disturbances that can affect people and equipment working in space and on earth.
8. Storm Prediction Center provides tornado and severe weather watches for the contiguous United States along with a suite of hazardous weather forecasts.

9. Weather Prediction Center provides nationwide analysis and forecast guidance products out through seven days.[24]

Data and services of the NCEP are provided online and are accessible by the public over the Internet.

The Office has not yet adopted GIS for the analysis and visualization of weather data beyond what is provided through the available systems and models but staff are exploring various options for doing so. Staff have indicated that this would greatly enhance their ability to provide useful data and analysis products including:

- increase the detail and quality of weather models by adding detailed information such as topography and land cover;
- establish access to population, watershed, hydrology and infrastructure information to be able to determine more accurately where there are resources most at risk from weather events;
- combine weather data and forecasts with remote sensing to better understand area-specific trends and impacts of weather conditions;
- combine historical weather data with other geographic information to better measure and understand the impacts of climate change over time.

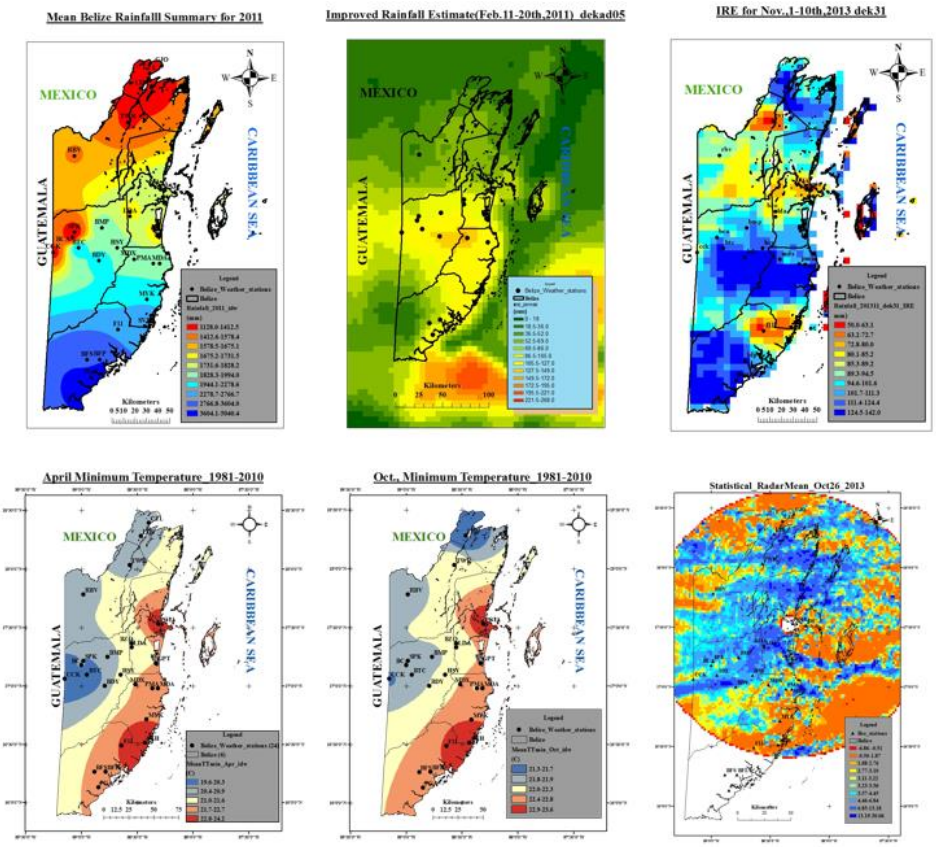

Figure 35 - GIS Based Prototype Weather Data Analysis and Visualization Examples

[24] http://en.wikipedia.org/wiki/National_Centers_for_Environmental_Prediction

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Develop and manage inventory of meteorological stations
- Provide map interface for accessing meteorological data
- Conduct geographic analysis to determine need and feasibility for more monitoring stations based on multiple stakeholder requirements
- Cooperate with other organizations in weather data collection (e.g. estimate of precipitation via cellular telephony signal analysis between towers)
- Provide geographic interface for recording and visualizing weather balloon readings
- Provide geospatial tools to support combination of radar, meteorological station, satellite and other related information for improved weather monitoring

4.4.2.3 Analyze Weather and Prepare Agro meteorology Reports

The Office utilizes its data collection and forecasting capabilities to create specific data products for the agricultural sector which is very important to the Belize economy as a whole. This includes daily/weekly forecasts, monthly bulletins, and drought monitoring and precipitation outlook. Information is tied to agricultural communities and locations where the monitoring stations are located. The information is not generally shown on maps, but staff indicated that the ability to do so and to combine this with land use maps showing farmlands and crop types would add value to the products and services provided.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Provide more geographically specific reports to farming communities;
- Customize reports according to specific clusters of farmlands, crop types, types of infrastructure, and other context.

4.4.2.4 Participate in emergency preparedness and response

The Office plays a critical role in disaster preparedness and response in Belize, since most of the critical vulnerabilities are weather related. The service is part of the National Emergency Management Organization (NEMO) and there is a hotline between the Hydromet office at the international airport and the NEMO headquarters in Belmopan. During an emergency the Chief Meteorological Officer relocates to the NEMO headquarters. Storm tracks, wind and precipitation and storm surge models are monitored carefully be Hydromet staff and these are communicated to the NEMO center on a regular basis. While staff can monitor the radar and international storm models they do not currently have the tools to be able to mash up information from multiple sources to further assess the implications of a storm event and the associated vulnerabilities to loss of life and property, disabling of infrastructure and other immediate potential impacts. Staff have indicated that the provision of ubiquitous access to a variety of information to be combined and analyzed with the available weather data would

greatly improve the assessment of possible vulnerabilities, the preparation of more effective contingency plans, and especially in ensuring that disaster response and recovery efforts are well informed.

At present, the Office relies on internet connectivity to information from external sources which cannot be relied upon in an emergency. It was indicated that there are plans to establish a direct satellite link to the National Hurricane Center in Florida to ensure that information can continue to flow to the Office and NEMO during an extreme storm event when the telephone system may be rendered inoperable.

There are two other notable emergency-related systems that the Office is involved including:

Emergency Managers Weather Information Network (EMWIN). EMWIN is a suite of methods of making available a live DataStream of basic text and graphic weather data, and providing access to stored sets of basic unenhanced data, using a variety of techniques and technologies. Each method has advantages and disadvantages over the others, hence this multilayered approach to enable multiple methods of availability. The EMWIN DataStream includes virtually all U.S. National Weather Service (NWS) products which are of potential interest to mariners. EMWIN systems, such as the one implemented at the Belize National Meteorological Office can also be programmed to sound an alarm in cases of severe weather. EMWIN's present methods in use or under development for disseminating the basic EMWIN DataStream include:

- Radio -- limited number cooperative VHF/UHF stations
- Internet -- http://iwin.nws.noaa.gov/iwin/main.html or FTP download
- Satellite -- GOES 8, GOES 9, etc.[25]

The Office is currently connected to the EMWIN system via the internet. This is to be replaced in the near future with a direct satellite link via Geonetcast. GEONETCast is a global network of satellite based data dissemination systems providing environmental data to a world-wide user community. The current partners within GEONETCast initiative include the National Oceanic and Atmospheric Administration (NOAA), the World Meteorological Organization (WMO), the Chinese Meteorological Administration (CMA) and EUMETSAT, as well as many prospective data provider partners.[26]

Chalillo Dam Break Early Warning System. The Office has installed one node in the Chalillo Dam Break Early Warning System. The Chalillo Dam is situated along the Macal River and used for hydroelectric generation. The early warning system is part of the plan for the dam and required as part of the environmental compliance plan. In the case of a dam break, the Office and all other nodes on the system would receive an alarm and would then

[25] http://www.nws.noaa.gov/os/marine/emwin.htm
[26] http://wiki.geonetcast.org/geonetcast/html/index.php/Main_Page

undertake pre-planned activities to evacuate populations from threatened downstream areas among other contingency provisions.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Provide geographically specific weather input to hurricane reporting
- Provide geographically specific forecasts and reporting for storm surge
- Provide geographically specific forecasts and reports for potential flooding
- Utilize locally available data to refine regional models, reports and forecasts
- Generated geographically specific scenarios to support hazard and vulnerability assessment scenarios for contingency planning purposes
- Generate geographically specific scenarios to support emergency preparedness drills
- Conduct downstream flooding and damage assessment for various levels of dam break scenarios

4.4.2.5 Provide data on as-needed basis.

The service makes any of its data available to the other agencies, universities and the public on an as-needed basis. Information can be requested online and is provided free of charge. There are presently no policy restrictions to the provision of weather data and the dissemination of such information or production of unique analysis or products on a request basis are only constrained by the limitations of staff and technology resources.

Figure 36 - Weather Data Request Form

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Provide geographic interface for access to community specific weather information and forecasts
- Provide online mechanism for outside entities to access and download selected Hydromet data and model output information for specific geographic regions

- Provide online web map services for data and analytical products that can be consumed by other mapping interfaces and websites directly

4.4.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions:

Weather Station Locations Map. The Belize National Meteorological Office collaborated with the Ministry of Natural Resources and Agriculture (MNRA) Land Information Center (LIC) in the development of a map indicating the locations of all meteorological weather monitoring stations across the country. The 34 stations are identified by the name of the community or location in which they are situated.

Weather Monitoring Data. The Belize National Meteorological Office was originally entering weather monitoring information to ***CLICOM***, a program for standardized weather data compilation and management prepared by the World Meteorological Organization, World Climate Data and Monitoring Programme (WCDMP). This program developed a standard for weather database management and involved the installation of PC-based climate database software, hardware and a comprehensive training program in more than 100 national meteorological organizations around the world. The project provided the foundations for demonstrable improvements in climate services, applications and research in these countries. Information collected at each of the weather station locations includes, but is not limited to:

- Air temperature
- Wind speed and direction
- Relative humidity
- Pressure
- Precipitation
- Evaporation
- Sunshine duration

Weather Balloon Data. The Belize National Meteorological Office launches a weather balloon from the Philip Gladson International Airport. This is launched daily to measure wind speed and direction, lapse rate, temperature and other factors to determine atmospheric stability and other conditions at different elevations. The balloon is tracked in terms of its geographic location and elevation. After about one hour and once the balloon reaches a certain elevation it bursts and the data recorder is collected and fed into a Weather Balloon Database and transmitted to the University of Wyoming. That information has not been used in other systems to visualize the track and recorded information, but staff indicated this would be a useful GIS application for the future.

Weather Radar Station Data. The Belize National Meteorological Office maintains a single weather radar station, located at the Philip Goldson International Airport. The Rainbow 5 system by Gematronik Weather Radar Systems. Rainbow® 5 is a comprehensive, state-of-the-art sensor management system for multi-radar network management, data analysis and display. It fulfills needs in the fields of radar management, weather monitoring/nowcasting, hydrology, aviation and research.

CIMSS Weather Data Products. The Cooperative Institute for Meteorological Satellite Studies (CIMSS) is a Cooperative Institute formed through a Memorandum of Understanding between the University of Wisconsin-Madison (UW-Madison), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA) in 1980. CIMSS operates as an institute within the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison. CIMSS scientists conduct research using remote sensing systems for meteorological and surface-based applications and provide a variety of products and online services for general use by the public and other meteorological organizations worldwide. The Belize National Meteorological Office utilizes many of the real-time, near real-time, historical and predictive CIMSS products that are made available online.

National Hurricane Center Storm Tracking Data. The Belize National Meteorological Office utilizes data products from the National Oceanic and Atmospheric Administration (NOAA), U.S. National Weather Office, National Hurricane Center (NHC). The NHC is a component of the National Centers for Environmental Prediction (NCEP) located at Florida International University in Miami, Florida. The HSU prepares and issues analyses and forecasts in the form of text advisories and graphical products. The HSU issues coastal tropical cyclone watches and warnings for the United States and its Caribbean territories and provides watch and warning recommendations to other World Meteorological Organization (WMO) Region IV meteorological services.

Geostationary Satellite System (GOES) Remotely Sensed Data. The Geostationary Satellite system (GOES), operated by the United States National Environmental Satellite, Data, and Information Office (NESDIS), supports weather forecasting, severe storm tracking, and meteorology research. Spacecraft and ground-based elements of the system work together to provide a continuous stream of environmental data. The National Weather Office (NWS) uses the GOES system for its United States weather monitoring and forecasting operations, and scientific researchers use the data to better understand land, atmosphere, ocean, and climate interactions. Designed to operate to geostationary orbit, 35,790 km (22,240 statute miles) above the earth, thereby remaining stationary with respect to a point on the ground, the advanced GOES I–M spacecraft continuously view the continental United States, neighboring environs of the Pacific and Atlantic Oceans, and Central, South America and southern Canada. The three-axis, body-stabilized spacecraft design enables the sensors to "stare" at the earth and thus more frequently image clouds, monitor earth's surface temperature and water vapour fields, and sound the atmosphere for its vertical thermal and vapor structures. Thus the

evolution of atmospheric phenomena can be followed, ensuring real-time coverage of short-lived dynamic events, especially severe local storms and tropical cyclones—two meteorological events that directly affect public safety, protection of property, and ultimately, economic health and development.[27] The Belize National Meteorological Office utilizes data products from the GOES/NESDIS.

NCEP Weather and Environmental Forecasts. The Office relies heavily on forecasting information through the United States **National Centers for Environmental Prediction** (**NCEP**) which delivers national and global weather, water, climate and space weather guidance, forecasts, warnings and analyses to its Partners and External User Communities. These products and services are based on a service-science legacy and respond to user needs to protect life and property, enhance that nation's economy and support the nation's growing need for environmental information. The centers form part of the National Weather Office.

There are nine centers:

1. Aviation Weather Center provides aviation warnings and forecasts of hazardous flight conditions at all levels within domestic and international air space.
2. Climate Prediction Center monitors and forecasts short-term climate fluctuations and provides information on the effects climate patterns can have on the nation.
3. Environmental Modeling Center develops and improves numerical weather, climate, hydrological and ocean prediction through a broad program in partnership with the research community.
4. National Hurricane Center provides forecasts of the movement and strength of tropical weather systems and issues watches and warnings for the North Atlantic and the Eastern Pacific ocean.
5. NCEP Central Operations sustains and executes the operational suite of numerical analyses and forecast models and prepares NCEP products for dissemination.
6. Ocean Prediction Center issues weather warnings and forecasts out to five days for the Atlantic and Pacific Oceans north of 30 degrees north.
7. Space Weather Prediction Center provides space weather alerts and warnings for disturbances that can affect people and equipment working in space and on earth.
8. Storm Prediction Center provides tornado and severe weather watches for the contiguous United States along with a suite of hazardous weather forecasts.
9. Weather Prediction Center provides nationwide analysis and forecast guidance products out through seven days.[28]

Data and services of the NCEP are provided online and are accessible by the public over the Internet.

4.4.4 Existing Systems

[27] http://en.wikipedia.org/wiki/Geostationary_Operational_Environmental_Satellite
[28] http://en.wikipedia.org/wiki/National_Centers_for_Environmental_Prediction

The Belize National Meteorologic Office currently uses the following computerized systems in carrying out its functions:

CLICOM. The Belize National Meteorological Office was originally entering weather monitoring information to ***CLICOM***, a program for standardized weather data compilation and management prepared by the World Meteorological Organization, World Climate Data and Monitoring Programme (WCDMP). This program developed a standard for weather database management and involved the installation of PC-based climate database software, hardware and a comprehensive training program in more than 100 national meteorological organizations around the world. The project provided the foundations for demonstrable improvements in climate services, applications and research in these countries. In the late 1990s, the WCDMP initiated a Climate Database Management System (CDMS) project to replace CLICOM and take advantage of the latest computer technologies to meet the varied and growing data management needs. The new CDMSs offered improved data access and security and much greater utility for users. The Meteorological Office ran into issues with the CLICOM system and is now in the process of developing a new database, although staff continue to use the system for data entry. As part of the upgrade process the Office is also looking to install nine new automated stations.

Rainbow 5 Gematronik Weather Radar System. In addition to the weather monitoring station network and balloon measurements, the Office also maintains a single weather radar station, located at the Philip Goldson International Airport. The Rainbow 5 system by Gematronik Weather Radar Systems is a comprehensive, state-of-the-art sensor management system for multi-radar network management, data analysis and display. It fulfills needs in the fields of radar management, weather monitoring/nowcasting, hydrology, aviation and research. The system includes platform independent graphical user interfaces and client-server architecture. The TCP/IP based communication concept supports heterogeneous multi radar environments. The system can support a single or multi radar networks and provides a full range of more than 50 different meteorological products. It has data analysis, research and display application Rainbow® DART embedding product generation and cartographic image projections (PROJ4) and supports 3D display and 3D cross sections. It also has the ability to interface with GIS in both vector and raster formats and supports export to Google Earth.[29]

National Hurricane Center Storm Tracking Data. The Belize National Meteorological Office utilizes data products from the National Oceanic and Atmospheric Administration (NOAA), U.S. National Weather Office, National Hurricane Center (NHC). The NHC is a component of the National Centers for Environmental Prediction (NCEP) located at Florida International University in Miami, Florida. The NHC mission is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts, and analyses of hazardous tropical weather and by increasing understanding of these

[29] http://www.gematronik.com/fileadmin/media/pdf/product-information/Datenblatt.RAINBOW.13.engl.pdf

hazards. To meet its mission, the NHC is composed of several units. The Hurricane Specialist Unit (HSU) maintains a continuous watch on tropical cyclones and areas of disturbed weather within the North Atlantic and eastern North Pacific basins. The HSU prepares and issues analyses and forecasts in the form of text advisories and graphical products. The HSU issues coastal tropical cyclone watches and warnings for the United States and its Caribbean territories and provides watch and warning recommendations to other World Meteorological Organization (WMO) Region IV meteorological services. The HSU also conducts an extensive outreach and education program, training U.S. emergency managers and representatives from many other countries affected by tropical cyclones.[30]

Geostationary Satellite System (GOES) Remotely Sensed Data. The Geostationary Satellite system (GOES), operated by the United States National Environmental Satellite, Data, and Information Office (NESDIS), supports weather forecasting, severe storm tracking, and meteorology research. Spacecraft and ground-based elements of the system work together to provide a continuous stream of environmental data. The National Weather Office (NWS) uses the GOES system for its United States weather monitoring and forecasting operations, and scientific researchers use the data to better understand land, atmosphere, ocean, and climate interactions. Designed to operate to geostationary orbit, 35,790 km (22,240 statute miles) above the earth, thereby remaining stationary with respect to a point on the ground, the advanced GOES I–M spacecraft continuously view the continental United States, neighboring environs of the Pacific and Atlantic Oceans, and Central, South America and southern Canada. The three-axis, body-stabilized spacecraft design enables the sensors to "stare" at the earth and thus more frequently image clouds, monitor earth's surface temperature and water vapour fields, and sound the atmosphere for its vertical thermal and vapor structures. Thus the evolution of atmospheric phenomena can be followed, ensuring real-time coverage of short-lived dynamic events, especially severe local storms and tropical cyclones—two meteorological events that directly affect public safety, protection of property, and ultimately, economic health and development.[31] The Belize National Meteorological Office utilizes data products from the GOES/NESDIS.

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- Radio -- limited number cooperative VHF/UHF stations

[30] http://www.nhc.noaa.gov/aboutintro.shtml
[31] http://en.wikipedia.org/wiki/Geostationary_Operational_Environmental_Satellite

- Internet -- http://iwin.nws.noaa.gov/iwin/main.html or FTP download
- Satellite -- GOES 8, GOES 9, etc.[32]

The Office is currently connected to the EMWIN system via the internet. This is to be replaced in the near future with a direct satellite link via Geonetcast. GEONETCast is a global network of satellite based data dissemination systems providing environmental data to a world-wide user community. The current partners within GEONETCast initiative include the National Oceanic and Atmospheric Administration (NOAA), the World Meteorological Organization (WMO), the Chinese Meteorological Administration (CMA) and EUMETSAT, as well as many prospective data provider partners.

Chalillo Dam Break Early Warning System. The Office has installed one node in the Chalillo Dam Break Early Warning System. The Chalillo Dam is situated along the Macal River and used for hydroelectric generation. The early warning system is part of the plan for the dam and required as part of the environmental compliance plan. In the case of a dam break, the Office and all other nodes on the system would receive an alarm and would then undertake pre-planned activities to evacuate populations from threatened downstream areas among other contingency provisions.

Central American Probabilistic Risk Assessment (CAPRA). The Office is collaborating with NEMO in the implementation of the Central American Probabilistic Risk Assessment (CAPRA) system for Belize. CAPRA provides communities and national counterparts with comprehensive methods and tools for risk analysis and risk management, learning materials (such as an on-line atlas of hazard and risk in the countries) and capacity building initiatives for national institutions. CAPRA embraces an open-source concept and publishes its work on a community edited website for active participation from country counterparts from the government, academia and civil society. It creates awareness that most natural disasters are predictable, that impacts can be mitigated and that one can be better prepared. Started with seed funding from Global Facility for Disaster Reduction and Recovery (GFDRR) in Nicaragua, the initiative has grown into a leveraged partnership between the World Bank, Inter-American Development Bank, UNISDR, CEPREDENAC, and governmental institutions in Belize, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua. NEMO is facilitating the development of CAPRA for Belize.

4.4.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- The Office has not yet officially adopted GIS, although at least one staff has acquired a personal license of ArcGIS and has been using that to experiment with the application of GIS to the weather sector;

[32] http://www.nws.noaa.gov/os/marine/emwin.htm

- The Office could benefit from access to data from other agencies such as population, land cover, infrastructure, topography and other;
- Staff in the Office have had little access to GIS or related training;
- The Office collects or compiles a wide variety of weather data and provides a variety of reporting products for aviation, agriculture, the insurance industry and others. Formalization of mapped products to refine and expand the type and frequency of derivative data products for various industry and community services would be of value, especially if this information can be offered online in combination with data from other agencies.
- This Office and others involved in emergency response in the country are not tied together by a reliable data and voice communications network. Strengthening of this infrastructure is needed to decrease vulnerability and increase the ability to mobilize and coordinate a multi-sector response effort.

5 MINISTRY OF HOUSING AND URBAN DEVELOPMENT

5.1 Central Building Authority

Desk Study with agency review.
Person(s) Responding: Arnaldo Romel Hernandez, Director of Building Control

Date: August 15, 2014

5.1.1 Organization and Mission

The Central Building Authority (CBA) under the Belize Building Act Amendment 2005, has oversight over the building of all structures in Belize. The CBA is a building control body which assesses both the plans and final result of all private sector building operations.

CBA has approximately 6 staff: 1 Director, 1 Office Administrator, and 4 Building Inspectors. The Authority recently received an additional 5 supporting staff from the Housing Department, each of whom have professional training in building and construction.

CBA has the following major functional areas that are relevant to the use of GIS and the BNSDI:

1. Intake, review and approve building permits
2. Conduct building/site inspections;
3. Carry out soil testing;
4. Carry out concrete testing.

5.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

5.1.2.1 Intake, review and approve building permits.

All building and construction works in Belize are required to secure a building permit before construction is started. This includes any kind of a residence, apartment building, resort and tourist facilities, commercial and institutional and industrial buildings, agricultural structures, a pier and other over-water structures, detached out buildings, and moveable structures, whether temporary or permanent. Building permits are also required for any remodels, or

renovations of existing structures. CBA is the agency responsible for administering the building permit process. Applications are submitted according to standard forms and supporting documents as per CBA standards and checklists. This must include proof of no objection by up to 15 agencies depending on the type and location of construction, including:

- Central Building Authority;
- Ministry of Health;
- Civil Aviation Department;
- Land Utilization Authority;
- Belize Police Department;
- Coastal Zone Management Authority and Institute;
- Ministry of Natural Resources;
- Local Municipal Authority;
- Public Utilities Commission;
- Fisheries Department;
- National Fire Service;
- Department of Environment;
- Housing and Planning Department;
- Belize Port Authority;
- Belize Tourism Board.

When an application is found to be complete, it is entered to a ***plan log register*** which initiates the building permit approval process. A CBA reference number is given to each building owner to help him/her identify their building construction status. In addition, the following information is documented for each building owner within the plan log:

- Parcel #
- Community
- Village
- District
- Construction Material
- Description
- No. of Floors
- Change Use
- Proposed Use
- Building Dimensions
- Area of Lot
- Lot Cover
- Occupancy
- Parking

All information mentioned above is currently in excel format. A GIS Consultant was hired by the Authority to develop a ***building footprint/building stop order database*** which joins all the attributes within the plan log to each footprint. The consultant used ArcGIS Software to

develop this database. One point is taken at an initial inspection and then points at every corner of the building are taken upon completion or near completion of the structure. The GPS coordinates are collected in eastings and northings with the following projection WGS 1984 UTM Zone 16N.

Three printed copies minimum are required for submittal. Upon completion of the process a digital copy of the plan is kept on file only. After plans are approved they are scanned and kept on a designated server. All printed plans are returned to owner upon receiving approval. ***DIMS (Data Information Management System)*** has been developed to manage the information as well as GIS.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Log building permit applications with geographic reference (explicit coordinates or verifiable street address or plot number)
- Support "one-stop-shop" for digital building permit submissions and initial review by multiple agencies
- Capture spatial footprint of proposed structure, and allow "status" to be adjusted as the building permit process moves forward to final occupancy permit or commissioning
- Utilize contextual data from multiple organizations to assess proposed building compliance
- Add climate change related potential hazards as an element for consideration in building permitting

5.1.2.2 Conduct building/site inspections

Once a permit has been approved and construction initiated, CBA staff will perform site inspections at appropriate times. There is a written site report for each construction site visited while in the field. Upon returning to office this data is imported into an excel database labelled “Site & Stop Order Report”. Site reports are scanned and stored on the server.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Utilize GIS to plan and track building inspection schedules
- Provide geographic interface for accessing building permit case files
- Produce building permit status maps and reports
- Conduct building history and trend maps and statistical information over time

5.1.2.3 Carry out soil testing

The soil profile at each construction site is required by an engineer who will design the foundation of the proposed building. If ground water level conditions are known testing is conducted. The water table is terminated by one of several factors. The water table would be estimated if there is a water source (river, lagoon, pond etc.) nearby. If there is a recent construction nearby we would inquire if they have knowledge of the water table. We would

also refer to the data from the data sheets acquired from the Ministry of Rural Development. Finally the water table would be noted at times while anchoring the equipment for soil testing. However, estimation of water tables does not affect results of soil testing data. In addition, a GPS point location is recorded for each area where soil testing is conducted.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Log soil testing sites geographically
- Provide access to soil testing online through a map interface
- Utilize soil testing as input to soil mapping and geotechnical assessment efforts

5.1.2.4 Carry out concrete testing

A non-destructive concrete testing method is carried out at each construction site to verify the strength of concrete using schmidt proseq hammer. Information/results of testing are made available to clients upon request. The test results for concrete testing are being stored digitally and are also recorded in the written report labelled by project name or owner's name. Tests are not associated with a CBA# as test are done upon request by any independent professional or institution.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Log concrete testing results geographically
- Provide access to concrete testing online through a map interface
- Maintain historical record of concrete tested sites and results over time

5.1.3 Data Used or Generated

The CBA presently uses or generates the following information that is relevant to GIS or the BNSDI:

Building Permit Plan Log Register. Building permit applications that have been approved for submission are recorded to the Building Permit Plan Log Register. A Central Building Authority sequence number is assigned for common reference during the permit approval and construction inspection process. The Parcel # is used as the primary location reference.

Building Footprint Database. A GIS Consultant was hired by the Central Building Authority to develop a ***building footprint/building stop order database*** which joins all the attributes within the building permit plan log to each footprint. The consultant used ArcGIS Software to develop this database. Cooperative efforts have been conducted with various agencies but this is not formal it has been done more on a personal basis and on a project basis.

Data Information Management System (DIMS). After building permit plans are approved they are scanned and kept on a designated serve at the CBA.

Site & Stop Order Report. Once a permit has been approved and construction initiated, CBA staff will perform site inspections at appropriate times. There is a written site report for each construction site visited while in the field. Upon returning to office this data is imported into an excel database labelled "Site & Stop Order Report". Site reports are scanned and stored on the server.

5.1.4 Existing Systems

MS Excel. Microsoft Corporation's Excel spreadsheet application is being used to store information regarding building permit plan logs.

ArcGIS. The Central Building Authority is utilizing a temporary license of ArcGIS for the management and use of its building footprint database.

5.1.5 Computing Infrastructure

CBA utilizes a central network drive where all its information is archived and managed. In addition, individual building inspectors have their own computer with a fully functional AutoCAD 2014 software. Only one building inspector has a temporary ArcGIS 10 for desktop software license installed to his machine which stores all relevant spatial data.

5.1.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the LIC:

- With the completion of the building footprints database CBA intends to write project proposals for such things as hurricane flood risk to buildings in Belize and/or Climate Change Risk to Coastal Buildings and Infrastructure in Belize;
- With the establishment of the BNSDI, CBA can partner with other governmental and non-governmental organization to acquire the best data available to perform analysis for its intended projects;
- CBA intends to train key building inspectors in the use of GIS technology to begin updating its building footprint database on a regular basis;
- There is inconsistency in the availability and quality of spatially referenced data in country. Through the NSDI it is expected that most governmental and non-governmental organization participate so that all data layers becomes standardized to enhance spatial analysis in future national projects;
- There is incomplete knowledge about the availability and quality of existing spatially referenced data in country. That is, organizations are currently duplicating efforts because nobody knows who owns which data. In addition, data sharing among organizations is challenging at times because they don't want to enter a data sharing agreement. Therefore through NSDI, organizations can share data easily and build on the individual dataset rather than re-do the layers.

6 MINISTRY OF ENERGY, SCIENCE & TECHNOLOGY AND PUBLIC UTILITIES

6.1 Geology, Energy, Science and Technology Departments and Public Utilities Commission

Person(s) Interviewed: Ambrose Tillitt, Director Energy Department
energy.director@estpu.gov.bz
Craig Moore, Deputy Director Geology Unit
depdirector.gdp@estpu.gov.bz
Derek Davis, Director of Electrical Sector ddavis@puc.bz
Claudio Leal, Water Inspector cleal@puc.bz

Interview Date(s): June 9, 2014
Desk Study Date(s): July 8-11, 2014

6.1.1 Organization and Mission

This stakeholder survey write-up was compiled through a combination of personal interviews, desk study review of available documentation and online information and telephone follow-up.

The Ministry of Energy, Science & Technology, and Public Utilities was founded in 2012. The Ministry is currently divided into the Department of Geology and Petroleum, the Energy Unit, the Science and Technology Unit. The Ministry also works closely with the Public Utilities Commission (PUC) which has been included in this write-up.

Geology and Petroleum Department. The Geology and Petroleum Department was established in 1984 as part of the Ministry of Natural Resources. In 2012 the department moved to the new Ministry of Energy, Science & Technology and Public Utilities. The department is responsible for governance of the petroleum industry in Belize. The department's mission statement is to "To accelerate the development of Belize's petroleum resources through the creation of a vibrant petroleum industry, with the assistance of international investors, cognizant of environmental costs, thereby improving the welfare of Belizeans into the 21st century." This department has 13 staff.

Energy Unit. The Energy Unit was established in 2012 and has responsibility for governance of the energy sector in Belize. The Unit's mission statement is to "To plan, promote and effectively manage the production, delivery and use of energy through Energy Efficiency, Renewable Energy, and Cleaner Production interventions for the sustainable development of Belize. Key activities performed by the Energy Unit include data collection for the purpose of

planning Belize's future energy supplies and calculating greenhouse gas emissions, public awareness on topics such as energy efficiency, as well as regulation and market reforms that promote a sustainable future for Belize.

Science and Technology Unit. The Science and Technology Unit is responsible for the promotion of Science and Technology in Belize. The Unit plays a key role in Belize's efforts to achieve Target 8.f in the millennium development goals. The Unit conducts a number of activities that promote engagement with Science and Technology in Belize, including through the ICT roadshow.

Public Utilities Commission. The purpose of the Public Utilities Commission is to regulate the electricity, water, and telecommunications sectors in Belize to efficiently provide the highest quality services at affordable rates, ensuring the viability and sustainability of each sector. While administratively distinct from the MoESTPU, the activities of the PUC are very closely tied to the interests and operations of the Ministry so is being documented in this context.

These Departments currently carry out several primary activity areas that have some relevance to GIS and BNSDI including the following:

Geology and Petroleum Department

1. Facilitate and oversee geologic and petroleum exploration studies
2. Administer petroleum operating concessions
3. Review environmental impact assessments

Energy Unit

4. Develop and support national renewable energy development
5. Promote and support energy efficiency initiatives
6. Promote and support clean energy production initiatives

Science and Technology Unit

7. Promote and support the development and application of science and technology in Belize

Public Utilities Commission

8. Participate in Public Utility Strategic Planning.
9. Review and approve Public Utility rates.
10. Monitor Public Utility Performance.

6.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

GEOLOGY AND PETROLEUM DEPARTMENT

6.1.2.1 Facilitate and Oversee Geologic and Petroleum Exploration Studies

Petroleum exploration in Belize began in the 1930's. Oil exploration licenses were granted to the large oil companies such as Shell, Esso, Texaco, Gulf Oil, Anschutz and Chevron as well as smaller companies such as Occidental Petroleum and Phillips Petroleum and small independent oil companies to explore for petroleum in both the onshore and offshore areas of Belize. Many ***two dimensional seismic surveys*** were conducted most of which were done in the offshore waters of Belize and thousands of line kilometers of seismic data were acquired. Up to 2000, a total of 50 ***exploration wells*** were drilled, 34 onshore and 16 offshore. The first exploration well that was drilled in Belize was the Yalbac #1 well located in the Yalbac Hills in the Cayo District which was drilled by Gulf Oil in 1956. No commercial discovery was made in any of these wells. They were all dry and some had minor oil shows. The Eagle #1 well drilled in 1984 in Belmopan came closest which recovered approximately 3 barrels of light crude oil when it was production tested, but did not prove commercial. The last well drilled during this exploration period was the Gladden #1 well drilled by the Dover Consortium in 1997 in the Glovers Reef area.[33]

In 2000 an oil seep was discovered at 130 feet in a water well drilled at Calla Creek in the Cayo District. This sparked new interest in Belize and this resulted in the granting of an exploration license to Belize Natural Energy Ltd. (BNE) which made the first commercial discovery of petroleum in July 2005 in Spanish Lookout in the Mike Usher #1 well. The oil discovered in Spanish Lookout is a light crude oil with an API gravity of 40°. This discovery was developed by BNE into the Spanish Lookout Oilfield which is currently producing an average of 2,100 barrels of oil per day. BNE later made another commercial discovery in October 2008 in the Never Delay area in the Never Delay #1 well. This crude oil is also similar in density to the Spanish Lookout crude oil. This discovery was also developed by BNE into the Never Delay Oilfield and is currently producing an average of 16 barrels per day. The Spanish Lookout and Never Delay crude oils are trucked from the oilfields to BNE's export facility in Big Creek and shipped and sold to the US Gulf Coast. BNE is the only producer of crude oil in Belize.

There are currently 9 companies which hold exploration licenses in Belize and are carrying out ***seismic surveys*** and drilling ***exploration wells*** in the continuous search for commercial petroleum. The ***Belize Petroleum Contracts Map*** shows these companies and their license areas.

There have been several geologic studies conducted in Belize over several decades. The latest and most detailed geology map for the country was authored by Geologist Jean H. Cornec, a founding director of Belize Natural Energy (BNE), with additional updates in 2004. According to the author, this map represents a synthesis of the available geologic data generated over the previous 75 years.

[33] http://estpu.gov.bz/index.php/geology-petroleum/belize-petroleum-industry

Historical seismic surveys, ***test well borehole data*** and other information from pre-2012 studies conducted mostly during the 1960's and 1970's were either lost or only available in hardcopy format. Some of the companies that were conducting those studies at the time still have the information but want to charge high fees for providing the information. Therefore the Ministry has commissioned a company to digitize all the old seismic survey data that they have. This effort should be completed within 6 months of this writing. All new contracts and operating licenses require that all collected data must be submitted to the Ministry in industry-standard format.

Borehole data being compiled in Belize includes lithography and geohydrologic information for upper strata that are not needed for petroleum exploration but is very relevant for groundwater resource management.

Data for 85 wells is being compiled by a company TGS-NOPEC, who processes the information to a variety of information products that are then sold back to oil companies and consultants, with the government taking a share of that revenue.

TGS-NOPEC Geophysical Company, referred to as **TGS** and listed on the Oslo Stock Exchange, was founded by a 1998 merger of TGS (**T**omlinson **G**eophysical **S**ervices Inc.), Calibre Geophysical Co. Inc (founded 1981), and NOPEC (**No**rwegian **P**etroleum **E**xploration **C**onsultants) International ASA founded in 1981. TGS provides multi-client geoscience data to oil and gas exploration and production companies worldwide. In addition to extensive global geophysical and geological data libraries that include multi-client seismic data, magnetic and gravity data, digital well logs, production data and directional surveys, TGS also offers advanced processing and imaging services, interpretation products, permanent reservoir monitoring and data integration solutions.

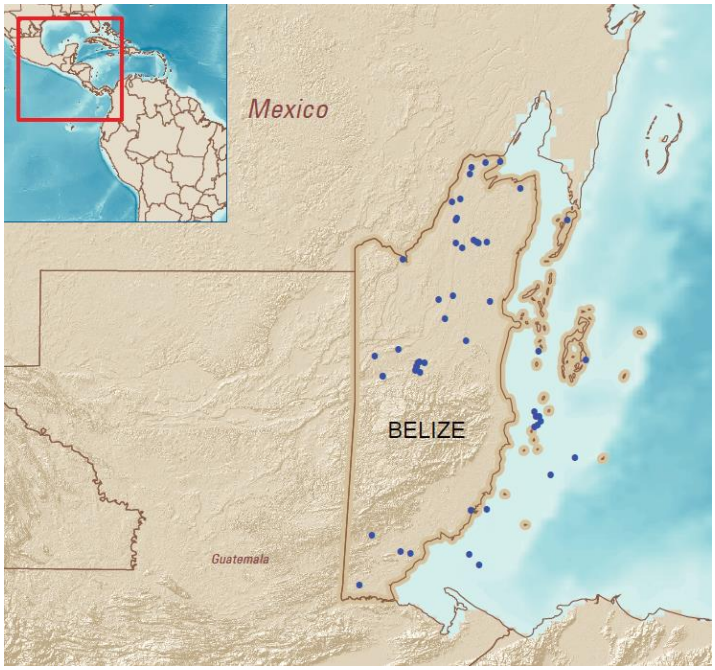

Figure 37 - TGS Petroleum Well Data

Belize well log data is available via LOG-LINE Plus! ®, an online gateway to TGS' collection of well log and other borehole-related data. The online interface has search and data

browsing options to enable users to find the data they need quickly, and download it immediately. LOG-LINE Plus! draws from TGS' quality controlled collection of more than six million instances of well data from key exploration plays worldwide. TGS is authorized to license well data via an agreement with the government of Belize.

Historical seismic data does not include topography and bathymetry information, however detailed surface information for both land and sea bottom is collected as part of newer surveys.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Develop and maintain GIS-based digital archive of past geology mapping efforts
- Maintain location and borehole information for all exploration wells
- Maintain location and results of seismic line testing information
- Manage petroleum contracts boundaries
- Develop and maintain an archive of all historical petroleum exploration information
- Collect and make available topographic, bathymetric and bottom type information

6.1.2.2 Administer Petroleum Operating Concessions

The petroleum industry in Belize is governed by the Petroleum Act and Regulations and the terms and conditions of the licenses. The Geology and Petroleum Department administrates the petroleum industry and supervises and monitors all exploration and production operations pursuant to the Act, Regulations and terms of the licenses. Other Government agencies which regulate the petroleum industry are the Income Tax Department and the Department of the Environment.

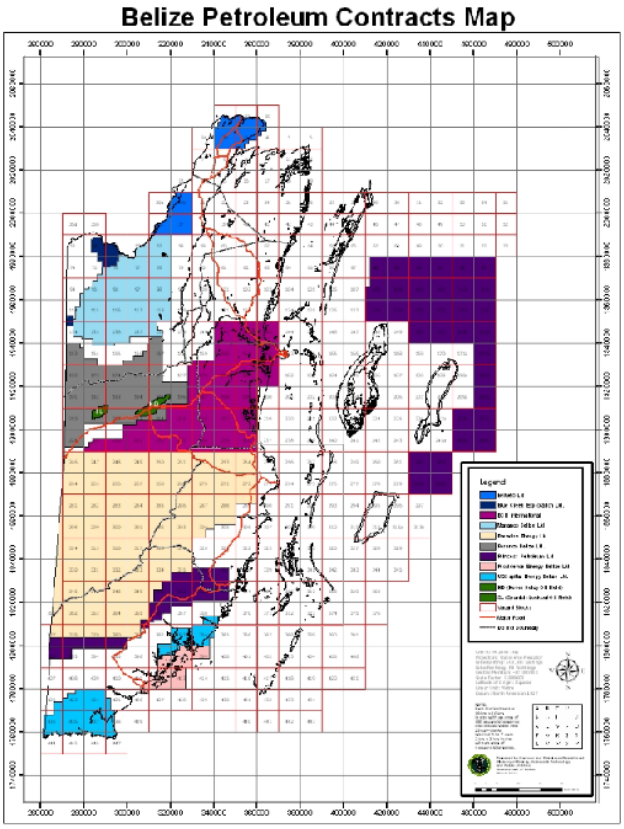

Figure 38 - Belize Petroleum Contracts Map

The Geology and Petroleum Department maintains a map illustrating the location and extent of all ***existing petroleum contracts*** across the country. The operating companies are required to submit production information per the terms of their agreements with the Government of Belize.

The Never Delay and Spanish Lookout Oilfields are the only oilfields discovered so far in Belize. Belize Natural Energy Ltd. (BNE) discovered both oilfields and is the company producing them. The oilfields are located in central western Belize in the Cayo District, shown in yellow in the map below.

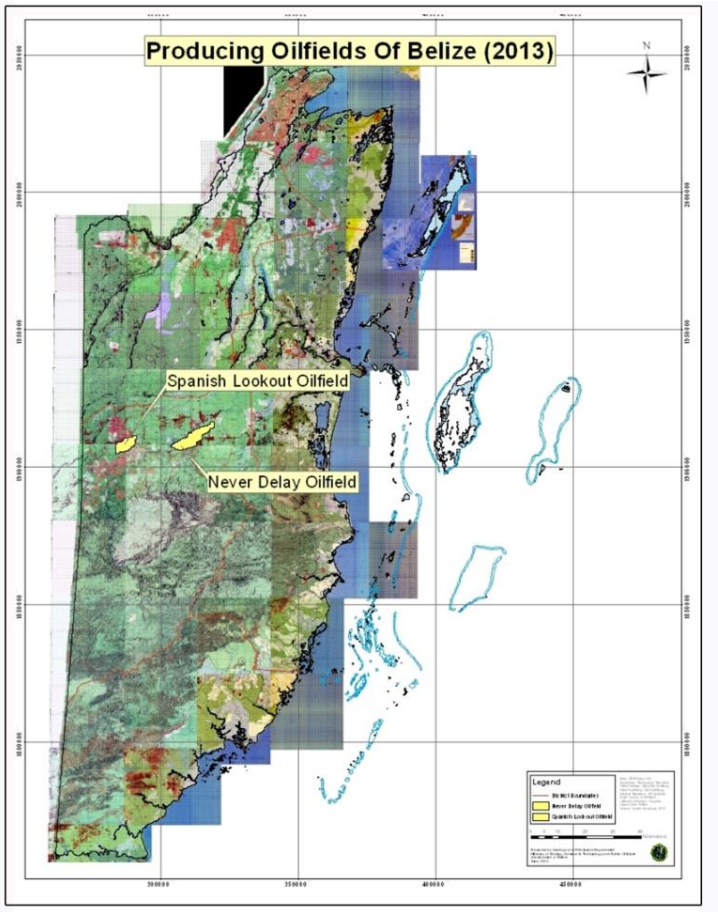

Figure 39 - Producing Oil Fields in Belize

The Spanish Lookout Oilfield is located in the Spanish Lookout Mennonite farming community. The oilfield is currently producing an average of 2,100 barrels of oil per day. At its peak the Spanish Lookout Oilfield was producing an average of 5,000 barrels of oil per day and now is in decline.

The Never Delay Oilfield is located in the Never Delay area just outside of Belmopan. The oilfield is currently producing an average of 16 barrels of oil per day. The Never Delay Oilfield was previously producing as much as 500 barrels of oil per day but this has decreased dramatically due to permeability issues which BNE is evaluating.

Oil is produced from the fields and piped to a central production facility at each field where it is stored in tanks and loaded into tanker trucks which transport the oils to BNE's export facility at the Big Creek Port where they are offloaded and mixed into storage tanks. The oils are shipped out of Belize from this export facility in a tanker to the US Gulf Coast where it is sold on the spot market. Some of the Spanish Lookout crude oil is sold locally from the central production facility at the field to local industries that utilize it in equipment such as broilers and generators.

Production is measured by BNE personnel and certified by the Petroleum Technicians of the Geology and Petroleum Department who supervise and monitor production operations at each

field. A daily production report is produced for each field by BNE and is submitted to the Department.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Tie operational reports to specific wells and contract areas
- Generate petroleum product maps and statistical reports for current status, historical trends and future projections
- Maintain inventory of petroleum production and transport assets

6.1.2.3 Review Environmental Impact Assessments

The Geology and Petroleum Unit is responsible for reviewing all environmental impact assessments relative to geologic and geophysical matters. This includes assessment of any geologic hazards, including earthquake risk (generally low in Belize), and liquefaction (can be caused by structure overloading and/or oscillation from strong winds). While slope failure and landslides has not been an issue in the past, there is concern that there is a trend towards building on steeper slopes than in the past which may increase risk in this area.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Log all environmental impact assessments geographically
- Provide tools for accessing and analyzing geologic aspects of submitted environmental impact assessments
- Conduct seismicity analysis modeling for hazard and vulnerability assessment
- Provide access to wide variety of population, community facilities, and infrastructure and jurisdiction information for contextual reference.

ENERGY UNIT

6.1.2.4 Develop and Support National Renewable Energy Development

The Energy Unit is working for a rapid expansion in the use of renewable energy in Belize over the next few years. As part of this the Unit is undertaking various activities to establish a baseline regarding existing renewable resource potential as well as existing installed systems.

Through the website < http://estpu.gov.bz/images/media/renewable%20energy.pdf> the Unit is soliciting the assistance of companies and individuals to self-declare their own usage of distributed generation and/or renewable energy covering:

- Solar Panel
- Wind Turbine
- Hydro Plant
- Diesel Generator
- Biofuel Generator

- Gasifier
- Digester
- Other

The online form includes locational reference by address as well as latitude and longitude coordinates (with note suggesting these be established using the provider's phone). Through this form the Unit is requesting a variety of information about the size, type and location of existing devices, as well as information about you're the user's experiences with the device, how successful it has been, and any challenges they may have encountered.

The Unit also plans to develop a sustainable energy atlas for the country. Such an atlas would characterize the available renewable energy resources across the country, combined with the existing grid electrical supply, existing distributed generation facilities and other environmental, economic and social factors. The purpose of the Atlas would be to provide a baseline of existing conditions and future potential that can be used to develop a strategy for a diversified energy framework plan for the Country.

The Unit is the Belize coordinator for the regional "Renewable Energy and Energy Efficiency Technical Assistance (REETA) Project". The REETA project is a four year project designed to support the institutional structure for the promotion of Renewable energies (RE) and Energy Efficiency (EE) in the Caribbean. Relevant actors in the Caribbean will be supported in their efforts to satisfy the demands of a growing market for RE and EE in the Caribbean. The project is being sponsored by the German Government and the political counterpart of the project is the Energy Unit of the CARICOM Secretariat (CCS). The project is based on the achievements of the Caribbean renewable Energy Development Programme (CREDP), but will have a stronger focus on, capacity development, energy efficiency and energy consumer needs.

Aspects of GIS and the BNSDI that are directly relevant to this functional area includes but is not limited to the following:

- Conduct analysis to determine renewable energy sources
- Assess the location and characteristics of energy demand
- Assess the location and characteristics of existing energy supply
- Perform siting analysis for proposed renewable energy projects
- Develop and maintain national inventory of renewable energy generation sites and facilities
- Monitor and assess performance of renewable energy facilities over time
- Prepare smart energy atlas and master plan for Belize representing a diversified, sustainable energy portfolio for the country

6.1.2.5 Promote and Support Energy Efficiency Initiatives

The Energy Unit is actively involved in promoting and supporting energy efficiency programs and project across Belize. GIS and the BNSDI can be used in a variety of ways to support this program, including but not limited to:

- Track the locations and characteristics of existing energy efficiency case studies;
- Monitor energy consumption rates by neighborhood as the basis for targeted energy efficiency promotion and outreach efforts;
- Leverage above analysis by providing to the private sector to support their marketing of energy efficiency products and services;
- Track the effectiveness of energy efficiency awareness and outreach programs over time.

6.1.2.6 Promote and Support Clean Energy Production Initiatives

The MESTPU, along with the Public Utilities Commission (PUC) of Belize on behalf of the Government of Belize (GOB), and the Belize Electricity Limited (BEL) identified the need for the phased addition of new generation or supply capacity to Belize's National Electricity System of some sixty (60) Mega-watts of Firm Capacity over the period from 2013 to 2023. Pursuant to the stated policy of the MESTPU/GOB to promote clean, renewable energy supply in Belize, and as a viable means of displacing higher cost thermal generation where feasible, a Request for Proposal (RFP) for the addition of some fifteen (15) MWe of rated capacity generation or supply facilities utilizing wind or solar technology or other non-firm renewable generation sources was published.

In the RFP, Bidders were advised that the entire RFP process and the subsequent construction and operation of any facilities for generation and supply are subject to the Laws of Belize and that all prospective bidders are required to practice due diligence by becoming familiar with all relevant Laws and the potential implications of such on any proposals made. Relevant legislation that prospective bidders are urged to become familiar with that has implications for the application of GIS technology and the BNSDI includes, but is not limited to, those described in the following table.

Act	GIS and BNSDI Relevance
Public Utilities Commission Act a) secure that all reasonable demands for utility services are satisfied b) secure that license holders are able to finance the provision of service for which they are licensed c) protect the interest of consumers in respect of: • the prices charged and the other terms of supply • the continuity of supply • the quality of services provided d) promote efficiency and economy in the utility sector • promote research, development and use of new techniques • protect the public from dangers arising from the supply of utility services • secure the establishment and maintenance of	▪ Accurate accounting of all public utility assets by location ▪ Monitoring of utility consumption by areas ▪ Monitoring of outages and complaints by areas ▪ Monitoring of utility bill payments by areas ▪ Utility capital improvement planning based on land use and development plans ▪ Monitoring preventive and ad hoc maintenance activities by area ▪ Access to accurate data from others (population census, community locations and statistics, buildings and topographic information, flooding areas and other environmental hazards, protected areas, land ownership, etc.)

machinery for promoting the health and safety of persons employed in sector The Commission, in exercising its functions, has a duty to take into account the effect on the physical environment.	▪ Maximize sustainable use of renewable energy sources ▪ Ensure electric utility generation, transmission and distribution facilities are designed and operated in an environmentally and financially sustainable manner
Electricity Act	▪ Accurate accounting of all electric utility assets ▪ Monitoring of electric consumption by areas ▪ Monitoring of outages and complaints by areas ▪ Monitoring of electric bill payments by areas ▪ Electricity network system control and data acquisition (SCADA) – geospatial as well as network schematic visualization ▪ Electrical supply capital improvement planning ▪ Monitoring preventive and ad hoc maintenance activities by area
Environmental Protection Act • ensure the protection and rational use of natural resources for the benefit of the present and future generations • prevent and control pollution by coordinating all activities relating to the discharge of wastes into the environment • examine and evaluate and if necessary carry out environmental impact assessments and risk analysis and to make suitable recommendations to mitigate against harmful effects of any proposed action on the environment	▪ Support planning for the sustainable use of renewable energy sources while protecting biodiversity and natural and cultural heritage ▪ Facility siting and routing in consideration of environmental factors ▪ Minimize environmental impacts from energy operational activities
National Integrated Water Resources Act	▪ Maximize sustainable utilization of water resources for hydroelectric and other purposes ▪ Plan and design electrical facilities to maximize sustainable usage of water resources while minimizing adverse impacts
Land Acquisition Act (Public Purposes)	▪ Plan electrical utility facility and route siting to minimize impact on privately owned lands
Forest Act	▪ Plan, design and operate electrical utility facilities and routes to avoid conflicts with high economic and environmental value forests
Wildlife Protection Act	▪ Plan, design and operate electrical utility facilities and routes to avoid impacts to endangered species, biodiversity and habitat

GIS and access to the full range of data currently held by the BNSDI stakeholders could be used to support each step in the project development and implementation process:

Bid formulation. At the time of this writing, the period for bid submission has already passed and proposals are undergoing evaluation. In the future, the bidders for such projects should be able to tap into the BNSDI data resources to be able to provide better project formulation and facility siting that considers all the relevant factors, thus resulting in more complete, defensible and sustainable projects.

Bid evaluation. Similarly, with accessibility to the right data the process for reviewing and evaluating the feasibility and potential impacts of proposed projects may be greatly expedited.

Project detailed design. Given the level of data that may be required for detailed facility design it may be necessary to carry out site-level surveys. However, the existing GIS data in Belize will provide important supporting information such as land ownership, building inventories, surface hydrology, flood hazard areas, and other such contextual information.

Facility operations and maintenance. GIS can be used to monitor facility asset inventories, production, operations and maintenance activities. This will be especially important for build, own, operate and transfer (BOOT) projects wherein it is in the interest of the government to ensure that the value of assets is protected through preventive maintenance and other measures.

Project monitoring and evaluation. GIS will also provide the tools to be able to effectively monitor the implemented electrical generation projects and to evaluate their impact, individually and collectively.

SCIENCE AND TECHNOLOGY UNIT

6.1.2.7 Promote and support the development and application of science and technology in Belize

The Science and Technology Unit is responsible to promote the development and application of science and technology capabilities in the country. There has been an initial focus on the use of information and communication technologies to transform Belize into a knowledge-based economy. GIS is a unique technology that can greatly contribute to the wise and sustainable development of the Country. There is a need to develop a better awareness about what GIS has to offer, and to promote the development of the technical and institution capacities to utilize the technology to its full potential. The MoESTPU is in a unique position to effectively introduce and develop GIS capacity through the various energy and public utilities activities it is involved in and to translate these accomplishments in a way that can be showcased as contributing to the promotion and development of technology capabilities in Belize.

GIS and the BNSDI can be used in a variety of ways to support this program, including but not limited to:

- Promote the use of geographic information science, systems and thinking in support of better planning and decision making in Belize
- Promote and support open public access to selected government-produced data that can support civil society, government transparency, education uses, and development of new applications and services by the private sector

PUBLIC UTILITIES COMMISSION

6.1.2.8 Participate in Public Utility Strategic Planning

The purpose of the Public Utilities Commission (PUC) is to regulate the electricity, water, and telecommunications sectors in Belize to efficiently provide the highest quality services at affordable rates, ensuring the viability and sustainability of each sector. As part of this mission, the PUC works with the individual utility companies and the MoESTPU to consider and set strategic targets for better and more cost-effective delivery of utility services to customers throughout the country. Part of this includes the introduction of GIS and related technologies to contribute to more efficient operations and delivery of services to the clients. Discussion regarding the potential role of GIS and BNSDI in helping to achieve technology-supported utility company transformation is discussed separately within each of the stakeholder survey write-ups for the individual utilities.

GIS and the BNSDI can be used in a variety of ways to support this program, including but not limited to:

- Provide improved basis for understanding the geographic distribution of current and future energy demand and supply
- Utilize place-aware social media for two-way exchange of information with utility customer communities
- Develop diversified energy portfolio that optimizes available renewable energy resources and supply of energy to key demand sectors in the most effective manner

6.1.2.9 Review and approve Public Utility Rates

When implemented correctly, a GIS-based utility mapping exercise creates in parallel a complete fixed-asset inventory, with the added advantage that the location of each component is known and the data is structured in a manner that can be used to monitor and simulate network performance and behavior as well as many other applications. A complete utility information infrastructure, inclusive of GIS for the spatial component of the information, provides a basis for integrating systems across each utility, as well as cost avoidance by sharing certain base information with others in the BNSDI community. For example, a GIS based fixed asset database can also provide the framework for linking operations and maintenance activities to the features (including preventive maintenance scheduling and as-needed work order), and as the basis for financial accounting and asset valuation. Likewise, the GIS can be used to visualize the network as geographic map or schematic within a System Control and Data Acquisition (SCADA) system. This same database can be used to monitor customer calls and diagnose and respond to service outage events, among many other applications.

The type of information integration mentioned above is a means to the achieving a more efficient and effective utility, and the methods for doing so within the electrical, water and telephony sectors are well established. Such efficiency can result in significant cost savings

and improvements in customer services that are key to the PUC's mission and objectives, ultimately resulting in lower rates and better services to the customers.

GIS and the BNSDI can be used in a variety of ways to support this program, including but not limited to:

- Utilize GIS to provide geographically linked public utility assets register
- Utilize GIS linked asset register for financial and maintenance management
- Improve customer satisfaction through streamlined and more reliable utility operations and timely response to customer requests and inquiries
- Minimize total cost of running utility by improving planning, design, operations, maintenance and administrative processes

6.1.2.10 Monitor Public Utility Performance

A key role of the PUC is to monitor and assess the performance of the utilities over time. This is important in reinforcing the role of the PUC as the overseer of the public interests when it comes to utility services and rates. Performance is measured in a variety of ways that can be supported by GIS and the BNSDI, including but not limited to the following:

- **Customer complaints**. GIS provides a basis for tracking and analyzing customer complaints by location. Complaints can be linked to an address location or GPS coordinates from a smart phone or other mobile device;
- **Outage events**. GIS supports outage management by tracing customer reports across the network to diagnose the likely faulty device or location in electrical or water networks. It can also be used to identify the devices or valves that need to be closed to isolate a break so that it can be worked on, as well as record and visualize the amount of time required to make system repairs and restore service.
- **Water quality testing**. Water quality reports and flow modeling can be used to analyze areas affected by any detected chemical or biological test that exceed acceptable limits.
- **Preventive maintenance program assessment**. With preventive maintenance schedules and work orders tied to fixed assets it is possible to understand the effectiveness of preventive maintenance activities and to assess areas with repeat problems that may suggest component refurbishment or replacement.

6.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting MoESTPU and PUC functions:

Vintage Seismic Data. Petroleum exploration in Belize began in the 1930's. Oil exploration licenses were granted to the large oil companies such as Shell, Esso, Texaco, Gulf Oil, Anschutz and Chevron as well as smaller companies such as Occidental Petroleum and Phillips Petroleum and small independent oil companies to explore for petroleum in both the onshore and offshore areas of Belize. Many two dimensional seismic surveys were conducted

most of which were done in the offshore waters of Belize and thousands of line kilometers of seismic data were acquired. Studies conducted mostly during the 1960's and 1970's were either lost or only available in hardcopy format. Some of the companies that were conducting those studies at the time still have the information but want to charge high fees for providing the information. Therefore the Ministry has commissioned a company to digitize all the old seismic survey data that they have. This effort should be completed within 6 months of this writing. All new contracts and operating licenses require that all collected data must be submitted to the Ministry in industry-standard format.

Borehole data being compiled in Belize includes lithography and geohydrologic information for upper strata that are not needed for petroleum exploration but is very relevant for groundwater resource management. Data for 85 wells is being compiled by a company TGS-NOPEC, who processes the information to a variety of information products that are then sold back to oil companies and consultants, with the government taking a share of that revenue.

Belize Petroleum Contracts Map. The Belize Petroleum Contracts Map shows these companies and their license areas. The boundaries are based on geographic coordinates associated with each contract.

Belize Geology Map. There have been several geologic studies conducted in Belize over several decades. The latest and most detailed geology map for the country was authored by Geologist Jean H. Cornec, a founding director of Belize Natural Energy (BNE), with additional updates in 2004. According to the author, this map represents a synthesis of the available geologic data generated over the previous 75 years.

Renewable Energy Producer/User Sites. Through the website < http://estpu.gov.bz/images/media/renewable%20energy.pdf> the Unit is soliciting the assistance of companies and individuals to self-declare their own usage of distributed generation and/or renewable energy covering:

- Solar Panel
- Wind Turbine
- Hydro Plant
- Diesel Generator
- Biofuel Generator
- Gasifier
- Digester
- Other

The online form includes locational reference by address as well as latitude and longitude coordinates (with note suggesting these be established using the provider's phone). Through this form the Unit is requesting a variety of information about the size, type and location of existing devices, as well as information about you're the user's experiences with the device, how successful it has been, and any challenges they may have encountered.

Energy Producer Proposals. The MESTPU, along with the Public Utilities Commission (PUC) of Belize on behalf of the Government of Belize (GOB), and the Belize Electricity Limited (BEL) identified the need for the phased addition of new generation or supply capacity to Belize's National Electricity System of some sixty (60) Mega-watts of Firm Capacity over the period from 2013 to 2023. Pursuant to the stated policy of the MESTPU/GOB to promote clean, renewable energy supply in Belize, and as a viable means of displacing higher cost thermal generation where feasible, a Request for Proposal (RFP) for the addition of some fifteen (15) MWe of rated capacity generation or supply facilities utilizing wind or solar technology or other non-firm renewable generation sources was published. Bids for facilities at specific locations will likely have an address or GPS coordinates that can be used to tie those proposals to locations on the map.

6.1.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

GIS. The Geology and Petroleum Department is utilizing GIS to manage information regarding geology data and petroleum contracts.

6.1.5 Computing Infrastructure

All staff in these Sections have access to a PC and basic Office applications. The MoESTPU has a dedicated Information Technology (IT) unit.

6.1.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the MoESTPU and PUC:

- The MoESTPU and PUC will not be producers of much original geospatial or related data, but will be a major user of data from other original sources;
- The exception to the above is the seismic and well data that is currently licensed through a commercial company which may constrain redistribution by the Ministry. However, there is likely information that can be isolated from those that are of specific commercial interest to the petroleum industry that can be used for other purposes such as the borehole data from the upper strata that will be useful for groundwater analysis, and topographic and bathymetric data along seismic lines that can be used to refine existing digital elevation models. Boundaries of existing contract areas will also be important information for other users for cadastral and land use planning purposes;
- GIS can provide a strong foundation for the development of a "Belize Sustainable Energy Atlas". This could provide an important and innovative basis for the development of a diversified energy framework strategy for the Country;
- The use of GIS by the PUC is highly dependent upon the development of capacity to capture and manage data systematically within each of the involved utilities;

7 MINISTRY OF FORESTRY, FISHERIES AND SUSTAINABLE DEVELOPMENT

7.1 Department of Forestry

Person(s) Interviewed: Perceival Cho, PhD, Forest Officer frm@ffsd.gov.bz

Interview Date(s): 20 June, 2014

7.1.1 Organization and Mission

The Forest Department fosters Belize's economic and human development by effectively enforcing relevant policies and regulations for the sustainable management of its natural resources through strategic alliances and efficient coordination with relevant stakeholders

The Chief Forest Officer reports directly to the Chief Executive Officer and the Minister on all aspects related to the Forest Department. The CFO is supported by a team of Forest Officers whom, also assist in the supervision of the range offices. The Forest Department, in order to be more effective and efficient in carrying out its many obligations, has been organized in a programmatic approach. This has given rise to the following programs that form the Forest Department:

1. Protected Areas Management Program;
2. Forest Resources Planning and Management Program;
3. Forest Revenue and Exploitation Control Program;
4. Law Enforcement Program;
5. Wildlife Program;
6. National and International Partnership Program;
7. Manage National Herbarium.

Each of the above program areas has special relevance to GIS and the BNSDI, as outlined in sections following.

7.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

7.1.2.1 Protected Areas Management Program

The role of the Protected Areas Management Program (PAMP) is the management of the 38 of the 45 protected areas under the Forest Department's mandate. These are defined into five categories which include Nature Reserves, Forest Reserves, National Parks, Natural Monuments, and Wildlife Sanctuaries. Management is achieved through the enforcement of the National Park System Act of 1981. The program through strategic alliances and coordination guarantee the sustainable management of our natural resources. Co-management agreements are established with CBOs and NGOs to install management presence and encourage participatory local stakeholder in management.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Maintain mapped inventory of all protected areas and the resources and infrastructure within them
- Develop conservation and landscape management plans for protected areas
- Participate in EIA review and approval process;
- Monitor activities and performance of co-management agreements within protected areas
- Monitor changes in land use, land cover and infrastructure development within areas around protected areas that may impact them
- Conduct socioeconomic studies and surveys of populations related to protected areas, and develop education and outreach programs to encourage stewardship behavior
- Assess potential impacts to protected areas from climate change
- Provide online access to mapped information about protected areas for education, awareness and tourism purposes
- Provide access to protected area data services for use by research scientists and students

7.1.2.2 Forest Resources Planning and Management Program

The Forest Resources Planning and Management Programme operates under the overall theme of Sustainable Forest Management which refers to an ecosystem-oriented management approach that takes into account the environmental, silvicultural, economic, and social aspects of forest management. The goal is to foster healthy forests which provide for the wise use (conservation) of timber and non-timber resources, wildlife, soil, water and biodiversity, tourism and recreation without undermining their availability and quality for present and future generations.

The primary legal mandate for the Forest Resources Planning and Management Programme is Forest Act and the Forest Rules which sets out the activities that are permitted in any forested area and the procedures necessary to carry out those activities. The program administers the issuance of ***Long-term Forest Licenses (LTFLs)***. LTFLs are contractual agreements between

the Government of Belize, the representative agent being the Forest Department, and a logging company. The agreement allows for the extraction of trees for conversion into timber following strict conditions for environmental compliance and sustainable management. If these conditions are not met then several sanctions may be imposed on the logging company, including the revocation of the license. The Department currently maintains a database of ***Forestry Leases*** in shapefile format indicating a point location within each forestry plot. This is linked to an ***MS Access*** database containing basic information regarding each plot.

One of the conditions require that the logging company produce a ***Sustainable Forest Management plan*** (SFMP), which acts as a comprehensive guide to the sustainable management of that the particular license area. It should take into consideration all the environmental idiosyncrasies of the area for optimum management for a term of the contract which ordinarily spans thirty to forty years. Every year thereafter they are required to submit an Annual Plan of Operations (APO) which details their activities for that particular logging year and all provisions being made to ensure compliance with license conditions and the approved SFMP guidelines. It recently implemented a monitoring and evaluation project to assess the level of compliance with license conditions and is in the process of refining the way in which these licenses are administered.

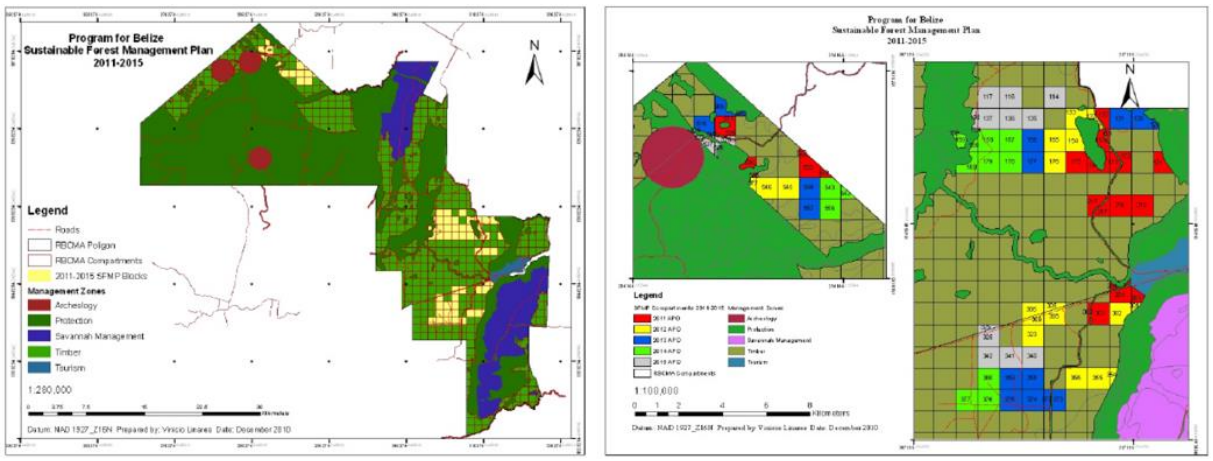

Figure 40 - Typical Mapped Information in a Sustainable Forest Management Plan

As part of the preparation of an SFMP, timber companies must prepare detailed ***Timber Stock Surveys*** for representative areas. This includes the mapping of every tree above a certain trunk diameter in a 1000 ha. Area. This survey also includes the recording of any other features that may affect timber production include archaeological sites and other factors.

The Belize Private Forests Act, Chapter 217, Revised Edition 2000 indicates that the taking of any mahogany or cedar tree on private land requires a permit from the Ministry. It also states that the taking of any mahogany or cedar tree over 2 feet girth during the clearance of land for agriculture does not require a permit unless it is to be sold as timber.

The Forest Department is planning to undertake a complete forest inventory starting in 2015. This will include the consolidation and integration of multiple timber lease database files that

were created since 2007, and the updating and refinement of both tabular and geospatial information. The Department also plans to develop a standard for future applications that will require information in digital, GIS-ready form based on UTM/NAD27 Datum. In the past the Department used to provide the forest inventory information to the MNRA LIC on a regular basis. This practice was discontinued over time due to staff shortages and other priorities. The Department would like to revive the practice especially if this can be complemented with access to other relevant information needed to evaluation forestry plans, including but not limited to soils, slope, land use, surface hydrology, and other relevant information.

RapidEye high resolution satellite imagery was acquired under the Regional REDD Program in Central America and the Dominican Republic. The Program functions under the direction of the Central American Commission on Environment and Development (CCAD) - the environmental branch of the Central American Integration System (SICA). The programme receives support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) funded by the Federal Republic of Germany through the Federal Ministry for Economic Cooperation and Development (BMZ).

The imagery includes 65 tiles each covering 15 sq. km. Each tile is approximately 250 MB and is available for use across government. This imagery is currently being used with IDRISI software to derive land cover mapping for the area covered, utilizing remote sensing classification that is refined using Existing Forest Cover GIS data to help in the classification process. This work is to be completed by the end of 2014.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Record and track forestry lease areas and associated planned production information;
- Participate in EIA review and approval process;
- Monitor changes in forest land cover using aerial or satellite imagery and correlate this to planned production;
- Identify illegal logging;
- Support permit application review, monitoring and enforcement;
- Support development of national forest inventory;
- Provide access to reference information from other organizations (cadastral, environmental, population census, land use, mining and petroleum leases, etc.) to support assessment and monitoring activities;
- Manage Sustainable Forest Management plans in GIS format.

7.1.2.3 Forest Revenue and Exploitation Control Program

The Forest Revenue and Exploitation Control Program (FREC) is charged with the responsibility of assessing royalty payments due to the Government by logging companies and individual loggers. The program charges royalties based on a Royalty Schedule that can be found in the Forest Rules and Forest Act.

Loggers are billed per unit of resource extracted (volume, individual tree or seedling tree, or number of bush sticks etc.), and prices vary with the species of tree or plant being extracted. Any movement of any extracted resource must be approved and proof of approval is by way of possession of a valid permit or way bill that allows the person to move forest produce during the hours of 6:00 am and 6:00 pm. Movement of forest produce outside this time and without a permit or way bill is illegal and perpetrators are subject to prosecution. Another control point for the FREC program, particularly with regards to medium and large scale logging, is the stamping of logs with certified Forest Department hammers. Each log should bear two hammered marks, one bearing a numbered symbol as shown below and the other being the registered symbol of the logger/logging company. Logs that have not been stamped in this manner are being transported illegally. The program is responsible for administering petty-permits and NTFP permits for non-timber forest produce extraction.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Monitor extraction and revenue by specific area;
- Monitor land cover change and correlate to planned extraction locations and rates to identify any illegal activity;
- Estimate potential sustainable forestry revenues based on national forest inventory.

7.1.2.4 Law Enforcement Program

The Law Enforcement Program may be best described as a cross-cutting initiative with the program being the single coordinating focal point, but the objectives are achieved via the concerted efforts of all Forest Department personnel irrespective of their portfolios.

Law Enforcement at the Forest Department entails prosecuting persons suspected of forest offences and educating the general public about what is legal and what is illegal within the scope of the Laws of Belize as it relates to forests and forested areas. The Department carries out various proactive operations such as patrols in the forest reserves and other protected areas to deter the presence of Xatero's and illegal immigrants who exploit the forest resources of Belize. Many of these operations are in collaboration with National Security personnel such as the Belize Defense Force and the Special Patrol Unit (SPU) of the Belize Police Department. Illegal activities are perpetrated by both local Belizeans and non-nationals, and reducing the severity of these activities is something that requires consistent and coordinated planning and implementation by Forest Department personnel and other relevant stakeholders such as co-managers of protected areas and logging companies.

The program is headed by a Forest Officer with the support of all other Forest Department personnel and the Belize Defense Force and the Police Department of Belize.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Provide Ministry staff with access to activities within forest areas that have been permitted by other organizations (mining, agriculture, settlement, etc.);
- Monitor land cover change relative to permitted extractions and other approved activities to help identify areas of potential offences;
- Utilize location-aware social media for reporting of potential offences by the public;
- Record and track infractions and associated enforcement actions;
- Share all of the above information among the relevant stakeholders;
- Build awareness of monitoring and enforcement actions to deter would-be offenders.

7.1.2.5 Wildlife Program

The Wildlife Program enforces regulations for the sustainable management and protection of wildlife, and works to improve the publics' appreciation of wildlife and its role in the environment. The Wildlife Program is charged with the responsibility of protecting wildlife from hunting and other extractive activities.

These responsibilities are carried out through the establishment and enforcement of regulatory legislature. The wildlife program works with other Non-Government Organizations (NGOs) towards the rehabilitation, relocation, and/or eventual release of wildlife.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Record and track wildlife by habitat;
- Utilize social media to identify potential wildlife infractions;
- Record locations and data concerning infractions including follow-up and status;
- Track hunting licenses and permitted takings.

7.1.2.6 National and International Partnership Program

The National and International Partnership Program was established to provide assistance to the Department's and country's efforts to fulfil obligations under the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and other environmental agreements relevant to the Forest Department, by lending technical support to the National Focal Points of these Conventions.

The program also identifies and mobilizes resources available to Belize for mainstreaming associated activities, and serves as the liaison within the Department to foster networking at the national and international levels, all aimed at the building the institutional and technical capacity of the Forest Department.

The National and International Partnership Program is presently operating as a shadow program that has no Program Manager or scheduled program activities. However there are several initiatives under the portfolio of different programmes that follow the intent of the National and International Partnership program. For instance the Sustainable Land Management Project is being executed by the Forest Department, and the Tri-national project comes under the direction of the Protected Areas Management Program. There are also several national projects under the auspices of Forest Department Programmes such as the Panthera Project being overseen by the Law Enforcement Programme.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Record, monitor and report all features, habitats, species and activities related to various conventions and treaties;
- Access geospatial data of others that may relate to the above.

7.1.2.7 Manage National Herbarium

A Herbarium is a collection of preserved dried plant samples, well documented, mounted, labelled and systematically classified for use in scientific study. The National Herbarium was developed through the Forest Planning Management Project in 1996. It holds approximately 18,000 specimens. This collection provides an excellent coverage of the Belizean Flora. It contains 155 Families, 1,219 Genera, and 3,049 Species of plants.

It also contains 84 type specimens collected by William A. Schipp between 1929-1935. These include 2 Holotype specimens and 82 Isotype specimens.

One staff of the Forest Department oversees the management and upkeep of the herbarium. The National Herbarium is used primarily in plant identification and it also vital in providing assistance in research to students and as well the public.

Areas of this function that can be supported through GIS and the BNSDI include, but are not limited to the following:

- Provide a map interface indicating the location where each herbarium specimen was collected;
- Link geographic locations with database, imagery and scientific reference material for each specimen;
- Provide habitat maps indicating the range where each type of plant can be found.

7.1.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting DOE functions at present:

Long-term Forest Licenses (LTFLs) Case Files. LTFLs are contractual agreements between the Government of Belize, the representative agent being the Forest Department, and a logging company. The agreement allows for the extraction of trees for conversion into timber following strict conditions for environmental compliance and sustainable management.

Forestry Lease Location Database. The Department currently maintains a database of Forestry Leases in a digital shapefile format indicating a point location within each forestry plot. Coordinates are in UTM/NAD27 coordinate system and datum. This is linked to an MS Access database containing basic information regarding each plot.

Sustainable Forest Management plan (SFMP). SFMP's must be produced by forestry companies as a comprehensive guide to the sustainable management of that the particular license area. It should take into consideration all the environmental idiosyncrasies of the area for optimum management for a term of the contract which ordinarily spans thirty to forty years. Every year thereafter they are required to submit an Annual Plan of Operations (APO) which details their activities for that particular logging year and all provisions being made to ensure compliance with license conditions and the approved SFMP guidelines.

Timber Stock Survey. As part of the preparation of an SFMP, timber companies must prepare detailed Timber Stock Surveys for representative areas. This includes the mapping of every tree above a certain trunk diameter in a 1000 ha. Area. This survey also includes the recording of any other features that may affect timber production include archaeological sites and other factors.

Tree Felling Permits for Private Lands. The Belize Private Forests Act, Chapter 217, Revised Edition 2000 indicates that the taking of any mahogany or cedar tree on private land requires a permit from the Ministry. It also states that the taking of any mahogany or cedar tree over 2 feet girth during the clearance of land for agriculture does not require a permit unless it is to be sold as timber.

RapidEye Satellite Imagery. RapidEye is a 5 meter Satellite Imagery product from Blackbridge LLC. With a constellation of five Earth Observation satellites, the RapidEye constellation images over 4 Million square kilometers of Earth every day, and has amassed nearly 3.0 Billion square kilometers in its archive in just two years of commercial operation. With an unprecedented combination of wide area repetitive coverage and five meter pixel size multi-spectral imagery, RapidEye is an obvious and cost-effective choice for many industries and government agencies. This imagery is well suited for land use and land cover analyses as well as large area monitoring projects. Any projects that would benefit from near real-time services would be well served by the RapidEye constellation of satellites. The collections occur at 11:00 am local time (daily off-nadir, every 5.5 days at-nadir).

7.1.4 Existing Systems

All staff in the Forest Department have access to a PC. The ICT infrastructure is maintained by the Ministry.

Microsoft Access. This is the primary database management system in use by the Forest Department.

ArcGIS. ESRI's ArcGIS software is used to view forestry permit location information in Shapefile format.

IDRISI. IDRISI is an integrated geographic information system (GIS) and remote sensing software developed by Clark Labs at Clark University for the analysis and display of digital geospatial information. IDRISI is a PC grid-based system that offers tools for researchers and scientists engaged in analyzing earth system dynamics for effective and responsible decision making for environmental management, sustainable resource development and equitable resource allocation.

7.1.5 Other Issues, Opportunities and Constraints

The following additional issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Need for detailed topographic information that is not currently available in Belize was expressed.

7.2 Department of Environment

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Erwin Jimenez, Data Manager jimenez70@gmail.com

Interview Date(s): 20 June, 2014

7.2.1 Organization and Mission

The Department of the Environment (DOE), within the Ministry of Forestry, Fisheries and Sustainable Development, is responsible for fostering the prudent use and proper management of the natural resources of Belize, the preservation, protection and improvement of the environment and the control of pollution, thus guaranteeing a better quality of life for present and future generations.

The DOE was formed in September 1989, became functional in 1991 and was legally established in 1992 by the enactment of the Environmental Protection Act (EPA).

The main objectives of the DOE are:

- To foster an appreciation for the natural environment of Belize and the importance of a healthy environment in the pursuit of the social and economic well-being of all Belizeans;
- To identify the major environmental problems confronting Belize and to work towards the solution of these problems;
- To assist and work in close partnership with project proponents in ensuring that their projects are both environmentally and technically sound through the implementation of Government's Environmental Impact Assessment requirements;
- To have an effective compliance monitoring programme aimed at ensuring compliance with Belize's Environmental Laws;
- To continue the development of a functional process for strong intra/inter-ministerial and inter-sectoral cooperation which is essential in addressing environmental issues;
- To work closely with local, regional and international agencies and organizations on environmental issues; and
- To develop and promulgate new regulations and standards for the prevention and control of pollution aimed at ensuring a greater and healthier quality of life for all Belizeans.

The Department's major tasks are to recommend priorities among environmental programs and to assist in achieving international cooperation in dealing with environmental problems. Some strategies of the Department are centered on:

- Strengthening the coordination of environmental activities between government and non-government organizations.
- Promoting environmental planning for key areas of development such as the coastal zone, islands and tourism sites.
- Facilitating public participation in environmental issues.
- Establishing, upgrading and maintaining information systems to store data and other information on the environment so as to facilitate planning and monitoring.

The Department of the Environment works closely with other government agencies to ensure that environmental concerns are considered in all development plans. Passage of the 1992 Environmental Protection Act mandated that the DOE be vested with authority to oversee the nation's environmental matters. These include matters concerning urbanization, mining, petroleum development, agriculture, and aquaculture among others.

To fulfill its mandate and ensure protection of and rational use of Belize's natural resources, the Department of the Environment is currently focusing on five major areas, each of which has relevance to GIS and the BNSDI:

- Environmental Law & Policy Unit;
- Public Awareness/Information Management Unit;
- Environmental Enforcement/ Compliance Monitoring Unit;
- Project Execution Unit;
- Project Evaluation/EIA Unit.

The DOE maintains approximately 23 full time positions. This includes 19 technical and 4 administrative staff.

The specific functional areas carried out by these programs that have special relevance to GIS and the BNSDI include the following:

1. Develop and manage environmental policies
2. Administer environmental impact assessments
3. Conduct environmental monitoring and enforcement
4. Manage environmental projects
5. Conduct environmental awareness and outreach

7.2.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

7.2.2.1 Develop and Manage Environmental Policies

The DOE is involved in advising the Government of Belize on policies relating to environmental matters and review and revise, as necessary, existing environmental legislation regulations as well as strengthening their enforcement.

The major functions of the Policy and Standards Unit are to analyze environmental data and information gathered by the Public Awareness and Information Unit to develop appropriate Plans and Policies for recommendation to the Government; to manage all International Environmental Conventions and Protocols applicable to Belize; to continuously review and analyze the effectiveness of environmental law and policy and make recommendations for their improvement; and to prepare draft of new legislation and amendments to current legislation governing the functions of the Department.

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Monitor the affects and impacts of existing legislation as related to environmental issues;
- Identify and analyze alternative policy and regulatory scenarios;
- Monitor, assess and align government agencies' plans, programmes and activities that affect the environment;
- Define and analyze alternative recommendation scenarios for national policies and standards to promote improvement in environmental quality to meet the conservation, social, economic, health and other goals of Belize;
- Assess and define environmental program priorities;

- Help to shape environmentally sustainable projects to be funded through international funding agencies;
- Provide geographically-enable method for coordinating among Department units (Project Evaluation & EIA Unit, Public Awareness and Information, and the Enforcement and Monitoring Unit);
- Support management and compliance with all International Environmental Conventions and Protocols for which Belize is a Party or is contemplating becoming a Party, including assessment of benefits and costs of commitments. Specific existing International Initiatives, Environmental Laws and Conventions include:
    - C.C.A.D. (Central American Commission on Environment and Development – organization responsible for the regional environmental agenda in Central America);
    - Montreal Protocol. The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion;
    - BASEL Convention. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDC's).
    - Biodiversity. The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has three main goals: a)conservation of biological diversity (or biodiversity); b)sustainable use of its components; and c)fair and equitable sharing of benefits arising from genetic resources
    - Prior Informed Consent (PIC) Convention. The PIC procedure, along with information exchange, is one of the key provisions of the Rotterdam Convention. The PIC procedure is a mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of those chemicals listed in Annex III of the Convention and for ensuring compliance with these decisions by exporting Parties.
    - C.L.C. Convention. The International Convention on Civil Liability for Oil Pollution Damage, 1969, renewed in 1992 and often referred to as the CLC Convention, is an international maritime treaty that was adopted to ensure that adequate compensation would be available where oil pollution damage was caused by maritime casualties involving oil tankers (i.e. ships that carry oil as cargo).
    - Draft Legislation for the activation of the C.L.C. 1992 Convention and the Fund Convention.

- Cartagena Convention. The Cartagena Convention seeks to promote regional cooperation towards the protection and sustainable development of the Wider Caribbean Region.
- Land Base Source of Marine Pollution.
- O.P.R.C. Convention. International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) is an international maritime convention establishing measures for dealing with marine oil pollution incidents nationally and in co-operation with other countries.

- Track and monitor national and regional environmental issues as part of assisting the CEO in achieving international cooperation.

7.2.2.2 Administer Environmental Impact Assessments

An Environmental Impact Assessment (EIA) is a planning tool that promotes environmentally sound development practices. It examines both the adverse and beneficial environmental consequences of a project design on human health and the natural and cultural environment, and ensures the development of mitigation measures to address these consequences during project development.

The environmental legislation of Belize requires that any project or activity which may have significant impact on the environment may be required to carry out an EIA and following the rules as set out in the Environmental Impact Assessment Regulations and its Amendment of 2007. The role of the DOE is to examine and evaluate EIA's and risk analysis and make suitable recommendations to mitigate against harmful effects of any proposed action on the environment and ensure that the Government's Environmental Clearance Process is implemented for all environmentally sensitive projects.

EIA's often result in the preparation of an Environmental Compliance Plan (ECP) that spells out the compliance conditions that must be met by the project owner as a condition of project approval by the DOE.

The major function of the Project Evaluation/EIA Unit and its 4 staff is the implementation of the Department's environmental clearance process, with respect to project proposals, programs, activities and undertakings requiring environmental screening, to ensure that the environmental implications associated with these activities are adequately addressed. In addition, the unit is also responsible for the development of an on-going Public Awareness Program on the EIA Procedures; the coordination of evaluation/assessment studies required improving implementation of the EIA Procedures; and the establishment of close working relationships with other public agencies, the private sector and the non-governmental organizations.

EIA Case Files are presently maintained in paper form. These are referenced in ***DOE Project Database*** which is a digital MS Access database with details concerning each project reviewed by the DOE. This database has information regarding approximately 1750 projects

containing about 25 columns of information for each project. The paper case files have all the information used in processing each project. A Project Database includes GPS coordinates that if not provided by the applicant are collected by the DOE staff when they visit the site, using a handheld Garmin. Geographic points are collected in UTM zone coordinates win NAD27 datum.

Environmental Compliance Plans (ECP's) and EIA's since 2010 have been scanned and these are made available online, in addition to the hardcopy documents that are placed in local libraries for public access. These documents prior to 2010 are only available in hardcopy form.

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Record and track EIA locations;
- Support analysis of EIA's by the National Environmental Appraisal Committee (NEAC);
- Conduct initial assessment of project location and scope to help determine whether an EIA is required or not;
- Support the development of Environmental Compliance Plans (ECP's) for projects that have been granted environmental clearance by the NEAC;
- Monitor, assess and refine EIA criterial and regulations;
- Assess individual and cumulative environmental impact of development, industrial and all other activities that may have significant impact on the environment;
- Record, track and monitor permitted projects and activities;
- Provide public with information regarding EIA's and their significance as a planning tool and for safeguarding public safety and welfare;
- Provide geographically based information and visualizations to support public hearings;
- Provide information access to other agencies to support strengthening of intra and inter-ministerial cooperation and coordination;
- Provide information and tools to support EIA training;
- Provide environmental baseline and analytical tools to support environmental planning for key areas such as Coastal Zone, islands, and proposed tourism, residential and industrial sites;
- Record and track approved project locations;
- Record and track locations of companies or individuals involved in the preparation of EIA's in Belize;
- To conduct and coordinate investigations, studies, surveys and research on issues related to the state of the environment and issues impacting ecosystems in Belize;
- Monitor projects that have been granted environmental clearance.

7.2.2.3 Conduct Environmental Monitoring and Enforcement

The Environmental Compliance Monitoring and Enforcement Unit of 4 staff is responsible for ensuring compliance with the Environmental Protection Act and subsequent regulations and regulate matters potentially hazardous to the environment by establishing and enforcing standards for pollution control. The functions of this unit are primarily centered on the enforcement and coordination of enforcement of environmental standards and monitoring compliance with those standards. In addition, the unit's function is also dedicated to conducting compliance monitoring of the environmental conditions contained in environmental compliance plans as well as other projects granted environmental clearance by the Department of the Environment and those contained in other licenses and permits issued by other agencies.

This Unit maintains an ***Environmental Complaint Log*** in paper form. Complaints will often be submitted over the phone and each is recorded on paper and an entry is made to a complaint log. If the complaint is related to a specific project, then the notes will be cross-filed to the two different paper file locations. Complaint locations most often use an address or community name.

The Unit is also involved in emergency response activities including marine spills and other toxic release situations. DOE is working with the National Emergency Management Organization (NEMO) towards the development of a new ***Oil Spill Contingency Plan*** for Belize. There is a previous plan form the early 2000's and updates that were added in 2008 and 2011. The plan will include mapping of environmental resources at risk, environmental sensitivity index (ESI) mapping, locations of response assets, and other such information, part of which will be recorded in GIS.

It is also interested in the transport of hazardous materials and ensuring that this is done safely. A ***Pollution Release and Transfer Registry (PRTR)*** system is under development by CITO to support this function.

The DOE has developed an ***Online Processing of Application Licenses (OPAL)*** system that is used to capture information about each environmental license.

The DOE maintains a ***Registry of Wastes and Emissions Database*** in MS Access. This was created originally in 2004 but has not been maintained.

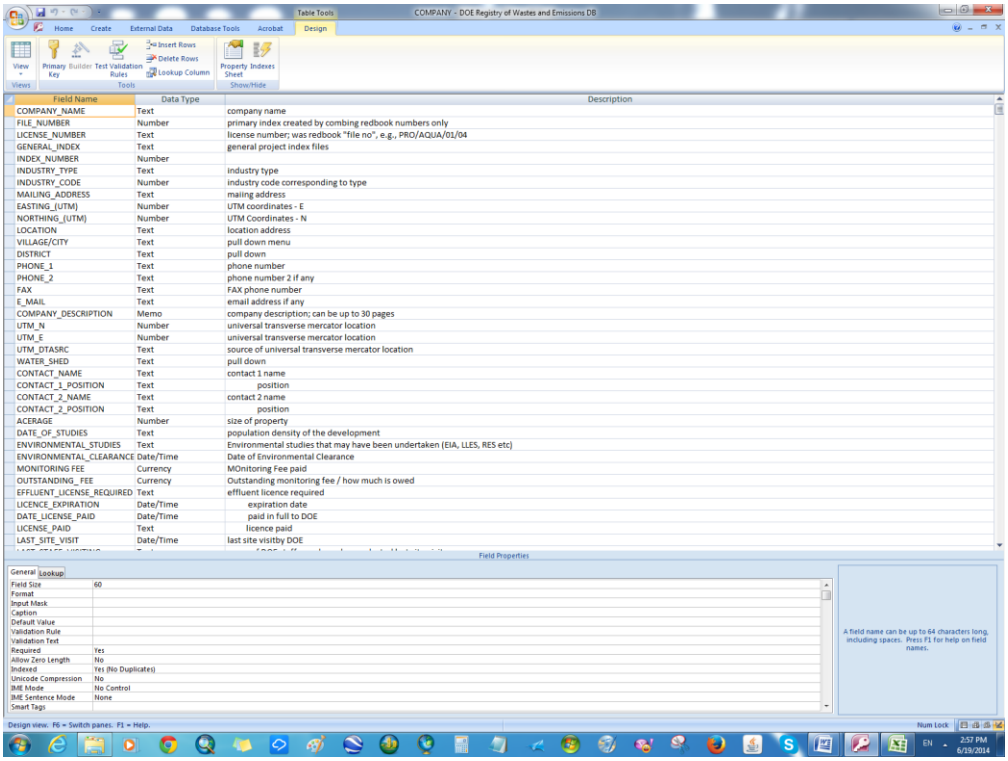

Figure 41 - DOE Registry of Wastes and Emissions

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Track locations of environmental permits and inspections;
- Route and track environmental inspection activities;
- Monitor, collect, and analyze effluent and other pollutants;
- Maintain a register of all wastes, discharges, emissions, deposits or other sources of emissions or substances that are of danger or potential danger to the environment;
- Undertake surveys and investigations into the causes, nature, extent, and prevention of pollution and generate reports of the investigations;
- Identify and monitor areas for pollution cleanup and resource recovery improvements;
- Georeference environmental complaints;
- Track violation tickets, stop orders and abatements notices by location;
- Conduct place-based surveys on environmental matters;
- Assess environmental hazards, vulnerabilities and resources at risk;
- Prepare and assess contingency scenarios for environmental emergency response;
- Conduct assessment of individual and cumulative development environmental impacts on land, sea and air;
- Record and monitor Environmental Compliance Plans (ECP's) for existing and new projects;
- Prepare environmental maps and geographic visualizations to support public

awareness and education.

7.2.2.4 Manage Environmental Projects

The DOE coordinates all activities for projects being executed under the Department to ensure their successful implementation and work closely with reputable international organizations to enhance environmental prospects for Belize.

Projects information is currently maintained by the DOE in paper case files. There are currently over 400 files that are filed sequentially by category. There is no case file librarian, thus every officer is responsible for filing their own information. A project reference number is established with the initial submittal, and this number is then used by all involved as a common reference.

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Project area assessment and formulation;
- Project design;
- Project management and reporting;
- Project monitoring and evaluation.

7.2.2.5 Conduct Environmental Awareness and Outreach

The DOE is involved in educating the public on environmental matters through public education campaigns and district outreach activities, in order to encourage community based environmental planning and enforcement of regulations. The major functions of the public awareness and information management unit includes the promotion of the environmental programs of the Department of the environment and the management of the environmental information necessary in ensuring proper environmental planning, monitoring and evaluations for the other units within the department and for other organizations. In this respect, this unit provides the EIA preparers, researchers, decision-makers and the general public with the necessary up-to-date technical and scientific information through a library service.

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Support environmental education with access to current and historical environmental information and geographic visualizations of environmental issues;
- Provide public with access to environmental information in a form that can be easily understood by lay audience;
- Prepare environmental analyses to support state of environment reporting and symposia presentations;

- Generate environmental maps and graphics for the press and public awareness campaigns, presentations and speeches;
- Support EIA public hearings and consultations with environmental issue data visualizations;
- Maintain access to related data maintained by other organizations through the BNSDI;
- Maintain georeferenced bibliographic information;
- Maintain information regarding environmental conditions, trends and projections;
- Monitor and assess changes in the natural environmental systems and analyze drivers and pressures that are causing these changes;
- Monitor and assess the cumulative impact of permitted emissions;
  Continuously Review The Adequacy Of Existing Data Management Systems And Data Bases;
  Upkeep And Maintain The Department's Information System And Equipment;
- Provide supporting material for national activities relative to international environmental days of recognition (e.g. World Environment Day, Earth Day, Ozone Day, International Beach Clean-Up Day, etc.);
- Utilize geospatially enabled social media and other media to facilitate two-way exchange of information with the public concerning environmental issues and conditions;
- Track and monitor the locations and characteristics of community-based and civil society environmental planning, monitoring, enforcement and assessment activities;
- Support the preparation of annual state of the environment reporting and planning;
- Monitor, assess and track environmental complaints from the public.

7.2.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting DOE functions at present:

DOE Project Database. The DOE Project Database is a digital MS Access database with details concerning each project reviewed by the DOE, inclusive of 25 columns of information. GPS coordinates collected using handheld Garmin GPS in UTM/NAD27 coordinate system are included within the fields.

Environmental Impact Assessments (EIA) Case Files. Paper case files are maintained for each project EIA processed by the DOE. These contain all the information and correspondence for the project and EIA.

Environmental Impact Assessments (EIA's). The environmental legislation of Belize requires that any project or activity which may have significant impact on the environment may be required to carry out an EIA and following the rules as set out in the Environmental Impact Assessment Regulations and its Amendment of 2007. EIA documents since 2010 are scanned and made available online.

Environmental Compliance Plans (ECP's). Environmental Impact Assessments (EIA's) often result in the preparation of an Environmental Compliance Plan (ECP) that spells out the compliance conditions that must be met by the project owner as a condition of project approval by the Department of Environment (DOE). ECP documents since 2010 are scanned and made available online.

Environmental Complaint Log. The Department of Environment (DOE) maintains an Environmental Complaint Log in paper form. Complaints will often be submitted over the phone and each is recorded on paper and an entry is made to the complaint log. If the complaint is related to a specific project, then the notes will be cross-filed to the two different paper file locations. Complaint locations most often refer to an address or community name.

Registry of Wastes and Emissions Database. The DOE developed a Registry of Wastes and Emissions Database in MS Access. This was created originally in 2004 but has not been maintained.

7.2.4 Existing Systems

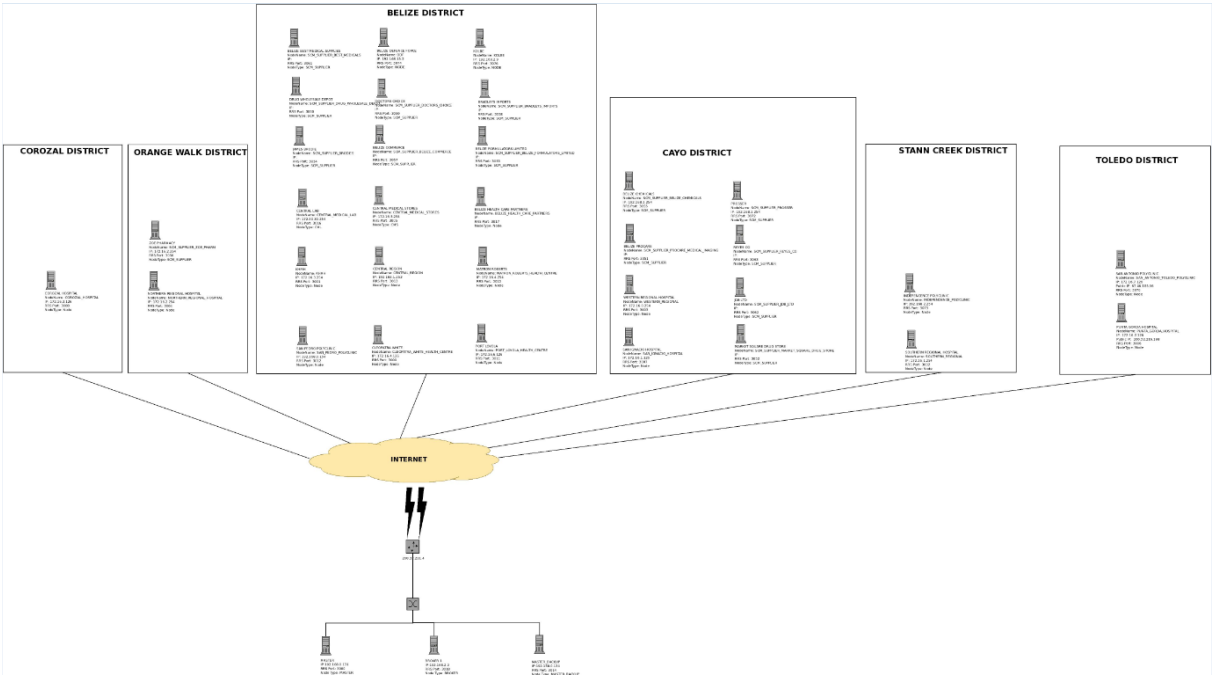

Figure 42 - DOE Computing Infrastructure Diagram

All staff in the DOE have access to a PC. These are all connected to a central server and there is a drive for each unit. The Heads of Units have access to each other's databases on the separate drives. The ICT infrastructure is maintained by the Ministry in cooperation with CITO.

Pollution Release and Transfer Registry (PRTR). The Belize PRTR Online Reporting System is an internet database designed to provide the community, industry and government with information on the types and amounts of 101 pollutants being emitted to air and water as

well as on-site and off-site transfers of waste and of pollutants in industrial effluents. Here you can learn about PRTR's, receive up to date news on the progress being made with Belize's PRTR and find informative links and documents.[34]

The DOE has developed an **Online Processing of Application Licenses (OPAL)** system that is used to capture information about each environmental license.

7.2.5 Other Issues, Opportunities and Constraints

The following additional issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Raw data collected by consultants to support EIA's are owned by the project sponsor and there is no requirement to submit that information to the government;
- There are no data standards or guidelines associated with EIA preparation at present, although this is being planned for implementation within the next year.

7.3 Department of Fisheries

Person(s) Interviewed: Desk study (agency review requested)

Interview Date(s): 12 September, 2014

7.3.1 Organization and Mission

The mission of the Fisheries Department is to provide the country and people of Belize with the best possible management of its aquatic and fisheries resources, with a view to optimize the present and future benefits through efficient and sustainable management.

The Fisheries Department is organized to the following units:

Capture Fisheries. The Capture Fisheries Unit is the arm of the Department that is responsible for providing the necessary legislative and management interventions to facilitate the continued development and proper management of Belize's marine fisheries resources. In 2004, important resource assessment exercises were carried out on the lobster, conch, shrimp and West Indian Topshell welk.

Aquaculture Resource Mobilization and Education (ARME). The ARME guides the overall mission for aquaculture development by guiding the development of a competitive aquaculture industry while at the same time maintaining the viability of the environment and providing responsible stewardship for inland fisheries resources of the

[34] http://www.prtr.doe.gov.bz/

nation as well as the ecosystems that support them. This is carried out to provide sustainable benefits for Belizeans of present and future generations.

Ecosystem Management Unit (EMU). The EMU manages the country's marine reserves, conducts marine environmental assessments, manages CITES marine related matters and regional fisheries policy formulation. The Unit applies an "ecosystems management" approach, representing a shift from the protection of specific species and sites to the protection of entire ecosystems and the regulation of activities within those systems. The marine reserves comprise a set of Fisheries Management Tools (FMT) implemented by the Department to ensure sustainable fishing.

Administration and Support Unit (ASU). The ASU is the support arm of the Department that is tasked with responsibility for license issuance, revenue collection, human resources, accounts, purchase, stores and security.

Conservation Compliance Unit (CCU). The CCU is responsible for patrolling the national waters of Belize ensuring that the fisheries laws of the country are adhered to.

High Seas Unit (HSU). The HSU regulates the issuing of vessel licenses and ensures that all vessels on the high seas comply with the international conservation and management regulations.

The Units outline above carry out a variety of activities that have some relevance to the use of GIS and the BNSDI:

1. Conduct fisheries assessments;
2. Prepare marine reserve management plans;
3. Manage marine protected areas.

7.3.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

7.3.2.1 Conduct fisheries assessments

The Department is involved in conducting or overseeing fisheries assessments to determine the status and health of commercial species and as input to fisheries policies and practices. Examples include the following:

Spiny Lobster Assessment (2010). The Department undertook a study in 2010 with the support of the Marine Fisheries Institute of Iceland of the status of the Spiny Lobster (*Panulirus argus*), one of the most commercially important fishery resource in Belize. This study involved several activities that are relevant to the use of GIS and the BNSDI.

Areas within this function that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Conduct fish habitat and population studies
- Monitor fish catch statistics and trends by location over time
- Monitor fish habitat and population statistics over time
- Provide fisheries assessment data and recommendations to policy makers in maps and statistical graphics that me the issues and remedies understandable and compelling
- Maintain inventory of fisherman, fishing infrastructure, and fish markets

7.3.2.2 Prepare marine reserve management plans

The Department is responsible for overseeing and the development and adoption of marine reserve management plans for key protected areas. These are generally conducted within the parameters of the Coastal Zone Management Plan (CZMP – 2014) and the framework required by the National Protected Area Policy and System Plan (NPAPSP, 2006). Each plan includes general information on the physical and biological attributes of the reserve, documents the current uses and management problems, defines the goals and objectives of the marine reserve, summarises conservation planning, outlines specific management programmes, including the zoning plan, sets in place the means for measuring reserve effectiveness, and recommends an implementation schedule.

GIS and BNSDI functions that are relevant to this activity includes, but is not limited to the following:

- Provide a map representation of the general context for each marine reserve;
- Provide a mapped database of critical habitats;
- Provide a mapped database of existing marine and terrestrial ecosystem resources and services;
- Provide a mapped database of human settlements and infrastructure;
- Provided a mapped database of touristic facilities, resources and services;
- Provide a mapped database of commercial facilities and activities;
- Provide a mapped database of climatic conditions;
- Provide a mapped database of historic storm tracks and impacts;
- Provide a mapped database of geologic, soils and geophysical features;
- Provide a mapped database of topographic and bathymetric information;
- Provide a mapped database of tides, waves and currents;
- Provide a mapped database of sea bottom types;
- Provide a mapped database of plant and animal species observations;
- Provide access to fish catch and fisheries trend information;

- Provide a mapped database of previous research activities;
- Provide a mapped database of archeological sites;
- Conduct conservation issue, opportunity and constraint analysis;
- Conduct conservation suitability assessment;
- Identify and analyze alternative management scenarios;
- Delineate and record conservation use zones;

7.3.2.3 Manage marine protected areas

Belize has 13 marine protected areas, administered by two Government authorities - the Fisheries Department (Department of the Ministry of Agriculture and Fisheries) and the Forest Department (Ministry of Natural Resources) - in partnership with a number of co-management agencies (large NGOs - the Southern Environmental Association, Toledo Institute for Development and Environment, and Belize Audubon Society – and smaller community-based organizations – Sarteneja Alliance for Conservation and Development and Friends of Swallow Caye).[35]

The Fisheries Department has the mandate to sustainably manage and develop Belize's fishing sector, under the Fisheries Ordinance (1948, revised in 2000), and complimented by the Fisheries Regulations of 2004. Under this, the Protected Area Management programme falls under the Ecosystems Management Unit, through which the Fisheries Department establishes and manages the eight Marine Reserves.

GIS and BNSDI functions that are relevant to this activity includes, but is not limited to the following:

- Develop and manage marine protected areas boundary maps
- Participate in EIA review and approval process
- Prepare patrol and marine protected area surveillance plans
- Monitor human activities within and around marine protected areas
- Issue and track violation notices
- Utilize remote sensing techniques to detect illegal activities

7.3.2.4 Participate in regional marine protection and fisheries initiatives

PREPAC. The PREPAC project was a project funded by the Taiwanese Government, through SICA OSPESCA for Central America. The project entailed the identification of inland water bodies within the various countries and selection of one as a case study. Belize identified the New River Lagoon for which characterization of the lagoon was made. Activities on the second phase include the collection of socio-economic, physical, biological and environmental data of the lagoon. This information will form the basis for the formulation of a management plan for the New River Lagoon, which will in turn assist in the formulation

[35] http://www.fisheries.gov.bz/

of a Continental Fisheries and Aquaculture Management Plan for the Central American Isthmus.

The Mesoamerican Barrier Reef System (MBRS). The MBRS Project is funded by the Global Environment Facility (GEF) and the Governments of Belize, Guatemala, Honduras, and Mexico. The project is implemented by the World Bank and is executed by the four countries through the Central American Commission on Environment and Development (CCAD) of the System for Central American Integration (SICA). The MBRS project is being executed by the Project Coordinating Unit (PCU) on behalf of CCAD, with headquarters in Belize City, Belize. The Mesoamerican Barrier Reef System Project goal is to enhance protection of the unique and vulnerable marine ecosystems comprising the MBRS, and to assist the countries of Mexico, Belize, Guatemala and Honduras to strengthen and coordinate regional policies, regulations, and institutional arrangements for the conservation and sustainable use of this global public good. The MBRS Project assist in training for staff in monitoring, for fisheries in alternative livelihoods, and finances to conduct monitoring such as SYNOPTIC Monitoring for corals, sea grass, mangroves and fish.

Caribbean Regional Fisheries Mechanism (CRFM). The Caribbean Regional Fisheries Mechanism is a project opened to the governments of Caribbean Countries with headquarters in Belize City. The vision of CRFM is “To promote sustainable use of fisheries and aquaculture resources in and among Member States, by development, management and conservation of these resources in collaboration with stakeholders to benefit the people of the Caribbean region.” The project has various projects such as: CFRAMP which is aimed at promoting sustainable utilization, conservation and management of the fishery resources of member countries. The ACP-EU Fisheries Project, "Strengthening of Fisheries and Biodiversity Management in ACP Countries", which was initiated in late 1997 and has the participation of the Bahamas, the Dominican Republic, Haiti and Suriname, in addition to the twelve CARICOM countries

The ***"Integrated Caribbean Regional Agricultural and Fisheries Development Program - Fisheries Component"*** (CARIFORUM), funded by the European Union under Lome IV, which is intended to augment the efforts of CFRAMP and extend it to the other four CARICOM countries, namely Bahamas, Haiti, Dominican Republic and Suriname. Implementation of this project commenced in August of 1999.

GIS and BNSDI functions that are relevant to this activity includes, but is not limited to the following:

- Develop and maintain portions of regional marine databases within Belize territorial waters
- Conduct special studies
- Develop and manage data in support of regional collaborative efforts (e.g. Mesoamerican Barrier Reef System (MBRS) study.
- Develop and disseminate methods and tools for use of GIS for marine protection and fisheries management

- Participate in regional marine ecosystem monitoring and assessment

7.3.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting DOE functions at present: No additional information provided.

7.3.4 Existing Systems

All staff in the Forest Department have access to a PC. The ICT infrastructure is maintained by the Ministry.

No additional information provided.

7.3.5 Other Issues, Opportunities and Constraints

The following additional issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Need for detailed topographic information that is not currently available in Belize was expressed.

7.4 Department of Climate Change

Person Interviewed: Ms. Ann Gordon, National Coordinator

Interview Date: 8 April, 2016

7.4.1 Organization and Mission

Note: This is a follow-up interview that was conducted more than one year later than others in this report, recognizing the important current and future role that this office will play in the utilization of the BNSDI in regards to climate-smart development. During the intervening period there was an administrative re-structuring of the government that changed the configuration of several Ministries, including the Ministry of Forestry, Fisheries and Sustainable Development. At the time of this writing, the National Climate Change Office is now within the newly formed Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development.

The National Climate Change Office (NCCO) within the Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development is responsible for overseeing and orchestrating efforts to mainstream Climate Change into its national development processes and mechanisms. The NCCO is responsible for overseeing the development and implementation of the "National Climate Change Policy, Strategy and Action Plan to

Address Climate Change in Belize (NCCPSAP)[36], coordination with multiple sectors in terms of climate change planning, mitigation, adaptation and public awareness and communications, and providing secretariat support to the National Climate Change Committee (NCCC). The Ministry serves as the National Focal Point for Climate Change and has the responsibility for the coordination and implementation of Climate Change policies and measures with respect to the fulfilment of the country's obligations under the UNFCCC, and fulfilling this responsibility is supported by the NCCO.

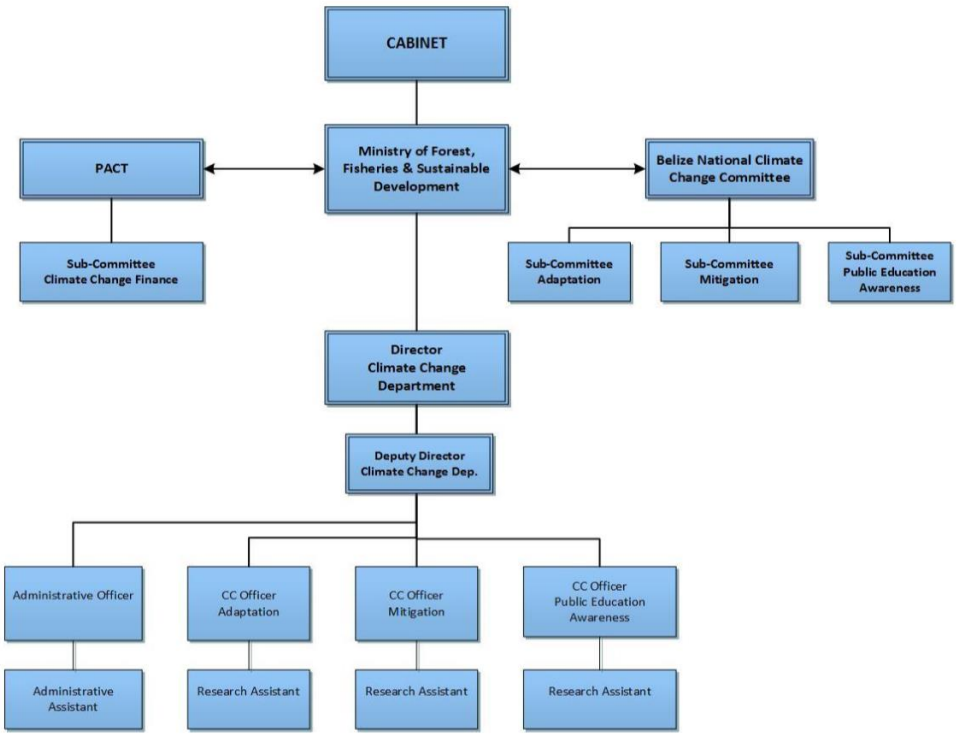

Figure 43 – Proposed Organigram

Figure 1 above is the proposed organization structure for the NCCO within the framework of the Ministry and in support of the Belize National Climate Change Committee and the Cabinet. While the intended organization, roles and responsibilities for the NCCO have been defined, they have not yet been fully operationalized. In the meantime, the office carries out priority functions with a limited staff of four persons, including 1 National Coordinator, 1 Climate Change Officer, 1 Project Manager and a Project Assistant (out of approximately 13 planned) with periodic technical support from other organizations. When fully operational, the NCCO will be responsible for overseeing and orchestrating the full extent of the NCCPSAP.

Prior to the adoption of the NCCPSAP the Government of Belize had issued no formal, overarching, national policy in respect of Climate Change mitigation and adaptation. In 2008, a draft Adaptation Policy was developed but was never finalized or adopted. However, since the publication of its First National Communication to the UNFCCC, the GOB has sought, through several line ministries, to

[36] A NATIONAL CLIMATE CHANGE POLICY, STRATEGY AND ACTION PLAN TO ADDRESS CLIMATE CHANGE IN BELIZE, Caribbean Community Climate Change Centre Lawrence Nicholas Building Ring Road Belmopan, Belize, 2014

initiate policy-based activities, at the sector level, to address (adapt and mitigate) the impending impacts of Climate Change. Some of the key policy initiatives undertaken to date are as follows:

- Integrated Coastal Zone Management Plan (2013)
- Ministry of Energy, Science, Public Utilities, Transport, Communications and National Emergency Management, Strategic Plan 2012-2017and Sustainable Energy Action Plan for BelizeIntegrated Water Resource Management Policy,
- Growth and Sustainable Development Strategy 2016-2019,
- The National Climate Resilience Investment Plan (2013)

The country has also embarked on a number of initiatives to review sector policies, legislation and other initiatives which will address issues of adaptation and mitigation in sectors which are most vulnerable to the impacts of Climate Change. These initiatives include the:

- Marine Conservation and Climate Adaptation (MCCA) project for Belize
- Management and Protection of Key Biodiversity Areas

In addition, other initiatives are being pursued towards the development of policies and project initiatives to address adaptation and mitigation in other sectors. These are as follows:

- National Agriculture Sector Adaptation Strategy and Action Plan to Address Climate Change in Belize (completed February, 2015)
- The National Adaptation Strategy to Address Climate Change in the Water Sector in Belize
- Readiness Preparation Proposal (R-PP) to the Forest Carbon Partnership Facility (FCPF)
- Opportunities for Climate-compatible Tourism Development in Belize

7.4.2 Activity Areas

The following provides an overview of the activities associated with the NCCO and NCCPSAP that are most relevant to GIS and the BNSDI in Belize. This is described in two parts. The first characterizes the assessment of vulnerability in each of the key identified sectors. The second part is based on the planned activities that are specified in the NCCPSAP. This is seen as providing the most comprehensive picture of the GIS and BNSDI support that will be required as the NCCO evolves to carry out its function as envisioned in the NCCPSAP. These activities are described in the context of each of the key sectors that are expected to be most affected by Climate Change, and the priority actions to be taken within each.

7.4.2.1 Provide Secretariat Support to the Belize National Climate Change Committee (BNCCC)

The NCCO provides secretariat support to the Belize National Climate Change Committee (BNCCC). The Committee is tasked with advising the government on its responsibilities under the UNFCCC as well as to orchestrate the implementation of appropriate policies and strategies to ensure continued sustainable development in Belize. The Committee includes the following members:

- Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development – (**Chair)**

- Ministry of Finance, Public Service, Energy and Public Utilities
- Ministry of Economic Development, Petroleum, Investment, Trade and Commerce **(Vice Chair)**
- Ministry of Health (NHI, Primary Health Care)
- Ministry of Works, Transport and NEMO
- Ministry of Tourism and Civil Aviation
- Representative from the Private Sector (Chamber of Commerce) **(Vice Chair)**
- Representative from NGO/CBO Umbrella Group (APAMO)
- Representative from the University of Belize

The adopted Terms of Reference for the BNCCC are listed in the following table along with identification of how GIS and the BNSDI can support each, where relevant:

TOR Function	GIS and BNSDI Relevance
The development of an integrated national policy, a strategy and action plan for climate change. These must take into consideration Belize's exposure to the negative effects as well as the opportunities arising from climate change.	▪ National spatial assessment of climate change related hazards and opportunities ▪ National spatial mapping of populations, facilities and infrastructure that can be impacted by climate change ▪ National assessment of populations, facilities and infrastructure vulnerability to climate change impacts ▪ National carbon accounting system
The development of national positions on climate change issues. This shall include participation in and leadership of the national climate change development processes; the United Nations Framework Convention on Climate Change (UNFCCC), including the Conference of the Parties and its subsidiary bodies and other organs; and participation in other international and regional fora.	▪ National climate-smart geographically based accounting and performance management system to support international reporting and communications
Adopt and give effect to a strategy to ensure that climate change is mainstreamed into national development plans and policies and is fully integrated within government's national budget;	▪ Integration of national climate-smart mapping within plans across all sectors ▪ Monitor and assess climate-smart performance and adaptive management over time
Review and advise government on the capacity building, institutional and other resource requirements needed to fully implement the strategy and action plan;	▪ Provide climate-smart geographic and statistical portal with data and tools needed to support sector-based planning and awareness building
Develop and maintain a register of all climate change related projects, programmes and research activities in Belize.	▪ Maintain a map-supported registry of all climate change related projects, programmes and research activities
Participate in and monitor resource mobilization efforts, focusing on accessing resources to support Belize's economic and social development programs, and implementation actions for the national action plan, on the local, regional and international levels.	▪ National climate-smart geographically based accounting and performance management system to support international reporting and communications
Coordinate the preparation and presentation of national	▪ National climate-smart geographically based

communications and other legally mandated documentation to the UNFCCC to ensure compliance with the Convention;	accounting and performance management system to support international reporting and communications
Facilitate Belize's effective participation in the Convention and its mechanisms and other bilateral and multi-lateral programs and activities	▪ National climate-smart geographically based accounting and performance management system to support international reporting and communications
Establish sub-committees and other entities to assist with the implementation of these Terms of Reference;	▪ Support sub-committee works with geospatial and statistical analysis and reporting
Any other tasks or activities within the framework of the Convention and which are designed to support the implementation of the national climate change program.	▪ As applicable
The BNCCC will recommend evaluation processes to ensure that Belize is meeting its goal and objectives on the UNFCCC.	▪ National climate-smart geographically based accounting and performance management system to support international reporting and communications

The NCCO is actively supporting the works of the Committee but is not directly utilizing GIS or other information technology systems to do so. Technical support and resources are sometimes provided by the Caribbean Community Climate Change Center (5C's) and the MNRI Land Information Center (LIC).

7.4.2.2 Provide Secretariat Support to the BNCCC Mitigation Sub-Committee

The NCCO provides secretariat support to the BNCCC Mitigation Sub-Committee. The adopted Terms of Reference for the sub-committee are listed below followed with identification of how GIS and the BNSDI can support each, where relevant:

- Prepare work plan including a timeline for achieving key issues
- Facilitate the development of programmes containing measures to mitigate climate change, include looking at barriers and opportunities for mitigation, strategies to integrate mitigation measures into national development priorities, and the preparation of mitigation projects for funding.
- Facilitate the development of effective low emission development strategies;
- Provide guidance to the Nationally Appropriate Mitigation Action (NAMA) Approval process;
- Provide guidance to the Nationally Determined Contribution (NDC) process;
- Provide guidance to the Clean Development Mechanism (CDM), and other market mechanisms;
- Review technical documents of projects and provide feedback;
- Suggest technical capacity building capacities and participate in sub-regional, regional and international training on mitigation related activities.
- Establish technical expert group to perform specific tasks. Technical expert group may include: technical experts in greenhouse gas inventory, technology needs assessments, clean development mechanism and other market mechanism, reducing emissions from

deforestation and forest degradation, forest conservation, sustainable forest management and enhancement of forest carbon stocks (REDD+).

GIS and BNSDI functions that could support this activity area include:

- Use of national climate change vulnerability and opportunity mapping to support prioritization of government programs and investments;
- Utilize spatially-enabled national carbon accounting system to identify, prioritize and measure the effectiveness of low emission development strategies;
- Provide geographic and statistical mapping and analysis for input to NDC and CDM mechanisms;
- Utilize National Climate Smart development portal to support project review and guidance;
- Utilize National Climate Smart development portal to support awareness, education and capacity building within all relevant sectors.

7.4.2.3 Provide Secretariat Support to the BNCCC Public Education Sub-Committee

The NCCO provides secretariat support to the BNCCC Public Education and Outreach Sub-Committee. The adopted Terms of Reference for the sub-committee are listed below followed with identification of how GIS and the BNSDI can support each, where relevant:

- Facilitate Knowledge Attitude and Practice (KAP) process to obtain baseline information on level of awareness
- Facilitate the Development of a Climate Information Management system
- Develop and implement effective public education, information and awareness campaigns on disaster risk reduction and climate change targeting youths and general public

GIS and BNSDI functions that could support this activity area include:

- Utilize National Climate Smart development portal to support awareness, education and capacity building within all relevant sectors and the public.
- Identify areas of potential high climate change impacts relative to local populations to help in building community-specific climate awareness and education programs;
- Track and report the location of area specific climate awareness and education programs.

7.4.2.4 Conduct Vulnerability Assessments

A national vulnerability assessment was carried out to identify what areas of the country will be most affected by climate change and variability and to determine how these changes may affect key sectors of the economy. This study was necessarily carried out at a very general level utilizing various scenarios and predictive models in regards to major expected disruptions including precipitation, flooding and drought, temperature, sea level rise, and

storm surge events. These were used to identify the types of potential impacts on each sector. More detailed assessments have been carried out within various specific studies, and eventually it will be required to carry out more detailed spatial analysis and planning that can be used to guide area-specific mitigation and adaptation projects and programs. NCCO staff mentioned that in particular the topography information available in Belize today is too coarse to support community specific analyses.

The following summarizes the area of impact expected within each priority sector. This is used here as a basis for identifying the types of spatial analysis functions where GIS and the BNSDI could support more detailed assessment and planning:

Sector Impacts	GIS/BNSDI Relevance
Agriculture ▪ Higher temperatures will favour some crops like rice however, economically important crops in Belize such as sugarcane and citrus will be adversely affected. ▪ Warmer weather resulting from high temperatures will cause soil aridity, lead to proliferation of pests and diseases, and put pressure on water resources for water irrigation purposes. ▪ Rain-fed agricultural production will be affected, demanding improved management techniques and consequently increasing the cost of production. ▪ Sea level rise will cause saline intrusion and soil salinization. ▪ The combined impact is low agricultural yields, decrease in food production and higher food prices	▪ Geographically detailed analysis of all climate change hazards across Belize ▪ National agriculture census and crop/livestock estimation ▪ National assessment of current and future water resources and irrigation infrastructure ▪ Sea level rise analysis and hazard assessment ▪ Detailed national agriculture vulnerability assessment
Forestry ▪ Increase in the intensity of storms and hurricanes will negatively impact forestry resources, including flora and fauna ▪ Changes in climatic, hydrologic and soil conditions could lead to changes in the composition of natural vegetation. ▪ Extreme weather events (hurricanes and storms) cause uprooting of trees, and loss of commercial value and revenue ▪ Increased overall aridity could exacerbate drought potential over the long term, thus causing habitat loss and contributing to decline and death in some tree species. ▪ Increases in pests and diseases (bark beetle) and forest fires	▪ National land use and land cover mapping of forest resources and habitat ▪ Climate variability projections, including local microclimate ▪ Assessment of forest areas susceptibility to damage from hurricanes and major storms ▪ Identification of areas that may be subject to drought in the future ▪ Identification of forest areas that may be subject to stresses that will increase their potential susceptibility to pests, diseases and forest fires.
Fisheries & Aquaculture ▪ Rising sea level will adversely impact on fish habitat including wetlands, coral reefs and sea grasses where fish spawn, breed, feed and or grow to maturity.	▪ National inventory of fish habitats, wetlands, coral reefs and other habitats and breeding grounds ▪ Monitoring of near surface water temperature and acidification ▪ Monitoring of fish populations

▪ Rising near-surface water temperature and increasing acidification may cause massive bleaching and dieback of corals. ▪ Decrease in fish production ▪ Damage to and losses in aquaculture	▪ Monitoring of habitat condition ▪ Damage assessment of fisheries and aquaculture resources following major storm events
Coastal & Marine ▪ Sea level rise will lead to increased erosion, loss of beaches ▪ Damage to valuable infrastructure, increased inundation, loss of agricultural lands and crops, coastal wetlands, mangroves sea grass beds and ecosystems, and displaced coastal communities. ▪ Flooding and marine inundation ▪ Saline intrusion into freshwater lenses ▪ High temperature will result in loss of coral reefs and reduction in fish stock	▪ Beach erosion monitoring ▪ National inventory of critical infrastructure and communities ▪ Assessment of critical infrastructure vulnerability to climate change impacts ▪ Damage assessment following major storm events ▪ Terrestrial and marine flood inundation risk assessment ▪ Identification of areas of freshwater resources susceptible to saline intrusion ▪ Monitoring of marine temperatures
Tourism ▪ Climate Change, along with sea level rise, would result in loss of beaches, properties and public infrastructure, and result in a decrease in aesthetics and a loss of attractiveness of the destination. ▪ Coastal areas in Belize will experience high levels of saltwater intrusion and rising water tables, thereby reducing water quality, driving up the cost of water ▪ Higher temperatures will discourage older visitors, because of their susceptibility to heat stress. ▪ Tropical storms and hurricanes, compounded by sea level rise, are also likely to increase in intensity, size and duration, causing flooding and damage to transport and other infrastructure. ▪ Decrease in tourism arrivals could ultimately result in loss of employment for large numbers of persons who are currently employed in the tourism sector.	▪ National inventory of tourism resources and infrastructure ▪ Assess vulnerability of tourism resources and infrastructure to saltwater intrusion ▪ Assess vulnerability of tourism resources and infrastructure to increased storm activity ▪ Assess potential disruption to touristic facilities and associated impacts on local employment and community economies
Human Health ▪ Climate Change will lead to higher levels of some air pollutants, will lead to an increasing number of extreme weather events and increased outbreaks and transmission of diseases through unclean water ▪ Higher temperature will increase the spread of vector diseases. ▪ Higher temperatures will also cause heat stress and will also lead to psychological stresses. ▪ Decrease in rainfall will affect potable water supply	▪ National monitoring of air pollution ▪ Monitoring and assessment of macro and local climate events and trends ▪ Monitoring and assessment of potable water resources
Human Settlements ▪ Increase in frequency and intensity of storm surge will cause more flooding and disrupt or destroy coastal settlements. ▪ Increase in frequency and intensity of storm surge and extreme rainfall will cause damages to infrastructure from flooding and erosion. ▪ Damage to transport facilities (roads, ports,	▪ Storm surge and flooding hazard analysis ▪ Assessment of the vulnerability of existing critical infrastructure and human settlements to storm surge and flooding damage and disruption ▪ National inventory of the location and characteristics of health and safety infrastructure ▪ Assessment of the vulnerability of existing health and safety infrastructure to storm surge and

airports) ▪ Damage to public facilities (water supply, energy generation) ▪ Damage to health and safety infrastructure ▪ Damage to cultural assets	flooding damage or disruption ▪ National inventory of important cultural assets ▪ Assessment of the vulnerability of existing important cultural assets to storm surge and flooding damage
Water Resources ▪ Less rainfall combined with increase in temperature will result in increased evapotranspiration and loss of available surface water. ▪ Changes in the hydrological cycle will decrease water levels and adversely impact on the generation of hydropower. ▪ Decrease in precipitation will reduce groundwater and aquifer recharge. ▪ As an effect, available water resources will be reduced	▪ National inventory, monitoring and assessment of water resources ▪ Assess vulnerability of hydropower potential to changes in hydrologic cycles ▪ Monitor precipitation trends and impacts on groundwater resources
Energy ▪ Increasing use of fossil fuels increase the amount of GHG emissions into the atmosphere. ▪ The demand for electricity is likely to increase as a response to rising temperatures and a demand for air-conditioning, and among increasing populations ▪ Oil price fluctuations and consequent fluctuations in costs of production of electricity; and ▪ Changes in the hydrological cycle will decrease water levels and adversely impact the generation of hydropower	▪ National monitoring of GHG emissions ▪ Monitor and assess temperature changes and impacts on electricity consumption ▪ Monitor and assess impacts of oil price fluctuations on electrical service costs and potential community impacts ▪ Monitor and assess the impact of hydrologic cycle changes on hydropower resources

The vulnerability assessment carried out for the development of the NCCPSAP was conducted by the project consultant firm with inputs from various sources and experts in Belize. The following summarizes the various analyses and data sources involved that have some implication for the BNSDI program:

Meteorological Historic Data. The historical data used to define the climate in Belize was provided by the National Meteorological Service of Belize and came from a set of sixty-six (66) stations scattered across the country. The period of observations varied widely for the different meteorological elements at the various stations. For example, some of the stations which recorded rainfall had data series beginning as early as 1912 while rainfall data collection for a few of the other stations began only in the late 1970s. Further, although all the stations recorded rainfall, only a handful recorded the other atmospheric elements.

Climate Change Projections Data. The climate change projection data used in the development of the NCCPSAP are mostly the result of the regional downscaling performed by the PRECIS model at 25 km resolution, with boundary conditions from the ECHAM5 global climate model (GCM) to generate the higher-scaled resolution and forced by the SRES A1B scenario. Further very high-resolution model downscaling was also performed using the Direct Area Downscaling (DAD)

model (Charlery and Nurse, 2010). The DAD model allows the development of very high-resolution downscaling in small domains such as watersheds, islands and where observed data is not regular or standardized. Additional data were extracted from the United Nations Development Programme (UNDP) Climate Change Country Profiles project (McSweeney *et al.* 2008; 2009). This latter dataset provides country- scale data files and multi-model scenario-based projections for several developing countries, including Belize. The dataset makes available observed and modeled climate data for climate impact assessment and exploration by providing observed data and future climate projections modeled using the SRES scenarios in the IPCC Fourth Assessment Report for each country, including Belize, in a standard format (Meehl *et al.,* 2007; McSweeney *et al*, 2008, 2010). Projections included:

- Air Temperature
- Rainfall
- Wind Speed
- Relative Humidity

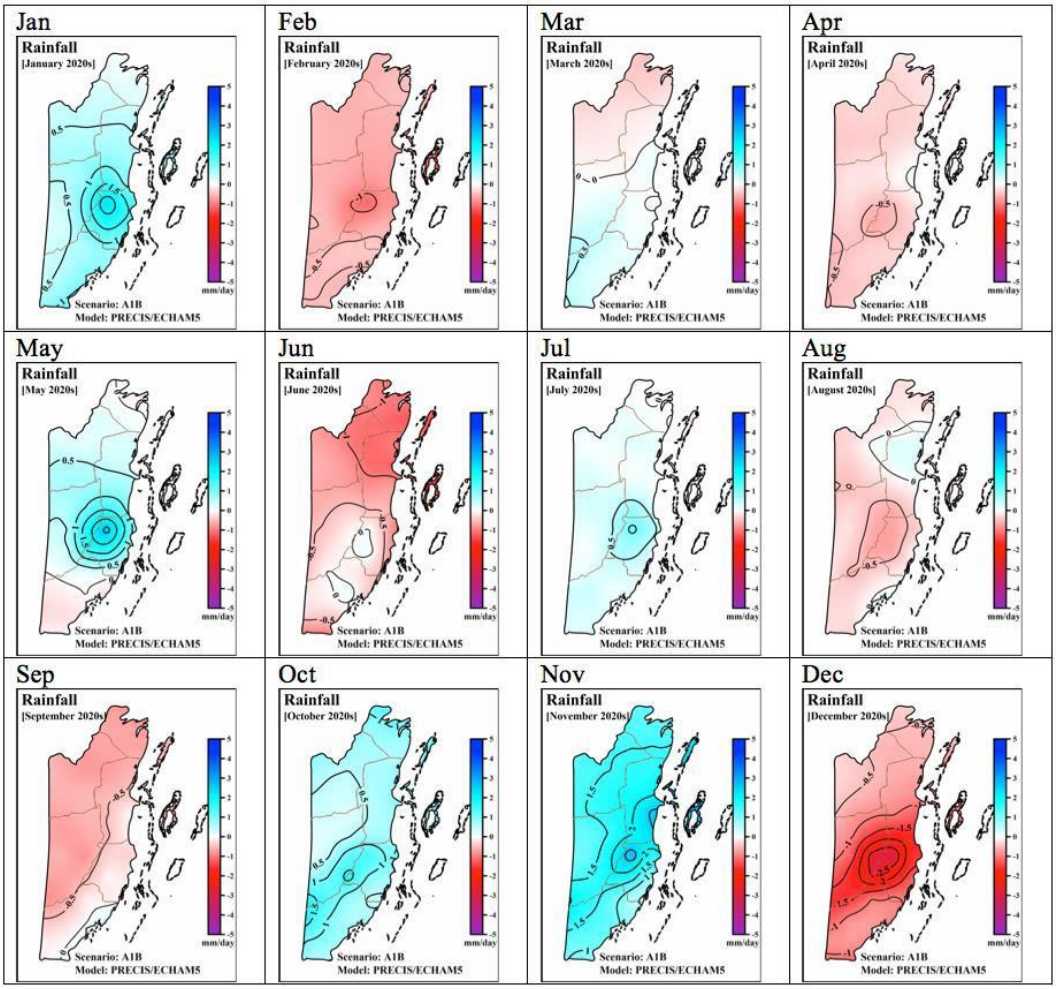

Figure 44 – Example Geographic Outputs of Climate Change Analysis

Sea Level Rise. Data on sea level rise provided for the coastal waters of Belize (Longitude 88oW) by the IPCC reports (IPCC 2007, 2013) were utilized, along with some additional data

for the three Representative Pathways Projection for three scenarios from the Hadley Centre Global Environmental Model version 2 Earth System configuration (HadGEM2-ES).

7.4.2.5 Oversee the Implementation of the National Climate Change Policy, Strategy and Action Plan (NCCPSAP)

The NCCPSAP outlines actions to be taken within each priority sector to optimize climate change mitigation and/or adaptation. The following table lists these actions and identifies those GIS and BNSDI capabilities that could support them.

Sector and Actions	GIS/BNSDI Relevance
Agriculture (crops and livestock) 1. Review national agricultural policies and regulations to ensure the incorporation of Climate Change adaptation and mitigation measures in all aspects of the planning, decision-making and operational processes and related programmes including water resource management, erosion and flood control, soil conservation, drought, agricultural research, livestock, seeds, crops, markets, food security, disaster risk management and technology transfer. 2. Implement soil fertility management mechanisms and soil- water management systems to address soil quality issues. 3. Promote and ensure the use of drought resistant crop development techniques or climate smart agriculture technology and associated water management techniques that will increase yield per unit area. 4. Develop and endorse the use of climate-resilient seeds and livestock breeds that are better adapted to the increased temperatures. 5. Initiate Integrated Pest Management (IPM) practices to keep pests below economic threshold levels in order to minimize risks to human health, organisms and the environment. 6. Promote the reduction of agricultural GHG emissions through: altering crop cultivation methods; implementing effective livestock management that involves changing the feeding practices of livestock; and improved manure management that controls the way in which the manure is decomposed. 7. Strengthen agricultural research and development and improve on the data collection capacity and analysis capabilities of the sector. 8. Facilitate greater public-private initiatives to implement cost-effective measures to address crop	▪ Develop and maintain comprehensive national agricultural resources inventory ▪ Monitor and assess agricultural production conditions and trends ▪ Monitor and assess soil resources and management ▪ Assess and map areas that will be subjected to increased drought and temperatures in the future ▪ Utilize climate change mapping in agricultural planning and extension services ▪ Monitor, assess and respond to agricultural pest outbreaks ▪ Monitor, assess and manage agricultural GHG emissions ▪ Provide training in agricultural data collection, management and analysis ▪ Provide farmers with area specific data and recommendations ▪ Establish comprehensive monitoring and assessment for agricultural early warning system ▪ Map and analyze food security supply chains ▪ Utilize spatial analysis to support agricultural insurance programs

development, livestock production, and improving soil quality in the interest of building resilience to Climate Change. 9. Initiate and enhance community-based agricultural extension services to support Climate Change adaptation . 10. Initiate education awareness programmes to draw attention to the impacts of Climate Change on the sectors and measures to adapt and mitigate those anticipated impacts. 11. Incorporate Early Warning system. 12. Provide support for institutional strengthening of the Ministry. 13. Facilitate Market access for agricultural products and incentives to add value along the production line. 14. Undertake research on the usefulness and applicable models of crop insurance to facilitate and provide recovery from various disasters affecting the agricultural sector	
Forestry Adaptation and mitigation of Climate Change on the forestry sector in Belize are based on the goals and objectives outline in the Draft Forestry Policy as well as those activities contained in the RR-P. Together, they will provide the platform on which a sustainable forestry management, Climate Change mitigation and low carbon development program can be pursued. The RRP proposal which outlines the REDD+ strategy initiatives identified a number of initiatives for the development of the strategy for REDD+. These are as follows: 1. Organize and Consult a. National Readiness Management Arrangements b. Information Sharing and Early Dialogue with Key Stakeholder Groups c. Consultation and Participation Process 2. Prepare the REDD-plus Strategy a. Assessment of Land Use, Land Use Change Drivers, Forest Law, Policy and Governance b. REDD-plus Strategy Options c. REDD-plus Implementation Framework (Institutional Strengthening & Capacity building) d. Social and Environmental Impacts during Readiness Preparation and REDDplus Implementation 3. Develop a National Forest Reference Emission Level and/or a Forest Reference Level a. Design and establishing a reference scenario model in readiness framework b. Develop reference models	▪ Establish and maintain national forest inventory ▪ Establish and maintain national forest reference emission database ▪ Monitor and assess land cover and land use change

c. Conduct Independent assessment 4. Design Systems for National Forest Monitoring and Information on Safeguards a. National Forest Monitoring System b. Designing an Information System for Multiple Benefits, Other Impacts, Governance, and Safeguards Component 6: Design a Program Monitoring and Evaluation Framework	
Fisheries and Aquaculture 1. Develop and Implement management approaches and polices that strengthen the livelihood asset bases, and improve understanding of existing response mechanism to climate variability to assist in planning adaptation. 2. Adopt the new Fisheries Resources Bill and subsidiary regulations that incorporate international principles and approaches which are required for responsible and sustainable fisheries management. 3. Develop policy and plan to conserve and protect sensitive and healthy habitats (mangrove, sea grass, reefs) to improve resilience of main commercial species to Climate Change. Develop Conservation Programmes, Policies and Plans 4. Support mangrove and fisheries conservation and management plans to protect wetlands and sea grass beds for fisheries to become resilient to Climate Change. Encourage diversification in fish species. 5. Enhance marine protected areas of natural significance into climate smart sanctuaries. 6. Develop marine spatial plans, area-based fisheries management approaches, regulated coastal development, and embark on ecosystem rehabilitation. 7. Explore the development of alternative livelihood plans for fishers who are affected by the establishment of restricted fishing measures. 8. Develop an information clearing house to provide regular and accessible public information on Climate Change effects in the marine ecosystems and coastal zone to promote behavior change designed to minimize climate risks in MPAs and replenishment zones. 9. Consolidate and strengthen the MPA system by establishing Fisheries Reserve or expand no - take zone in MPAs. Effective Monitoring 10. Monitor compliance with EIA regulations requirements for coastal mangroves alterations. 11. Conduct annual reef health and fisheries stock assessments. 12. Monitoring biophysical, social, and economic indicators linked to management and policy responses	▪ National inventory of fisheries, fishing communities and supporting infrastructure ▪ National inventory of sensitive and healthy marine habitats supporting fisheries ▪ Identify fisheries, fishing community and fishing infrastructure vulnerability to climate change impacts ▪ Conduct marine spatial planning in support of sustainable fisheries and aquaculture ▪ Maintain map of marine protected areas ▪ Analyze marine protected areas vulnerability to climate change factors

and adopt multi-sector adaptive strategies, such as instituting species specific management plans on fishing seasons, to minimize negative impacts. Conduct further research on marine resources 13. Conduct further research on the vulnerability and sustainability of marine resources to Climate Change. 14. Conduct specie-specific studies (e.g. determine impacts of sea surface temperature and ocean acidification on conch and lobster). Mariculture /Aquaculture 15. Improved feeds and selective breeding for higher temperature tolerance strains to cope with increasing temperatures and shifting to more tolerant strains of molluscs to cope with increased acidification. 16. Undertake integrated water use planning taking into account the water requirements (availability and quality) and social and economic importance of Sector Factors Adaptation Measures fisheries and aquaculture in addition to other sectors. 17. Improve the efficiency of water use in aquaculture operations and other adaptation options; and 18. Strengthen and endorse outputs from the National Water Quality Working Group (develop baseline and monitoring program and identify trends with respect to marine and fresh water fishery).	
Coastal and Marine Resources 1. Increase and strengthen the capacity of the CZMAI to ensure developments within the coastal areas of Belize include an adaptation strategy to mitigate the effects of Climate Change. 2. Implement recommendations in respect of the development of a coastal management plan to ensure proper land use. 3. Develop a programme and acquire equipment to monitor and provide early warning in respect of storm surges. 4. Implement mangrove restoration or sea and river defense structures to prevent coastal erosion. 5. Implement monitoring techniques to assess beach erosion and water quality. 6. Manage further development of the coastline, especially in vulnerable areas such as the Belize and Corozal districts. 7. Inclusion of adaptation strategies in management planning in all coastal and marine areas 8. Undertake restoration projects to increase the coastline resilience to sea level rise. 9. Review and amend the Building Code, especially as it relates to coastal constructions. 10. Revise and streamline the current legislation and policies that relate to the management of the coastal zone to eliminate overlaps and close existing gaps.	▪ Strengthen the GIS technical capacity of CZMAI ▪ Develop and maintain CZMP plan ▪ Monitor and predict storm surge events ▪ Assess areas for potential mangrove restoration and erosions control ▪ Monitor and assess beach erosion ▪ Monitor and assess coastal water quality ▪ Identify and map sensitive coastal habitats ▪ Identify areas vulnerable to sea level rise ▪ Identify areas suitable for sea level rise adaptation ▪ Identify coastal areas susceptible to climate change impacts and ensure these are reflected in land use plans and building codes

Water Resources 1. Design and implement an IWRM programme in watersheds to reduce the impacts of Climate Change. 2. Enhance the protection of water catchment (including groundwater resources) areas and make improvements to the management and maintenance of existing water supply systems, 3. Strengthen the existing Human Resource capacities in the water sector for improved management practice including an improved hydrology and meteorology observation network and data collection 4. Develop Water Conservancy Management Systems including improvements to the management and maintenance of existing water supply systems taking into consideration the: a. protection and restoration of ecosystems and water management infrastructure; b. adoption of forest management plans to prevent and control soil erosion; c. introduction of water harvesting; d. prevention and control of water pollution; and, e. raising awareness to promote the effective and efficient use of water. 5. Conduct water resource assessment (especially ground water). 6. Undertake water policy reform including pricing and irrigation policies, 7. Develop flood controls and drought monitoring. 8. Improve trans-boundary cooperation regarding water resources 9. Strengthen the compliance monitoring capacity of staff in the MFFSD's DOE and other key agencies including provision of equipment and training in thematic areas such as compliance monitoring, use of new equipment, site inspection techniques, environmental audits, interpretation of lab analyses, and water quality monitoring to ensure the critical input to assess the health of the ecosystems therein and ensure long-term ecosystem services.	▪ Develop and maintain GIS capabilities within IWRM programme while also accessing BNSDI data resources ▪ Monitor land cover and land use change within watersheds ▪ Support quality data collection, management and use ▪ Develop and maintain national inventory of water resources and infrastructure ▪ Monitor and assess groundwater assets ▪ Monitor and assess water utilization ▪ Conduct flood hazard assessment ▪ Identify areas that may be susceptible to drought
Land Use and Human Settlements 1. Undertake a comprehensive assessment of human settlements and related infrastructure at risk from the effects of Climate Change, using inter alia, risk mapping and incorporate findings into the National Land Use Management Plan, and into the planning processes of NEMO. 2. Develop strategic land-use and settlements policy to adapt to potential rise in sea level, and integrate with land use, flooding and drainage plans. 3. Build the appropriate infrastructural defences to protect communities from damage caused by flooding and sea level rise.	▪ National inventory of human settlements and related infrastructure ▪ Assess human settlement and infrastructure vulnerability to climate change hazards ▪ Support climate smart spatial planning for human settlements, land use and infrastructure ▪ Analyze alternative defenses, mitigation and adaptation scenarios for human settlements ▪ Identify potential for green infrastructure responses to climate change hazards ▪ Monitor and assess human settlement building and associated land use

4. Improve drainage and sanitation facilities in rural and urban areas. 5. Develop Climate Change infrastructure risk assessment guidelines and methodology. 6. Creation of marshlands/wetlands as buffer against sea level rise and flooding, thereby offering protection to existing natural barriers. 7. Evaluate the feasibility of relocation of vulnerable communities 8. Review and modify housing designs and building codes to climate-proof existing and future housing and other infrastructure. 9. Enforce existing regulations and develop new regulations, which promote good building practices to meet the threat of sea level rise and dangerous storms and hurricanes	
Tourism 1. Undertake a sea level rise vulnerability mapping exercise as part of a revision of the Tourism Master Plans and Land Use Plans. Of particular concern should be assessment of the impacts of Climate Change on specific areas designated for tourism development and sites of historic and cultural importance. 2. Coastal management policies should be reviewed and revised to account for sea level rise and storm surge—with specific attention on regulations related to setback requirements, mangrove and coral reef conservation, beach nourishment, and property decommissioning. 3. Identify coastal tourism areas in Belize that are vulnerable to Climate Change, and which should be prioritized for adaptation actions. 4. Analyse the current policy environment to determine whether pertinent public policies support or undermine sustainable tourism development, ecosystem health/function, and climate adaptation. 5. Develop and implement management strategies for enhancing the resilience of coral to Climate Change for example, by reducing pollution and overfishing through the establishment and demarcation of fish sanctuaries. 6. Acquire and use high-resolution remote sensing data to monitor and evaluate engineering adaptations and support insurance risk assessments. 7. Implement maximum carrying capacity limits for areas that are impacted negatively from excessive human activity, such as mining, engineering and building or re-building operations. 8. Improve infrastructure to facilitate increased access to sites and resources. This includes the paving of roads, renovation of docking facilities for water taxis	▪ Support sea level rise vulnerability mapping ▪ National inventory of tourism locations, facilities and infrastructure ▪ Identify current and potential climate related hazards ▪ Identify and assess vulnerability of tourism locations, facilities and infrastructure to climate related hazards and prioritize for mitigation and adaptation ▪ Monitor and assess climate impacts and trends over time ▪ Monitor and assess tourism activities, impacts and trends ▪ Conduct monitoring and assessment for insurance purposes

and installation of professional signage at critical junctions. 9. Engage communities for the development of responsible tourism practices.	
Human Health 1. Undertake a Climate Change Vulnerability and Capacity Assessment for the health sector a. Assessment of impacts of Climate Change on human health and well being b. Establish baseline conditions by describing the human health risks of current climate variability and recent Climate Change, and the public health policies and programmes to address the risks c. Describe current risks of climate-sensitive health outcomes, including the most vulnerable populations and regions d. Identify vulnerable populations and regions e. Describe risk distribution using spatial mapping f. Analyse the relationships between current and past weather/climate conditions and health outcomes g. Identify trends in Climate Change-related exposures h. Take account of interactions between environmental and socioeconomic determinants of health i. Describe the current capacity of health and other sectors to manage the risks of climate-sensitive health outcomes 2. Improve the capture, management and monitoring of diseases and vectors affected by Climate Change and related forecasting and early-warning systems 3. Increase human resources capacity and improve efficiency 4. Develop education awareness programme to educate population on adaptation measures as it relates to family health and hygiene. 5. Enhance the epidemiology capacity of our health sector to address efficiently epidemics/ outbreaks. 6. Implement community-based participatory approaches to empower local communities to manage disease vectors in an integrated manner and thus increase their capacity to protect their health and climate resilience 7. Improve disease control and prevention; 8. Support capacity-building, including institutional capacity, for preventive measures, planning, preparedness and management of disasters relating to Climate Change, including contingency planning, especially for droughts and floods in areas prone to extreme weather events 9. Promote greater investment in health Infrastructure to ensure increased access of population to improved health care. These could include: a. Retrofitting health facilities and equipment (eg. Mobile Health Clinics, Amphibious Ambulance Services) b. New Building Codes for Health Facilities	

eleven (11) members with three sub-committees (Vulnerability Assessment and Adaptation, Mitigation, and Public Education and Outreach).

7.4.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used, planned and/or generated in the process of conducting NCCO functions:

Meteorological Historic Data. The historical data used to define the climate in Belize was provided by the National Meteorological Service of Belize and came from a set of sixty-six (66) stations scattered across the country. The period of observations varied widely for the different meteorological elements at the various stations. For example, some of the stations which recorded rainfall had data series beginning as early as 1912 while rainfall data collection for a few of the other stations began only in the late 1970s. Further, although all the stations recorded rainfall, only a handful recorded the other atmospheric elements.

Climate Change Projections Data. The climate change projection data used in the development of the NCCPSAP are mostly the result of the regional downscaling performed by the PRECIS model at 25 km resolution, with boundary conditions from the ECHAM5 global climate model (GCM) to generate the higher-scaled resolution and forced by the SRES A1B scenario. Further very high-resolution model downscaling was also performed using the Direct Area Downscaling (DAD) model (Charlery and Nurse, 2010). The DAD model allows the development of very high-resolution downscaling in small domains such as watersheds, islands and where observed data is not regular or standardized. Additional data were extracted from the United Nations Development Programme (UNDP) Climate Change Country Profiles project (McSweeney *et al.* 2008; 2009). This latter dataset provides country- scale data files and multi-model scenario-based projections for several developing countries, including Belize. The dataset makes available observed and modeled climate data for climate impact assessment and exploration by providing observed data and future climate projections modeled using the SRES scenarios in the IPCC Fourth Assessment Report for each country, including Belize, in a standard format (Meehl *et al.,* 2007; McSweeney *et al*, 2008, 2010). Projections included:

- Air Temperature
- Rainfall
- Wind Speed
- Relative Humidity

Sea Level Rise. Data on sea level rise provided for the coastal waters of Belize (Longitude 88oW) by the IPCC reports (IPCC 2007, 2013) were utilized, along with some additional data for the three Representative Pathways Projection for three scenarios from the Hadley Centre Global Environmental Model version 2 Earth System configuration (HadGEM2-ES).

Climate Project Registry Database. The National Climate Change Office (NCCO) plans to develop this database during 2016 to track and monitor climate-smart projects and programs nationally.

7.4.4 Existing Systems

All staff in the NCCO have access to a PC, and these are networked to a central server within the Office. The NCCO had maintained its own server under the previous Ministry and with the move to the new Ministry has maintained this server and local area network connectivity.

The office has reasonably reliable Internet access. The Internet speed is adequate most of the time but occasionally drops to a very slow rate.

The computing infrastructure of the NCCO is being administered and supported by the Ministry.

7.4.5 Other Issues, Opportunities and Constraints

The following additional issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Need for detailed topographic information that is not currently available in Belize was expressed.
- More information regarding the location and characteristics of communities, facilities and infrastructure that may be impacted by various climate change factors and hazards needed.
- Support data collection, management and used.

Develop and maintain GHG Inventory (Note: The NCCO will be responsible for coordinating the collection of data collection and management of the GHG Inventory for its Fourth National Communication in five sectors.: Energy, Agriculture, Forestry, Waste, Industrial processes)

7.5 Coastal Zone Management Authority & Institute

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Maritza Canto, Data Manager mcanto.bz@hotmail.com

Interview Date(s): June 26, 2014

7.5.1 Organization and Mission

The Coastal Zone Management Authority and Institute is a quasi-government entity that comprises two areas with aligned jurisdiction and responsibilities as summarized below.

The ***Coastal Zone Management Authority*** was established under the Ministry of Agriculture, Fisheries and Co-operatives. It is comprised of a Board of Directors appointed by the Minister and a Chief Executive Officer appointed by the Board. The Authority is an autonomous public statutory body charged with the responsibility of implementing and monitoring policies that govern the use and development of the coastal zone in Belize. The major functions of the Authority are:

- Advise the Minister on all matters related to the coastal zone, and on the formation of policies;
- Assist in development of programmes and projects;
- Foster regional and international collaboration;
- Commission research and monitoring;
- In consultation with stakeholders, assist in preparation of development guidelines and review the CZM Plan prepared in accordance with the Act;
- Maintain the national coral reef and coastal water quality monitoring programmes.

The Board can appoint special committees to examine and report on any other matters arising from its functions.[37]

The ***Coastal Zone Management Institute*** is the leading marine scientific research organization in Belize. It is headed by a Director with a technical staff to carry out monitoring and research programmes. The Coastal Zone Management Institute carries out the technical functions of coastal management in coordination with the various agencies involved. The Institute's main functions are to conduct marine research, maintain a data centre, provide information as required by the Authority, organize training courses, support other agencies involved in CZM, maintain coastal monitoring programmes, and to assist with preparation of a national CZM plan. Currently, the Institute is implementing five research and monitoring programmes: Coral Reef Monitoring Coastal Water Quality Monitoring Endangered Species Research focusing on manatee research Coastal Planning Data Analysis An education/public awareness programme is also an important component of the Institute, ensuring that that the public is provided with information on issues affecting the coastal and marine resources.[38]

The Institute was temporarily reduced to skeletal staff between 2005 – 2008. After 2008 the Institute was revived and went through another period of growth to support the development of the National Integrated Coastal Zone Management Strategy for Belize.

The functions carried out by the CZMAI that have particular relevance to the use of GIS technology and participation in the BNSDI include the following:

1. Manage coastal water quality and monitoring programmes;
2. Conduct manatee research;

[37] http://www.coastalzonebelize.org/?page_id=51
[38] http://www.coastalzonebelize.org/?p=116

3. Carry out coastal planning;
4. Develop and support education and awareness programmes;
5. Manage coastal data.

7.5.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

7.5.2.1 Conduct coastal water quality and monitoring programmes

Belize has an intricate coastal zone that consists of coastal plains, coastal lagoons, estuaries, numerous coral islands, the largest barrier reef in the Western Hemisphere and three outstanding atolls (Turneffe, Glover's and Lighthouse). Since 1987, a network of coastal and marine protected areas has been established to preserve the biodiversity of the coastal zone and to ensure sustainable use of the coastal resources. Schematically, it would appear as though the protected areas are in isolation of each other. The reality is that the protected areas are interconnected to the mainland via water and the atmosphere. The biological resources that the protected areas are expected to preserve are highly vulnerable to land-based sources of pollution. The quantity and quality of water entering the coastal zone are critical to the integrity and longevity of the ecosystems upon which we are dependent.

The Water Quality Programme was established in September 1992 under the Coastal Zone Management Project. The programme aims at collecting baseline water quality data for critical areas of the coastal zone. Considering that the value of the coastal zone is currently threatened by land based sources of pollution, the water quality monitoring programme has become necessary to detect pollutants and departures from acceptable water quality norms. The objectives of the Water Quality Programme are: To establish the natural chemical, biological and physical characteristics of the water bodies in the coastal zone of Belize, and to inform decision-making and national policies that promotes sustainable development and viable coastal activities in these bodies while protecting their natural integrity. To accomplish these objectives, ***75 water quality stations*** are strategically designated in the coastal zone of Belize. The stations are monitored once per month for basic physical and physicochemical parameters. Variables monitored in the field include:

- Temperature
- Salinity
- Conductivity
- Dissolved Oxygen
- Turbidity
- PH
- Depth

Water samples collected in the field are analyzed at the CZMAI Laboratory for:

- Nitrates
- Nitrites
- Phosphates
- Chlorophyll A.

Following each monitoring survey, the water quality data corresponding to each monitoring station is uploaded into the ***CZMAI Water Quality Database***. This data is used to generate reports about the coastal water quality.

Personnel of the Water Quality Monitoring Programme collaborate closely with other agencies involved with water quality monitoring such as the Public Health Bureau, Department of the Environment, the Environmental & Social Technical Assistance Project (ESTAP) and Watershed Reef Interconnectivity Scientific Study Project (WRIScS). This collaboration helps in streamlining the functions of the various agencies, avoiding duplication of efforts, enhancing data sharing, and updating water quality information nationally and internationally.[39]

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Develop and maintain inventory of coastal and marine resources;
- Maintain inventory of protected area boundaries and assets;
- Develop baseline water quality information (chemical, biological, physical properties) and subsequent monitoring updates over time;
- Leverage the BNSDI to access relevant data from other agencies;
- Maintain inventory and monitoring of water quality drivers and pressures over time;
- Provide tools for the spatial and temporal analysis of water quality monitoring information over time;
- Provide hydrodynamic analysis tools to better understand the relationships between water quality causes and effects;
- Provide tools for the analysis and visualization of water quality issues in ways that can be clearly understood by a lay audience;
- Provide analysis tools to model the implications of various intervention options (plans, policies, operations, enforcement, etc.);
- Establish location-aware social media channels for two way communication between the coastal water using stakeholders and the government.

7.5.2.2 Conduct manatee research

The Manatee Project of the Coastal Zone Management Authority and Institute began in August of 1996. The project focuses on research, management and education of the

[39] http://www.coastalzonebelize.org/?p=31

endangered Antillean manatee in Belize. The National Manatee Working Group acts as an oversight committee for the project. Committee representation is broad, including government (Forestry Department, Fisheries Department), academia (University of Belize), non-governmental (TIDE), and researchers (CZMAI, Dr. James Powell of Wildlife Trust, USA and Dr. Benjamin Morales of ECOSUR, Mexico). The primary activities of the committee are:

- To oversee the CZMAI National Manatee Project;
- To evaluate all proposed manatee research projects in Belize and provide recommendations to the relevant Ministry;
- To review legislation concerning manatees and provide recommendations to the Ministry. To ensure sound management plans are produced for protected areas.

Manatee population estimation is carried out through aerial survey, the latest of which was carried out in early summer 2014. The CZMAI also radio-tags some animals to be able to track their location and movements over time. GIS is being used to visualize these movements.

The Belize Manatee Recovery Plan is a comprehensive document that outlines a four-year schedule of conservation activities that has been followed. The two goals were 1) to prevent extinction or irreversible decline of the species in the foreseeable future, and 2) to prevent decline of the quality of their habitat.[40]

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Develop and maintain inventory of manatee habitat;
- Develop baseline and maintain manatee population census information over time by location;
- Maintain inventory and monitoring of manatee habitat and population impact drivers and pressures over time;
- Conduct habitat and population trend analyses;
- Track tagged animals spatially to understand movement and migration patterns;
- Provide tools for the analysis and visualization of manatee habitat and population viability issues in ways that can be clearly understood by a lay audience;
- Provide analysis tools to model the implications of various intervention options (plans, policies, operations, enforcement, etc.);
- Establish location-aware social media channels for two way communication between the public and the government.

7.5.2.3 Manage sport fishing program

In September of 2009 new Sport Fishing regulations were passed into law giving the Coastal Zone Management Authority (CZMA) the mandate to issue Sport Fishing licenses and collect

[40] http://www.coastalzonebelize.org/?p=19

Sport Fishing license fees. The new CZMA and new Fisheries legislation that was also signed has brought about the protection of the three main sport fishing species: Bonefish, Tarpon and Permit. These fish are for catch and release only purposes only.

Anglers wishing to go Sport Fishing now have to first get a license from the CZMA. The new regulations will be enforced by the relevant enforcement authorities. The CZMA has looked into the most efficient and widely accessible way of enabling anglers to purchasing a license with the help from many of the stakeholders involved. This ultimately led to providing the ability to buy the fishing license online. Information entered to this online form includes the address of the applicant, including street name and number, Country (international), and District (Belize only).[41]

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Track fishing licenses by licensee address and district
- Provide mobile phone application for voluntary reporting of fish catch information
- Track commercial sport fishing boat activities
- Produce maps and charts illustrating sports fish activities and catch statistics

7.5.2.4 Carry out coastal planning

The Coastal Zone Management (CZM) Institute's Coastal Planning Programme officially came about during the agency's 1990's project life. The scope of work and activities are driven by the programme's objectives and current coastal developmental issues in Belize.

Planning in Belize's coastal zone was once considered a low priority. This was probably due to the inaccessibility, unfriendly physical conditions, low market values and resident population of most coastal areas in the past. Consequently, ad hoc and uncoordinated development management was the status quo. Today however, over 35% of the nation's population resides in more than 23 coastal communities. In addition, tourism has grown tremendously over the past years. For example, traditional tourist arrivals have increased by 139% between 1998 and 2001; furthermore, over 84% of tourists are accommodated in coastal communities. These trends have resulted in increased economic, recreation, development, and resource management activities throughout the coastal zone of Belize. This scenario has demonstrated an urgent need for sound planning and management of Belize's coastal resources. Moreover, this need is considered even more important when the potential deleterious impacts of sea level rise and catastrophic storms, which have devastated lives and economies, are added to Belize's present scenario.[42]

The Belize Barrier Reef stretches 220 km along Belize's shoreline and has earned its place as the second largest unbroken reef system in the world. This worldly acclaim only partially represents the reef's importance, as its role as a critical host to a myriad of marine life is

[41] http://www.coastalzonebelize.org/?page_id=133
[42] http://www.coastalzonebelize.org/?p=14

unparalleled. It is extremely critical to the livelihood of the Belizean populace as it offers great ecological and socio-economic benefits. In 1996, in recognition of both its scientific and aesthetic importance, the World Heritage Site Committee formally adopted a portion of the reef system called the Belize Barrier Reef Reserve System as a World Heritage Site. Despite the reef's importance, as in other countries around the world, it faces serious threats, both natural and more often, human caused. Impacts from these threats are some of the variables that the Belize Coastal Zone Management Authority and Institute attempts to assess.[43]

The coastal zone planning program has undergone two distinct periods. The first period beginning in 1998 was funded by the United Nations Development Programme (UNDP). Following the completion of this activity in 2005 the planning function was reduced to a skeletal staff. In 2010 the planning efforts were revived, now comprising a staff of The Institute has been involved over the past two years in the development of the ***National Integrated Coastal Zone Management Plan for Belize***. The Strategy was completed in 2013 and at the time of this writing was awaiting final endorsement by the Cabinet. The development of the Strategy involved engagement of all the key government and other stakeholders that are involved in the management and/or use of the coastal zone.

The Strategy has four main functions. These are:

- Helping to link the economic potential of the coastal zone with equitable allocation and sustainable use of its resources, while improving the decision-process over the use of these resources;
- Facilitating further appreciation by stakeholders and interest groups of the interdependence between all natural resources and processes, and human interventions in the coastal area of Belize;
- Promoting the scientific understanding that is essential to the setting and maintenance of targets and standards for environmental and natural resources management in the coastal area of Belize;
- Fostering even greater collaboration between all involved parties in the development and management of this complex yet vital national asset.

Enhancement of existing laws, regulations, policies and guidelines relating to conservation, resource management and development control in the coastal zone are an important part of this Strategy. These will support a coastal area management framework that addresses (a) the need for improved management approaches in locations between, as well as within, Coastal and Marine Protected Areas, and (b) the special requirements for managed development and conservation in the barrier reef region, particularly the cayes.

In the coastal area, natural or man-made events and activities are intimately linked over large spatial scales by ocean processes. In this complex and dynamic setting, an integrated approach to development planning, conservation and natural resources management is required. This approach takes account of:

[43] http://www.coastalzonebelize.org/?p=4

- Environmental characteristics of coastal ecosystems and the pre-requisite for maintaining ecosystem integrity;
- Pressures and impacts associated with national and international land and marine-based development;
- Factors that may change or otherwise impact the coastal system, including climate change.

Integrated Coastal Management requires both pro-active planning measures, as well as response systems after problems have been identified. This is an evolving and essential element of the planning and environmental management process for Belize. To deliver it, enhanced and sustained collaboration is needed between various agencies of Government, the non-governmental and private sectors, and the wider public.

By Law, the Strategy and detailed plans that will follow it require review and, if necessary, revision every four years. This review can take account of the relative success of various components, lessons learned, and data and information from ongoing scientific research and monitoring on the condition of the coastal and marine environment.

The ***Belize Integrated Coastal Zone Management Plan (2013)*** includes a national strategy document and region-specific coastal zone management policy recommendations for nine (9) coastal planning regions nationwide. The Plan also includes a spatially explicit zoning scheme that can be viewed by accessing the web portal http://www.coastalzonebelize.org/cz_portal/index.html#.

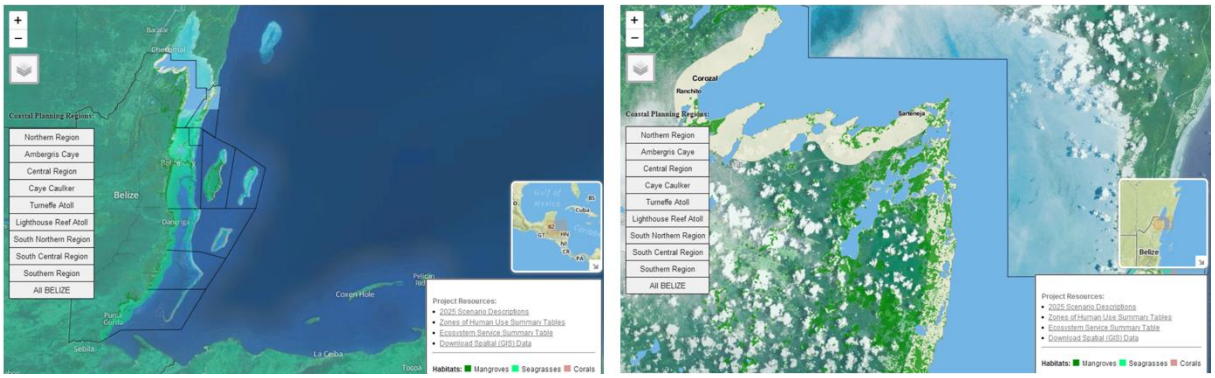

Figure 45 - Geographic Portal for Belize ICZMP

The development of the current Plan included the application of the InVEST Habitat Risk Assessment (HRA) model. This has been used to assess the risk posed to coastal and marine habitats by human activities and the potential consequences of exposure for the delivery of ecosystem services and biodiversity.

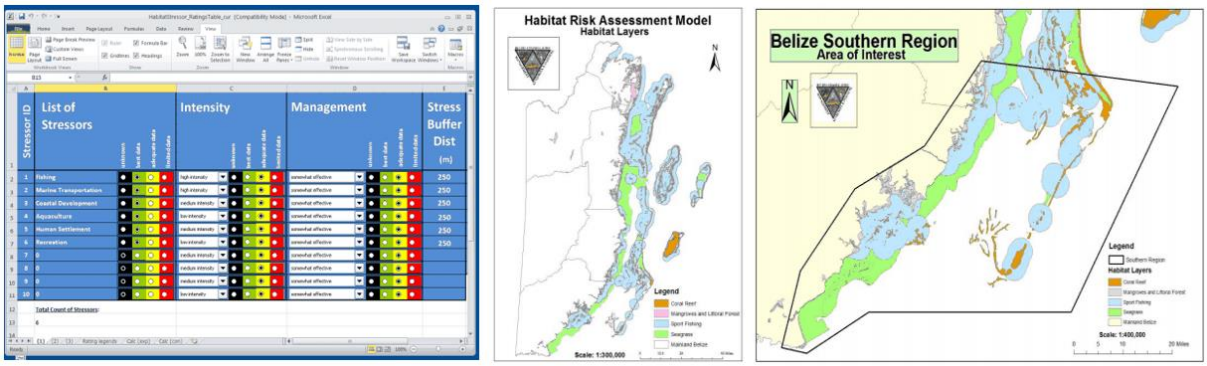

Figure 46 - Example interface and outputs of the InVEST Model

The ICZMP web portal provides a utility to download selected data from the Plan including*:

- Base Layers;
- Elevation;
- Coastal Planning Regions;
- Natural Habitats;
- Zones of Human Use;
- InVEST Model Outputs

*Note – the download utility was not functional at the time of this writing.

The basic planning unit used for the study was a framework of eco-zones that were defined by a multi-stakeholder team at the beginning of the effort. The study area covered all the marine areas as well as 3 KM inland in order to include the coastal communities that have the most interactions with coastal environments and resources.

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Develop and maintain inventory of coastal and marine resources and their state over time;
- Leverage the BNSDI to access relevant data from other agencies;
- Develop inventory and monitor the characteristics of socioeconomic drivers and pressures on coastal environmental resources and ecosystems over time;
- Monitor impacts of drivers and pressures on resource and ecosystem state over time;
- Provide tools for environmental impact forecasts and early warnings;
- Maintain inventory of protected area boundaries and assets;
- Support environmental system modeling to understand and forecast complex interactions between ecosystems and manmade and natural systems (e.g. climate change);
- Provide tools for the analysis and visualization of coastal environmental resource issues in ways that can be clearly understood by a lay audience;
- Provide analysis tools to model the implications of various intervention options, including the intersection, alignment and cumulative effects of interventions by multiple organizations (plans, policies, operations, enforcement, etc.);

- Establish location-aware social media channels for two way communication between the coastal stakeholders and the government
- Monitor and evaluate intervention program effectiveness over time and provide tools, information and multi-stakeholder processes to calibrate interventions over time.

7.5.2.5 Develop and support education and awareness programmes

In July 1999 the Education and Public Awareness Unit was established. The goal of the programme is to increase and improve the knowledge and understanding of issues affecting the coastal zone, therefore better preparing communities to make informed decisions on the use of the coastal and marine resources. An extension to the Education and Public Awareness Programme is the CZM Reference and Research Library, which was officially opened in May 2003. The Education and Public Awareness Programme has produced various brochures, booklets, reports and audiovisual material for dissemination to the public to create awareness of issues affecting the coastal zone.

The CZM Institute' Education and Public Awareness programme is also responsible for producing the annual State of the Coast Report and the organization's quarterly newsletter Coastline. In addition, the Education and Public Awareness programme supports the CZM Institute programmes in conducting workshops/seminars, training, and in delivering presentation to stakeholder groups. Through the Education and Public Awareness Programme, the CZMAI has coordinated events such as Manatee Week, Coastal Awareness Week Dive in to Earth Day, Open Day and Coast Fair. In 2002 the CZMAI received a grant from the U.S. National Fish and Wildlife Foundation to implement the Conservation of Goff's Caye and Reef Habitat (ConGREH) Project. The primary objective of project is to reduce impact to these ecologically fragile habitats through mooring buoys installation, ongoing monitoring and research, and educational training/awareness programs to gain formal support for their sustainable utilization and long-term management. Education and public awareness has been a significant component of the ConGREH Project.[44]

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Provide the public with access to basic data and easy to understand analysis and visualization regarding coastal environmental issues;
- Provide easy to understand visualizations of coastal environmental issues to the local and international media;
- Establish location-aware social media channels for two way communication between the coastal stakeholders and the government;
- Utilize the BNSDI for streamlining data sharing among coastal stakeholder organizations;
- Develop web-based and smart phone applications that orient and sensitize coastal users to the nature and sensitivities that characterize each area;

[44] http://www.coastalzonebelize.org/?page_id=64

7.5.2.6 Manage coastal data

The Coastal Zone Management Institute manages a large amount of data, both tabular and geographical in nature. Geographic Information Systems (GISs) have most often employed vector data because, its flexibility allows users to easily attach attributes and perform queries and calculations. However, with the introduction of high-quality georeferenced raster images, GIS designers are increasingly incorporating raster layers to visually enhance their systems and provide a Geographic Information System with the benefits of vector data combined with the visual impact of raster images.

The Data Center acts as an integral supporting arm for the Coastal Zone Management Institute. The functions of the Centre is to develop and maintain a Geographic Information System, which is capable of analyzing data, both spatial and non-spatial data. The Centre is equipped with the latest GIS and Remote Sensing software and hardware such as ERSI software products, a 48 inches SummagridV Digitizing Tablet and a Hewlett Packard Design Jet 1055cm plotter.

At this time when Belize's population is increasing and tourism is soaring, natural resource managers are discovering the power of GIS. In 1995 when the Coastal Zone Management Unit of the Fisheries Department was established, GIS was chosen as the tool to help in managing the coastal zone of Belize. Today GIS is helping the Coastal Zone Management Institute (CZMI), Government, and Non-Government Organizations in Belize, in finding common ground, by providing a framework for the analysis of resource management data. The technical staff at the CZMI is using GIS as an aid to monitor trends and assist in the making of critical decisions. Patterns and critical habitats are easily identifiable by integrating both spatial and non-spatial data into our GIS, where it is organized, analyzed, and spatially displayed (mapped).

GIS enables the development of such scenarios that can test static as well as dynamic hypotheses about resource use, changes and alternatives given model inputs and outputs. This allows for different options to be studied in a cost-effective and non-hazardous manner. GIS provides a powerful visual aid to both technical and non-technical audiences in developing a better understanding of the issues/problems facing us today.

The Data Centre stores all spatial and attribute data derived under the different technical/research units of the Institute. Among the most used and requested corporate layers of the Institute are the Coastal Protected Areas of Belize, the Marine Habitat, for the entire coastal area and the Manatee Sightings layer.[45] The list of data maintained by the CZMAI in the next section.

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

[45] https://www.coastalzonebelize.org/?p=262

- Provide data repository for the development and management of coastal data
- Provide geoportal for exploring, locating and accessing coastal data and online data services
- Establish standards for coastal resource monitoring data
- Establish agreements for the sharing of coastal data among relevant stakeholders
- Establish credentials, authority and agreements for selective accessing of sensitive coastal data (endangered species locations, archeological sites, etc.)
- Provide online services, templates and tools for field data capture

7.5.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting MoH functions at present:

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting CZMAI functions at present:

Data set	**Date - Publication**	**Originator (Source Project)**	**Preferential Scale (approximate)**	**Notes**
Coral reef	unknown	U.K. Ordnance Survey / Directorate of Overseas Surveys	1:250,000	this highly generalized dataset was apparently digitized from the 1:250,000 Ordnance Survey sheets
	2002	WWF (MACR database v 1.1)	unknown	while CZMAI provided coral reef spatial data to this effort, it is unclear if the Belizean data included in WWF's regional map of the Mesoamerican reef is from CZMAI
	2004	WRI (Reefs-at-Risk in the Caribbean project)	unknown	the Belize reef data contained in WRI's regional dataset is from CZMAI (therefore see notes below); the sources for other datasets are listed in the attribute table for this dataset
	2005	CZMAI (UNDP-GEF CZM Project)	1:100,000	extracted by WRI from CZMAI's national marine habitat map (see notes below on CZMAI national marine habitat map)
Benthic habitat	1997	CZMAI (UNDP-GEF CZM Project)	1:100,000	this effort was done through the UNDP-GEF Coastal Zone Management Project in 1997 (now the Coastal Zone Management Authority & Institute), with the collaboration of the University of Sheffield, Coral Caye Conservation, and the University of New Castle upon Tyne; the source of this data is LandSat TM imagery from 1996 (inner lagoon) and 1997 (atolls); the overall benthic classification was found to be 60% accurate for benthic classes, and 80% accurate for geomorphologic classes; commonly cited as the Pete Mumby marine habitat map, the lead author on this work was actually the CZMP's Hugo Matus

	2001	Meerman & Sabido (Central America Ecosystems Mapping Project)	1:100,000	this is apparently a draft product digitized from the CZMAI national marine habitat map; it appears in printed format on the 1:2,100,000 Central America Ecosystems Map, and was apparently digitized for that project
	2004	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000	based on the earlier digitization by Meerman, this work was completed through the auspices of the NPAPSP project, and is publicly available as a part of the 'bze_ecosys_2004.shp' dataset from which it can be extracted
Reef Geomorphology	1997	CZMAI (UNDP-GEF CZM Project)	1:100,000	see notes on CZMAI national marine habitat map above; both benthic habitat and geomorphology are attributes of this dataset
	2005	Institute for Marine Remote Sensing of the University of South Florida (Millennium Corals Mapping Project)	1:100,000	like the CZMAI national marine habitat map, reef geomorphologic information has been extracted from LandSat imagery (ETM); in the case of Belize, LandSat imagery was supplemented partially with IKONOS data (areas near Placencia); it should be noted that this effort used a slightly different classification scheme from the one employed in the CZMAI effort
land use / land cover (also otherwise described as 'vegetation,' and 'ecosystems')	1959	Wright et al. ("Land in British Honduras" publication)	1:250,000	source of this data is visual interpretation of aerial photography and in-depth field surveys by Charles Wright and his associates
	2004	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	the main source of this data is the Meerman & Sabido ecosystem map, possibly supplemented with data from Wright et al's "natural vegetation" map
	2005	Emch et al. ("Forest Cover Change in the Toledo District" study)	1:100,000	the source of this data is sub-pixel supervised-classified LandSat MSS imagery; accuracy assessment reveals the results are highly accurate (90-95%); the classification scheme utilized is a simple six-class scheme
	2002	DiFiore (Master's thesis, Columbia University)	1:100,000	as a part of her master's degree thesis, DiFiore used supervised classification of LandSat imagery to investigate land cover change along the Belize River riparian corridor between 1989 and 2001
	1994	Fairweather & Gray (FAO-funded "the Land Use of Belize 1989-92" study)	1:50,000	the source of this data was visually-interpreted SPOT XS satellite imagery, which possesses 20m resolution, and apparently supplemented with detailed ground surveys; the agricultural cover data corresponds well to the agricultural cover statistics for this period

	2005	Earth Satellite Corporation (GeoCover project)	1:100,000	this dataset is termed 'circa 1990' land cover, despite the fact that the imagery used ranges from 1989 to 1994; the Earth Satellite corporation utilized an unsupervised classification technique to develop this dataset in a standardized global classification scheme; visual analysis reveals that this dataset underestimates agricultural cover; hillshaded broadleaf forests tend tobe classified instead as shrubland; satellite imagery used (see below for specific dates) also correspond to different phonological cycles
	1995	Iremonger & Brokaw (Natural Resource Management Project - NARMAP)	1:250,000	the source of this data was visually-interpreted LandSat TM imagery for 1993, printed at 1:250,000 scale (instead of at 1:100,000 scale), and supplemented with LIMITED ground surveys / fly-overs; while this map has been referred to as the "natural vegetation map," this data also shows un-natural (i.e. human-induced) cover such as agriculture and settlements
	2004	Ek (Master's thesis, Ohio University)	1:100,000	as part of his master's thesis, Ek used supervised classification to investigate land cover change in central Belize (LandSat World Reference System path 19 row 48); the comparison is between scenes from 1993 and 2003; the latter classification results are reported as 92% accurate
	2001	Meerman & Sabido (Central America Ecosystems Mapping Project)	1:250,000	this map is intended to be an update and extension of Iremonger & Brokaw's map, supplemented with additional updated Landsat TM satellite imagery of central and western Belize (hence the 1996 and 1998 label); flyovers and a limited number of ground surveys were conducted; following on earlier works, the mapping technique used was visual interpretation
	1998	White et al. ("Remote Sensing Analysis of Land Use and Land Cover, Central Belize" study)	1:100,000	building on White et al's earlier deforestation study, the team used ground control points to perform a supervised classification on an area of central Belize (roughly the southern half of the Belize district); the classification scheme used mirrors the one used by Fairweather & Gray (1994)
	2005	Emch et al. ("Forest Cover Change in the Toledo District" study)	1:100,000	the source of this data is supervised-classified LandSat ETM imagery and field surveys; accuracy assessment reveals that the results are highly accurate (84-91%); the classification scheme utilized is a simplified six-class scheme
	2004	Penn et al. ("Vegetation of the Greater Maya Mountains" study)	1:50,000	the source of this data is a supervised classification of Indian Resource Satellite (IRS) imagery, which has 20m pixel resolution; this dataset classifies land cover into 32 classes
	2005	Earth Satellite Corporation (GeoCover project)	1:100,000	this data is termed 'circa 2000' land cover; see notes above on 'circa 1990' EarthSat GeoCover data
	2002	DiFiore (Master's thesis, Columbia University)	1:100,000	see notes above on 1989 DiFiore land use / land cover data

	2002	White et al. (Impacts of Hurricane Iris study)	1:100,000	the White et al team used both LandSat ETM imagery and data from another sensor, the Advanced Land Imager (ALI) to evaluate the impacts of Hurricane Iris in the Monkey River area by generating pre- and post-Hurricane Iris land cover datasets; classifications with both datasets proved highly accurate (86-97%)
	2004	Ek (Master's thesis, Ohio University)	1:100,000	see notes above on 1993 Ek land use / land cover data
	2005	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000	this map is an update of the Meerman & Sabido map, supplemented by additional fieldwork; major updates are the expansion of agriculture, utilizing 2004 Landsat ETM imagery acquired through the NPAPSP project; following on earlier works, the mapping technique used is visual interpretation
	2011	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	1:100,001	Map of the Ecosystems of Belize version 2011 is an update from the 2001 Belize Ecosystems Map (Meerman & Sabido, 2001) and the subsequent 2004 version of the same. has been enhanced using a substantial set of new data. The data quality of the 2011 version has greatly improved over the 2001 and 2004 versions. The classification still follows the UNESCO system developed for the Central American Ecosystems Map and is thus completely consistent with that product. Some of the Ecosystem variants as used in the 2004 version have been collapsed and integrated in the parent classification.
Forest cover	1996	White et al. ("Deforestation in Belize" study)	1:100,000	the first White et al (1996) study, and subsequent studies were collaborations between the University of Texas-Austin's Bureau of Economic Geology and Center for Spatial Research, and Belize's Forest Department and Land Information Centre; the deforestation study used supervised classification to extract forest cover data for three periods; the original classification scheme involved 17 classes, which for the purpose of analysis were aggregated to forest / non-forest
	1996	White et al. ("Deforestation in Belize" study)	1:100,000	
	1996	White et al. ("Deforestation in Belize" study)	1:100,000	
	2000	unknown (Paseo Pantera project)	unknown	while the original creation / publication date of this dataset is unknown, it was published on Ford & Clarke's 2000 Maya Forest data CD; forest cover is divided into "lowland rain forest," "inland swamp forest," "mangrove," and "pine forest"

				please note that in addition to the above datasets from studies which have looked specifically at forest cover, forest cover data can also be extracted from land use data (for instance, as can settlement boundaries and other data)
Mangrove cover	1998	Zisman (doctoral dissertation)	1:40,000	this data is the second update of the original national mangrove mapping done by Zisman along with Murray and Gray; the original work utilized only LandSat TM imagery, while this and the prior update utilized both aerial photography and substantial ground surveys; this data is mainly relevant to mainland Belize because of only partial cover of the cayes and projection issues
	1998	Zisman (doctoral dissertation)	1:40,000	this data is the second update of the original national mangrove mapping done by Zisman along with Murray and Gray; the original work utilized only LandSat TM imagery, while this and the prior update utilized both aerial photography and substantial ground surveys; this data is mainly relevant to mainland Belize because of only partial cover of the cayes and projection issues
	2010	CATHALAC	1:100,000	This dataset depicts fragmentation and resiliency of Belize's national mangrove cover in 2010, based on satellite-based mapping of Belize's mangroves for 1980, 1989, 1994, 2000, 2004, and 2010, and based on the earlier work of Simon Zisman (1998). Fragmentation was analyzed by identifying mangrove patches which had been reduced in size within the period analyzed. Based on that, a fragmentation history was compiled, and risk was estimated based off that history. In addition to the fragmentation history, an index of patch irregularity (related to the perimeter and area) was also developed. Resiliency was also identified based on identification of mangroves which had regrown after clearance. This data was developed for the World Wildlife Fund (WWF)'s Mesoamerican Reef program in July 2010.
Map sheets / Topographic sheets	variable	U.K. Ordnance Survey / Directorate of Overseas Surveys (E755 sheets)	1:50,000	all of the sheets for mainland Belize were scanned by the University of Mississippi's Geomatics Centre (UMGC); unfortunately, these cover varying periods, which can only be deduced from inspection of the particular land use shading schemes utilized by sheets for different periods; it seems that sheets from both edition 6 and edition 5 were used
	1993	U.K. Ordnance Survey / Directorate of Overseas Surveys (E755 sheets)	1:50,000	these are listed separately as this set was scanned by the University of Florida, but has not been georeferenced or corrected for warping; unlike the sheets scanned by the University of Mississippi, these possess their legends
	1986	King et al (NRI Land Resource Assessments)	1:100,000	the source data for this is aerial photography; the printed map sheets were scanned and corrected by Emch et al. (2005)
	1986	King et al (NRI Land Resource Assessments)	1:100,000	the source data for this is aerial photography; the printed map sheets were scanned and corrected by Emch et al. (2005)

	1999	U.S. National Imagery & Mapping Agency (Digital Atlas of Central America project)	1:250,000	the U.S. National Imagery & Mapping Agency has produced 1:250,000 topographic maps of Central America which may have been generated from the individual countries' 1:250,000 sheets; it is unknown what period these sheets correspond to, but were published on the Hurricane Mitch-related Digital Atlas of Central America
Satellite training data / Ground control points	2005	Emch et al.	1:250,000	digitized from visual inspection of LandSat MSS imagery
	1998	White et al. ("Remote Sensing Analysis of Land Use and Land Cover, Central Belize" study)	unknown	GPS points (uncorrected) of various land features and vegetation types
	2005	Emch et al.	1:100,000	digitized from visual inspection of LandSat ETM imagery
	2002	DiFiore (Master's thesis, Columbia University)	unknown	GPS points (uncorrected) of various land features and vegetation types
Country boundaries	unknown	University of Edinburgh	1:50,000	according to Chris Hecker's notes (BAS), this layer may actually have been digitized from 1:250,000 Ordnance Survey sheets rather than 1:50,000 sheets
Boundary line	unknown	University of Edinburgh	1:50,000	unlike the other country boundaries dataset listed above, this dataset is merely the line theme of the boundary line which separates Belize from Guatemala and Mexico
Cayes	unknown	University of Edinburgh	1:250,000	this dataset may be a subset of the larger polygon dataset of Belize's landmass (i.e. country boundaries); it is apparent that this dataset has been digitized, however, from the 1:250,000 map sheets (while it is alleged the other was digitized from the 1:50,000 map sheets); this dataset is considerably incomplete, and the boundaries of the cayes (changeable in themselves) should not be considered precise; it may be that better comprehensive cayes datasets exist in private collections
District boundaries	unknown	University of Edinburgh	1:250,000 (?)	this dataset seems to have been digitized from the 1:250,000 topographic sheets; the other possibility is that it was digitized from the finer detail 1:50,000 sheets; it should be noted that a number of versions of this dataset exist, including one without the boundaries for the Dangriga cayes, which the common version does include
	unknown	Land Information Centre	1:250,000 (?)	this dataset was published on the CCAD web site and can be downloaded therefrom; this dataset is apparently just a merge of the above polyline dataset digitized from the 1:250,000 topo sheets with the country

				boundaries polygon dataset
Electoral boundaries	unknown	Land Information Centre	1:50,000 (?)	this is a dataset of Belize's existing 29 electoral divisions
	2005	Land Information Centre	1:50,000 (?)	in April 2005, the Land Information Centre, along with the Elections & Boundaries Commission, had completed a draft map of re-drawn electoral boundaries; this dataset contains 31 electoral divisions
Territorial waters	1993	Coastal Zone Management Project - World Conservation Monitoring Centre	1:250,000	this dataset is one of a series that were digitized by Janet Gibson of the CZMP while visiting the WCMC (now UNEP-WCMC) in Cambridge; these were digitized on the 1:250,000 sheets; this dataset includes both a 3 mile and 12 mile maritime boundary
	2004	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000 (?)	utilizing information contained within the Belize Maritime Areas Act of 1992, Meerman has re-drawn the boundaries of Belize's territorial waters and exclusive economic zone; this dataset includes both territorial waters and the exclusive economic zone (EEZ); it is possible that another version of this dataset was created by the Land Information Centre, but its existence cannot be confirmed
Elevation (contours)	unknown	University of Edinburgh	1:50,000	100m intervals, digitized from 1:50,000 Ordnance Survey E755 sheets (the sheets themselves contain contours in 20m intervals)
	2004	Shuttle Radar Topography Mission (SRTM)	1:350,000	100m intervals generated from 90m digital surface model data
Elevation (digital elevation model)		Intermap Star3i	1:40,000	this elevation data was acquired through an overflight in 1999 by Intermap; like the SRTM data described below, this is a digital surface model which captures canopy, and NOT a digital terrain model; the spatial resolution of this dataset is 10m; the data source is not satellite-borne radar but aerial radar; this data was acquired through the MBC project and has LIMITED circulation
	2001	Global 30-arc Second Topographic Data (GTOPO30)	1:4,000,000	this is a 1km resolution dataset developed by the US Geologic Survey from interpolating contour data collected for the countries of the world
	2004	Shuttle Radar Topography Mission (SRTM)	1:350,000	this elevation data was acquired through NASA's February 2000 Shuttle Radar Topography Mission; the spatial resolution of the available data is 90m (there is also a 30m dataset which is NOT available); this dataset has been acknowledged as a digital SURFACE model and not necessarily a digital terrain model (i.e. a 'first-surface' DEM which captures canopy); this 2004 version has filled gaps which were present in the earlier published version

	2005	University of the West Indies-Centre for GeoSpatial Studies (CDERA hazard mapping & vulnerability assessment project)	1:20,000	using spot heights collected from surveys in early 2005, the UWI-CGS interpolated these points to create a digital terrain model for southern Ambergris Caye
Slope	1992	King et al (NRI Land Resource Assessments)	1:100,000	see notes on the King et al. soil data
	2005	Shuttle Radar Topography Mission (SRTM)	1:100,000	generated (using slope command) from 30m digital surface model data; because of SRTM artifacts, will represent not the ground's slope, but the canopy's slope
	2004	Shuttle Radar Topography Mission (SRTM)	1:350,000	generated (using slope command) from 90m digital surface model data; because of SRTM artifacts, will represent not the ground's slope, but the canopy's slope
Relief (hillshade)	2004	ProNatura (Selva Maya EcoRegional Planning Project)	1:380,000	generated using the hillshade command; specific solar azimuth / elevation parameters to which this data corresponds are unknown
	2004	Shuttle Radar Topography Mission (SRTM)	1:100,000	generated using the hillshade command from 30m digital surface model data; this hillshade refers to specific solar azimuth / elevation parameters
	2005	Shuttle Radar Topography Mission (SRTM)	1:350,000	generated using the hillshade command from 90m digital surface model data; unlike the 30m data, hillshades with unlimited solar azimuth / elevation parameters can be generated as the source DEM is available
Geology (surface)	1986	Cornec	1:250,000 (?)	this dataset was probably digitized from a printed copy of Cornec's map, which was produced in the days of the UNDP-funded geology project
	2001	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	from the metadata, it is unclear what the sources of this data are
Geomorphology	2004	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	from the metadata, it is unclear what the sources of this data are
Soils	1959	Wright et al. ("Land in British Honduras" publication)	1:250,000	edited by J. Meerman to include updates by I. Baillie; soil types are not described in traditional classification (e.g. FAO), and are therefore idiosyncratic to Belize
	1992	FAO-UNESCO (Soil Map of the World)	1:5,000,000	also referred to as the SOTER (soil & terrain) database, the world soil map was originally published between 1974 and 1978 in a number of sheets; in 1992, an updated digital version was released; the down-side of this dataset is obviously is extremely coarse scale

	1992	King et al (NRI Land Resource Assessments)	1:100,000	the source of this data is the most comprehensive soil survey conducted in Belize (mostly fieldwork, supplemented w/ aerial photography and some satellite imagery); conducted between 1986 and 1992; soil types are not described in standard classification (e.g. FAO or USDA), and are therefore idiosyncratic to Belize; the accompanying NRI reports contain the correlations that could be used to convert this map into standard FAO / USDA classifications
	2004	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	from the metadata, it is unclear what the sources of this data are; this dataset is in the FAO classification scheme
Rainfall (isohyets)	1973	Walker	1:250,000 (?)	apparently Meerman digitized Walker (1973)'s map of Belize's isohyets, which was probably in turn generated from data collected or provided by the National Meteorological Service
Rivers	unknown	University of Edinburgh	1:50,000	digitized from 1:50,000 Ordnance Survey E755 sheets, which were in turn derived from high resolution aerial photographs; visual comparison with the scanned E755 sheets reveals a possible that a datum shift with the river data, which would have extreme implications on other derived data; according to Esselman and Meerman, digitizing of the stream network in southeastern Belize is better than the digitizing of rivers in the Maya Mountains
	1998	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	"synthetic stream network" derived from a digital terrain model; this data does not resemble the stream network digitized from the topographic sheets
	2003	Esselman et al	1:50,000	same as the dataset digitized by U. Edinburgh, but with extra attribute data such as geology, type, etc.
	2005	USGS (IABIN-DGF project)	1:100,000	"synthetic stream network" derived from a 30m resolution digital surface model (SRTM); this dataset is considered an intermediate product and will require a great deal of refinement
	forthcoming	USGS (IABIN-DGF project)	1:100,000	see notes above on IABIN-DGF generated Belize / Guatemala synthetic stream network
		1:50,000 Ordinance Survey Maps (UK); Jan Meerman (stream orders, names); Sandor Rickets (digitizing); Peter Esselman (project rationale), Climate Resiliance Project under the Global Facility For Disaster Reduction and Recovery" (2013).	1:50,000	This dataset contains vector streamlines for all of the domestic watersheds of Belize. The lines were hand digitized from 1:50,000 maps from Belize that were scanned and georectified. Each stream segment has attributed indicating stream order, elevation, slope and where available names.

Lagoons / water bodies	unknown	University of Edinburgh	1:50,000	this dataset is fairly incomplete; digitized from 1:50,000 Ordnance Survey E755 sheets, which were in turn derived from high resolution aerial photographs
		Peter Esselman and Sandor Ricketts	1:50,000	This dataset contains water body polygons for all of the domestic and international watersheds of Belize. The polygons were hand digitized from 1:50,000 maps from Belize, Guatemala, and Mexico that were scanned and georectified.
Watersheds / catchments	1992	King et al (NRI Land Resource Assessments)	1:250,000 (?)	not much is known about the generation of this dataset, except that there are notable errors in the boundaries of the catchments; this dataset is generally treated as sacrosanct despite the fact that it is not "hydrologically correct" per se; in terms of origin the boundaries of the major catchments were probably roughly sketched out the NRI team
	1995 (?)	NARMAP	1:250,000 (?)	this dataset shows a better definition of the Sibun River watershed; from the attribute data, this dataset has also been further edited / updated by J. Meerman
	2003	ProNatura (Selva Maya EcoRegional Planning Project)	1:250,000	the source metadata for this are obscure, but apparently this was generated using the 1:250,000 digital elevation model that ProNatura assembled using spot heights from the topographic sheets for the respective Selva Maya countries
	2005	WRI (ICRAN-MAR project)	1:350,000	despite the fact that the source SRTM data represent a digital surface model, this dataset can be considered the most "hydrologically correct" watershed boundary dataset, despite obvious errors with regards to extremely small watersheds; hydrologica accuracy was assured by superimposing 1:50,000 river data into the elevation data ("burning rivers"); this dataset is also the third iteration produced through the ICRAN-MAR project
	2005	USGS (IABIN-DGF project)	1:100,000	the hydrologic accuracy of this dataset is in question not only because of the fact that the SRTM is merely a surface model, but also because of the hydrologic corrections that were incorrectly incorporated (rivers were burned in from the 1:1,000,000 scale Hydro1K data instead of that of a comparable resolution to the elevation model)
	forthcoming	USGS (IABIN-DGF project)	1:100,000	see notes on IABIN-DGF Belize / Guatemala watershed dataset
	2011	Jan Meerman Update of Emil Cherrington SERVIR CATHALAC	1:50,000	Watershed layer for Belize originally prepared by Emil Cherrington for SERVIR (CATHALAC) using SRTM data sources. His original dataset was modified for most coastal watersheds based on field surveys and topography interpretation by Jan Meerrman. Many boundaries of coastal watersheds were simplified. Errors (many slivers) were removed

Bathymetry / Depth	unknown	Royal Admiralty Charts	unknown	the Royal Admiralty's bathymetric data were apparently digitized from the hard copies at some point by The Nature Conservancy's marine country program; the spacing between the points is variable
	1993	Coastal Zone Management Project - World Conservation Monitoring Centre	1:250,000	this dataset is one of a series that were digitized by Janet Gibson of the CZMP while visiting the WCMC (now UNEP-WCMC) in Cambridge; these were digitized on the 1:250,000 sheets; bathymetric data from this dataset are contoured, in fathoms; data is mainly for the inner barrier reef lagoon, and also for the atolls
	2001 (?)	WRISCS project	unknown	these were apparently acquired using the RoxAnn sounder; bathymetric data for other areas was apparently also collected by WRISCS
	2002	WWF (MACR database v 1.1)	unknown	this dataset exists as bathymetric contours; due to the lack of accompanying metadata / attribute data, it is unknown how this dataset was generated
	2004	WRI (Reefs-at-Risk in the Caribbean project)	1:4,000,000	this data exists as a raster (1km grid); it was developed by WRI's Lauretta Burke using satellite imagery data from NOAA, NASA, and the Danish Hydrologic Institute
	2004	Programme for Belize (TNC Freshwater Initiative)	unknown	according to E. Ariola (personal communication), a sounder was used to capture this data
	2005	Wildlife Conservation Society (Glover's Reef Living SeaScape project)	unknown	these data were collected in 2005 using a sounder and non-differential handheld GPS unit; the grid spacing is 1km
Settlements	1992	University of Edinburgh	1:250,000	this dataset was probably digitized from the points on the 1:250,000 topographic sheets; it contains 289 settlements
	2004	Meerman	1:350,000	according to the metadata, this dataset was created from three main sources: (i) the 1:350,000 International Travelers Map of Belize, (ii) data from CSO, and (iii) Meerman's own point data; the points in this dataset, for the most part, constitute the "centers" of the communities listed; data from CSO (2000 census) was integrated to give estimates of population size for each settlement; this dataset contains 263 entries, compared to the 289 settlements in the earlier U. Edinburgh dataset
	1994	Fairweather & Gray (FAO-funded "the Land Use of Belize 1989-92" study)	1:50,000	extracted from the Fairweather & Gray land use dataset; see notes above
	2001	Meerman & Sabido (Central America Ecosystems Mapping Project)	1:250,000	extracted from the Meerman & Sabido ecosystem map (for which at least two versions exist)
	2004	Meerman	1:100,000	digitized from LandSat ETM imagery

	2005	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000	extracted from the Meerman ecosystem dataset; see notes above
	2010	Jan Meerman	1:100,000	Point dataset of Belize Towns, Cities, villages and communities. Point locations are approximate centres of densest infrastructure patterns and do not indicate any legal center of a community. Principal Source of information is the National Association of Village Councils of Belize (NAVCO): http://navco.org.bz/village_council.html These data have been augmented with a village dataset distributed by CCAD: http://www.ccad.ws/mapas/mapoteca.htm and further strengthened with actual fieldwork recording settlements with the use of a GPS.Population data are based on the 2010 Population Census and have been provided by the Statistical Institute of Belize (SIB)
	2010	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	1:100,000	Polygon dataset of settlements in Belize based on 2010 Landsat 30 resolution data Derived from 2010 Land use map
	2011	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	1:100,000	Polygon dataset of settlements in Belize based on 2010 Landsat 30 resolution data Derived from 2010 Land use map
Roads	unknown	University of Edinburgh	1:50,000	apparently digitized from the 1:50,000 Ordnance Survey E755 sheets; the specific time period is unknown but were probably digitized from the most recent OS sheets; this dataset (along with most of the other OS sheet-derived data) was apparently digitized by the University of Edinburgh
	unknown	University of Edinburgh (but updated by the Land Information Centre)	1:50,000	this data was apparently used by David Gray in his study with Chomitz, and constitutes one of the few roads datasets for which the time period is available; according to Gray, the road network digitized from the 1:50,000 sheets by the University of Edinburgh was updated by the Land Information Centre using differential GPS units
	2004	Meerman	1:50,000	according to the metadata, this dataset is an update of the LIC's roads dataset, using 2000-03 LandSat imagery, and road coverage data for southern Belize from the ESTAP project
	2010	Meerman	1:75,000	Road Shapefile for Belize based on 2008 Landsat Image

	2011	Meerman,Belize Tropical Forest Studies	1:75,000	2011 update from a road Shapefile for Belize based on 2008, 2010 and 2011 Landsat Images. Principal change with previous versions lies in the classification of roads.
Hotels	2005	Belize Tourism Board	1:250,000 (?)	building on an earlier point dataset digitized by The Nature Conservancy, and utilizing the most recent information provided by the Belize Tourism Board, the efforts of WWF's Shalini Cawich have resulted in an updated dataset of the locations of Belize's over 500 hotels
	2012	Belize Tourism Board	1:50,000	The hotel data set layer is a revision of a hotel data layer originally provided by The Nature Conservancy (TNC), which contained 227 hotels. Using an updated list (2012) provided by the Belize Tourism Board's Registrar of Hotels, the TNC layer was manually edited to update the dataset to 700 hotels
Airstrips	2005	Civial Aviation Authority	1:50,000	coordinate data were provided by the Civil Aviation Authority ("Authorized Aerodromes" document), but digitized by the Coastal Zone Management Institute; in a number of cases where only partial coordinate information was provided, points had to be verified / corrected using the 1:50,000 map sheets
Shipping ports	2005	Coastal Zone Management Authority & Institute	1:50,000	these ports were digitized directly from the 1:50,000 sheets by the Coastal Zone Management Institute for inclusion on the Belize Coastal Data CD compilation by WRI
Shipping lanes	1993	Coastal Zone Management Project - World Conservation Monitoring Centre	1:250,000	this dataset is one of a series that were digitized by Janet Gibson of the CZMP while visiting the WCMC (now UNEP-WCMC) in Cambridge; these were digitized on the 1:250,000 sheets; general transportation routes were provided by the Belize Ports Authority
Water taxi route	unknown	Belize Port Authority, Coastal Zone Management Authority and Institute	unknown	
Aquaculture & mariculture	1994	Fairweather & Gray (FAO-funded "the Land Use of Belize 1989-92" study)	1:50,000	this dataset has been extracted directly from Fairweather & Gray's 1994 land use study
	2005	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000	this dataset has been extracted directly from Meerman's 2004 Belize ecosystems dataset

Mines / Quarries	2004	Geology & Petroleum Department	1:250,000	this dataset was digitized by Jan Meerman from coordinate data provided by the Geology & Petroleum Department; these data were probably acquired using non-differential handheld GPS units
	2005	Geology & Petroleum Department	1:250,000	this dataset is an update of the dataset digitized by Jan Meerman, using coordinate data provided by the Geology & Petroleum Department
Land tenure / survey boundaries	1992	King et al (NRI Land Resource Assessments)	unknown	this map was digitized by King et al. and currently exists both as a line theme and a polygon dataset
	2005	Programme for Belize (National Protected Areas Policy & System Plan project - NPAPSP)	unknown	this dataset, improved a little by the Programme for Belize as part of the NPAPSP, exists as a polygon dataset; the coverage of current protected areas is fairly incomplete
	2002 (	Environmental, Social and Technical Assistance Project (ESTAP)	unknown	according to Francis Crawford (formerly of ESTAP), this data is a correction of the LIC's tenure data, and was acquired mainly using handheld GPS units
	unkno	Land Information Centre	unknown	this dataset or set of datasets includes cadastral data for the entire country - town and village surveys, as digitized by the Land Information Centre of the Ministry of Natural Resources' Department of Lands & Surveys; in the form of this dataset, the LIC has the boundaries for surveys of all communities throughout the country; it is unknown how current this data is
Agricultural suitability	1992	King et al (NRI Land Resource Assessments)	1:100,000	the major output of the Land Resource Assessments was the re-classification of soil types into a simplified 5-class agricultural suitability system that indicates areas generally suited to agriculture; the tables contained within the individual NRI reports address specific crop suitability, though it is apparent that this has never been linked into the spatial data - a task that needs to be done at some point
Timber production suitability	1992	King et al (NRI Land Resource Assessments)	1:100,000	generally speaking, as indicated on p. 2 of King et al (1993), lands classified as having an agricultural suitability of 3-4 are recommended for 'forest management and production,'
Flood plains / flood risk	1992	King et al (NRI Land Resource Assessments)	1:100,000	this dataset is also credited as the Land Information Centre, which extracted flood plain locations from King et al's land systems; King et al's Agricultural Development Prospects in Belize report (p. 113) explain that the team had already estimated flood risk across 16 classes; unfortunately, the tables correlating those classes with particular land systems cannot be found
Wind hazard	1999	Caribbean Institute for Meteorology & Hydrology (OAS Caribbean Disaster Management Project)	1:4,000,000	according to the online documentation, this map was prepared by the Caribbean Institute for Meteorology & Hydrology for the OAS' Caribbean Disaster Management Project; the data is cited as having a 1km resolution, and being highly generalized; the TAOS

				model was used to generate the dataset
Storm surge hazard	1999	Caribbean Institute for Meteorology & Hydrology (OAS Caribbean Disaster Management Project)	1:50,000	according to the online documentation, this map was prepared by the Caribbean Institute for Meteorology & Hydrology for the OAS' Caribbean Disaster Management Project; the data is cited as having been generated from the contour lines on the 1:50,000 topographic sheets; the TAOS model was used to generate the dataset
Fire risk	2004	Meerman	1:250,000	as noted in the dataset's metadata, this dataset is "a digital approximation of wildfire risk to natural areas in Belize"; fire risk is divided into 19 classes from 0-18
Relative erosion potential	2004	World Resources Institute (Reefs-at-Risk Caribbean project)	1:4,000,000	a modified version of the Revised Universal Soil Loss Equation (RUSLE) was used (REP = pct_slope * Land_cov_eros_rate * Precip_mm * porosity / 1,000) to generate this dataset; datasets used were soil porosity from the 1:5M SOTER database, peak rainfall from the Global Arc CD, and 1992-93 land cover data from USGS' GLCC database; more detailed notes are contained within the Belize Coastal Data CD compiled by WRI
	forthc	World Resources Institute (ICRAN-MAR project)	1:350,000 (?)	as a part of its work under the ICRAN-MAR project, WRI will be revising its REP mapping using more detailed elevation and land cover data
Land degradation risk	2005	Meerman (UNCCD rapid land degradation survey)	1:250,000 (?)	as stated in the metadata, 8 variables have been used to estimate potential for land degradation; done through the UNCCD rapid land degradation survey of Belize, this dataset represents the first effort to map overall potential for land degradation
Threats to Belize Barrier Reef (expert-mapped)	2005	World Resources Institute (Reefs-at-Risk Caribbean project)	1:250,000	in a series of workshops hosted by BAS, CZMAI, WCS and WWF, a variety of then-current threats to the reef were mapped on hard copy maps and then transferred into a GIS; while the positional accuracy of this expert mapping cannot be confirmed, these compare favorably with the threats to the Belize Barrier Reef system modeled by the World Resources Institute in its follow-up analysis
Threats to Belize Barrier Reef (modeled)	2005	World Resources Institute (Reefs-at-Risk Caribbean project)	1:250,000	main modeled threat types are (i) coastal development, (ii) inland / watershed-based sources of pollution / sediment, and (iii) marine based threats; detailed notes on the modeling - which is based on weighting of threat indices - are included on the Belize Coastal Data CD compiled by WRI
Agricultural Uses	2011	lands Information Centre(Follow up from Meerman and Sabido)	1:100,000	Map of the Ecosystems of Belize version 2011 is an update from the 2001 Belize Ecosystems Map (Meerman & Sabido, 2001) and the subsequent 2004 version of the same has been enhanced using a substantial set of new data. The data quality of the 2011 version has greatly improved over the 2001 and 2004 versions. The classification still follows the UNESCO system developed for the Central American

				Ecosystems Map and is thus completely consistent with that product. Some of the Ecosystem variants as used in the 2004 version have been collapsed and integrated in the parent classification.
Biological Corridors	unkno	unknown (Paseo Pantera project)	unknown	while the original creation / publication date of this dataset is unknown, it was re-published on Ford & Clarke's 2000 Maya Forest data CD
	2002 (	Meerman et al (Mesoamerican Biological Corridor project)	unknown	this dataset delineates primary and secondary corridor routes, as well as barriers to connectivity
	2011	Meerman,Petracca & Zeller,	unknown	2011 rendering of Principal Biological Corridors connecting Belize's protected areas based on a study in 2000 into the feasibility of Northern Biological Corridor and a consolidation study in 2002. In 2011 a study was conducted to determine a Central Belize Biological Corridor. These three studies are integrated here and corrected with regards to the actual status of land development in the area.
Protected Areas	2001	Land Information Centre	1:100,000	this dataset, corresponding to the protected areas system in 2001, can be downloaded from the CCAD site; datasets of earlier protected areas coverages, are also in existence
	2005	Meerman	1:100,000	this is a significant update of earlier protected areas coverage data; updates to site boundaries have been done using data contained within Statutory Instruments; this dataset also contains Bird Sanctuaries and certain archaeological reserves not mapped in earlier datasets (but which nonetheless existed in earlier periods)
	2011	unknown	unknown	
	2011	Meerman	unknown	Digital protected area polygon data were created using the various issues of the Government Gazette Statutory Instruments with added information of private landholdings that opt to qualify as a Private Protected Areas within BAPPA. The latter are included for planning purposes, although as yet un-recognized, these candidate private PA's are typically being managed for biodiversity protection and thus form an extra tool in the management of national biodiversity resources. This is a work in progress with several inconsistencies (largely as a result of insufficient descriptions and generally lacking topology).

	2012	Land Information Centre	1:100,000	The dataset was developed to assist the Ministry of Natural Resources and the Environment and Government of Belize for better decision making, sustainable development and conservation of our Natural Resources
Marine Protected Areas	2004	Coastal Zone Management Institute	1:100,000	The Marine Protected Areas (MPA) coverage developed by the Coastal Zone Management Institute is based on bounding coordinates provided by Government of Belize Statutory Instruments which delineate the boundaries of the various protected areas dotting the marine landscape. While originally developed in 2003, the dataset is also current as of 2004, as the network remained unchanged until February of 2005 with the declaration of the St. George's Caye Mangrove Reserve (not included in this dataset).
No take Zones	2011	Lands Information Centre	unknown	Digital protected area polygon data was created using the legal descriptions of the boundaries as published on the Government Gazette Statutory Instruments (legal decrees).
Archaeological sites / reserves	unkno	Land Information Centre	1:250,000	this is a dataset of Archaeological Reserves, probably digitized directly from the most recent 1:250,000 topographic sheets; this dataset only contains 8 sites and may not be the most recent of the Archaeological Reserve datasets
	1995	Paseo Pantera consortium	unknown	this dataset, re-published in Ford & Clarke's 2000 Maya Forest GIS database, contains points for 38 archaeological sites in Belize; the source of 37 of the 38 entries in the dataset is some other dataset called "National Geographic Land of the Mayas"
	2005	Meerman (National Protected Areas Policy & System Plan Project - NPAPSP)	1:100,000	this is a dataset of Archaeological Reserves; this contains 12 reserves
Spawning and Agreggation Sites	2003	Unknown	unknown	developed from the 2003 protected areas layer
	2011	Unknown	unknown	this was extracted from the 2011 protected areas layer to develop the spag sites that were added
Sites of Interest	2004	Meerman	1:50,000	this is a dataset of various sites of interest (caves, archaeological sites, peaks, quarries, cliffs and other similar points), digitized from the 1:50,000 survey sheets
MARXAN gap analysis results	2005	Meerman & Cawich (National Protected Areas Policy & System Plan Project - NPAPSP)	unknown	this dataset indicates possible priority areas for conservation; see Meerman report for full details on the generation of this dataset

7.5.4 Existing Systems

All relevant information and data is stored to a shared network drive. In addition, the data centre is equipped with the ESRI ArcGIS ArcView Desktop 10.0 and an Hp Design Jet 510 plotter.

7.5.5 Other Issues, Opportunities and Constraints

- Some relevant key issues that needs to be considered that may either streamline or constrain sharing of information with others in the BNSDI stakeholder community include: Inaccessibility to up-to-date and GIS-processable data, inefficient data discovery mechanism, lack of standardization, and absence of seamlessness in data layers.

8 MINISTRY OF TOURISM, CULTURE AND CIVIL AVIATION

8.1 Ministry and Belize Tourism Board

Person(s) Interviewed: Survey response and desk study research.

Survey Packet Response Date(s): 10 August, 2014
Desk Study Date(s): 16 September, 2014

8.1.1 Organization and Mission

The Ministry of Tourism, Culture and Civil Aviation (MTCCA) is a government entity that provides leadership, strategic direction, good governance and oversight on all matters relating to the development of tourism, culture and civil aviation for and on behalf of the Government of Belize. In this capacity, the Ministry is expected to ensure that tax revenues are being efficiently utilized to support the national development plans/ priorities as determined by the legislature and to enhance transparency and accountability in the overall governance of the sectors it represents.

The Ministry has direct oversight and is responsible for the following agencies: The Belize Tourism Board (BTB), the National Institute of Culture and History (NICH), the Border Management Agency (BMA), the Belize Airports Authority (BAA), the Department of Civil Aviation (DCA) and the Belize Archives and Records Service (BARS). In this respect, the Ministry is to facilitate and have oversight over the development of plans and policy and the delivery of those. The Ministry is also responsible for the coordination, reporting and finance of these agencies. This write-up addresses the oversight role of the Ministry and the Belize

Tourism Board. Other relevant divisions and entities are addressed in other write-ups where these have direct significance to the use of GIS and the BNSDI.

The Ministry serves as the primary liaison between the public and private sectors and is as a key facilitator with external agencies/partners for the overall development of tourism, culture and civil aviation in Belize. The Ministry is tasked with the responsibility of attending to all legal obligations/commitments; international conventions; agreements and other institutional arrangements on behalf of the Government of Belize.

The Ministry has 10 regular staff, excluding the Chief Executive Officer and Minister). Key functions of the organization include:

- To develop, maintain and enhance governance structures;
- To steward cross-sector coordination, integration and mainstreaming of activities geared towards the sustainable development of tourism, culture and civil aviation sub-sectors;
- To develop the necessary policies for the proper planning and sustainable development of the sub-sectors in compliance with international standards and norms;
- To ensure the relevance of the sub-sectors in conjunctions with national development plans/programs/priorities;
- To address the physical planning and infrastructure needs for the growth of the sub-sectors;
- To build investor confidence and facilitate new direct foreign investments;
- To safeguard employment conditions and promote job creation for Belizeans;
- To maximize the socio-economic benefits throughout the country of Belize; and,
- To adopt sound development principles for the sub-sectors it serves, in order to maximize the socio-economic benefits, minimize environmental impacts and improve socio-cultural welfare of Belizeans.

The Ministry and BTB addressed here carry out several primary activity areas that have some relevance to GIS and BNSDI including the following:

MINISTRY

1. Oversee portfolio governance
2. Represent tourism and aviation sectors in national planning and policy making
3. Oversee tourism planning and development
4. Oversee civil aviation planning, development and operations
5. Oversee culture and historic resources management

BELIZE TOURISM BOARD

6. Conduct planning for sustainable national tourism development
7. Manage tourism data

8.1.2 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

MINISTRY
Activities of the Ministry that have direct relevance to the use of GIS and the BNSDI are outlined in the sections following.

8.1.2.1 Oversee Portfolio governance

The Ministry is responsible for the oversight and coordination of the activities of all of its associated divisions and entities, and the alignment of tourism development with other national development needs and priorities.

Ways in which GIS and the BNSDI are relevant to this functional area include, but are not limited to the following:

- Maintain access to all Ministry geospatial and related data
- Facilitate GIS data coordination across the Ministry
- Facilitate access to BNSDI data network on behalf of Ministry departments
- Monitor and evaluate Ministry department projects and outcomes over time

8.1.2.2 Represent tourism and aviation sectors in national planning and policy making

The Ministry represents the issues, needs and priorities of the tourism and civil aviation sectors in Belize in regards to national planning and policy making. Tourism has been identified as a national development priority within the Belize Horizon 2030 plan. Aspects of this function that can be supported by GIS and the BNSDI include the following:

- Maintain geographically-based inventory of all tourism facilities, attractions and infrastructure;
- Maintain geographically-based inventory of all civil aviation facilities and infrastructure;
- Monitor tourism development issues and trends;
- Develop geographically based analysis of tourism development issues, opportunities and challenges and provide reporting and mapped visualizations to support policy and decision making.

8.1.2.3 Oversee tourism planning and development

The Ministry is responsible to oversee tourism planning in Belize, including the development of the National Sustainable Tourism Masterplan for Belize 2030 (see more details under BTB

below). In its oversight role, the uses of GIS and the BNSDI that would be relevant at the Ministry level include:

- Overview of existing tourism resources in the Country relative to projected or potential future demand;
- Overview of the infrastructure and program development of other sectors that could impact tourism development (transport, urban development, environmental resource management plans, public investment plans, etc.);
- Monitor tourism facility and infrastructure development;
- Monitor and evaluate tourism related revenue and tax generation over time.

BELIZE TOURISM BOARD

The mission of the Belize Tourism Board (BTB) continues to be, to market Belize both locally and internationally, and to direct tourism planning and development. The BTB has upheld its close relationship with the Ministry of Tourism & Culture and the private sector to develop and market Belize as a premier sustainable tourism destination.[46] Activities that have some relevance to the use of GIS and the BNSDI include, but are not limited to the following:

8.1.2.4 Conduct planning for sustainable national tourism development

The BTB has been involved in the development of the National Sustainable Tourism Masterplan for Belize 2030. The development and adoption of the National Sustainable Tourism Master Plan (NSTMP) laid out the development pathway of the tourism industry, focusing on making Belize a sustainable tourism destination, with a strong emphasis on product development revolving around six key product clusters, quality and standards, infrastructure, governance, and marketing. The NSTMP also identified the anticipated roles of all key actors and stakeholders in the implementation of the 20 year plan, including roles of the BTB, the MTCCA, the role of a Master Plan Execution Office (MPEO), the National Institute of Culture and History (NICH), and the private sector, among others. Functional areas of this activity that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Prepare location-based inventory of all touristic facilities, sites and attractions (cultural, nature-based, sun and beach, cruise, nautical, leisure and entertainment);
- Map historical and cultural routes;
- Assess tourism infrastructure capacity (transportation, water, energy, telecommunications, waste management, sewage, etc.);
- Plan, design and implement tourism oriented signage and wayfinding;
- Capture and manage tourism activities and revenues by location;
- Identify tourism development physical opportunities and constraints;
- Assess potential impacts of climate change on existing and potential tourism sites;
- Identify opportunities for tourism expansion plans in specific locations;
- Prepare and record tourism development plans for specific destinations;
- Conduct environmental impact assessments for tourism development plans;

[46] http://btb.travelbelize.org/btb/btb-overview/current-action-plan

- Promote and support private sector investment in tourism development at specific sites;
- Provide data and analysis tools for tourism development project formulation and finance;
- Monitor tourism development and revenues over time.

8.1.2.5 Manage tourism data

The Information Management Department was established as an addition to the recommendations of the BTB 2010-2012 Action Plan, with the goal of integrating and consolidating all of the BTB data needs, processing and analysis. An ***Integrated Tourism Management Database System (TMDS)*** was conceived as a central repository for the compilation, analysis and distribution of tourism related data, information and knowledge in Belize. The BTB is responsible for managing this repository intended to span market intelligence such as general market leads and mailing lists; registries and records including hotels, tour guides, retirees, cruise ships, and time shares; and statistical data such as protected area visitation, visitor arrivals and visitor expenditure, in addition to the financial and transaction data of the organization itself. This data is invaluable to policy makers and the private sector for effective advance planning, successful marketing, and to reinforce awareness of the fundamental value of tourism to the country of Belize.[47] This system is currently being implemented and monitored for effectiveness

Functional areas of this activity that can be supported by GIS and the BNSDI include, but are not limited to the following:

- Provide geographic basemap for recording, analyzing and visualizing current and historical tourism data;
- Provide analytical tools to project tourism site, infrastructure and program development based on alternative options and scenarios;
- Utilize geospatial tools to develop tourism development analyses and visualizations to keep leadership and investors informed of progress, trends and opportunities for investment.

8.1.3 Data Used or Generated

The following geographic and related information are being used or generated by the Ministry and its various divisions or related entities:

Belize Tourism Attractors Map. A map of tourism attractors was developed as part of the preparation of the National Sustainable Tourism Masterplan for Belize 2030.

[47] http://www.sustainabletourismbz.org/destinations/integrated-tourism-database.html

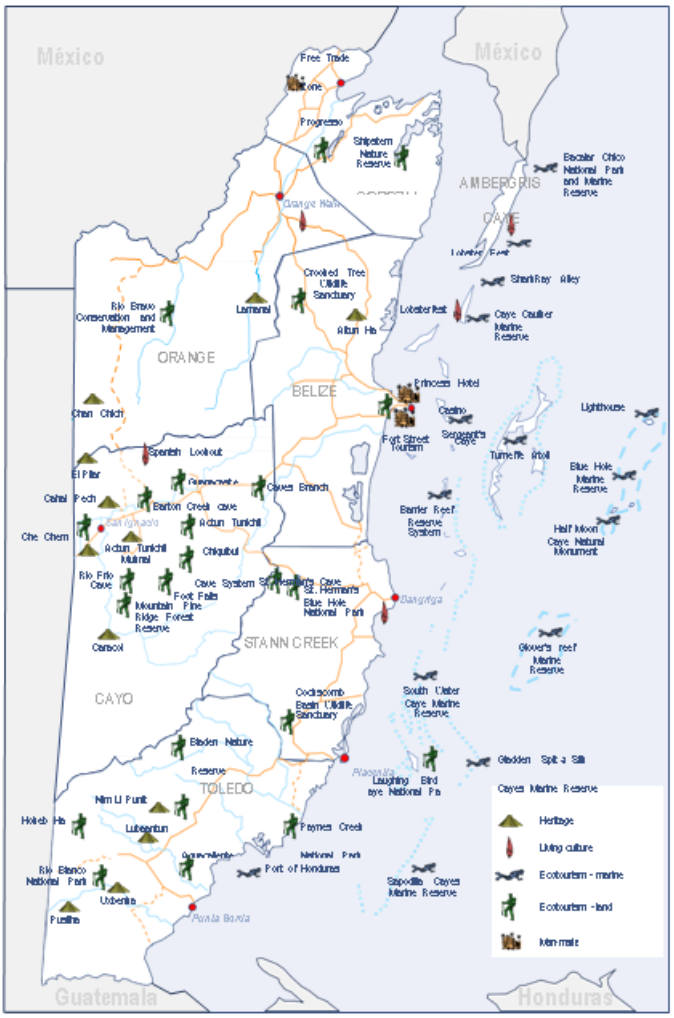

Figure 47 - Tourism Attractor Map of Belize

Road Network Map 2010. A map of tourism attractors was developed as part of the preparation of the National Sustainable Tourism Masterplan for Belize 2030. This depicts the major land surface routes connecting the major urban centers and touristic destinations in Belize.

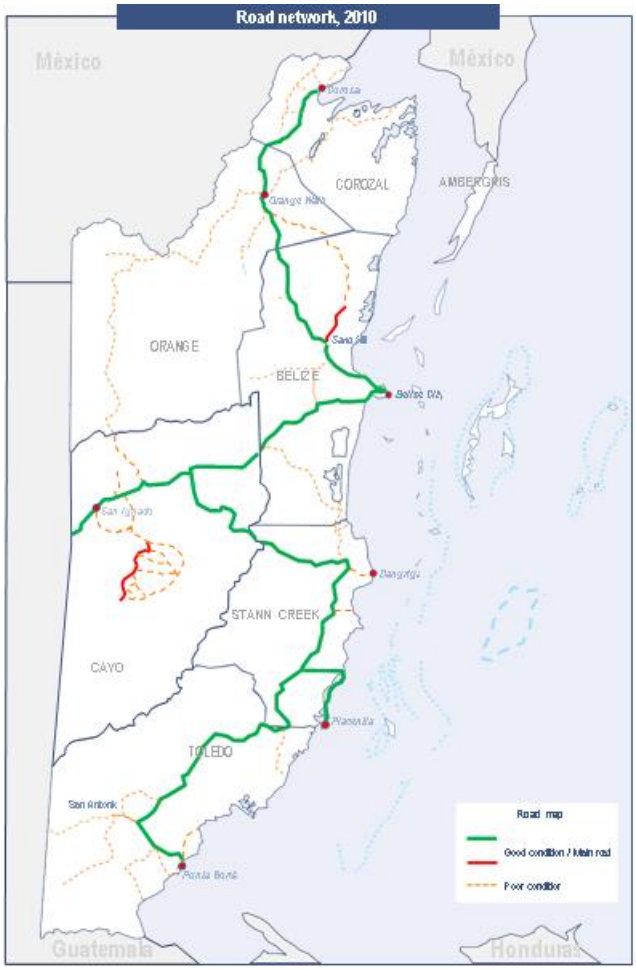

Figure 48 - Road Network 2010

Road Network Map 2010. A map of major land surface routes connecting the major urban centers and touristic destinations in Belize was developed as part of the preparation of the National Sustainable Tourism Masterplan for Belize 2030.

Regular Routes by Sea 2010. A map of regularly scheduled sea routes connecting the major coastal urban centers and touristic destinations in Belize was developed as part of the preparation of the National Sustainable Tourism Masterplan for Belize 2030.

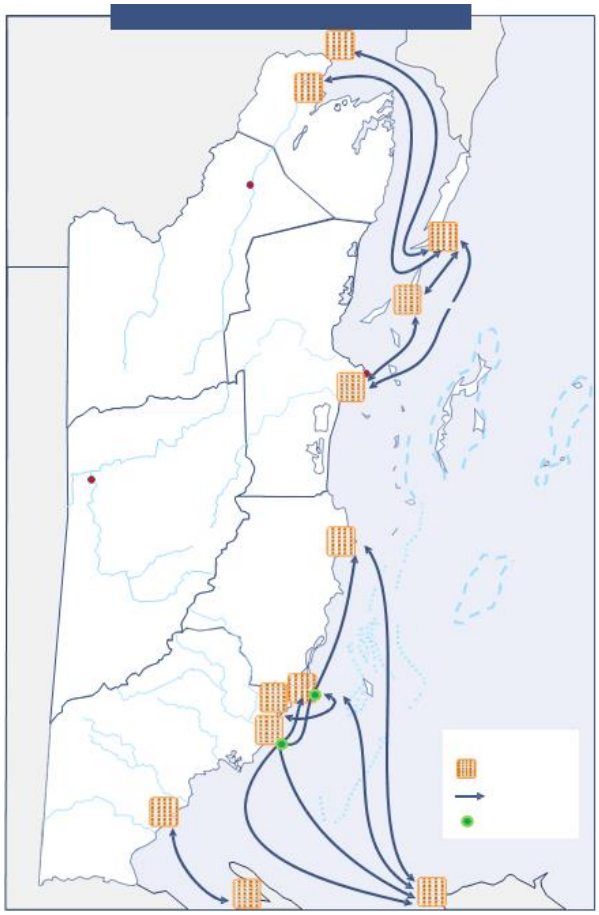

Figure 49 - Regular Routes by Sea 2010

Intensity of Visits. A map depicting the intensity of tourism visits was developed as part of the preparation of the National Sustainable Tourism Masterplan for Belize 2030.

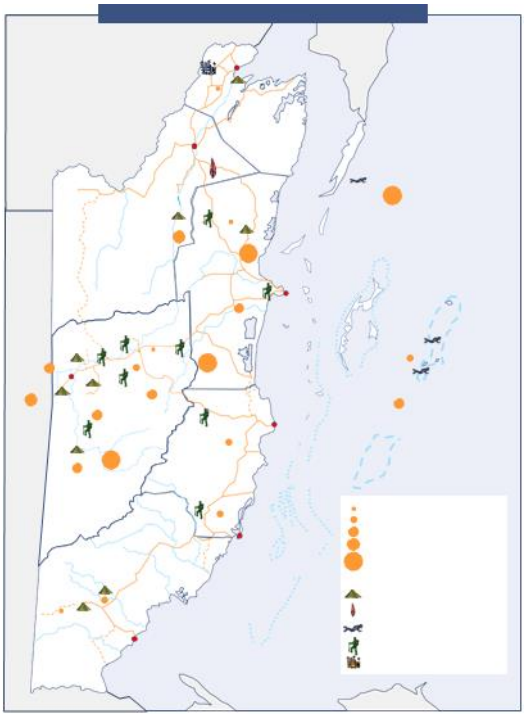

Figure 50 - Intensity of Visits per Type of Tourism Asset

General tourism development targets. A generalized map indicating areas and general tourism development approach as identified in the National Sustainable Tourism Masterplan for Belize 2030.

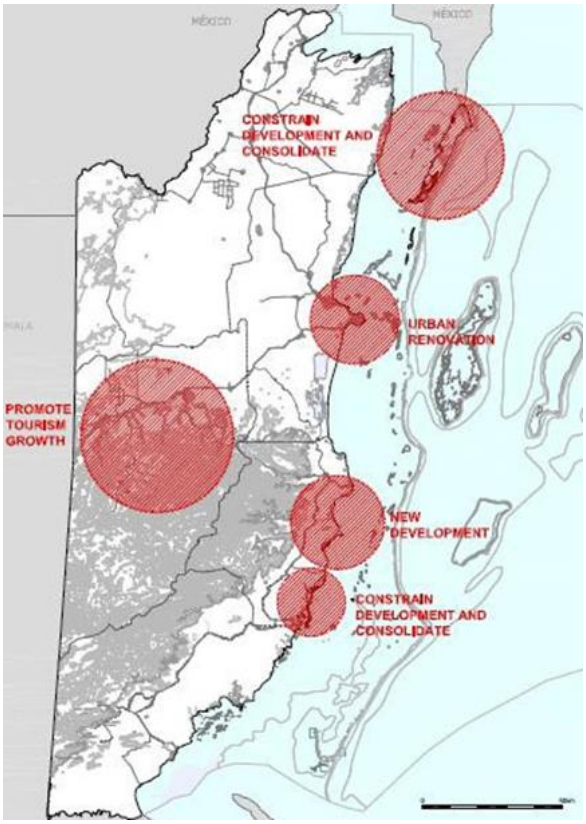

Figure 51 - Tourism Development Targets

Tourism Development Model – National Level. A generalized map indicating areas and general tourism development models identified in the National Sustainable Tourism Masterplan for Belize 2030.

Tourism development model for Belize- National level (2030)	
Development	High value/ low impact
Density	1 – 2 – 3
Overnights (2030)	5.895.376
Overnight growth (2010 – 2030)	2.88
Hotel rooms (2030)	13.754
New hotel rooms (2010 – 2030)	6.869

Figure 52 - Tourism Development Model - National Level

Tourism Development Model – Regional Level. A generalized map indicating areas and general tourism development models for a regional as identified in the National Sustainable Tourism Masterplan for Belize 2030.

Tourism development model for Central Coast Belize (2030)	
Development	Infill
Density	3
Overnights (2030)	897.376
Overnight growth (2010 – 2030)	2.92
Hotel rooms (2030)	2.026
New hotel rooms (2010 – 2030)	1.039

Figure 53 - Tourism Development Model - Regional Level

8.1.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

Integrated Tourism Management Database System (TMDS). No additional information provided.

8.1.5 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the Ministry:

- Build capacity in integrating GIS and more advanced information management
- Building infrastructure within the Ministry and linked with the agencies under the ministry to make use of available data and integrate our raw data into GIS.
- Capacity within line ministries
- Basic infrastructure to allow for linkages within and throughout sectors
- Financial Resources
- Up to date and current data are not available.
- Current data collection may not provide a comprehensive data map that would allow for decisions to be made effectively.

9 MINISTRY OF FINANCE AND ECONOMIC DEVELOPMENT

9.1 All Departments

Person(s) Interviewed
or providing information: Ms. Karlene McSweaney
Mr. Duane Belisle

Interview Date(s): NA

9.1.1 Organization and Mission

The mission of the Ministry of Finance and Economic Development is to advise on, coordinate and implement the government's economic and fiscal policies and programs including the generation and allocation of financial resources to provide appropriate public services and to contribute to the overall development of Belize.

The stated vision of the organization is to improve the quality of life for all citizens and residents of Belize through the efficient and effective allocation of financial resources and the promotion of sound economic and financial policies and programs. The strategic objectives of the Ministry are to:

- Maintain appropriate levels of government spending to contain imports and so maintain the stability of the exchange rate peg;
- Contain public sector external debt and debt service payments to sustainable levels;
- Provide infrastructure development to stimulate investment and economic activity and hence growth in GDP;
- Promote social policies to assist the most vulnerable groups in society;
- Promote security of the populace and guard natural resources;
- Achieve Fiscal sustainability and improved financial management practices;
- Strengthen the framework for financial accountability and oversight;
- Reform and modernize the revenue collection and tax regime;
- Pursue effective money and credit policies.

9.1.2 Activity Areas

The Ministry plays a key financial coordination and tracking role that will be key to the BNSDI in the future. The most effective SDI initiatives nearly always include a function to:

- review proposed project plans across all sectors;
- identify the geospatial and related data requirements of those projects;

- advise the project sponsors of information that may already exist that may be of use to the project;
- identify any data gaps that will require new data collection or compilation; and,
- establish a coordination mechanism to ensure that any new data that is produced from each project is done so in a manner that, to the extent practical, is structured in a manner that can be used for other purposes across the SDI community in the future.

The Ministry has visibility to all public investment projects whether internally financed by the Government of Belize (GoB) or financed through external sources. Many of the capital expenditure projects require access to quality information about the places they are to be located, the infrastructure or facilities they relate to, the populations they are intended to serve, and the benefits to be provided. They must also be defined in a manner that avoids or mitigates adverse environmental and social impacts. These projects fall into several discrete categories as used in structuring the Ministry's Public Sector Investment Program reports:

- Infrastructure
    - Roads, streets, drains and bridges
    - Buildings
    - Water and sanitation
    - Transportation and communication
    - Electricity
- Economic Services
    - Agriculture
    - Tourism
    - Business and market development
    - Environment and natural resource management
- Social Protection
    - Education
    - Health
    - Poverty and social protection
- Public Administration
    - Governance
    - Security and civil rights

The primary sources for public sector investment include the following, along with the % of Ongoing PSIP for 2012 and 2013, to illustrate the range and type of finance for development projects:

Institution	Acronym	Total Funding (Bzd 2012)	% of Ongoing PSIP (2012)	Total Funding (Bzd 2013)	% of Ongoing PSIP (2013)
Central American Bank for Economic Integration	CABEI	$ 25,211,600	4.4	$ 25,211,600	3.6
Caribbean Development Bank	CDB	$ 111,148,852	19.5	$ 135,053,011	19.5
European Union	EU	$ 63,765,780	11.2	$ 121,986,025	17.6
InterAmerican Development Bank	IADB	$ 114,494,000	20.1	$ 110,007,863	15.9
World Bank	WB	$ 35,505,788	6.2	$ 35,992,288	5.2
Government of Belize	GOB	$ 80,486,847	14.1	$ 94,021,038	13.6
Other*	Other	$ 139,581,534	24.5	$ 171,583,322	24.7
		$ 570,194,401	100.0	$ 693,855,147	100.0

Table 13 - PSIP by Source Institution for 2012 and 2013

While the project submission, management and reporting requirements of the various donors varies depending on the type of project, type of funding and other factors from organization to organization, each follows a similar process. The stages of project development that are relevant to GIS and the BNSDI can be generally characterized as including the following:

Country strategy. Each international finance institution (IFI) will usually have an investment strategy that has been worked out in collaboration with the host country. This provides the strategic framework within which specific programs and projects are to be defined.

Project identification. Identifies the general parameters for a specific project that aligns with the priorities expressed in the country strategy. Project identification is normally carried out in collaboration between the IFI and the appropriate responsible authority in each sector. Once a project is identified, this may trigger the issue becoming an element in an IFI's finance "pipeline".

Preparation. The preparation process involves further definition of the project, often in direct consultation with the direct project proponents at the sector level. Ideally this preparation takes advantage of up to date and authoritative data upon which project priorities and assumptions can be based. This may also involve the preparation of feasibility analysis and other studies ensuring that the proposed project is viable and in compliance with environmental and social safeguards and other such criteria.

Appraisal. Project appraisal involves independent evaluation of the project efficacy and feasibility. This may include an assessment of the need for the project and its feasibility though technical, socioeconomic, financial, legal, and environmental analysis.

Approval. The approval process involves final review and commitment on the part of both the country and the IFI.

Implementation. Project execution is carried out by a team that may include government staff, contractors and other participants. Contractor support would normally be secured through a competitive bidding process. Project Management Office (PMO) functions within the government will normally oversee the implementation process, often with oversight and support of the IFI.

Monitoring and evaluation. Monitoring and evaluation activities may be carried out throughout the project formulation and implementation process, including a final evaluation at project completion. Ideally this activity is extended by the country and or IFI into the future to evaluate the cumulative impacts of multiple projects based on evidence-based data of target socio-economic and environmental conditions, with calibration of the country strategy based on impact findings over time.

Each of the stages mentioned above requires good information for solid decision making. Where up to date and authoritative information is available, as is the intention of the BNSDI, this can help both to streamline and strengthen the project formulation process as well as the project review and approval process. The BNSDI would also provide a foundation for recognizing potential for project alignment and coordination across sectors where opportunities for mutual benefit and synergy exist.

The following sections provide an overview of the types of projects being carried out in Belize over the past two years, and a listing of the ways that GIS and the BNSDI could support such activities. This is intended to illustrate the utility of GIS and the BNSDI, both as input to the later requirements analysis and the shaping of recommendations for how the BNSDI can support the strengthening and optimizing of development investment in the country. These same activities in some cases are listed in the write-ups for each of the individual agencies carrying out these projects, but listed here both to ensure that all relevant activities are covered and to further illustrate the importance of this Ministry's visibility to development investment works across all sectors.

9.1.2.1 Conduct infrastructure investment projects.

This sector includes the definition, formulation and implementation of capital infrastructure projects including roads, streets, drains and bridges, buildings, water and sanitation, transportation and communication and electricity.

The types of projects being carried out in this sector that have some relevance to GIS and the BNSDI are summarized in the following table:

Type of Project	GIS and BNSDI Relevance
Planning and design of transportation network facilities and upgrades	▪ Accurate and up to date inventory and condition assessment of existing transportation infrastructure; ▪ Trip origination and destination assessment; ▪ Traffic modeling and capacity analysis;

	▪ Identification and analysis of transport network construction and upgrade options; ▪ Identification, formulation and feasibility analysis for transport master plan and associated priority projects.
Bridge construction and refurbishment	▪ Inventory and condition assessment of existing bridges; ▪ Identify bridge vulnerability to natural disasters and importance to emergency response activities; ▪ Identification, formulation and feasibility analysis for priority bridge construction and refurbishing projects.
Road and highway construction and refurbishment	▪ Provide basemap and geophysical data to support roadway and highway engineering design; ▪ Provide geographically based project tracking and management system; ▪ Produce transportation asset inventory to support maintenance and financial asset management activities;
Improve road safety	▪ Map and assess traffic accidents and other road safety related events; ▪ Analyze road safety issues, opportunities and constraints; ▪ Identify road safety intervention measures ▪ Prepare plan for road safety intervention actions; ▪ Track and manage road safety intervention actions; ▪ Monitor and evaluate road safety interventions and calibrate plans to optimize positive impacts and improvements over time.
Rehabilitation and construction of drainage facilities	▪ Assess drainage facility capacity and vulnerability to major storm events; ▪ Provide basemap and geophysical data to support drainage facility engineering design; ▪ Provide geographically based project tracking system; ▪ Produce drainable asset inventory to support maintenance and financial asset management activities;
Preparation of feasibility studies for roads and bridges	▪ Provide basemap, geophysical and environmental data to support road and bridge feasibility assessments; ▪ Provide geographically based bibliography for transportation studies;
Improve road and drainage conditions in selected communities as part of poverty alleviation program	▪ Provide access to population census socio-economic information to identify the most economically disadvantaged communities and neighborhoods; ▪ Utilize poverty information as another dimension for the prioritization of road and drainage capital investment projects
General improvement of municipal infrastructure and its management	▪ Provide access to municipal infrastructure asset information; ▪ Provide access to land use and population data; ▪ Provide access to land ownership and tenure information; ▪ Identify natural hazards and associated vulnerability of municipal infrastructure ▪ Provide geospatial tools for municipal infrastructure assessment and planning.
Construction and refurbishment of community facility buildings (police, school, sports stadium, mental health, library, youth center, elderly housing, market, etc.)	▪ Provide access to community facility asset information; ▪ Provide access to existing land use and population data; ▪ Provide access to land use plans and projections; ▪ Provide access to land ownership and tenure information; ▪ Provide geospatial tools for community facility assessment, planning and siting.
Upgrade and rehabilitation of airstrip facilities	▪ Inventory and condition assessment of existing airstrips and helipads; ▪ Preparation of upgrade and rehabilitation plans for priority airstrips and helipads; ▪ Track and manage airstrip and helipad upgrade projects.

Planning and design of potable water network facilities and upgrades	▪ Accurate and up to date inventory and condition assessment of existing potable water infrastructure; ▪ Current and near term future water demand analysis; ▪ Water system modeling and capacity analysis; ▪ Identification and analysis of water network construction and upgrade options; ▪ Identification, formulation and feasibility analysis for potable water master plan and associated priority projects.
Design of potable water supply systems and upgrade projects	▪ Provide basemap and geophysical data to support potable water facility engineering design; ▪ Provide geographically based project tracking system; ▪ Produce potable water system asset inventory to support operations and maintenance and financial asset management activities;
Construction and upgrading of potable water production and storage facilities	▪ Provide access to water resource master plan information ▪ Provide basemap and geophysical data to support potable water production engineering design; ▪ Provide geographically based project tracking system; ▪ Produce potable water production system asset inventory to support operations and maintenance and financial asset management activities;
Construction and upgrading of water supply network	▪ Provide basemap and contextual data to support water supply network engineering design; ▪ Provide geographically based project tracking system; ▪ Produce water supply network asset inventory to support maintenance and financial asset management activities;
Improve rural water and sanitation governance	▪ Inventory and assessment of rural water supplies, including quantity and quality of extracted water; ▪ Inventory and assessment of sanitation facilities; ▪ Provide access to rural building and population data; ▪ Establish a mapped basis indicating the location and jurisdiction of all local water boards.
Construction and upgrading of sanitary sewer system	▪ Accurate and up to date inventory and condition assessment of existing sanitary sewer infrastructure; ▪ Provide access to existing and planned land use information; ▪ Current and near term future sewer system demand analysis; ▪ Sewer system modeling and capacity analysis; ▪ Identification and analysis of sewer network construction and upgrade options; ▪ Identification, formulation and feasibility analysis for sewer master plan and associated priority projects.
Institutional capacity building for water system governance	▪ Incorporate GIS management and technical capacity building in to the water system governance program
Development of solar energy generation demonstration project	▪ Conduct geospatial siting analysis for optimum location for solar energy generation demonstration project;
Provision of electricity from renewable energy sources to rural and peri-urban areas	▪ Conduct geospatial analysis for high potential renewable energy sources (solar, hydro, biomass, wind, etc.); ▪ Identification of rural and peri-urban economically disadvantaged neighborhoods; ▪ Identification, formulation and feasibility analysis for sewer master plan and associated priority projects.
Extend electrical services to disadvantaged communities	▪ Identification of economically disadvantaged neighborhoods; ▪ Identification, formulation and feasibility analysis for electrical network

	extension projects.

9.1.2.2 Conduct economic service investment projects.

This sector includes the definition, formulation and implementation of capital infrastructure and related projects including agriculture, tourism, business and market development and environment and natural resource management.

The types of projects being carried out in this sector that have some relevance to GIS and the BNSDI are summarized in the following table:

Type of Project	**GIS and BNSDI Relevance**
Plan, design and implement agriculture services program	▪ Develop a geographically based inventory of the existing and potential demand for agricultural services; ▪ Develop a geographically based inventory of the existing and planned provision of agricultural services; ▪ Conduct a geographically based gap analysis between the demand for agricultural services and the existing and planned supply programs and activities; ▪ Prepare plan for the augmentation of agricultural services to fill gaps; ▪ Monitor and evaluate agricultural service provision and use findings to calibrate service provision programs for maximum positive impact;
Promote and support the development of integrated farming systems	▪ Provide geographically based farm inventory; ▪ Assess potential and readiness for integrated farming system introduction; ▪ Prepare plan for outreach and capacity building program; ▪ Monitor program execution; ▪ Monitor and evaluate program outcomes over time, and calibrate plans and activities to reflect lessons learned and evolving context.
Upgrade research and extension facilities	▪ Add GIS and utilization of the information resources of the BNSDI as a focal research and extension support function within the agricultural sector
Conduct farmer training and capacity building activities	▪ Support farmer training and extension service capacity building
Prepare agriculture irrigation and drainage policy and national strategic plan	▪ Provide national inventory and assessment of farms; ▪ Identify irrigation and drainage issues; ▪ Prepare geographically based agriculture irrigation and drainage strategy.
Conduct community project for improvement of agriculture production for poor families	▪ Provide access to population census socio-economic data at the community and neighborhood levels; ▪ Identify target populations for improvement of agricultural production; ▪ Assess and record community level needs and priorities; ▪ Prepare and record community based agriculture production improvement mechanisms; ▪ Track and manage community based agriculture production improvement mechanisms; ▪ Monitor and evaluation the effectiveness of community based agriculture production improvement activities and calibrate plans and activities to optimize positive impact over time.
Promote and provide training for better agriculture technology and methods	▪ Provide access to population census socio-economic data at the community and neighborhood levels for rural areas; ▪ Provide access to geographically based agricultural census;

	▪ Identify target beneficiary communities for training, and define the technologies and methods that may be appropriate for each based on existing situation and context. ▪ Track training activities geographically; ▪ Monitor and evaluate program outcomes over time.
Support the expansion of rice seed production	▪ Provide access to geographically based agricultural census; ▪ Inventory and assess existing rice cultivation and identify areas for potential future expansion; ▪ Track seed distribution; ▪ Monitor and evaluate rice production over time and adjust program efforts to maximize positive outcomes.
Promote and provide training for better food processing technology and methods	▪ Provide access to population census socio-economic data at the community and neighborhood levels for rural areas; ▪ Provide access to geographically based agricultural census; ▪ Provide geographically based inventory of existing food processing plants including accounting of what technologies are being used currently; ▪ Identify target beneficiary stakeholders for training for food processing technologies and methods; ▪ Track training activities geographically; ▪ Monitor and evaluate program outcomes over time.
Promote and provide training for better aquaculture technology and methods	▪ Provide access to population census socio-economic data at the community and neighborhood levels for rural areas; ▪ Provide access to geographically based agricultural census, inclusive of aquaculture sites; ▪ Identify target beneficiary stakeholders for training for aquaculture technologies and methods; ▪ Track training activities geographically; ▪ Monitor and evaluate program outcomes over time.
Conduct capacity building to improve agriculture disease management	▪ Provide geographically based agriculture disease and pest monitoring and assessment system; ▪ Establish mobile phone based agricultural extension service for disease diagnosis; ▪ Track disease incidence and spread; ▪ Develop and apply intervention strategies to stop disease spread; ▪ Monitor and evaluation system effectiveness over time and improve/refine systems based on lessons learned and new disease or pest challenges/
Conduct national cattle testing and certification program	▪ Provide access to geographically based agricultural census, inclusive of cattle farming sites; ▪ Prepare cattle testing and certification plan; ▪ Conduct and track cattle testing and certification activities; ▪ Track meat products from farm to fork or export.
Prepare master plan for the improvement of sustainable tourism	▪ Prepare inventory of existing high potential tourism resources and facilities ▪ Assess resource pressures and sustainability; ▪ Assess potential for diversification of overnight tourism product for emerging destinations
Support targeted lending	▪ Identify areas for targeted lending based on criteria (low-income housing, agriculture, industrial development, etc.); ▪ Conduct feasibility and lending risk analysis; ▪ Monitor and evaluation loan performance and development outcomes.
Support capacity building for Belize Coalition of Service	▪ Record location and characteristics of Coalition members; ▪ Monitor and assess program member performance

Providers	
Support financial services for poor farmers and rural communities	▪ Conduct population data analysis to identify target neighborhoods; ▪ Inventory and record access to existing financial services; ▪ Conduct geographically based analysis of financial service gaps; ▪ Prepare master plan for improvement of specific financial services within each target community, neighborhood or farming area; ▪ Track and assess utilization of financial services over time.
Administer small scale enterprise grants	▪ Identify target areas for small scale enterprise grants; ▪ Track the location and characteristics of grant applications; ▪ Conduct rapid feasibility analysis for small grant applications and advise candidates of areas for improvement; ▪ Track the location, characteristics and performance of grantee enterprises.
Promote and support rural household employment in gardening and horticulture	▪ Identify target areas and populations; ▪ Prepare outreach and engagement program by area; ▪ Track and monitor program activities
Plan, design and support development of specialized economic development facilities	▪ Assess areas for special economic development (e.g. Maya House of Cacao and Chocolate Museum or National Enterprise Development Center) ▪ Conduct geographic siting analysis; ▪ Provide geographically based project tracking system; ▪ Monitor and evaluate
Improvement of land management capacity	▪ Inventory and characteristics of land ownership and tenure status for all lands in Belize ▪ Provide tools for the processing and tracking of land tenure transactions; ▪ Provide access to land tenure information by all agencies involved in land administration, management and infrastructure activities;
Improvement of solid waste management capacity	▪ Prepare geographically based assessment of current and projected future waste stream processes; ▪ Conduct landfill siting analysis in consideration of waste generation, transport and environmental issues, opportunities and constraints; ▪ Monitor and evaluate landfill operations and impacts over time.
Strengthen protected areas management	▪ Provide mapped inventory of the location, boundaries and resources of each land or marine protected areas; ▪ Identify key threats to each protected area; ▪ Conduct protected area gap analysis (spatial, policy, legal, etc.) ▪ Prepare and implement protected area strengthening plan; ▪ Monitor effectiveness of protected area management programs over time
Strengthen capacity for climate change adaptation planning and reporting	▪ Provide access to relevant information from all sectors ▪ Conduct climate change hazard assessment; ▪ Conduct climate change vulnerability assessment for populations, infrastructure and resources at risk; ▪ Develop plans for climate change adaptation in all sectors; ▪ Monitor climate change variables and calibrate adaptation schemes according to observations and refined projections over time; ▪ Calculate and report on carbon emission reductions, climate change observations, planning and reporting to the UNFCC COP and other venues.
Manage marine fisheries	▪ Inventory and assessment of commercial and recreational fish stock within Belize territorial waters; ▪ Prepare fisheries forecasts under status quo; ▪ Define sustainable fisheries intervention options and assess the environmental and economic impacts of each;

	▪ Develop and record sustainable fisheries program; ▪ Implement fisheries management programs, including definition of enforcement areas and actions to be taken; ▪ Record and manage fisheries program assets; ▪ Support public education programs with map and geographic visualizations regarding fisheries issues and responses; ▪ Monitor fisheries conditions and calibrate programs to maintain sustainability over time.
Manage pollutant release and transfer registration.	▪ Register geographically and report permitted and accidental pollutant releases to land, sea and air; ▪ Track the transfer of hazardous chemicals; ▪ Assess potential hazards and vulnerabilities for pollutant and hazardous material storage, transfer, or accidental release; ▪ Prepare and record emergency response contingency plans for pollutant and hazardous material release; ▪ Support the management of cleanup and recovery efforts following accidental pollutant or hazardous material release; ▪ Monitor environmental and social cumulative impacts of permitted pollutant release over time.

9.1.2.3 Conduct social protection investment projects.

This sector includes the definition, formulation and implementation of capital infrastructure and related projects for public education, health, poverty alleviation and social protection.

The types of projects being carried out in this sector that have some relevance to GIS and the BNSDI are summarized in the following table:

Type of Project	**GIS and BNSDI Relevance**
Enhancement of education policies, strategies and facilities	▪ Mapped inventory and assessment of schools and school facilities, assets, students and programs; ▪ Identification of education targets and gaps by school district; ▪ Identification of policies and strategies needed to improve the education sector nationally and specific foci within each district; ▪ Identification of requirements for new schools, or the extension or refurbishment of existing schools; ▪ Identification of community specific teacher training program requirements; ▪ Provide a geographically based school project tracking and management system; ▪ Provide a geographically based school facility space planning, maintenance and asset management system.
Control and prevention of HIV/AIDS	▪ Provide a geographically based inventory of current and past HIV/AIDS incidence; ▪ Identify exposed and vulnerable populations to HIV/AIDS spread; ▪ Develop geographically targeted programs to control and prevent HIV/AIDS spread;
Improvement of children's health and nutrition	▪ Provide access to population census data at the neighborhood level; ▪ Identify poorest and most vulnerable populations; ▪ Inventory and assess capacity of existing NGO's and community based

	organizations; ▪ Develop and record geographically based assessment of child health and nutrition issues in target communities and neighborhoods; ▪ Develop and record child health and nutrition intervention strategies at the community and neighborhood levels; ▪ Support the development of community based programs to enhance child health and nutrition programs; ▪ Monitor and assess child health and nutrition program effectiveness over time and calibrate programs to maximize positive outcomes.
Improve health conditions among the poorest populations	▪ Provide access to population census data at the neighborhood level; ▪ Identify poorest and most vulnerable populations; ▪ Inventory and assess capacity of existing NGO's and community based organizations; ▪ Develop and record geographically based assessment of local health conditions; ▪ Develop and record health improvement strategies at the community and neighborhood levels; ▪ Support the development of community based programs to enhance community health initiatives; ▪ Monitor and assess health program effectiveness over time and calibrate programs to maximize positive outcomes.
Develop plans for the achievement of target MDG's	▪ Provide access to multi-sector data that relates to MDG's; ▪ Conduct MDG assessment at the community and neighborhood levels to the extent this can be supported by available information; ▪ Develop community level requirements analysis for the achievement of target MDG's; ▪ Develop and record community level interventions for the achievement of target MDG's; ▪ Implement and track intervention program activities; ▪ Monitor and assess health program effectiveness over time and calibrate programs to maximize positive outcomes.
Support the development of social transformation and poverty alleviation projects	▪ Provide access to community level analysis of social and economic conditions and trends; ▪ Geocode neighborhood social and economic surveys; ▪ Support neighborhood level analysis of social and economic issues and opportunities; ▪ Develop and assess alternative program elements for addressing social and economic issues; ▪ Plan and implement social programs and track progress at the community and neighborhood levels; ▪ Monitor and assess social and economic program effectiveness over time and calibrate programs to maximize positive outcomes.
Conduct customs reform	▪ Support the capture of trade data include recording for good the point of entry and shipping destination.
Computerization of Driver's Licensing system	▪ Support the standardization and integration of the nationwide system; ▪ Support geocoding of driver home address; ▪ Support linkage of driver license information to geocoded traffic ticket and accident reports;
Assessment and upgrade to the PSIP-MIS	▪ Provide a foundation for recording and tracking PSIP's by location; ▪ Provide access to geospatial information from all sectors to support better project formulation and appraisal; ▪ Assess PSIP geographic distribution and potential interrelationships,

	providing a basis for better project coordination and alignment; ▪ Provide tools for the reporting of project status, monitoring and evaluation according to the requirements of each donor or IFI; ▪ Provide geographic based tools for PSIP monitoring and evaluation, individually and cumulatively.
Enhance rural development program activities	▪ Provide geographic based assessment of rural development issues, opportunities and constraints; ▪ Develop and maintain location-based inventory of rural small and medium sized micro-enterprises; ▪ Assess infrastructure requirements and gaps for rural small and medium sized micro-enterprises; ▪ Develop community and neighborhood specific plans for the enhancement of rural small and medium sized micro-enterprises.
Develop and manage disaster risk management plan	▪ Assess natural disaster risks nationally; ▪ Identify vulnerable populations, infrastructure and resources at risk; ▪ Prepare disaster mitigation and emergency response contingency plans; ▪ Identify and record the locations and inventory of government owned and other potential disaster response assets; ▪ Support disaster response activities; ▪ Support disaster cleanup and recovery process; ▪ Support disaster resistant community planning and design; ▪ Monitor climate change trends, forecast impacts to disaster emergency preparedness and calibrate planning and emergency preparedness plans over time.
Support public safety and crime prevention	▪ Provide data and tools to support crime analysis and response support; ▪ Provide a basis for geocoding crime incidents; ▪ Provide geographic map basis for computer aided police dispatch; ▪ Provide vehicle tracking capability.
Support fire safety	▪ Conduct geographically based assessment of fire hazard and vulnerability; ▪ Provide geographic basis for the inventory and assessment of existing fire response facilities and assets; ▪ Assess the need for and siting of new fire stations; ▪ Assess the need for and siting of new fire hydrants.

9.1.3 Data Used or Generated

No additional information provided

9.1.4 Existing Systems

No additional information provided

9.1.5 Issues, Opportunities and Constraints

None stated.

9.2 Central Information Technology Organization

Agency Representatives: Michelle Longsworth, Director, michelle.longsworth@cito.gov.bz
John Robateau, Systems Analyst, john.robateau@cito.gov.bz
Response Date: 7/18/2014

9.2.1 Organization and Mission

The Central Information Technology Office (CITO) was established in 2004 from the Belmopan Computer Center which had been re-organized in 1999 under the FMDP Project (1997) to provide Management, Administration and Support for the newly implemented Government of Belize Wide Area Network (GoB WAN) and its Enterprise Applications. The Central Information Technology Office is dedicated to providing efficient and effective Information Technology and Information Systems services for the Government of Belize Wide Area Network and the wider public service as required by the Government of Belize, through the provision of state-of–the art Information and Communication Technology (ICT) services, delivered by highly qualified and dedicated ICT professionals in a most cost effective and responsive environment.[48]

The main Strategic Objectives of the CITO are to:

- Ensure that the GoB WAN provides the computer tools required for the framework agreed with the stakeholders of the network;
- Ensure that the implemented GoB WAN relational database management systems which support the various implemented applications are administered, maintained and monitored;
- Ensure that all the GoB WAN network security, network management, emergency recovery procedures, and user group management issues are implemented, administered, monitored and addressed;
- Evaluate, recommend and advise on the selection and creation of IS/IT/ICT Systems for, and on behalf of the Ministry of Finance;
- Develop IS/IT/ICT policies, standards, best practices and guidelines for the GoB WAN;
- Provide leadership and guidance to the GoB and the wider public service in the delivery of IS/IT/ICT services;
- Foster strong professional relationships with private sector companies and local educational institutions in furtherance of the development of IS/IT/ICT in Belize;

The Vision of the Central Information Technology Office is to excel in delivering Information and Communication Technology management, support, development and strategy formulation for the Government of Belize Wide Area Network and the Wider Public Service that enables the vigorous pursuit of excellence , and in doing so, be valued by their clients as a source of expert advice and support.

[48] http://unpan1.un.org/intradoc/groups/public/documents/un-dpadm/unpan048994~1.pdf

The Mission of the CITO is dedicated to providing efficient and effective Information Technology and Information Systems services for the Government of Belize Wide Area Network and the wider public service as required by the Government of Belize, through the provision of state-of-the-art Information and Communication Technology (ICT) services, delivered by highly qualified and dedicated ICT professionals in a most cost effective and responsive environment.

CITO is responsible to provide support to all 94 sites country wide and all equipment at each site which includes most government offices country-wide. The CITO is presently staffed with 30 GoB employees, inclusive of 26 technical staff and 4 administrative employees.

CITO comprises 6 sections, including the following:

- System Analysis and Software Development;
- Network Security and Infrastructure;
- System Administration;
- Database Management and Help Desk Support;
- Policy and Training
- Administrative Support.

The CITO carries out several functions that are of particular relevance to GIS and the BNSDI, including the following:

1. Develop and oversee ICT plans, policies, procedures, guidelines and standards;
2. Support government-wide e-solutions and applications;
3. Provide data center and internet services;
4. Provide information security services;
5. Develop and implement E-Government and ICT policies, strategy and plan of action;
6. Provide ICT related training to government employees and the general public;
7. Conduct eGovernment and ICT stakeholder engagement and coordination across government.

9.2.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that are most relevant to the use of GIS technology among the stakeholders and various aspects of the Belize NSDI.

9.2.2.1 9.4 Develop and oversee ICT plans, policies, procedures, guidelines and standards.

CITO is responsible for the development of ICT policies, procedures, guidelines and standards based on international sound practice and to be applied by all government agencies. Work has been initiated in the development of a comprehensive e-Government strategy which is currently in rough draft form now.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Ensure that ICT policies, procedures, guidelines and standards reflect and support matters that are specific to geospatial data and application services and the objectives of the BNSDI;

9.2.2.2 Plan, develop and manage GoB network

CITO is involved in the planning, development and management of the GoB Wide Area Network (WAN).

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Ensure that the current and planned GoB network considers and can support the type and level of network traffic that could be generated though the BNSDI.

9.2.2.3 Support government-wide e-services and applications

CITO is involved in the planning, implementation and support of key government-wide e-services and applications and web services for the government. These include applications support for SmartStream, SIGTAS, GICS, Email and websites. A summary of each system follows:

SmartStream. CITO has implemented the SmartStream accounting and payroll system. Smart Stream is a recognised leader in financial transaction management solutions that enables firms to streamline operations and increase customer service value through increased automation.

SIGTAS is a modern tax administration system that allows governments to improve tax compliance and thus increase collected revenue. Implemented in more than 20 countries, it can take care of any tax type via parameter setting. It includes specialized modules like VAT, Property tax, Licenses, Motor Vehicle and E-filing. SIGTAS aims to improve a country or a state/province tax compliance which should in return increase the government collected revenue (tax-to-GDP ratio).[49] The software and database (Oracle) are being used to support the GoB income tax and general sales tax offices.

Government Integrated Collection System (GICS). CITO has implemented a government integrated collection system (GICS) to consolidate, standardize and better

[49] http://www-304.ibm.com/partnerworld/gsd/solutiondetails.do?solution=48530&expand=true

coordinate government revenue collections and tracking. This function has been integrated into the SmartStream system.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- CITO is currently facilitating acquiring a government site license for ESRI's ArcGIS software;
- Beyond the basic software and associated functional modules there will be a variety of geospatial services that could be useful for multiple organizations. Consideration will need to be given to where and how these services should be provided to the BNSDI community;

9.2.2.4 Provide data center and internet services

CITO currently acts as the Data Center for the GoB by hosting servers for ministries/departments as well as providing virtual servers to those who are in need of servers and server space. CITO does not at present get involved in identifying common data and application requirements across government, although a need to do this has been implied during stakeholder meetings held as part of the Strategy development process. The need for central coordination of "fundamental registries" (e.g. integrated national registries for personal ID's, buildings, plots, vehicles, projects, etc.).

CITO also acts as the internet gateway for the GoB and manages the .gov.bz DNS service.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Ensure that the current and planned GoB network considers and can support the type and level of network traffic that could be generated though the BNSDI.

9.2.2.5 Provide information security services.

CITO operates a Security Operations Center (SOC) for GOB that collects, detects, alarms, processes, notifies, respond, analyzes, traces, monitors and performs all other activities that are relevant to Information Security. The government recently initiated a planning process for a secure government data center, inclusive of extensive measures for network and information security. There is a process underway to have this Center become ISO 20701 certified.

There was previously a National ICT Center. In 2012 this Center was combined with CITO and this Center is fully staffed and functional.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Establish a geospatial data security framework within the overall ICT security

strategy

- Ensure that proper credentials and channels are established to allow access to sensitive geospatial data only by authorized persons.

9.2.2.6 Develop and implement E-Government and ICT policies, strategy and plan of action

Once the strategic plan is completed, CITO will develop and implement a comprehensive set of e-Government and ICT policies that are in line with the strategy.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Coordinate closely with BNSDI to ensure geospatial matters are well represented in national e-Gov and ICT policy frameworks and strategies

9.2.2.7 Provide ICT related training to government employees and the general public.

Basic ICT knowledge, background and experience is important for GIS professionals as well as general computer users, which today includes most office workers. This prerequisite is very important in establishing the basic computing skills that are needed for leveraging computing technology, including GIS, across society in Belize.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Incorporate basic GIS awareness as part of basic ICT training
- Ensure universal access to GIS technical training for interested government employees and the public
- Provide GIS as one component of a “Leadership and Technology” summit aimed at raising the awareness of country leadership in regards to the use of information technology as a component of progressive government transformation

9.2.2.8 Provide ICT related training to government employees and the general public.

CITO is charged with providing ICT training to government employees and to take efforts to increase public utilization of computers by the general public.
GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Incorporate basic GIS awareness as part of basic ICT training
- Ensure universal access to GIS technical training for interested government employees and the public
- Provide GIS as one component of a “Leadership and Technology” summit aimed at raising the awareness of country leadership in regards to the use of information technology as a component of progressive government transformation

9.2.2.9 Conduct eGovernment and stakeholder engagement and coordination across government

CITO coordinates many aspects of eGovernment and ICT across government. Engagement takes a variety of forms as outlined below.

e-Government Task Force. An e-Government Task Force has been formed with a liaison assigned from each government agency. This Task Force is the primary channel of communications between CITO and the stakeholder community. This group also provides review and input on e-Government and ICT issues of common concern.

National ICT Committee. CITO is involved in the National ICT Committee, but this is facilitated by the Ministry of Energy, Science and Technology and Public Utilities (MESTPU).

Belize Coalition of Service Providers. This is a multi-agency special interest group (SIG) that is working together and with other interested parties to develop a "Belize Association of ICT Professionals". Participants include representatives from government, private sector, NGO's, Universities and interested individuals. The group is in the process of drawing up the Articles of Association now and hope to formally launch the Association in the near future.

GIS and BNSDI matters that have some relevance to this functional area include but are not limited to the following:

- Facilitate geospatial special interest group participation in e-Government for a
- Align BNSDI with e-Government stakeholder community engagement programs

9.3.1 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting CITO functions at present:

9.3.2 Existing Systems

The following illustrates the general configuration of the CITO network.

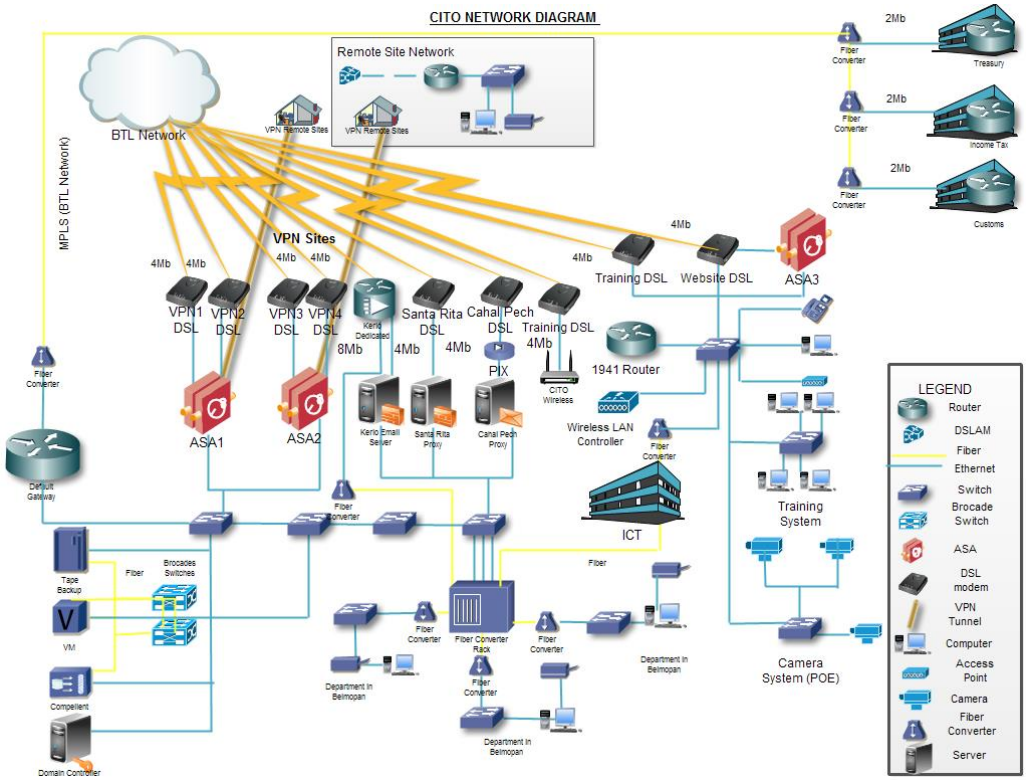

Figure 54 - CITO Government Wide WAN

9.3.3 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- The present ESRI GIS Enterprise License Agreement (ELA) is being formulated around government agencies only and does not include other semi or quasi-government entities such as statutory bodies, government-owned utilities, park co-management partners and other such organizations. Within the government, primary focus was placed on those agencies that were already using ESRI software. There may be some advantage at broadening the organizations that are eligible to participate in this program in the future.

10 Statistical Institute Belize

Person(s) Interviewed: Leopold Perriott, Director General lperriott@mail.sib.org.bz
Desmond Gordan, dgordon@mail.sib.org.bz
Sylvia Noralez, GIS Officer snoralez@mail.sib.org.bz

Interview Date(s): June 18, 2014

10.1 Organization and Mission

The Statistical Institute of Belize (SIB) was established on April 1, 2007, replacing the Central Statistical Office as the national statistical agency of Belize. The primary functions of the SIB are to collect, compile, extract, analyse and release official statistics pertaining to the demographic, social, environmental, economic and general activities and conditions of Belize on an impartial basis and in accordance with professional standards and ethics.

The SIB is governed by a board of directors, with representation from the government and non-government sectors. The SIB has its headquarters in Belmopan and maintains offices in Belize City and all towns, excluding Benque Viejo Del Carmen and San Pedro, Ambergris Caye.

The Institute is responsible to:

- Provide on an impartial basis, quantitative and representative information about the economic, demographic, gender, social and environmental situation in Belize, to all users including the National Assembly, the Government, institutions, undertakings, social and economic operators, academic institutions and bodies and the general public and where possible such data should be provided on a regional basis;
- Produce data and statistics subject to the principles of reliability, objectivity, relevance, statistical confidentiality, transparency, specificity, and proportionality, which mirror as faithfully as possible the real situation;
- Disseminate data and statistics to the public and the users thereof in a neutral and impartial way, focusing on the phenomena which are essential for decision makers and honouring the citizens' rights to public information.
- Supply the information necessary to evaluate the quality of official statistics, and make accessible to the public the methods used for their production, and how the principles, under which such statistics are gathered, are complied with;
- Provide such technical explanations of statistics produced to avoid erroneous interpretation;
- Conduct research on and further develop statistical methodology and technology;
- Monitor and coordinate the carrying out of tasks with statistical implications imposed on other public bodies;

The SIB has 35 full time staff, organized to 6 departments. Additional temporary staff or contractors are used as needed to conduct various surveys.

The SIB conducts several functions that relate most directly to GIS and the BNSDI, including the following:

13. Collect, compile and analyze statistical information
14. Publish and disseminate statistical information
15. Develop special products
16. Research and implement new methods and technologies

10.1.1 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided

for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

10.1.1.1 Collect, compile and analyze statistical information

The SIB is involved in collecting a variety of information concerning a wide variety of topics in the Country, compiling that information and applying statistical analysis to create summaries that are useful for policy makers and other stakeholders. Information included within the ***SIB Statistical Atlas*** includes statistical summaries in the following thematic areas:

- Population & Housing
- Vital Statistics
- Health
- Education
- Government Finance
- National Accounts
- External Merchandise Trade
- Consumer Price Index
- Banking and Public Finance
- Agriculture
- Labour Force
- Public Order
- Travel and Transportation
- Tourism and Immigration
- General & Municipal Elections
- Environment
- Miscellaneous

Most of these statistics are collected and reported at the National, District and Municipal level, with areas falling outside of cities or towns consolidated under a category of "Rural". Historical information and trends are included for certain time periods within which the information was collected.

GIS is being used currently to create thematic maps to illustrate some of the statistical information. Thus far the SIB is only officially producing statistical maps at the District or Town/Village level, although activities are underway to explore deriving statistical mapping at smaller geographic areas.

Some of the above information is collected from other agencies and organizations mostly on a yearly basis. Some economic reports are generated every 6 months while others are yearly.

Other organizations that regularly provide statistical information to the SIB include:

- Police Department
- Fire Brigade

- Ministry of Works and Transport
- National Meteorological Office
- Ministry of Natural Resources and Agriculture
- Ministry of Education
- Ministry of Finance
- Ministry of Health
- Vital Statistics Unit
- Ministry of Immigration
- Kolbe Foundation
- Ministry of Immigration Labor, Local Government, and Rural Development
- Development Finance Corporation
- Central Bank of Belize

10.1.1.2 Conduct Population Census

The SIB is responsible for conducting the national population census every 10 years. The last census was conducted in 2010 and took 6 months with over 800 enumerators mobilized. Enumeration districts are based on density and number of households in a given area, and these boundaries can change with time to reflect changes in population numbers and distribution. These enumeration areas overlap with but are not coincident with electoral divisions. Address information for each household is recorded where such information exists, otherwise location is only known down to the enumeration district (ED) level, although the boundaries of the ED's are not mapped. Enumerators also record the city, town or village information. Where residences fall outside a designated city/town boundary the enumerators record the address location as "Rural" within the District; a description of the residence is also recorded.

Once the census data has been collected it goes through an extensive quality assurance process as the data are processed for final publishing. At present this information is reported at the District and city/town and rural levels.

The SIB is under strict regulatory control per the Statistical Institute of Belize Act, 2006 in regards to the distribution of private information, stating that 'No information obtained in any way under this Act which can be related to an identifiable person or undertaking shall, except with the written consent of that person or undertaking or the personal representative or next-of-kin of that person, if he be deceased, be disseminated, shown or communicated to any person or body except - (a) for the purpose of a prosecution for an offence under this Act; or (b) to officers or employees of the Institute in the course of their duties under this Act. (2) The Minister may from time to time, with the concurrence of the Board, by Regulations, prescribe such further prohibitions on the disclosure of identifiable records or information obtained under this Act, as he may deem appropriate'[50]

[50] Statistical Institute of Belize Act, 2006

SIB is planning through a pilot program to explore the potential to tie all survey information, including the population census, to the specific/absolute locations where the information was gathered. This would allow the Institute to use GIS and related tools to help expedite and control the quality of survey data collected. Also, by tying the information to specific locations the SIB would be able to publish census information summarized within many different geographies beyond the ED's (e.g. settlement areas, police beats, administrative areas, etc) as long as such summaries comply with the privacy provisions of the Act. As part of this pilot program the SIB is using public domain tools that include "anonymization" rules to suppress information that could be used to interpret characteristics of a single family or individual.

This function can be further supported by GIS and the BNSDI in ways that include, but are not limited to, the following:

- Census Planning and Preparations
    - Utilize GPS and/or national building database/ roads database to assist in planning enumeration areas and to establish exact coordinates for most household locations;
    - Use up to date high resolution imagery to verify that all settled areas are being accounted for in the census;
    - Provide accurate and up to date maps to support pre-census household count verification;
    - Produce electronic enumeration district maps to be used by enumerators;
- Census Taking
    - Provide enumerators with location-aware devices to capture information in digital form in the field while also verifying location;
    - Track and monitor census taking activities and status on a daily basis;
    - Expedite data quality assurance and control workflow;
- Census Publishing and Distribution
    - Support the delineation of statistically logical census reporting areas based on population numbers and typologies (not restricted to original enumeration districts);
    - Publish census maps and statistics online for immediate consumption by all stakeholders;
    - Provide tools to support download of population census information to various formats for use by stakeholders in other systems.
- Between-Census Population Estimation
    - Provide tools to tie between-census household surveys to specific locations, and to extrapolate that information to derive place-specific estimations of population change.
- Special Studies – with location-specific information the SIB would be able to conduct a variety of special studies on behalf of stakeholders. These studies would use proprietary information to create a variety of statistical summary outputs that do not

compromise compliance with the Statistical Institute Act. Many of these would be requested for commercial purposes for which service fees might be logically charged, thus representing a potentially significant revenue stream to support SIB activities and infrastructure strengthening. Examples include:

- Generate population and socioeconomic statistics by police beat;
- Generate population and socioeconomic statistics for settled areas with no official boundaries;
- Generate population and socioeconomic statistics by electrical distribution feeder area, water pressure zone, or sewer collection area;
- Derive consumer profile maps based on profiles provided by commercial vendors of products and services;
- Generate probably public transit ridership statistics by block face;
- Identify financially vulnerable populations down to the block level;
- Many others….

- Poverty Mapping – SIB will be able to launch a coordinated strategy to strengthen the capacity to produce poverty maps and produce maps of living standards and human well- being. Poverty alleviation us at the forefront of development agenda. As a result there is an increase for quality statistics to evaluate and monitor progress towards Poverty Reduction Strategies. BNSDI will allow for spatial representation and analysis of poverty indicators to identify "where the poor are" and explain the interrelationships among the influencing factors, and to know "why they are poor". Consequently, poverty mapping is important to BNSDI as it will pinpoint the high poverty indices and additionally provide decision makers with the capacity to identify those in need and evaluate the performance of interventions.

10.1.1.3 Conduct original surveys

The SIB conducts a variety of original surveys to support some of its reporting requirements. These include labor force surveys which are conducted twice per year. Also household surveys are conducted through stratified sampling, in part to calibrate population forecasts to update the decadal census information. Other original data collection through surveys includes:

- Consumer Price Index from Business Establishments
- Visitor Expenditure Survey (Belize Tourism Board)
- Multiple Indicator Cluster Survey (UNICEF)
- Child Labor Survey (ILO)
- Sexual Behavior Survey
- Gender Inequities Survey
- Other Ad-hoc Surveys

10.1.1.4 Compile economic statistics

The SIB is the official source for the most critical economic statistics for the country. These include Gross Domestic Product (GDP), Consumer Price Index (CPI – from which inflation rate is derived), and external trade (imports and exports).

10.1.1.5 Publish and disseminate statistical information

The SIB is responsible for publishing all official statistics on behalf of the government. This takes the form of a variety of statistical bulletins and press conferences that are usually produced every monthly, quarterly, bi-annually or annually. Standard statistical products include:

- Abstract of Statistics
- Labor Force Survey Reports
- Monthly Trade Bulletins
- Monthly Consumer Price Index
- Quarterly and Yearly Gross Domestic Product (GDP)
- Ad-hoc Survey Reports

10.1.1.6 Develop special products

The SIB develops special statistical studies and reports on a limited basis, typically based on requests from government leaders.

Examples of how GIS and the BNSDI can be used to support this function include:

- Plan and manage special surveys;

- Conduct geospatial analysis to derive statistical summaries (e.g. average distance between students and where they go to school, persons within walking distance of a park, etc.);
- Create geostatistical summaries and analyses from existing geospatial data from other agencies;
- Produce geostatistical visualizations to better communicate key issues to decision makers and the public;

10.1.1.7 Research and implement new methods and technologies

The SIB is proactively exploring new methods and technologies for conducting its work. At present the office is investigating the use of digital devices for field data collection, in association with various GPS and related techniques for establishing location coordinates. The Institute is also looking into advanced statistical methods for processing statistical information is ways that increase the quality and value of the information while maintaining anonymity.

10.1.2 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting SIB functions at present:

- Trade
- GDP
- CPI
- Census Database: Demographics, Housing and Population
- Labor Force

10.1.3 Existing Systems

SIB maintains servers and a number of PC's throughout its office. There are 48 PCs : 25 Laptops and 23 Desktops. All staff have access to PC's which are all networked with access to a main server. The SIB currently two 4 MB internet connection for faster service to the community.

MS SQLServer is being used as the main database for the Institute.

Wingate Web Server. The Wingate Proxy Server is used by the SIB to provide statistical information and products over the web. This server provides a internal IP to access the net and Belize Telecommunication provides internet.

SPSS. SPSS Statistics is a software package used for statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. The current versions (2014) are officially named IBM SPSS Statistics. Companion products in the same family are used for survey authoring

and deployment (IBM SPSS Data Collection), data mining (IBM SPSS Modeler), text analytics, and collaboration and deployment (batch and automated scoring services).[51] SIB is using SPSS as its primary tool for statistical analysis.

Stata. Strata is a general-purpose statistical software package created in 1985 by StataCorp. Most of its users work in research, especially in the fields of economics, sociology, political science, biomedicine and epidemiology. Stata's capabilities include data management, statistical analysis, graphics, simulations, regression analysis (linear and multiple), and custom programming.[52] Strata is being used by the SIB for selected statistical analysis purposes.

ArcGIS. Esri's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.[53] The SIB is utilizing ArcGIS as its primary tool for geospatial analysis and visualization.

GeoNode. GeoNode is a geospatial content management system that utilizes several other open source packages, such as Django, PostGIS, pyCSW, GeoExplorer, etc. GeoNode is being used as a common platform among the Belize NSDI stakeholder community. SIB has been experimenting with setting up a GeoNode platform at the Institute to become one of the early nodes in the BNSDI network.

10.1.4 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Finding persons with strong statistical background in Belize is difficult and with geo-statistical background is nearly non-existent. There is a need for a specific capacity building program to increase skillsets in this area within the SIB, and to encourage such training in advance degree and technical college curricula in the country and region;
- The connection between statistics and policy-relevant decision making is not as strong as it could be. There is a need to increase awareness among policymakers and to develop innovative, creative and compelling statistical products to increase the strength of this linkage;
- The SIB has not been involved in the eGovernment initiative in Belize as of yet;

[51] http://en.wikipedia.org/wiki/SPSS
[52] http://en.wikipedia.org/wiki/Stata
[53] http://en.wikipedia.org/wiki/ArcGIS

- There is a need to develop specific criteria for the "anonymization" of statistical information to maintain compliance with the substance and spirit of the Statistical Institute Belize Act of 2006, and in line with international best practice;
- There is a need to build more awareness and capacity in the use of GIS at the SIB, to increase awareness in the stakeholder community as to what is possible and useful, and to build the SIB capacity to support these new capabilities.
- Staff have identified three areas for increased GIS utilization within the SIB, including a) data collection b) management of complex data configurations and c) for data publishing.

Link of "Protype Census Map" :
http://ukdataexplorer.com/belize_prototype_google_18_july_2014/

10.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Finding persons with strong statistical background in Belize is difficult and with geostatistical background is nearly non-existent. There is a need for a specific capacity building program to increase skillsets in this area within the SIB, and to encourage such training in advance degree and technical college curricula in the country and region;
- The connection between statistics and policy-relevant decision making is not as strong as it could be. There is a need to increase awareness among policymakers and to develop innovative, creative and compelling statistical products to increase the strength of this linkage;
- The SIB has not been involved in the eGovernment initiative in Belize as of yet;
- There is a need to develop specific criteria for the "anonymization" of statistical information to maintain compliance with the substance and spirit of the Statistical Institute Belize Act of 2006, and in line with international best practice;
- There is a need to build more awareness and capacity in the use of GIS at the SIB, to increase awareness in the stakeholder community as to what is possible and useful, and to build the SIB capacity to support these new capabilities.
- Staff have identified three areas for increased GIS utilization within the SIB, including a) data collection b) management of complex data configurations and c) for data publishing.

11 Belize Social Investment Fund

Person(s) Interviewed: Desk study with review by agency (Wendel Parham)

Interview Date(s): NA
Desk Study Date(s): 8 September, 2014

11.1 Organization and Mission

The Belize Social Investment Fund (BSIF) was incorporated in 1996 as a Statutory Body through the Belize Social Investment Fund Act within the Ministry of Economic Development. According to the Act, "The Fund shall, subject to the availability of resources, approve projects and programmes and provide, either wholly or partially, financial and technical assistance to community groups with development goals, and local government organizations, for the execution of such projects or programmes which will serve to provide basic services to the most severely affected groups in the country."[54]

The BSIF is the implementing agency for projects undertaken by the Government to address the basic human needs of the poorest of the poor and most vulnerable in Belize. The Fund is designed to assist communities in identifying their needs and prioritizing projects they want to submit for funding. The BSIF typically does not finance projects in excess of BZ $1.0 million dollars. All projects must be supported by a community-based organization, even if it is submitted in coordination with another institution.

Through its strategic plan, BSIF strives to ensure maximum alignment with the Government's macro policy for poverty reduction and elimination, as captured in the National Poverty Elimination Strategy and Action Plan 2007 -2011

The management of BSIF is carried out by a nine-member Board of Directors which reports to the Minister of Economic Development. Members of the Board have been nominated by their respective Ministry or Organization, then approved by the Minister of Economic Development. The Executive Director of the Fund is a non-voting member of the Board. The representatives have been selected from the following Ministries and Organizations:

- The Ministry of Economic Development,
- The Ministry of Education,
- The Ministry of Health,
- The Ministry of Human Resources
- The Ministry of Labour, Local Government and Rural Development
- The NGO Community (ANDA, CVSS, BACONGO)
- The Private Sector Organizations
- The Women's Commission, and
- The Youth Commission.

[54] http://www.sifbelize.org/

Note: The Social Investment Fund is also the implementing agency for the Belize Municipal Development Project (BMDP), a $30.0 Million dollar project which aims to improve access to municipal infrastructure and enhance municipal management in selected town and city councils of Belize.

The SIF carries out several primary activity areas in project implementation and monitoring that have some relevance to GIS and BNSDI including the following:

1. Identify potential projects;
2. Conduct community needs and assets assessments;
3. Carry out project appraisals;
4. Facilitate project approval process;
5. Manage project bidding process;
6. Supervise project implementation;
7. Conduct monitoring and evaluation.
8. Maintain contractor registry.

11.1.1 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

11.1.1.1 Identify potential projects

Ideas for potential projects may come from a variety of sources including community leaders, Ministers and Area Representatives. Project ideas are submitted to the SIF by letter or by completion of a Project Request Form. Forms are available online as well as from the SIF headquarters and district offices.

The SIF maintains a filing system for the submitted project requests. Project request forms require descriptive and cost information, among other topics. The forms also include location information for village, town, city and district.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Provide a geospatial reference to submitted project requests;
- Provide a map interface to access and track submitted project requests over time.

11.1.1.2 Conduct community needs and assets assessments

Upon receipt of letter or form, BSIF will screen the request for eligibility and conduct a Community Needs and Assets Assessment to help the community concerned to prioritize their needs and identify the necessary inputs to the project.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Provide access to neighborhood level socioeconomic data;
- Provide access to development and environmental context data;
- Provide access to community infrastructure information;
- Identify community level natural hazards and vulnerabilities, including those related to climate change;
- Link community needs surveys to location for current and future reference;
- Utilize location-aware social media to solicit feedback from community members;

11.1.1.3 Carry out project appraisals

After a project proposal meets the eligibility criteria and funds are identified to consider the project, the Technical Unit at BSIF will appraise the project and prepare a request for project approval. In approving a project or programme, the SIF is required to consider a variety of factors, including the following:

- the financial aspect of the proposed project or programme;
- whether the proposed project or programme can be undertaken expeditiously;
- the time required for the completion of the proposed project or programme;
- whether the proposed project or programme has the capacity to demonstrate technical, environmental, institutional and economic viability according to established project approval criteria;
- whether the proposed project or programme is in the geographic or sectoral priority areas identified for poverty alleviation;
- the operating costs in relation to the proposed project or programme; and
- whether the applicant is an organization or other group of persons that falls within the geographic areas for poverty alleviation.

When a project is being appraised, BSIF will meet with representatives of the community to form a Project Management Committee (PMC). The main role of the PMC is to assist BSIF in identifying needs, assets and during the implementation of the project. In addition, the PMC also plays a key role in the planning and implementation of regular community meetings to inform community leaders, Area Representatives and residents of the nature, scope and progress of the project with the aim to encourage community participation and ownership of the project.

The BSIF maintains a manual Case File for each Project Proposal and all the information relating to that project formulation and implementation goes into that file.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Provide access to wide variety of socioeconomic, infrastructure and environmental data to support needs and feasibility assessment;
- Utilize available data to explain issues and opportunities to community leaders and residents;
- Track project proposal status geographically.

11.1.1.4 Facilitate project approval process

Completed project proposals are presented to the BSIF Board of Directors for approval. On approval of a project, the BSIF notifies applicants and facilitating agents. The applicant is then invited to the BSIF office and briefed by the Legal Unit on the procurement procedures and contract procedure to be applied. Projects funded by the Basic Needs Trust Fund (BNTF) and the European Union need to have final approval from the Caribbean Development Bank (CDB) and the European Union, respectively. The same applies to approvals for project funded by the World Bank.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Provide data, visualization and reporting tools to support presentation of proposed projects to the Board of Directors;
- Provide data, visualization and reporting tools to support presentation of proposed projects to international finance institutions.

11.1.1.5 Manage project bidding and contracting process

Once a project has been approved, a contract needs to be signed. Up to three different types of agreements are required. The first is a Tripartite Agreement among the BSIF, the Community and the Line Ministry. The second agreement is a contract with an independent consultant who will supervise the works or provide training on behalf of BSIF. The third is an agreement for works between BSIF and the contractor, which shall be legally binding and will ensure the performance of the works according to specifications. Contracts are awarded through a competitive bidding process.

The SIF maintains a registry of qualified contractors for carrying out project implementation. The form includes location information, namely street, village, town, city and district. The form also includes information regarding the human resources, financial and material assets of the organization, including type/model of equipment owned.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Provide bidders with contextual information needed for preparing responsive bid;
- Provide a map that indicates the location of all registered contractors;
- Track what projects were carried out by what contractors over time as a historical reference;

11.1.1.6 Supervise project implementation

Depending on the nature and scope of the project, an engineering consulting firm may be contracted prior to the signing of the contract. The project, however, will be executed and monitored by BSIF. Supervision of the project will be carried out by BSIF and/or its consultants according to established guidelines. Generally, the supervision will verify:

- physical progress of work
- financial performance
- the degree of community participation; and
- if work is progressing in accordance with specifications and conditions of the contract.

After the completion of the project, a final report is prepared by the BSIF supervising Technical Officer. An official inauguration ceremony, and handing over of the project to the community normally follows.

GIS and the BNSDI could be relevant to this functional area in several ways including but not limited to the following:

- Link project management and status reporting information to project locations on a map;
- Create thematic maps indicating location, characteristics and status of all projects being undertaken;
- Provide a compiled and geo-located history of all projects overseen by BSIF.

The BSIF projects are reflected in the Public Sector Investment Project (PSIP) Reports of the Ministry of Economic Development.

11.1.1.7 Conduct monitoring and evaluation

The BSIF monitors and evaluate projects during the implementation process and in the defects liability period. However, BSIF is planning to address post project completion monitoring and evaluation.

11.1.2 Data Used or Generated

The following document sets/sources are being used and/or generated in the process of conducting BSIF functions:

- Project Case Files

- Local Community Information
- Statistical Institute of Belize
- All Government Ministries and Agencies
- Non-Governmental Agencies
- Regional and International Organizations

11.1.3 Existing Systems

The following systems are being used in the process of conducting this group's functions.

Local Area Network using CISCO equipment and operating under Windows Server 2012. Major Applications include MIS Application and AutoCAD.

11.1.4 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the BSIF:

- Budgetary Requirements
- IT staffing needs
- Capacity building (equipment and software)
- Training needs (accessing and utilizing information)

11 MINISTRY OF HEALTH

11.1 All Relevant Departments

Person(s) Interviewed: Ian Smith, Director IT ismith@health.gov.bz
Wayne Chiang, System Administrator wchiang@health.gov.bz
Arthur Martinez, GIS Technician amartinez@health.gov.bz

Interview Date(s): June 20, 2014

11.1.1 Organization and Mission

The Ministry of Health (MoH) is the government agency responsible for overseeing the entire health sector and is also the largest provider of public health services in Belize. The MoH offers affordable care to a majority of Belizeans with a strong focus on providing quality healthcare through a range of public programs and institutions.[55]

This stakeholder survey write-up is based on one interview with IT Unit staff, and information from the Ministry website and other provided documentation.

The Ministry covers a variety of service areas, each of which has relevance to GIS and the BNSDI:

- Central Laboratory Unit;
- Central Medical Stores;
- Dental;
- Environmental Health;
- Epidemiology;
- HECOPAB;
- Maternal and Child Health;
- Mental Health;
- Nutrition:
- Pharmacy;
- Planning Analysis and Policy Unit;
- Project Management Unit;
- Develop and manage public health information system.

The Ministry carries out the following functions that have some relevance to the use of GIS and participation in the BNSDI:

1. Provide medical laboratory services;

[55] http://en.wikipedia.org/wiki/Healthcare_in_Belize

2. Manage medical stores;
3. Provide public dental services;
4. Support environmental health;
5. Monitor and assess chronic and communicable disease;
6. Manage health education and participation bureau program;
7. Manage maternal and child health program;
8. Manage mental health program;
9. Manage nutrition and healthy lifestyle promotion program;
10. Manage pharmaceutical services and supplies;
11. Conduct public health planning and policy development;
12. Manage health sector reform project;
13. Develop and manage public health information system

11.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

11.1.2.1 Provide medical laboratory services

The Central Medical Laboratory (CML) provides clinical support to Health Care Providers of the entire public health system and act as a referral lab to the Regional and Community Hospital Laboratory. Specimens examined include tests for chemistry, hematology, micro-biology, serology, histology, cytology, and blood banking. Recently tests were added including; CD4, drug screening for marijuana and cocaine, CK-MB, Lipase, Gamma-GT, cholinesterase, and culture for food borne disease, also to assist with public health aspect of dengue, TB, malaria are being done.[56]

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Provide ability to link medical samples and test results to geographic locations;
- Provide selected access to geographically referenced test results for use by planners and researchers.

11.1.2.2 Manage medical stores

Central Medical Stores (CMS) is responsible to ensure the continuous supply of good quality Pharmaceuticals, Medical, X-ray, Galencials and Laboratory Supplies, through timely cost effective procurement. The Ministry of Health enters into a maximum price contract on a

[56] http://health.gov.bz/www/units/central-laboratory-unit

yearly basis with suppliers to provide Medical and Pharmaceutical supplies. These supplies are distributed to all seven (7) public Health Facilities and 37 Health Centers for outpatient, community outreach and hospital use following a schedule for delivery.[57]

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Record and display geographic locations of all public health facilities and health centers;
- Track delivery of medical supplies nationally;
- Provide spatially enabled dashboard showing the status of supplies in all health facilities and centers;
- Produce statistical maps and reports of medical supply usage at the facility level;
- Assess the location effectiveness of existing medical supply facilities and site new facilities;
- Provide planners and research analysts with access to dispensary data as part of early warning system for disease outbreaks.

11.1.2.3 Provide public dental services

The purpose of the Dental Program is to promote lifestyles that will reduce dental decay, dental diseases and to diagnose and manage dental decay and associated morbidity.[58]

The principal services provided include the following:

- Attention to pregnant women;
- Outreach mobile clinics to rural areas;
- Dental health education through mass media;
- Urban and rural school visits;
- In-patient surgical services.

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Provide map of all facilities where public dental services are offered;
- Track and monitor mobile clinic locations and history;
- Track and monitor urban and rural school dental visits and history;
- Utilize location-aware social media for connecting with dental patient community;
- Assess the location effectiveness of existing dental health facilities and services and site new programs;
- Analyze dental service delivery facilities relative to population census information;
- Produce statistical reports and maps concerning dental health at the community level;
- Track and analyze dental service delivery by locations over time.

11.1.2.4 Support Environmental Health

[57] http://health.gov.bz/www/units/central-medical-stores
[58] http://health.gov.bz/www/units/dental

The Environmental Health Unit is one of the preventive medicine arms of the Ministry of Health. It is mandated to contribute to the provision of healthy living and working conditions for the Belizean population. This is to be achieved through collaboration with related sectors (ministries, departments, units and communities) intra and multi-sectoral coordination and active community participation.[59]

Sub Units of Environmental Health include:

- Public Health
  - Food Safety
  - Water Quality
  - Animal Health
  - Sea Port
  - General Environmental Health
  - Communicable Diseases
- Vector Control
  - Dengue
  - Chagas Malaria

The Vector Control Program has the responsibility for maintaining a healthy environment that provides for the prevention and control of Malaria, Chagas and Dengue. Services provided include:

- Indoor spraying against the Malaria vector
- Outdoor spraying with ULV against the Dengue vector
- Diagnosis and treatment of Malaria and Dengue cases
- Surveillance of the vector
- Health education and promotion

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Track and monitor the locations of reported environmental health issues;
- Assess conditions where environmental health issues arise;
- Utilize population census data to assess potential exposures to environmental health issues;
- Utilize location-aware social media to engage with the public in regards to environmental health issues;
- Analyze environmental health issues and trends over time;
- Produce statistics concerning environmental health issues at the community level;
- Monitor and assess effectiveness of responses to environmental health issues over time.

11.1.2.5 Monitor and assess chronic and communicable disease

[59] http://health.gov.bz/www/units/environmental-health

The Epidemiology Unit is responsible for collection, compilation, analysis, and interpretation of health data and the dissemination of health information to support decision making on current and emerging health situations at the local, regional and national levels. The unit is also responsible for disease surveillance, outbreak investigation and control of communicable and non-communicable diseases.

The services provided by the Epidemiology Unit include:

- Periodic reports on the status of communicable and non-communicable diseases;
- Making data on morbidity and mortality available to health personnel and to the general public.

In 2000, the Unit was involved in using GPS to record the locations of malaria incidents in 16 villages across Belize. GPS positions were taken for each incident and suspected mosquito breeding locations.

Specific areas that GIS and the BNSDI can support this functional area includes, but is not limited to the following:

- Track and monitor the locations of reported chronic and communicable disease incidents;
- Assess contextual conditions where epidemiological and chronic disease conditions arise;
- Utilize population census and public facility data to assess potential exposures to disease outbreaks;
- Utilize location-aware social media to engage with the public in regards to communicable and chronic disease issues;
- Plan and track disease outbreak intervention activities;
- Analyze communicable and chronic disease issues and trends over time;
- Produce statistical reports and maps regarding communicable and chronic disease at the community level;
- Monitor and assess effectiveness of responses to disease outbreaks and chronic health issues over time.

11.1.2.6 Manage Health Education and Community Participation Bureau (HECOPAB) program

The Health Education and Community Participation Bureau (HECOPAB) is the health promotion arm of the Ministry of Health with responsibility to plan, coordinate and implement health promotion programmes, projects, interventions and activities throughout Belize.

HECOPAB was established in 1983 with technical and financial support from the United Nations Children's Fund (UNICEF). Up until 1995 HECOPAB operated as a single unit from the Belize District and Health Educators had to travel to the other districts to conduct

health promotion activities in collaboration with the Primary Health Care District Coordinators. However, with the amalgamation of HECOPAB and the Primary Health Care Unit, HECOPAB Units were established in all districts. Since 2002, the capacity of the Bureau has been strengthened with the establishment of a HECOPAB Unit in the capital city of Belmopan.[60]

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Monitor public health issues across the country geographically;
- Assess historical, current and project future public health conditions and trends;
- Assess public health issues relative to population census segments;
- Prepare maps and reports to assist in communicating public health issues and programs to the public;
- Utilize a map interface to support public health information access, sharing and analysis country-wide;
- Produce statistics concerning health education and public participation at the community level;
- Utilize location-aware social media to support two-way engagement with the public in regards to health related issues;

11.1.2.7 Manage maternal and child health program

The program is established with the purpose of facilitating a health care environment where there is an improved access, coverage and quality of basic care for mothers and children. Services provided are:

- Pre and postnatal integrated health care for women: this includes the monitoring and management of normal pregnancy, gynecological and obstetric pathologies
- Child health:
  - Vaccination of children against immuo preventable diseases
  - Provision of micronutrients for children namely – vitamin A and iron supplements
  - Surveillance of immuno - preventable diseases in children
  - The prevention and control of HIV transmission from mother-to-child
  - Prevention and control of Acute Respiratory Infections
- Sexual and reproductive health services

The aim of this service is to provide reproductive health care based on specific reproductive health needs of individuals and the community. The services are delivered through a network of eight urban and thirty-seven rural health centers that are staffed by Public Health Nurses, Nurse Practitioners, Rural Health Nurses, Domestic Auxiliaries and Driver/Mechanics. Community Nursing Aides and Traditional Birth Attendants form an important link between the programme and the community.[61]

[60] http://health.gov.bz/www/units/hecopab
[61] http://health.gov.bz/www/units/maternal-and-child-health

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Record and access mapped locations of urban and rural health centers;
- Provide access to birth data;
- Provide access to population census information and annual updates;
- Record and monitor pre and postnatal care services by patient location and health care facility;
- Record and track child immunizations by child home location and health care facility;
- Record and track micronutrient delivery areas;
- Record and monitor immune-preventable disease incidents in children by location;
- Record and track HIV incidents by patient home location;
- Produce statistics regarding maternal and child health issues at the community level;
- Assess the location effectiveness of existing maternal and child health facilities and services and site new programs;
- Record, analyze and track acute respiratory infections in children
- Monitor, report and evaluate effectiveness of maternal and child health care program interventions over time.

11.1.2.8 Manage mental health program

The mental health program serves the needs of persons with mental disorders, enhances their quality of life and creates networks that guarantee the delivery of care within the community. The services provided are organized and implemented throughout the country at the three levels of care indicated below.[62]

- Out- patient Services
  - Crisis Intervention
  - Individual therapeutic work
  - Therapeutic work with families
  - Mobile Clinics
- In-patient Service
  - Acute care in all general hospitals
  - Consultation Liaison
- Community Services
  - Outreach Program
  - Ancillary Services

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Record and access mapped locations of urban and rural mental health program facilities;

[62] http://health.gov.bz/www/units/mental-health

- Provide access to population census data;
- Record and monitor mental health cases;
- Monitor mobile clinic facility locations and movements;
- Track mental health issues and trends geographically across the country;
- Assess the location effectiveness of existing mental health facilities and services and site new facilities and service programs;
- Produce national statistics concerning mental health issues and trends at the community level;
- Monitor, report and evaluate effectiveness of mental health care program interventions over time.

11.1.2.9 Manage nutrition and healthy lifestyle promotion program

The Nutrition Department is responsible for:

- Coordinating and integrating the Ministry of Health's nutrition health plan into an inter-sector plan with relevant organizations;
- Initiating and directing the development of nutrition and dietetic education materials;
- Planning and supervising general in-service educational programs in nutrition;
- Developing and monitoring all nutritional services provided by the Ministry of Health;
- Providing nutritional counselling and ongoing nutritional education;
- Promoting healthy lifestyles to the general public;
- Informing the general public and vulnerable groups on nutritional needs and risks;
- Developing technical norms, standards and protocols in nutrition and dietetics;
- Conducting research projects and surveys related to nutrition;
- Monitoring and reporting on the nutritional status of the population.[63]

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Monitor and track health and lifestyle conditions and trends nationally;
- Provide access to population census data at the neighborhood level;
- Provide access to Ministry of Health health statistics at the community level;
- Map and track nutrition education and outreach activity locations;
- Provide interactive online maps regarding the conditions and trends of health and lifestyle issues for access by the public;
- Support research and analysis on health and lifestyle issues in Belize;
- Monitor and evaluate the effectiveness of public health interventions on health and lifestyle condition is Belize.

11.1.2.10 Manage pharmaceutical services and supplies

[63] http://health.gov.bz/www/units/nutrition

The program exists in order to provide the Ministry of Health with technical support in pharmaceutical matters and to provide safe and effective medicine to the ill and needy of society.

Pharmaceutical care includes provision of medication in accordance with the doctor's orders, the compounding of extemporaneous preparation, the management of patient at the ward level, patient counselling and education, ensuring the constant availability of pharmaceuticals and medical supplies, ensuring access of these by the patient; and the monitoring aspect to ensure safety of the pharmaceuticals and quality in the services provided.

Pharmaceutical services are being offered at each of the four regional hospitals, the three polyclinics and the forty two health centers countrywide. The level of services vary with the type of institutions. The regional hospitals have the full complement of the services available, whilst the urban health centers have full dispensing services offered by registered pharmacists. The dispensing services at the rural health centers are basic and are provided by rural health nurses and the community nurse's aide.

This program implements the licensing and accreditation mechanism for pharmacists and pharmacies respectively.[64]

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Provide map locations for all government pharmacies;
- Provide map locations for all licensed pharmacies;
- Track all over the counter and prescriptions provided at each pharmacy. Ideally this would be a real-time system that could be used as an early warning system for disease outbreak;
- Monitor pharmaceutical inventories geographically;
- Provide access to population census information;
- Assess the location effectiveness of existing pharmacies and site new facilities and service programs.

11.1.2.11 Conduct public health planning and policy development

As part of Belize's Health Sector Reform Program, the Ministry of Health established a Policy Analysis and Planning Unit with an Office for Health Economics (OHE). The OHE seeks to improve the performance of the health system and its resource allocation through the promotion and generation of evidence based data essential for appropriate policy development and planning in the Belizean healthcare setting.[65]

The OHE is responsible for research in Health Economics with an emphasis on:

- Health Sector Reform
- Health Care Financing and Expenditure

[64] http://health.gov.bz/www/units/pharmacy
[65] http://health.gov.bz/www/units/planning-analysis-a-policy-unit/office-of-health-economics

- Economic Evaluations of Key Healthcare Programs

Activities in related areas including:

- Social Policy
- Health Policy Development
- Health Sector Planning
- Social Insurance
- Country Poverty Assessments and Reduction Strategies
- Pay for Performance Initiatives
- Health Services Management Software
- Health Service Delivery Models

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Analyze public health issues and trends nationally;
- Record, monitor and assess the effectiveness of public health facilities and services across the country;
- Compare public health statistics and indicators at the community level relative to national and international standards;
- Define and model the potential impacts in public health planning and policy scenarios.

11.1.2.12 Manage Health Sector Reform Project (HRSP)

The Project Management Unit is a temporary organization established solely for the management of the Health Sector Reform Project (HSRP) within the Policy, Analysis and Planning Unit (PAPU) of the Ministry of Health. The PMU, headed by a Project Coordinator, is responsible for the overall planning, execution, coordination, evaluation and reporting necessary for implementation of the project in accordance with the standard procurement, disbursement and other loan administration requirements of the Caribbean Development bank (CDB) and the Inter-American Development Bank (IDB).

HSRP is a process aimed at introducing substantive changes in the different structures and functions of the sector, with a view to increasing the equity of its benefits, the efficiency in its management, and the effectiveness of its actions; and through this to achieve the satisfaction of the health needs of the population. It is an intense phase of transformation of the health systems based on situations that justify and make it viable.

Key areas of the program are:

- Efficiency in resource allocation
- Expansion and diversification of sources of financing
- Sector design and policies
- Development of the private sector
- Organization and delivery of health services
- Human resources policies and management
- Information systems
- Access to health services

- Management and functioning of support systems. [66]

Specific areas that GIS and the BNSDI can support this functional area include, but are not limited to the following:

- Geographically based analysis of public and private health facility and service demand and supply;'
- Support the formulation of public health sector policies, facilities, services and operations plans and strategies;
- Track and monitor projects geographically;
- Monitor and evaluate impacts of health sector reform community, district and national levels.

11.1.2.13 Develop and manage public health information system

The Ministry has been aggressively pursuing the application of information technologies for strengthening and streamlining the provision of public health services in Belize for over 20 years. The provision of health care in Belize has undergone radical changes in the last ten years. There is now greater inclusion of technology in day-to-day operations of the Ministry of Health at both the administrative level and at the clinical level. Belize has increasingly sought technological solutions over the years being one of the first Caribbean countries to pioneer health information systems from the 1990's gradually ascending to a world class system that is the ***Belize Health Information System (BHIS),*** a system that is national in scope and one that is touted as "the only system in the world that will integrate the entire health sector of Belize effectively destroying the gaps that are existing between many "stand alone health applications". This system's central feature is the Electronic Health Record (EHR) which creates a life-long unique patient identifier for every patient across the health system. The system is encounter-centric, capturing within the EHR, data of a patient's interaction with the health system, from clinical data to pharmaceutical data to laboratory data. Tapping into the EHR yields endless opportunities for health analysis even as the system continues to expand and new modules are brought on stream.[67]

The BHIS is being developed incrementally over a number of years, covering a majority of the Ministry's information management and utilization requirements.

[66] http://health.gov.bz/www/units/project-management-unit/health-sector-reform-program
[67] GISmoh – Geocoding Belize's Health Data, Wayne Chiang, 2011

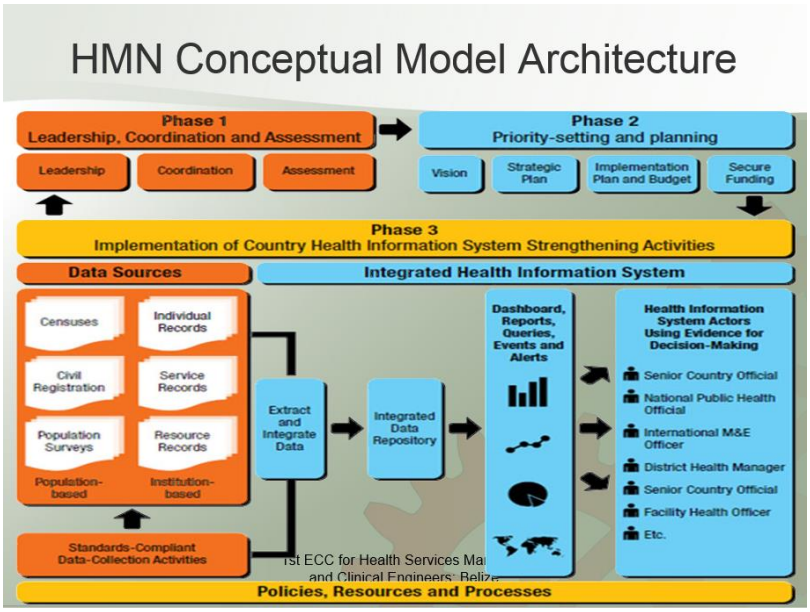

Figure 55 - HMIS Conceptual Model Architecture

Staff have indicated a need to expand BHIS to include the geospatial dimension in the future and have prepared a plan and proposal for doing so entitled "GISmoh - Geocoding Belize's Health Data". As stated in the proposal, "*Use of GIS can significantly add value to studies with its capabilities on capturing, storing, managing, and manipulating the spatial data. Additionally, several tools for executing spatial analysis (buffer, overlay, proximity, etc.) create new analysis tools, and mapping and visualization tools to communicate the results of analysis makes GIS an indispensable part of health planning and interventions. The proliferation of integrated technological health functions in Belize with the advent of the BHIS (Belize Health Information System) collecting socio-economic amidst health data and the premise of geo-referencing these data presents the opportunity that GIS will be more widely recognized as a powerful tool in healthcare planning, research and epidemiology.*"

Accompanying the GISmoh proposal, the Ministry IT staff also prepared a GISmoh Database Specifications document that outlines the geospatial requirements of the BHIS, addressing 6 thematic areas:

- People – a dimension used to manage persons including users and patients.
- Regions – a dimension used to manage regions/territories/areas such as countries, districts and municipalities.
- Data Collections – a dimension design to keep data gathered related to different subject matters. E.g. test results from different water sources; questionnaires created by epidemiology unit recording household data.
- Streets – a dimension used to manage streets.
- Addresses – a dimension used to manage addresses.
- Data Quality – a dimension used to record the source of the data for data quality control.

Conceptual data model diagrams and accompanying data dictionaries are included for each theme, one of which is shown as an example in the following figure:

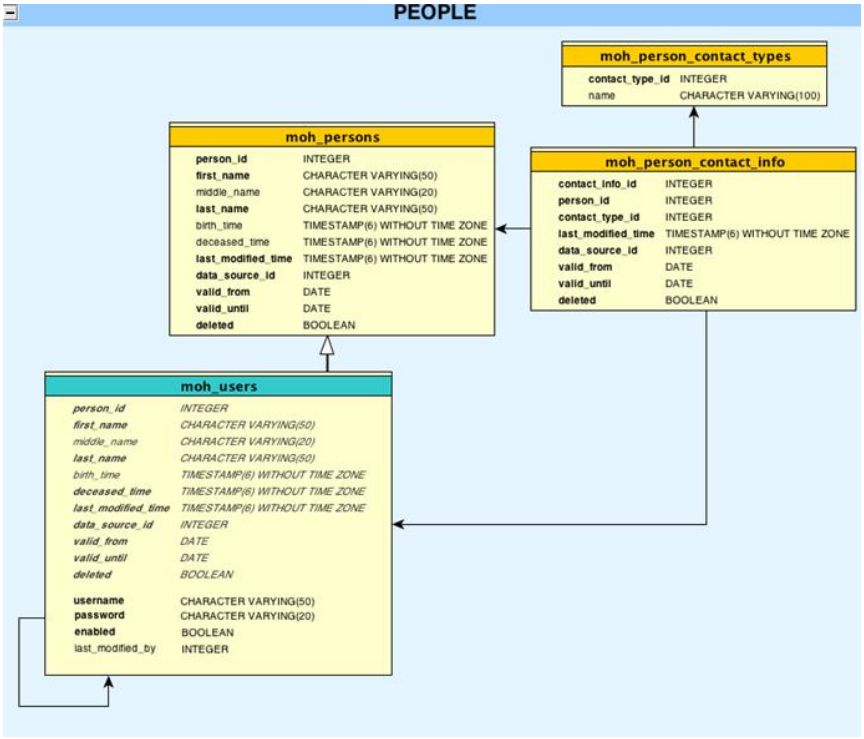

Figure 56 - Example GISmoh Conceptual Data Model

The IT Unit has conducted a comprehensive survey of habitable structures nationwide (***MOH Building Points Database***). The Unit is now collaborating with the MNRA LIC and other BNSDI stakeholders in completing this survey for all urban and rural areas and establishing of procedures to ensure this data is updated in the future.

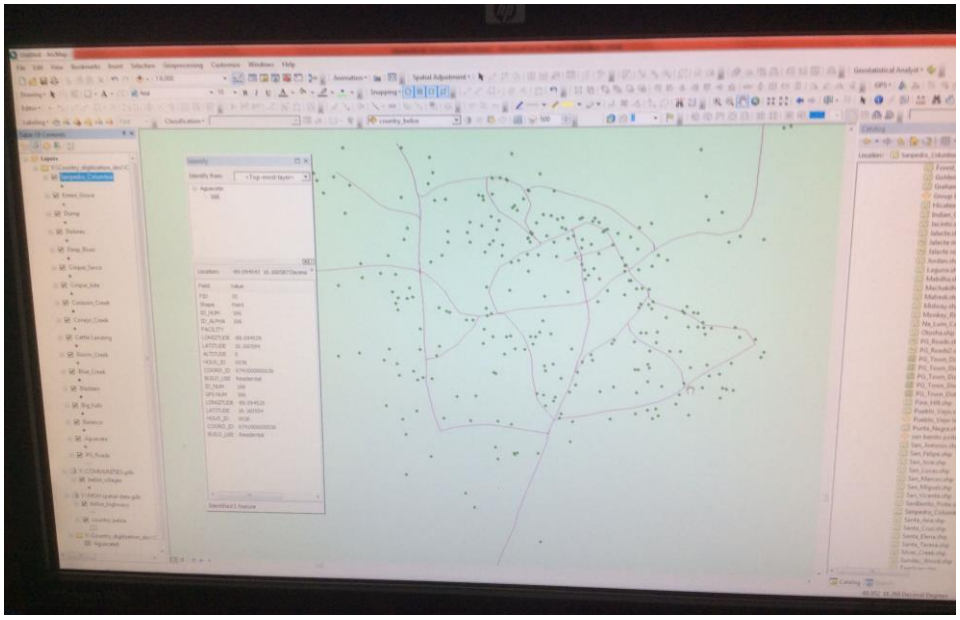

Figure 57 - MOH Rural House Locations Database

The MOH has also been collecting geographic coordinate locations for other matters on a case by case basis. This has included the collection of disease incident location information for Tuberculosis, HIV and Gastrointeritus. This information was collected in support of specific project related studies, but this has not yet been institutionalized as a standard practice.

11.1.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that are being used and/or generated in the process of conducting MoH functions at present:

BHIS Databases. The Belize Health Information System (BHIS) includes an extensive database covering most aspects of public health in the county. This includes patient identification information, encounters, facilities, procedures and other subjects. The Ministry of Health IT Unit has proposed the geocoding of health information.

MOH Building Points Database. The Ministry of Health IT Unit has used GPS to establish geographic coordinates for each habitable structure in the country. This information has been collected by District staff using handheld GPS and capturing coordinates in WGS84 datum. The Ministry has developed its own identification numbering system for buildings since street addresses do not exist outside of selected urban areas. The Ministry is currently collaborating with the MNRA Land Information Center (LIC) and other Belize NSDI stakeholders to complete a standardized national database of building points during 2014.

Road Map Database. The MOH originally acquired road centerline data from the MNRA Land Information Center (LIC). The Ministry IT Unit has been working with District staff to add centerlines where these did not exist previously or where new roads or tracks that are relevant to MOH business are identified.

Water Tank and Hand Pump Database. The MOH IT Unit has collaborated with District staff in collecting GPS coordinates for some water tanks and hand pumps.

Disease Incidents Database. The MOH IT Unit has collaborated with District staff in collection of GPS geographic coordinates in support of specific programs for Tuberculosis, HIV and Gastrointeritus. These surveys have been conducted for specific studies and this practice has not yet been institutionalized as a standard operating procedure within the Ministry

11.1.4 Existing Systems

The Ministry of Health maintains a wide area network connecting all the computers within the headquarters and providing internet VPN based connectivity to the district offices.

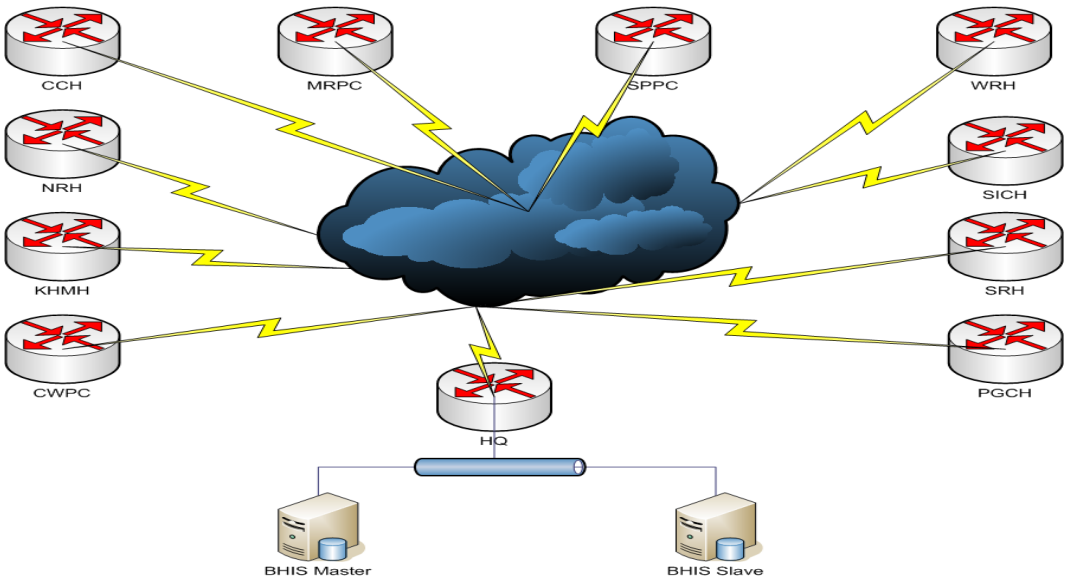

Figure 58 - BHIS Wide Area Network

BHIS. The Belize Health Information System (BHIS) is a national health information management system that is touted as "the only system in the world that will integrate the entire health sector of Belize effectively destroying the gaps that are existing between many "stand alone health applications". This system's central feature is the Electronic Health Record (EHR) which creates a life-long unique patient identifier for every patient across the health system. The system is encounter-centric, capturing within the EHR, data of a patient's interaction with the health system, from clinical data to pharmaceutical data to laboratory data. Tapping into the EHR yields endless opportunities for health analysis even as the system continues to expand and new modules are brought on stream.

11.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Many people within the Ministry have heard of GIS but are now aware of the range of uses that it can be put to within the health sector;
- Much of the data maintained by the Ministry of Health is of a private confidential nature. This information cannot be distributed outside the security of the Ministry, however it will be possible to generate public health statistics at the community level where these generalizations do not compromise privacy;

12 MINISTRY OF NATIONAL SECURITY

12.1 Belize Police Department Headquarters

Person(s) Interviewed: Mario Alcoser, PITU Manager, Mario.alcoser@police.net.bz
Jose Tillett, Police Constable/GIS Technician,
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Harry Noble, Consultant, harry.noble@police.net.bz

Interview Date: June 23, 2014

12.1.1 Organization and Mission

This stakeholder survey write-up was developed based on personal interviews with the Police Information Technology Unit (PITU) and desk study information derived from the Police Department website and other documentation. The PITU has collaborated with international experts in conceiving a comprehensive Crime Information Management System (CIMS) based on international best practices with adjustment and prioritization based on those practices that are most relevant to the needs of Belize today. This write-up therefore provides a brief overview of Department functions followed by listings of areas that GIS and the BNSDI may be able to add value to the planned expansion of the CIMS.

The Belize Police Force is responsible for preventing and detecting crime, protecting life and property, preserving peace and maintaining law and order in all parts of Belize and performing these duties in accordance with the Constitution of Belize. The Police Department includes 1,139 sworn members, 161 civilian and 54 paid Special Constables, amounting to 1 sworn police officer to 263 citizens and 7.4 square miles.

Police stations are located in key communities in all Districts of the Country, as indicated in the ***Police Stations Map*** illustrated below.

The BPD interfaces with many other organizations in conducting their activities, including but not limited to:

- Belize defense force and other security agencies
- Coast Guard
- Immigration
- Forestry department
- Customs
- Court authority
- Transport
- Prison
- Interpol

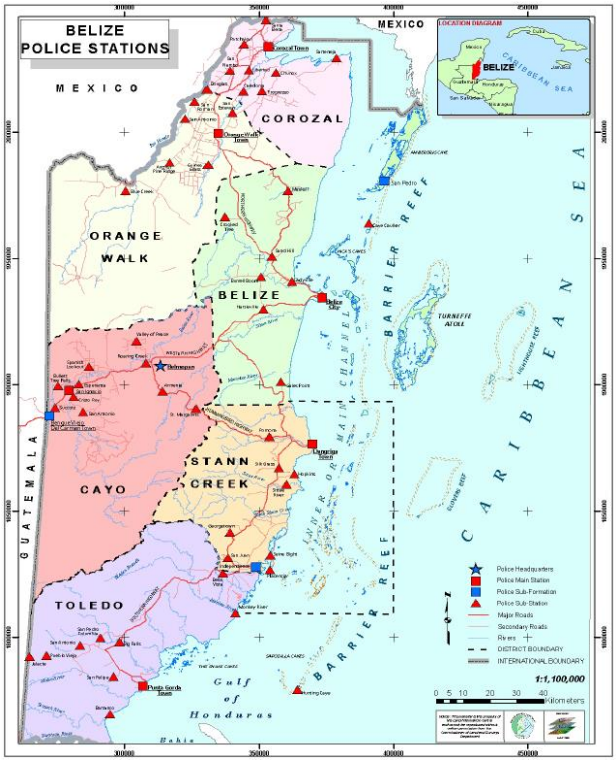

Figure 59 - Location of Police Stations in Belize

At present there is very little digital connectivity among security agencies in Belize. There is an intention to expand the BPD information infrastructure to include a more robust and integrated communications and data linkage framework across the Country and extending to international security and defense organizations with which Belize has cooperative agreements.

The Belize Police Department (BPD) is organized to several Sections under the direction of the Commissioner that perform a variety of functions that have relevance to GIS and the BNSDI as listed below. The Police Department is in the process of developing a comprehensive Crime Information Management System (CIMS) that is intended to cover nearly all the information management and utilization requirements of the Department. Some aspects of that system are already in place and inclusive of a geospatial component. Others are planned for incremental implementation over time.

HNCIB

1. Investigate crimes.

Special Branch

2. Conduct internal intelligence gathering and analysis

Commander Operations

3. Conduct police dispatch activities
4. Conduct drug intervention activities
5. Monitor and track released felons
6. Carry out preventative patrols
7. Conduct gang suppression activities

8. Conduct national traffic management
9. Conduct special patrol operations
10. Support joint emergency response

Eastern Division

11. Eastern Division covers Belize City where there is the greatest concentration of people and crimes in the country. The Division has units covering many of the other policing functions described for the other units within the BPD, so is not treated as a separate section in this write-up.

Management Services – Police Information Technology Unit (PITU)

12. Conduct facility and asset management
13. Develop, manage and operate crime information system

12.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

HEADQUARTERS NATIONAL CRIME INVESTIGATION BRANCH (HNCIB)

12.1.2.1 Investigate Crimes

The Headquarters National Crime Investigation Branch (HNCIB) is managed by a Senior Superintendent of Police (SSP) who answers to the Assistant Commissioner of Police (ACP) Operations. The Branch is staffed by 96 members consisting of 54 investigators and 42 support staff. They rely on the traditional retrospective case by case investigation of reported crimes with a marked dependence upon interviews, exhibits and statement collection as they assemble legal evidence pointing to a suspect or suspects. Scene of Crime Officers frequently gather what evidence they can but this aspect is rudimentary and limited by their training, their tools and limitations of the Forensic support known to exist at the National Forensic Laboratory.

Crimes are normally reported to the police station in the district where the crime occurred. Immediate response is handled by the local police who do much of the initial groundwork to visit the scene of the crime, take reports, and preserve evidence. A case file is opened for each incident. In the past, case information was maintained in paper files, but today these ***Crime Investigation Information*** is being entered to the ***Crime Information Management System***. Incident location is stored as either a street address or a location description relative to a community or neighborhood name, or other landmark reference.

Investigations are often supported by informants, information about whom is maintained in a ***Covert Human Intelligence Sources (CHIS) Database***. This database also includes address and contact information for informants. Investigators may also access information in the ***Convicted Parolees Database*** where there is the chance that a crime was committed by a repeat offender.

The Police Department is conducting GIS analysis to support criminal investigations today, but this is constrained by the lack of a reliable geocoding capability and analysis software that is specifically designed for police work, although there are plans to further strengthen these areas in the near future. Specific GIS-related capabilities that can support this function include but are not limited to:

- Geocode crimes, incidents and complaints to locations;
- Conduct crime analysis, including the assessment of the geographic patterns of crimes over time;
- Manage and retrieve crime case file information by location;
- Trace car navigation system information;

SPECIAL BRANCH

12.1.2.2 Conduct internal intelligence gathering and analysis

The Special Branch unit acquires and develops intelligence and conducts investigations to protect the State from perceived threats of subversion—particularly terrorism and other extremist activity. This Branch tracks narcotics trafficking and works with Interpol through a Joint Intelligence Coordination Center (JICC). The unit collects and analyzes a variety of statistics nationwide relating to criminal activity, transportation, financial activity,

Specific GIS-related capabilities that can support this function include but are not limited to:

- Capture, manage, distribute and correlated geo-intelligence information among multiple organizations;
- Track gun and ammunition sales and use;
- Define and assess infrastructure and resources vulnerability;
- Develop contingency response plans;
- Monitor and track suspicious land, air and sea vessel traffic;

COMMANDER OPERATIONS

Commander Operations includes all uniformed police officers and management of all police stations, neighborhood patrol and policing activities, gang suppressions, traffic management and special patrol operations. Those functions that are most related to GIS and the BNSDI are outlined in sections following.

12.1.2.3 Conduct police dispatch activities.

Crimes are usually reported to a local police station where typically a dispatch operator will direct the response to the appropriate unit within the police beat or assign the nearest unit. At present dispatch is handled manually through police radio and mobile phones. Local

dispatchers are typically familiar with the communities where they work and can identify geographic locations through an address or verbal description and then relay this information to the responding officer. An incident report is logged into the CIMS for each call requiring a dispatch. A case file is opened for each incident requiring subsequent follow-up or criminal investigation.

There is a fleet management function in the existing CIMS but this has only been applied thus far within Belize City. Location and other basic information is currently be transmitted through the mobile phone system and there is a plan to move this to a more robust communications platform in the near future.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Locate and geocode crime locations as part of computer aided dispatch;
- Monitor police patrol locations for dispatch reference;
- Use crime analysis to focus police assets where needed most;
- Monitor response activities and status;
- Record and manage all dispatch activities to support subsequent criminal investigations and crime pattern analysis.

12.1.2.4 Conduct drug intervention activities

The Commander Operations includes an Anti-Drug Unit that is involved in the tracking and suppression of drug trafficking activities in Belize. This includes the investigation in drug transportation, production and distribution, gathering of evidence, arrests of expected drug traffickers and other related activities.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Capture, manage, distribute and correlated geo-intelligence information among multiple organizations;
- Map and monitor suspected drug production, transport and distribution networks;
- Develop and implement intervention plans.

12.1.2.5 Monitor and track released felons

A Criminal Records Office (CRO) is in charge of monitoring and tracking released felons. This includes maintaining a digital case file for each felon and tracking compliance with parole and probation requirements. These case files are maintained within the CIMS, including keeping track of the home and work address for each person.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Track released felons by residential and work address or other geographic location;
- Make released felon information accessible for crime analysis and related policing functions;
- Support and track probation officer activities.

12.1.2.6 Carry out preventative patrols

The Belize Police Department is focusing on proactive and preventative police patrols in communities throughout the Country. The main function of patrol is to maintain public order,

address antisocial behavior, gather intelligence and respond to crimes and other incidents. The patrol function is made up of all uniformed officers, either on foot or mobile, who reassures the public through visible police presence and forge links with local communities to reduce problems of crime and nuisance. A primary objective is to have a police department which is highly visible, familiar by name and accessible with Community Police booths and to have targeted patrols aimed at reducing and detecting crime and importantly reducing people's fear of crime. The Department is striving to augment visible patrolling with the use of intelligence to proactively identify what is causing upset, anxiety or fear to local communities and then visibly tackling those specific issues.

Patrols are generally organized around geographically defined police beats. Specific GIS-related capabilities that can support this function include but are not limited to:

- Monitor locations of incidents, complaints, and reports;
- Monitor released felon locations;
- Utilize geospatially enabled social media to strengthen interface with local neighborhoods;
- Geospatially enabled computer aided dispatch;
- Crime analysis and asset deployment management;
- Fleet tracking and management.

12.1.2.7 Conduct gang suppression activities

The Department is involved in monitoring and suppression of gang activities. This includes tracking of known gang members, monitoring gang related activities and crimes, community outreach, and other activities.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Tracking gang areas and activities;
- Tracking of released felons with gang associations;
- Utilize geospatially enabled social media to strengthen interface with local neighborhoods;
- Crime analysis and asset deployment management;
- Track known gang member residence by address;
- Monitor gun and ammunition purchase and use.

12.1.2.8 Conduct national traffic management

The National Traffic Branch is responsible for coordinating and supporting traffic control throughout the country, however traffic patrol and ticketing duties are assumed by the City and Town Councils within their jurisdictions and the Ministry of Works and Transport on highways outside those jurisdictions. The BPD are responsible for recording and analyzing traffic accidents. Location references for accidents are typically the nearest address if in an area with addresses, a landmark reference, or an approximate mile marker reference if on a highway. Accident investigation and any subsequent transactions are entered to a case file within the CIMS. The PITU is currently exploring alternative methods for deriving reasonably accurate geographic coordinates for accident locations and there is an intention to add this capability in the future. This would help to give a more accurate picture of traffic

accidents over time, and could be used as an analytical tool to define and assess repeated accident locations to determine what intervention or signage might be required to address the issue.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Record and analyze traffic accidents by location
- Develop and maintain inventory of traffic safety signage, markings, pedestrian crossings and other relevant features
- Analyze traffic accident concentrations and trends over time
- Produce traffic accident analysis and statistical output maps and reports

12.1.2.9 Conduct special patrol operations

A Special Patrol Unit under the Commander Operations Branch is responsible for conducting patrols on an as-needed basis. These include special events, VIP visits, backup support and other duties on an as-needed basis.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Prepare special patrol plans;
- Provide common operating picture for special patrol activities;
- Monitor and track special patrol activities.

12.1.2.10 Support joint emergency response

The Police Department is an important part of the National Emergency Management Organization (NEMO) emergency planning and response framework. The Police Department stands ready to mobilize personnel and security assets in time of an emergency and to support relief efforts as needed. The applicability of GIS and the BNSDI to the emergency contingency planning and response area is covered in some detail under the NEMO stakeholder survey write-up.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Maintain inventory of security staging facilities and equipment
- Identify security risks associated with natural hazard vulnerable populations, facilities and infrastructure
- Support preparation of the security component of the national emergency contingency and response plans
- Provide access to common operating picture mapping during emergency response
- Provide tools for tracking vehicles and human resources during emergency response

MANAGEMENT SERVICES

Management services covers a variety of administrative and technical services, including”

- Internal Affairs

- National Prosecuting Branch
- Planning Unit and Inspections
- Personnel Officer
- Administration
- Chaplain, Welfare and Sports
- Police Information and Technology unit (PITU)
- Training Director
- Training Academy

12.1.2.11 Conduct facility and asset management.

The Planning Unit and Inspections is involved in compiling an inventory of all police department facilities and assets, planning and monitoring of facility maintenance. While the Ministry of Works is responsible for the preventive and as-needed maintenance of buildings and other major assets, the BPD handle most of the smaller issues locally.

Specific GIS-related capabilities that can support this function include but are not limited to:

- Develop and maintain inventory of police facilities, fixed and movable assets
- Prepare maintenance plans and contracts
- Maintain police facility space plans
- Plan and conduct maintenance inspections
- Plan for facility and equipment refurbishment and replacement

12.1.2.12 Develop, maintain, operate and support Crime Information Management System

Of special relevant to GIS and the BNSDI is the Police Information and Technology unit (PITU) which manages the Police Department information infrastructure nationwide. Specific functions carried out by PITU include:

- Provide Hardware, Software and Network support to address the needs of the Belize Police Department
- Development and Management of ICT network infrastructure
- Administration and Training of all ICT services
- Website and Intranet Management
- Application development
- ICT Research, Assessment, Testing and Documentation
- Administration and Training of all ICT services
- Development, Infrastructural Management and Administration of the Crime Information
- Management System (CIMS)
- ICT Crisis Emergency Response
- Public Education and Communication (social network)
- Development and Management of ICT network infrastructure
- Installation of ICT systems
- Systems Analysis

- Software development
- Crime Mapping
- Quality Assurance
- Data Analysis of CIMS records

The PITU has developed the current Crime Information Management System (CIMS), and is in the process of designing and implementing additional components to the system over time. It is intended that this system will ultimately support all the mission critical information management and analysis needs of the Department, including geospatial enablement of many functions.

12.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting this group's functions or are planned as part of the current system upgrade strategy:

Police Stations Map. The Belize Police Department (BPD) has collaborated with the Ministry of Natural Resources and Agriculture (MNRA) Land Information Center (LIC) to create a map illustrating the locations of all the police stations across the country.

The following manual information stores are in the process of being replaced with digital database management through the upgrading of the CIMS:

- Criminal Records (will replace Index Cards System at C.R.O.)
- Incident Reports (will replace Report Diary)
- Crime Reports (will replace Charge Register)
- Case File Management (will file Case File Register Book)
- Missing Passports (will replace Report Diary)
- Nominals (will replace Charge Register Book)
- Court/Bails (will replace Court Book)
- Information/Intelligence reports (replaces Files and Index Cards)
- Traffic (will replace Traffic Charge Register Book)
- Warrants (will replace Warrant/Wanted Persons Register Book)
- Custody and Prisoner Property (will replace Personnel Diary and Prisoner Property Book)
- Firearms (will replace Firearms Register Book)
- Stop and Search Database (new)
- Profile (Nominal)
- Deportee Database (new)

12.1.4 Existing Systems

The Police Department's IT Unit has developed its own infrastructure with the additional capability to serve all the security agencies of Belize. The department's systems are running

mainly on open source technology. Email, chat, intranet and DNS servers are hosted internally which provide service to the BPD countrywide.

Infrastructural Assets of PITU presently include the following:

I. Server Room
- VOIP server
- Email server
- Intranet/chat server
- Domain Name server
- Firewalls
- CIMS server `
- Virtual server (HR management2)
- Fingerprint server
- Interpol server

II. Connectivity
- 4mb dedicated internet – ISP BTL
- 8mb DSL internet – ISP BTL
- 1mb dedicated – ISP Alternative Networks

III. Battery Room and Electrical Generator
- Holds enough batteries to generate 6-8 hours of energy in the case of an emergency
- 35 KVA Generator

The upgrading of the police radio communication system to digital one, using the P25 technology, is presently underway and should be concluded at the end of the 2014. The PITU also assists in the implementation and maintenance of the Interpol System which is also housed at the Police server room.

Crime Information Management System (CIMS). The Police Information Technology Unit (PITU) developed, manages and administers the Crime Information Management System, CIMS, which tracks all incidents reported to police and all related investigations and case management from inception to final closure. This system allows the police to store all forms of data related to an incident; whether it be text, graphics, audio or video. CIMS is presently operational in Belize City, the Northern and Western regions of the country. The system is based on application software developed by Memex Technology Limited, now part of the SAS Company. CIMS will be introduced in the Southern part of the country in areas such Dangriga, Independence and Punta Gorda Town. This rollout will then be followed by the wireless implementation of the CIMS to mobile units. The CIMS application server also powers the Fuel Administration, a Firearms System which monitors and tracks the licensing of these weapons, and the automation of the Criminal Records Database with a goal to speed up the issuance of these records to the general public. The department's systems are running mainly on open source OS servers and the applications, including a Police Human Resource Management Information System (beta testing phase), are also developed in open source software. There is a proprietary software database engine used to run the CIMS. Other applications already established are a countrywide fingerprint system based on windows server 2008 and MSSQL, a SMS system to alert police on patrol, and a RFID system to monitor the patrolling of the police in Belize City is also on the pipeline. A camera surveillance system is used internally and on the streets of Belize City.

12.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- At present there is very little digital connectivity among security agencies in Belize. There is an intention to expand the BPD information infrastructure to include a more robust and integrated communications and data linkage framework across the Country and extending to international security and defense mechanisms with whom Belize has cooperative arrangements;
- As identified by the PITU, there is an urgent need for the laws of the country to be updated to accept digital evidence and to reflect the prevalence of digital technology and prosecution of cyber criminals;
- Policies need to be developed and implemented across all Government Ministries to cover acceptable usage terms and conditions of all Government equipment and software;
- The PITU has identified additional staff and staff capabilities will be required to conduct development and utilization of more advanced information systems for policing, including;
    - Communication System Manager - Required for P25 IP Digital Radio System
    - Digital Radio Technician - Required for P25 IP Digital Radio System
    - Developer - Required for development of additional CIMS modules, Gun Dealers Database, System generated reports, etc.
    - Database Administrator - Required for Porting CIMS Data Base to relational Oracle backend, Human Resource Management System, Zimbra Email Databases, etc.
    - System Administrator - Required for the upkeep, configuration, and reliable operation of Windows Data Center; Email, Chat, Intranet systems and ancillary equipment.
    - Computer Forensic Analyst – Required to conducts forensic examination of electronic evidence, including computer-related equipment, network devices, and information systems. Use forensic software applications to analyze, recover and present data use in police investigations or as evidence in criminal matters. Prepare written report of forensic examination and details computer-related system and related encryption, intrusion, security or deletion etc. and work closely with investigators and prosecutors to assist in the preparation of search warrants, investigative information, and cases for court purposes.
    - Crime Analysts – Review of all incident police reports, information/intelligence reports every day with the goal of identifying patterns, trends, problematic characters and hot spots as they emerge; report writing and actionable dissemination to respective agency and consequent feedback.

13 REGIONAL ORGANIZATIONS

There are many social, economic and environmental issues that go beyond national boundaries, and Belize is involved in various regional and international initiatives and programs. Likewise there are some regional organizations that conduct projects in Belize or regional studies that include Belize. The following outlines information regarding several regional organizations that have special relevance to the BNSDI.

13.1 Caribbean Community Climate Change Center

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utrotz@caribbeanclimate.bz
Timo Baur, Clearinghouse Manager / Information Systems Adviser, tbaur@caribbeanclimate.bz

Interview Date(s): June 20, 2014

13.1.1 Organization and Mission

The Caribbean Community Climate Change Centre coordinates the Caribbean region's response to climate change. Officially opened in August 2005, the Centre is the key node for information on climate change issues and on the region's response to managing and adapting to climate change in the Caribbean.

CCCCC is the official repository and clearing house for regional climate change data, providing climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States through the CARICOM Secretariat. In this role, the Centre is recognised by the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), and other international agencies as the focal point for climate change issues in the Caribbean. It has also been recognised by the United Nations Institute for Training and Research (UNITAR) as a Centre of Excellence, one of an elite few.

Based on the CARICOM mandate "to coordinate the regional response to Climate Change and its efforts to manage and adapt to its projected impacts", the primary objectives of the Centre include among other things:

- The promotion of the protection of the earth's ecosystems from the impacts of a Warming Climate and Sea Level Rise with special emphasis on the Caribbean,
- Improving the Regional Climate monitoring and modelling capacity, and

- Providing comprehensive policy and technical guidance through the application of the principles and actions enshrined in the Regional Framework for Achieving Development Resilient to Climate Change and its Implementation Plan.

The Centre is currently employing 40+ staff members. These are organized to 5 main units, including:

- Climate Science Unit;
- Administration Unit;
- Programme Management Unit;
- Renewable Energy and Technology Transfer Unit;
- Information and Communication Unit.

The CCCCC carries out the following activities that have some relevance to the use of GIS and the organization's participation in the BNSDI:

1. Conduct climate modeling;
2. Conduct CARIWIG Project;
3. Manage SIDS DOCK Program;
4. Manage Pilot Program for Climate Resilience:
5. Planning for climate compatible development in the Caribbean regional framework;
6. Develop and manage database management system for a regional integrated observing network for environmental change in the wider Caribbean;
7. Conduct EU GCCA project;
8. Coordinate 2011-2015 Caribbean regional resilience development implementation plan;
9. Coordinate 2012-2013 Caribbean risk management program;
10. Coordinate 2012-2014 Australian Caribbean Coral Reef Collaboration;
11. Manage coastal protection for climate change adaptation in the small island states in the Caribbean;
12. Manage the organization's information and communications infrastructure.

13.1.2 Activity Areas

Each of the above mentioned units is involved in various activities and programmes under the administration of the CCCCC. For the purposes of this study, the following sections outline the various current and recent activities and programmes that have some specific relevance to GIS and the BNSDI. The purpose is not to present a detailed accounting of each activity or programme, but rather an overview with emphasis on those components that can best illustrate how GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI can support regional and local cooperation.

13.1.2.1 Conduct climate modeling

The climate science unit, in cooperation with scientific and meteorological partners organizations, is generating outputs from (amongst others) ECHAM5 and Hadley climate

models in different resolutions, which are being plotted on a geospatial grid. A tool is in development to generate shapefiles for the newer models.

There are long-standing good relationships with the Belize national meteorological office. While the Belize national meteorological office focuses on meteorological observations about Belize, as well as shorter term meteorological forecasts, the Climate Change Centre provides regional climate modeling with longer term projections. The Climate Change Centre, under various project activities, has also been supporting the Belize meteorological service with the procurement and installation of weather stations as well as equipment for the digitalization of historical weather records.

Aspects of the climate modelling activity that can be supported by GIS and NSDI include, but are not limited to the following:

- Analyze and assess climate conditions and trends;
- Refine regional models utilizing locally available national data;
- Provide input to climate change vulnerability analysis;
- Monitor and refine trend forecasts and vulnerability assessments over time.

13.1.2.2 Conduct CARIWIG Project

CCCCC is collaborating with University of East Anglia (UK), University of the West Indies (Jamaica) and the Institute of Meteorology (Cuba) in the development of the CARIWIG project. This project is addressing the provision of locally relevant information on the weather impacts of climate change for a range of time horizons, training for stakeholder technical staff in the use of such weather information, the development of support networks within the region and development of partnerships with UK research institutes specializing in the management of a range of hazards and impacts. This is intended to provide managers and policy makers in the Caribbean with knowledge of the likely impacts and hazards arising from climate change that are specific to their geographical location in ways that the standard international models don't provide, and that are relevant to their planning time-horizons (e.g. the short term, 2030s, or the longer term, 2080s). This is different to the usual climate modeling, as it does not compute spatial projections of climate, but, based on those projections, provides simulations of possible future weather scenarios for specific geographical locations, i.e. individual weather stations.

A web service will be developed to provide this service through the adaptation and provision of leading weather-generator models from the EARWIG and the UKCIP09 climate knowledge systems. These weather generator models will be used to provide locally relevant weather projections based on the best available observed data and climate model outputs for the region.

The IDB Data Management System that is currently being developed is planned to support the collection, generation and storage of, time-series and geospatial datasets produced from hydro-meteorological and environmental data. For this purpose, the design document defined

a range of different data categories that are relevant for climate change, accordingly proposes data sets and geospatial appearance of possible maps, and identifies possible data sources in the region that can give the necessary input to generate those data sets.

Aspects of the climate modelling activity that can be supported by GIS and NSDI include, but are not limited to the following:

- Assess climate change related hazards and vulnerabilities
- Compile and manage from hydro-meteorological and environmental data
- Prepare hazard and vulnerability maps
- Train project participants in climate change tools and methods

13.1.2.3 Manage SIDS DOCK Program

SIDS DOCK is a SIDS–SIDS institutional mechanism established to facilitate the development of a sustainable energy economy within the small island developing states. The ultimate goal of SIDS DOCK is to increase energy efficiency by 25 percent (2005 baseline) and to generate a minimum of 50 percent of electric power from renewable sources and a 20-30 percent decrease in conventional transportation fuel use by 2033. Some SIDS have announced more ambitious goals for the reduction of fossil fuel based Greenhouse Gas (GHG) emissions. It is estimated that SIDS consume in excess of 220 million barrels of fuels and emit some 38 million tons of carbon from the energy sector. SIDS DOCK has four principal functions:

- Assist SIDS develop a sustainable energy sector, by increasing energy efficiency and development of renewable energy;
- Providing a vehicle for mobilizing financial and technical resources to catalyze clean economic growth;
- Provide SIDS with a mechanism for connecting with the global carbon market and taking advantage of the resource transfer possibilities that will be afforded, and;
- A mechanism to help SIDS generate the financial resources to invest in climate change adaptation.[68]

Aspects of the SIDS DOCK programme that can be supported by GIS and NSDI include, but are not limited to the following:

- Conduct renewable energy potential geographic analysis;
- Prepare inventory and assessment of existing energy supply and demand;
- Support Climate-Smart energy program planning and development;
- Provide a repository (knowledge network) of data and information regarding the application of geospatial tools and data to renewable energy planning and development;
- Support renewable energy project formulation and feasibility assessment;
- Support renewable energy project engineering and design;
- Provide asset management framework for renewable energy system operations and maintenance;
- Monitor and evaluate single and cumulative project effectiveness over time.

[68] http://www.caribbeanclimate.bz/ongoing-projects/2001-2012-sids-dock.html

13.1.2.4 Manage Pilot Program for Climate Resilience (PPCR)

The Pilot Program for Climate Resilience (PPCR), approved in November 2008, was the first program to become operational under the Strategic Climate Fund (SCF), one of two Climate Investment Funds. The PPCR is executed globally through a number of regional and national programs and is intended to:

- Pilot and demonstrate approaches for integration of climate risk and resilience into development policies and planning;
- Support the strengthening of capacities at the national levels to integrate climate resilience into development planning;
- Scale up and leverage climate resilient investment, especially by building on other ongoing initiatives;
- Enable learning by doing and lesson sharing at the country, regional and global levels;
- Strengthen cooperation and capacity at the regional level to integrate climate resilience in national and appropriate regional development planning and processes.[69]

One of the activities undertaken by the 5C's within this program has been the development of a "Climate Risk Screening Toolkit" to demonstrate the advantages of including assessments of climate risk adaptation measures in development planning. The primary aim of the toolkit is to:

a) evaluate projects for their sensitivity to climate variability and climate change,

b) identify those projects for which additional analysis will be required, and

c) ensure that investment decisions will lead to the delivery of outputs that are resilient to climate variability and change.

The overall framework of the tool is based on a standard project evaluation process, with additional attention to climate change vulnerability considerations. The screening criteria include:

<u>Sector sensitivity</u>

- High: Tourism, Agriculture, Forestry, Fisheries, Water, Health.
- Medium: Transport, Mining, Energy, Housing.
- Low: ICT, Education, Finance, Banking, Insurance, Creative.

<u>Location exposure</u>

- High: Coastal zone, Marine, Beach, Floodplain, Wetlands
- Medium: Coastal plain, Riverbank, Valleys, Urban, Rural, National.
- Low: Highlands, Forests, Other.

<u>Lifetime exposure (how long will the outputs last?)</u>

- High: 20+ years

[69] http://www.caribbeanclimate.bz/ongoing-projects/2009-ppcr-caribbean.html

- Medium: 10-20 years
- Low: Less than 10 years

The general flow of the assessment process is illustrated in the figure below.

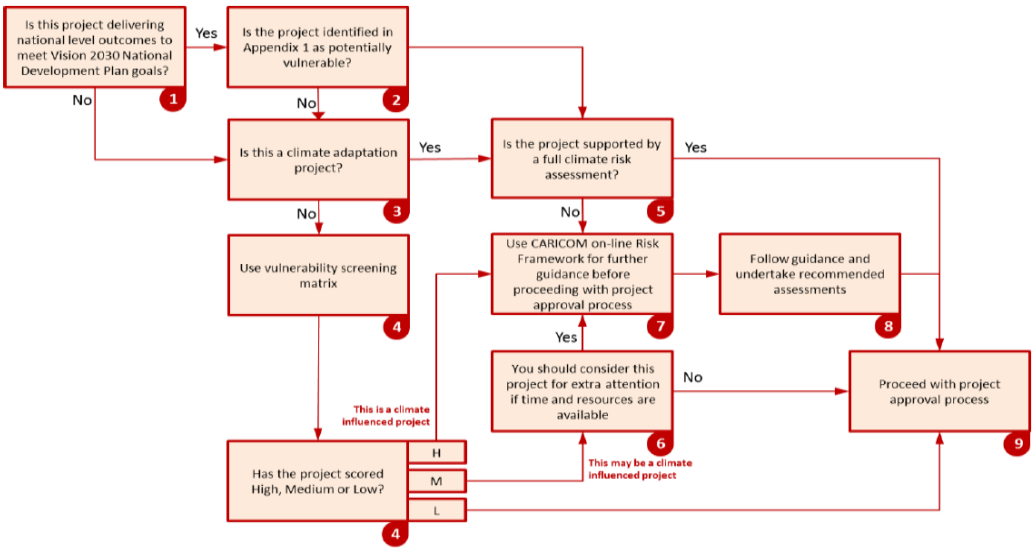

Figure 60 - Climate Risk Screening Process

A simple rating/scoring system is applied to this process. Projects that score higher on the risk rating scale are recommended for further study.

Aspects of the PPCR programme that can be supported by GIS and NSDI include, but are not limited to the following:

- Develop and pilot geospatial tools, techniques and data modeling sound practices and standards for climate risk assessment and resiliency planning;
- Support capacity building for use of geospatial technology and methods;
- Support integrated surveillance system (ISS) and early warning systems for vector borne disease;
- Develop and disseminate geospatial tools and methods for improving regional climate monitoring and projections, and applying multi-sector (water, health, agriculture and marine) adaptation strategies;
- Provide framework for scaling pilot geospatial tools and methods to other countries and regionally;
- Establish NSDI in member countries to institutionalize optimum coordination, information sharing and utilization for climate-smart, sustainable development.

13.1.2.5 Planning for Climate Compatible Development in the Caribbean Regional Framework

The Regional Framework defines CARICOM's strategic approach for coping with climate change and is guided by five strategic elements and some twenty goals designed to significantly increase the resilience of the CARICOM Member States' social, economic and environmental systems. It provides a roadmap for action by member states and regional

organisations over the period 2009-2015, while building on the groundwork laid by the CCCCC and its precursor programmes and projects in climate change adaptation. It also builds upon the extensive work undertaken by governments, regional organisations, NGOs and academic institutions in recent years assessing the impacts of a changing climate.

The strategic elements of the framework are as follows:

- Mainstreaming climate change adaptation strategies into the sustainable development agendas of CARICOM states.
- Promote the implementation of specific adaptation measures to address key vulnerabilities in the region.
- Promote actions to reduce greenhouse gas emissions through fossil fuel reduction and conservation, and switching to renewable and cleaner energy sources.
- Encouraging action to reduce the vulnerability of natural and human systems in CARICOM countries to the impacts of a changing climate.
- Promoting action to derive social, economic, and environmental benefits through the prudent management of standing forests in CARICOM countries.

Aspects of the Regional Framework programme that can be supported by GIS and NSDI include, but are not limited to the following:

- Introduce GIS and NSDI as an integral aspect of scientific and evidence-based climate change risk assessment and adaptation strategy development across all potentially impacted sectors;
- Establish institutional and technical mechanisms to facilitate open access to shared information resources across national and regional stakeholder communities;
- Provide visualization tools to communicate issues and alternative plans to decision makers and the public;
- Develop place-based strategies and defensible project plans for optimizing renewable energy utilization and attracting new investment;
- Assess climate change vulnerable populations and infrastructure and develop effective mitigation and resilience measures;
- Provide tools and methods for the effective inventory, management and utilization of standing forests;
- Provide effective tools and information for geographically based monitoring, evaluation and adaptive management options related to climate change related environmental and infrastructure conditions and trends;

13.1.2.6 Develop and Manage Database Management System for a Regional Integrated Observing Network for Environmental Change in the Wider Caribbean[70]

Currently the region lacks an integrated observing network that can enable comprehensive assessment of environmental change at the regional and national levels and that can be

[70] http://www.caribbeanclimate.bz/ongoing-projects/2011-2013-idb-data-management-system-dms.html

effectively used to meet the needs of adaptation and planning. There are various sensors deployed in the region, but the data output is disparate and there are no regional controls over data products. The core of such a network is a regional database management system (DMS) that will provide standardized data products useful for analyzing, predicting and forecasting environmental changes (oceanographic, atmospheric and ecological) and trends in the region.

The "Database Management System for Regional Integrated Observing Network for Environmental Change in the Wider Caribbean (DBS) is executed by the Caribbean Community Climate Change Centre (CCCCC) with the financial support of the Inter-American Development Bank (IDB). The need for such a regional DMS is recognized by CARICOM countries in order to provide the data and information that can improve the understanding of environmental change and impacts of sea-level change at the national and regional levels, in support of effective decision making in climate change adaptation.

The goal of the project is to build regional capacity to respond to the challenges and adverse impact of climate change in the Caribbean. Seven countries were proposed as the pilot beneficiary countries for this "Regional Public Good" project; these being Barbados, Belize, Dominica, Guyana, St. Lucia, and Trinidad and Tobago.

The components of the project include:

- ***Gap Analysis and Regional Plan of Action***. Inventory of existing and planned geospatial infrastructure and development of a regional plan to address identified gaps.
- ***Selection of DMS Inputs and Outputs and Conceptual DMS Design***. Development of conceptual DMS design for selected countries.
- ***Creation and Implementation of DMS***. The objective of this component is to develop a basic, expandable operational DMS through the enhancement of existing systems at the CIMH.
- ***DMS Outreach and Sustainability***. This component ensures the sustainability of the DMS after the life of the RPG including the establishment of institutional and technical infrastructure and capacity building.

At the time of this writing, the first two components of the above list have been completed. Key findings relative to Belize include:

The following table summarizes the priorities expressed by survey respondents in regards to climate priority issues in Belize:

Table 14 - Summary of Climate Priority Issues for Belize[71]

Priority Rank	Climate Change Issue

[71] PHASE 1: GAP ANALYSIS AND ACTION PLAN REPORT - Database Management System for A Regional Integrated Observing Network for Environmental Change in the Wider Caribbean, IDB project: ATN/OC-12554-RG. (May 2014).

1	– Not enough data sharing eg. Temperature – Accelerating Coral bleaching and coral disease linked to higher SST – Deforestation – We are interesting in studying the change in Temperature and Precipitation trend over the last 60 years across weather stations for Belize. – Transmission of infectious diseases – Coastal erosion that could possibly be tied to climate change. For the past 8 years coastal erosion has increased exponentially resulting in over 80 feet being eroded from some communities such as Monkey River in Southern Belize. Other communities like Punta Negra also in the South loss about 10 ft. over the past 5 years. Many families had to abandon their homes, which are now literally in the sea.
2	– Ocean acidification effects on coral, coralline alga, and other calcifying organisms – Water conservation – The impacts of Climate Change on Belize Barrier Reef. Coral Bleaching. – Food Quality Control – Possible changes in spawning seasons for key commercial fish species such as lobster, conch and sea cucumber which have designated open and closed seasons based on research done more than 20 years ago. If climate change affects the spawning seasons for these species, current open and closed seasons may not be as effective in protecting the species as they ought to be.
3	– Increased strength and or frequency of hurricanes - impacting reefs with reduced resiliency – Soil conservation – The impacts of Climate Change on Belize Coast Line. – Water Quality – Changes in weather patterns that result in increased drought or flooding leading to loss of crops, livestock etc. The loss of such livelihoods can result in increased pressures on Protected Areas.
4	– Sea level rise affecting coastal lagoons, mangroves, and deeper reefs – Flood prone areas – The impacts of Climate Change on Agriculture productivity. – Disaster Management – Increased exchange of information between policy makers and local communities for climate change adaptation. Many community members are ignorant when it comes to understanding the possible impacts of climate change on their lives.
5	– Increased fluvial run-off following increased storm events, possibly combined with increased nutrient run-off following increased fires – Production under covered structures – The impacts of Climate Change on Vector Borne Disease.

The study identifies key information gaps related to 10 areas of climate impact. These are summarized in the annex table to this write-up.

Aspects of the Data Management System that can be supported by GIS and NSDI include, but are not limited to the following:

Meteorological and Hydrological Data and Projections

- Provide geospatial framework for precipitation and general meteorological monitoring;
- Conduct a spatial assessment to support expansion of the meteorological monitoring network;
- Support geographically-based climate modeling and forecasting;
- Assess potential climate change impacts to agricultural productivity, tourism, and infrastructure
- Conduct a spatial assessment to support expansion of the hydrologic monitoring network;
- Provide framework for sharing of information among all the various groups currently maintaining meteorological and hydrological data and projections;

Hazards and Risks

- Conduct flooding vulnerability assessment based on conditions and trends;
- Forecast drought conditions and possible impacts to agriculture and water availability;
- Assess current and future projected hazard potential and vulnerability of communities, infrastructure and resources at risk of damage from hurricanes and storm surge impact;
- Assess and monitor beach erosion;
- Assess risk to disease and pest distribution and impacts to human health and agriculture;
- Provide framework for sharing of information among all the various groups currently hazard and risk assessments;

Geographical and Biophysical Environment

- Support detailed topographic modeling and analysis;
- Provide a geographic basis for terrestrial ecosystem and biodiversity monitoring and assessment of potential climate change impacts;
- Provide framework for sharing of information among all the various groups currently maintaining terrestrial resource and monitoring data;

Coastal Zone and Ocean

- Support detailed bathymetric and hydrodynamic modeling and analysis;
- Provide a geographic basis for marine ecosystem and biodiversity monitoring and assessment of potential climate change impacts;
- Provide framework for sharing of information among all the various groups currently maintaining marine resource and monitoring data;

Land Cover and Land Use

- Provide geospatial framework for the inventory and monitoring of land use and land cover change;
- Forecast potential impacts to existing land use and land cover from climate change;
- Support the management of protected areas and parks in both terrestrial and marine environments;
- Provide framework for sharing of information among all the various groups currently involved in managing, monitoring or enforcing protected areas and parks;

Agriculture and Food Security

- Provide geospatial framework for the inventory and monitoring of agriculture and agricultural productivity;

- Assess and monitor existing agricultural productivity;
- Assess and forecast seasonal agricultural productivity and potential impacts of climate change;
- Support the mapping and assessment of soils for various agricultural purposes;
- Provide framework for sharing of information among all the various groups currently involved with food security and planning;

Water: Availability, Quality, and Use

- Support the inventory, monitoring and assessment of water availability, quality and use;
- Assess the potential impacts of climate change on water availability;
- Provide a geographic basis for monitoring water abstractions and trends;
- Provide framework for sharing of information among all the various groups currently involved in managing, monitoring or using water resource data;

Energy: Use, Generation, Availability

- Provide geospatial framework for the inventory and monitoring of existing energy supply and demand;
- Support geographic-based forecasting for future energy demand;
- Support the inventory and analysis of potential new renewable energy resources;
- Support the planning, design and development of new energy infrastructure;
- Support the operations and maintenance of energy infrastructure;
- Assess the vulnerability of existing and planned energy sources to climate change;
- Provide framework for sharing of information among all the various groups currently involved in managing, monitoring or using energy resource data;

Socio-Economic Status

- Support the inventory and monitoring of commercial and industrial activities;
- Inventory and monitor the job market and household income levels and trends;
- Monitor and assess socio-economic status at the neighborhood level;
- Identify communities that are most susceptible to natural disaster impacts and economic shocks
- Provide framework for sharing of information among all the various groups currently involved in the planning, development and supply of community and social services;

Critical and Emergency Infrastructure

- Conduct hazard assessment and identify vulnerable populations and infrastructure at risk;
- Formulate adaptation strategies to minimize risks to populations and infrastructure;
- Prepare and record emergency contingency and response plans;
- Inventory and record location of emergency response resources;
- Provide a common operating picture for multi-user coordination during emergency response events (rescue and evacuation, food, water, medical supplies, etc.);
- Support the planning and implementation of post-disaster recovery activities.

13.1.2.7 Conduct EU GCCA Project

The Caribbean component of the Intra-ACP GCCA programme will further build on the results achieved by earlier programmes that were largely focused on climate adaptation measures, including:

- Caribbean Planning for Adaptation to Climate Change (CPACC) Project funded by the Global Environment Facility (GEF);
- Adapting to Climate Change in the Caribbean (ACCC) Project funded by the World Bank,
- Mainstreaming Adaptation to Climate Change (MACC) Project funded by the GEF;
- Special Pilot Adaptation to Climate Change (SPACC) Project, funded by the GEF;
- Pilot Programme for Climate Resilience (PPCR) funded by the Inter-American Development Bank.

The resulting Implementation Plan (IP) provides the basis for the implementation of the Intra-ACP GCCA programme in the Caribbean. Several activities are planned that have some relevance to GIS and/or the BNSDI:

Climate Monitoring. The existing regional climate monitoring system will be expanded and integrated in the Global Climate Observing Systems (GCOS). Under the programme, an additional 106 hydro-meteorological stations and 6 Coral Reef Early Warning Stations (CREWS) will be installed. Also a system for adequate collection, digitizing and storage of data retrieved from the expanded monitoring system will be put in place. Finally, a protocol for sharing the information through the CCCCC's Information Clearing House Facility will be developed.

Climate Modelling. In view of enhancing the predictive powers of the climate models currently in use, the programme will support the development of improved models based on data at smaller resolutions. In this sense, an adequate system of national and regional data nodes will be put in place and further work on ensemble climate modelling and downscaling models will be undertaken. The required capacity will be built through a specific training programme. Once available, the use of the improved Climate Models in studies on climate impact will be promoted through regional workshops and through the implementation of about 10 Climate Impact Studies in the region.

Vulnerability and Risk Assessment. Vulnerability and risk assessment techniques and methodologies will be developed and people will be trained in the application of the new methodologies. Subsequently, about 10 vulnerability assessments will be conducted in the field. This activity will be implemented in collaboration with the Caribbean Natural Resource Institute (CANARI) and the outcomes of the assessments will inform future land use planning, zoning and development planning. Also a number of risk and hazard assessments will be carried out and topographic maps indicating risk areas and levels will be produced in collaboration with the National Oceanic and Atmospheric Administration (NOAA).

Adaptation Projects. The development and implementation of concrete Adaptation Projects will be based on the experiences gained under the Special Pilot Adaptation to Climate Change (SPACC) Project in St Lucia, Dominica and St Vincent and the Grenadines. Following the identification and screening (feasibility studies, participatory consultations) of potential adaptation interventions, at least 2 adaptation projects will be funded and implemented.

Access to Carbon Financing. The programme aims to build regional and national capacity for increased access to available carbon financing. To enhance the region's participation in the CDM, the programme will support (1) the establishment and operationalisation of Designated National Authorities (DNAs), (2) the development of criteria for a first order screening of project proposals in the area of renewable energy and (3) the participatory development and implementation of two renewable energy projects in indigenous communities. Further, in view of increasing the region's preparedness to access REDD funding, the programme will organise a seminar on REDD. Emphasis will be put on enhancing the capacities in developing reference scenarios and in complying with Monitoring, Reporting and Verification requirements. Lead countries will be Guyana, Belize and Suriname.

13.1.2.8 Coordinate 2011 – 2015 Caribbean Regional Resilience Development Implementation Plan (IP)

The CCCCC has a mandate to coordinate the Caribbean Community (CARICOM) country's response to climate change and with assistance from the Commonwealth secretariat, developed the Regional Framework for achieving Development Resilience to Climate Change. With financial assistance from the Department for International Development (DFID) and the Climate Development Knowledge Network (CDKN), the Centre has finalized the Implementation Plan (IP) to actualize the Regional Framework document.

The IP highlights the existing and significant resource and capacity challenges that hold back the region's sustainable development and growth and a more cogent and coordinated approach to assist in resource mobilization and co-ordination of actions. This programme is one such initiative at a comprehensive and coordinated mechanism to addressing climate change impacts in the region.

Aspects of this program that can be supported by GIS and NSDI include, but are not limited to the following:

- Utilize the BNSDI as a comprehensive common repository for access to information about Belize;
- Support better and more defensible project formulation, design and feasibility analysis;
- De-risk projects through systematic analysis and utilization of accurate, authoritative data, and thereby attracting a broader range and diversity of project financing options for development of new climate smart infrastructure;
- Support more coordinated efforts among organizations and sectors;
- Provide a comprehensive information framework for project monitoring and evaluation;

- Provide a project dashboard to understand the location, extent and status of funded project works;
- Provide a geographically based historic record of projects and trends;
- Assess cumulative impact and program effectiveness.

13.1.2.9 Coordinate 2012-2013 Caribbean Risk Management Project

The Caribbean Risk Management Project builds on the work started by the Region in 2003 in the development of Risk Management Guidelines for decision makers, but is intended to be more attuned to the needs and special circumstances of the Region given the prevailing conditions. It will also incorporate the development of new tools and risk management methodologies. The Project will be executed in a phased approach. Phase 1 will be the development of a risk management, web-based tool to guide decision making. Phase 2 will provide in-depth training for country decision-makers. Phase 3 will undertake detailed risk assessments in selected countries. The overall objective is to embed risk assessment into decision-making and management systems across the region in finance and planning.

Aspects of this program that can be supported by GIS and NSDI include, but are not limited to the following:

- Provide GIS and NSDI as an enabling environment for climate smart government and development;

13.1.2.10 Coordinate 2012-2014 The Australia Caribbean Coral Reef Collaboration (ACCRC)

The Caribbean has lost 80% of its coral reefs over the last 50 years and this environment is under additional threat from climate change and warming seas. A two year program was conceived to bring together coral reef managers and policymakers from across the world to improve the outlook for the Caribbean's coral reefs in the face of climate change by developing a regional plan for reducing coral reef vulnerability to climate change, enhancing knowledge exchange between Australia and the Caribbean through collaborative projects, Providing a platform for engagement and capacity building across the region through a Climate Change Adaptation Resource Portal.

Aspects of this program that can be supported by GIS and NSDI include, but are not limited to the following:

- Provide GIS and NSDI as an enabling environment for climate smart coral reef science, policy and management;
- Support the inventory and assessment of coral reefs throughout the Mesoamerican barrier reef system;
- Monitor and assess reef health and trends over time;
- Provide a geographic basis for reef protection and regulatory enforcement;

- Provide framework for sharing of information among all the various groups currently involved in the protection, management and use of coral reef environments.

13.1.2.11 Manage Coastal Protection for Climate Change Adaptation in the Small Island States in the Caribbean

An additional project "Coastal Protection for Climate Change Adaptation in the Small Island States in the Caribbean"recently completed the planning phase. It will concentrate on implementation of local adaptation measures for the sustainable improvement of coastal ecosystems relevant for climate change adaptation in Saint Lucia, Grenada, St. Vincent and the Grenadines and Jamaica. This project will follow a bottom-up approach in which governmental and non-governmental institutions in participating countries can apply with proposals to pursue Local Adaptation Measures. The Local Adaptation Measures will be prepared by the participating organizations with support from the CCCCC.

The project has two major components:

- Component 1: Investments for sustainable improvements of coastal ecosystems relevant for climate change adaptation, including:
  - Measures related to the protection and sustainable management of ecosystems relevant for adaptation;
  - Measures related to the rehabilitation or substitution of ecosystems relevant for adaptation; and
  - Measures related to the monitoring of coastal ecosystems.
- Component 2: Assistance in the preparation and implementation of Local Adaptation Measures

Aspects of this program that can be supported by GIS and NSDI include, but are not limited to the following:

- Support inventory and assessment of coastal ecosystems and ecosystem services;
- Assess the vulnerability of coastal ecosystems and services to various climate change impacts;
- Support the formulation and modelling of alternative investment options;
- Provide a geographic basis for coastal ecosystem monitoring and adaptive management;
- Capacity building using geospatial tools, methods and "spatial thinking" to address coastal ecosystem management matters in a holistic, systemic and place-based manner.

13.1.2.12 Manage the organization's information and communications infrastructure

The Centre`s Information and Communication Unit operates the regional clearinghouse database, the official repository and clearinghouse for regional climate change-related data. It provides an important knowledge base by functioning as a proactive information exchange

facility that aids and supports stakeholders in accessing and sharing climate change related information and tools.
In general, application of geospatial data in the field of climate change has the ultimate goal to enhance mitigation and adaptation strategies, including the management of risks and disasters emerging from climate change. The Centre and its clearinghouse team have been actively supporting and facilitating activities that may bring this goal forward. The current strategy is to further expand on the identification, generation and collection of geospatial data with such relevance, such as maps depicting vulnerability, impact risk or other information useful for adaptation to, and mitigation of, climate change.

The Clearinghouse team is continuously maintaining a bibliographic catalogue with documents and links relevant for climate change in the region. It also operates several tools (e.g. the Caribbean Risk Management Online Tool CCORAL) and a geospatial search across the Geonode installations in the region. It is planned to extend the functionalities of this search tool to automatically backup the data from all Geonodes in the region.

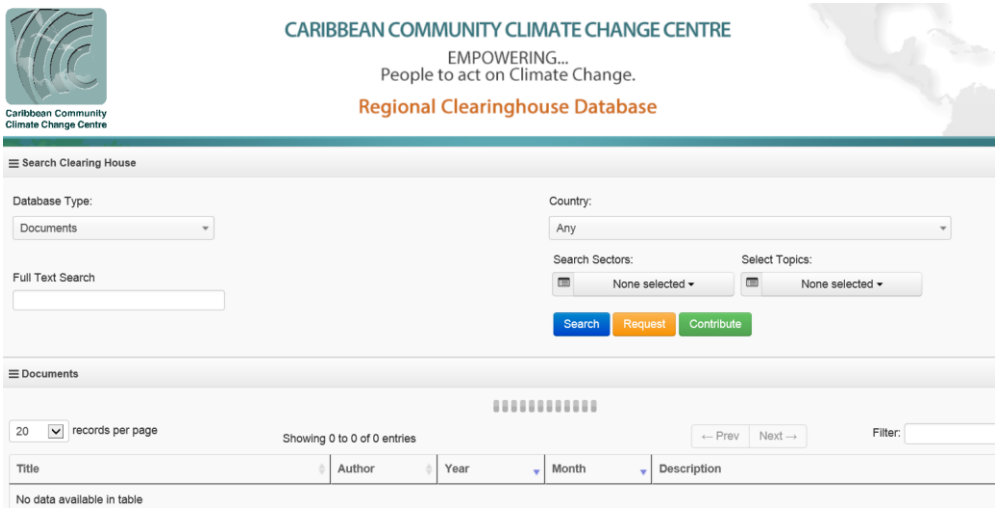

Figure 61 - CCCCC Regional Clearinghouse Database

The communication arm of the unit has planned to raise awareness activities under the SPCR to boost collection, transmission, availability and access to geo-spatial data to aid in identifying ongoing and potential impacts of climate change, such as beach erosion, landslides, and sea level rise.

The biggest challenge to date is the non-availability of relevant regional and national maps and shapefiles to illustrate the ongoing and potential impacts of climate change, the risks that emerge from such impacts to society and economic sectors, and the suitable adaptation and mitigation activities to react to those risks. The data that would be needed to create such maps is often scarce and not readily available. It must be found on a case by case basis.

Much of the Centre`s project activities are conducted externally. Various partners will use different geospatial or related information accessible to them and/or gathered locally as part of their project activities. As a standard practice, it is being recommended to managers of

CCCCC projects to provide copies of project data, documents, outputs and derivative products to the CCCCC Clearinghouse.

The Centre supports this by providing a regional catalogue of geospatial data in the national Geonode installations in the countries through the clearinghouse. It also provides geospatial data as part of various documents in the bibliographic database. The Clearinghouse unit can provide a listing of the documents in the bibliographic database that have some relevance to geospatial information, however there would be a charge for doing so to cover staff costs.

The bibliographic database is geocoded to the countries a document relates to and is retrievable on that basis.

The Centre also maintains a small internal collection of geospatial datasets related to Belize. The Clearinghouse unit can provide a list and metadata of geospatial datasets in this collection given that expected costs are covered.

12.1.3 Data Used or Generated

The following document sets related to GIS and/or the BNSDI that have been inventoried, used and/or generated through projects, programmes and activities that the CCCCC is involved with:

CCCCC Regional Clearinghouse Database Holdings. The CCCCC Clearinghouse Database provides extensive full text search functionalities and categorizations, which can support the process of determining which documents have relevant geospatial or related information.

The CCCCC Clearinghouse Database can be accessed through an online and a desktop client software. Credentials and technical support can be requested from clearinghouse@caribbeanclimate.bz.

Table 15 - Stations collecting environmental data across Belize[72]

Station Code	Org	Obs.	Measured Parameters	Storage	QA/QC	xmit	Share
Report Card for MesoAmerican Reef	Healthy Reefs Initiative	Manual	- Several	Paper	N/A	-	Yes
Port Honduras Marine Reserve – water quality	TIDE	Auto / Manual	Water quality: water temp, dissolved oxygen, salinity, turbidity, nitrate, phosphate, sedimentation rate,	Spreadsheet	Yes	Paper	No
Port Honduras Marine Reserve		Manual	Lobster abundance, lobster size, lobster	Spreadsheet	Yes	Paper	No

[72] PHASE 2: C-READ SYSTEM DESIGN, CONCEPTUAL DESIGN DOCUMENT - Database Management System for A Regional Integrated Observing Network for Environmental Change in the Wider Caribbean, IDB project: ATN/OC-12554-RG. (February 2014).

– Caribbean spiny lobster assessment		gender, lobster maturity					
Port Honduras Marine Reserve – queen conch assessment	Manual	Conch abundance, conch shell length, conch lip thickness	Spreadsheet	Yes		Paper	No
Port Honduras Marine Reserve – finfish assessment	Manual	Finfish abundance, fish tail and fork length, fish maturity	Spreadsheet	Yes		Paper	No
Port Honduras Marine Reserve – sea cucumber assessment	Manual	Sea cucumber length, weight, abundance	Spreadsheet	Yes		Paper	No

Table 16 - GIS datasets collated by organizations in Belize[73]

Organization	Layer Name	Type	Grid Units	Projection	Program	File Format	Share
Coastal Zone Management Authority & Institute	Administrative Boundaries	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	River	line	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Road Network	line	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Land use	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Land cover	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Watersheds	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Coastal zones	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Tourism infrastructure	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	National parks or attractions	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Settlements	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	DEM	raster	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No
	Socio-economic maps	polygon	-	WGS 1984 UTM Zone 16N	Arcview	.shp	No

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Healthy Reefs Initiative	Administrative Boundaries	polygon	-	-	Arcview	.shp	With partners
	Land use	polygon	-	-	Arcview	.shp	With partners
	Land cover	polygon	-	-	Arcview	.shp	With partners
	Watersheds	polygon	-	-	Arcview	.shp	With partners
	Coastal Zones	polygon	-	-	Arcview	.shp	With partners
	Tourism infrastructure	polygon	-	-	Arcview	.shp	With partners
	Natural parks or attractions	polygon	-	-	Arcview	.shp	With partners
	Settlements	polygon	-	-	Arcview	.shp	With partners
	Socio-economic maps	polygon	-	-	Arcview	.shp	With partners
	Bathymetric maps	polygon	-	-	Arcview	.shp	With partners
TIDE	Administrative Boundaries	polygon	km	UTM 16	Arcview	.shp	With partners
	River	line	km	UTM 16	Arcview	.shp	With partners
	Road Network	line	km	UTM 16	Arcview	.shp	With partners
	Land cover	raster	km	UTM 16	Arcview	.tif	With partners
	Watersheds	polygon	km	UTM 16	Arcview	.shp	With partners
	Point source pollution	Point / polygon	km	UTM 16	Arcview	.shp	With partners
	Settlements	polygon	km	UTM 16	Arcview	.shp	With partners
	Remotely sensed products	raster	km	UTM 16	Arcview	.shp	With partners
	Marine biodiversity monitoring sites	point	km	UTM 16	Arcview	.shp	With Partners partne
Ministry of Health	Administrative Boundaries	polygon	-	UTM	Arcview	.shp	No
	River	line	-	UTM	Arcview	.shp	No
	Road Network	line	-	UTM	Arcview	.shp	No
Ministry of Natural Resources	Administrative Boundaries	polygon	km	NAD27	Arcview	.shp	Yes
	River	line	km	NAD27	Arcview	.shp	Yes
	Road Network	line	km	NAD27	Arcview	.shp	Yes
	Settlements	polygon	km	NAD27	Arcview	.shp	Yes
Land	Administrative	polygon	m	NAD 1927	ArcGIS	.shp	Yes

Information Center	Boundaries	10.1	
			Centre
			River
			Road Network
			Land Use
			Land Cover
			Natural Parks or attractions
			Watersheds
			Settlements
			DEM
			Centre
			River
			Road Network
			Land Use
			Land Cover
			Natural Parks or attractions
			Watersheds
			Settlements
			DEM

12.1.4 Existing Systems

The Centre`s computing system consists of a network of desktop computers and two racks with 14 servers as well as internet, LAN and storage equipment (RAID and magnetic tape systems).

Caribbean Risk Management Online Tool (CCORAL). The Caribbean Climate Online Risk and Adaptation tooL – CCORAL - is an online support system for climate resilient decision making. It is designed to help decision makers to see all kinds of activities through a 'climate' or 'climate change' lens, and to identify actions that minimise climate related loss, take advantage of opportunities and build climate resilient development in their countries.

Proprietary search in geonodes in the region. This is an online application. See the link provided in the survey.

M-Files. M-Files is a suite of electronic content management (ECM) system software from M-Files Inc., based in the USA. This is installed on a local server. The Centre has decided against the use of Cloud services.

ArcGIS. Esri's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

12.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- With the independent Biodiversity and Environmental Resource Database System BERDS *(*www.biodiversity.bz), Belize has a good collection of environmental geospatial data that has been growing over the years. A Belize Spatial Data Infrastructure should ensure that this important collection, so far provided and maintained by a non-governmental effort, will be made accessible through the spatial data infrastructure, amongst other data provided by international and national organizations and the government. There is plenty data on Belize from NGO`s and international sources like the United Nations and it should be ensured that this data can be accessed through the infrastructure as well.
- One pressing issue in Belize is also that much geospatial data that exists at government departments is only available on paper (maps). For example in the coastal zone management unit, the national archives, and the lands and forestry departments. This

data is difficult to access for other departments and project activities which are not directly involved with these departments. It is thus at risk that these important sources are not been taken into account or ignored, which may in many cases reduce the accuracy of analyses. The material is also likely to deteriorate in the long run, despite its high historical value. It needs to be preserved, digitized and made accessible to a wider audience.

14 CATHALAC

Person(s) Interviewed: Desk study with agency review (pending)

Interview Date(s): na
Desk Study Date(s): 9/1/2014

14.1 Organization and Mission

Established in 1992, the Water Center for the Humid Tropics of Latin America and the Caribbean (in Spanish ¨CATHALAC¨- Centro del Agua del Trópico Húmedo para America Latina y el Caribe) is an autonomous international organization dedicated to promote sustainable development through applied research and development, education, and technology transfer in the areas of integrated watershed management, climate change, environmental modeling and analysis, and risk management in Latin America and the Caribbean.[74]

CATHALAC is financially autonomous and funded through its project work. Work is carried out for government and institutions through contracts and Memoranda of Understanding (MOU's).

The Center's thematic areas of work include:

- Integrated water resource management;
- Climate change;
- Environmental modeling and analysis;
- Risk management.

Primary functions carried out by CATHALAC that have direct relevance to the BNSDI include the following:

1. Provide education and training
2. Carry out applied research
3. Conduct special projects
4. Compile, manage and publish geographic information
5. Coordinate regional cooperation

[74] http://www.cathalac.org/en/about-us

14.1.1 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

14.1.1.1 Provide education and training

CATHALAC is dedicated to developing a regional community of professionals that are able to respond to the needs, opportunities and challenges related to the management of environmental and water resources. A Regional Training Center has been developed to provide the infrastructure needed to effectively carry out the organization's education programs. Programs currently include:

International Courses. This program includes the mobilization of international experts and participants in addressing current needs of Latin America and the Caribbean;

Graduate Diplomas. CATHALAC currently supports graduate diplomas in Integrated Water Resource Management (IWRM), ground water management and climate change. These courses are offered in Spanish through the organization's virtual education platform which is structured to facilitate collaborative learning among participants from different countries;

Education and Research Programs. CATHALAC supports internship programs to allow students to utilize the organization's technical infrastructure and research resources to address real-world issues.

Aspects of this functional area that are relevant to GIS and BNSDI in Belize include, but are not limited to the following:

- Provide access to technical education courses and infrastructure;
- Provide channel for student exchange and study abroad
- Establish and maintain online learning opportunities

14.1.1.2 Provide specialized services

CATHALAC is involved in carrying out specialized services supported through grants and project funding by service requesters. These services include:

- Apply earth observation technologies and environmental modeling to answer specific questions regarding historical, current and potential future uses of the region's natural resources;
- Provide scientifically valid information related to the use of sustainable resources for management decision making;
- Use remote sensing techniques to inventory the region's resources, taking advantage of the synoptic perspective of Earth Observation Systems (EOS);
- Provide countries in the region with the necessary tools and training to be able to sustainably manage their water resources;

- Study and analyze natural phenomena through continuous monitoring, collection and analysis of historical information;
- Assist in the identification of areas subject to recurring threats, and the assessment of their vulnerability to these threats;
- Provide information and tools for improved decision making and policy development in regards to food security.

Aspects of this functional area that are relevant to GIS and BNSDI in Belize include, but are not limited to the following:

- Provide access to specialized technical expertise and infrastructure;
- Technical cooperation and sharing of information and methods for environmental modeling and analysis;
- Technical cooperation and sharing of information and methods for integrated water resource management;
- Technical cooperation and sharing of information and methods for hazard and vulnerability assessment;
- Technical cooperation and sharing of information and methods for environmental monitoring.

14.1.1.3 Compile, manage and publish geographic information

CATHALAC is the regional hub for SERVIR for Latin America and the Caribbean. SERVIR is a joint venture between NASA and USAID which provides satellite-based Earth observation data and science applications to help developing nations improve their environmental decision making.[75]

The SERVIR initiative integrates satellite observations, ground-based data and forecast models to monitor and forecast environmental changes and to improve response to natural disasters. SERVIR enables scientists, educators, project managers and policy implementers to better respond to a range of issues including disaster management, agricultural development, biodiversity conservation and climate change. Principally supported by NASA and the US Agency of International Development (USAID), a strong emphasis is placed on partnerships to fortify the availability of searchable and viewable earth observations, measurements, animations, and analysis. A SERVIR coordination office and rapid prototyping facility is located at the NASA Marshall Space Flight Center in Huntsville, Alabama. Other regional SERVIR hubs are located at the Regional Center for Mapping of Resources for Development (RCMRD) based in Kenya, and the International Center for Integrated Mountain Development (ICIMOD) located in Kathmandu, Nepal.

Data that are maintained and disseminated by CATHALAC that have some relevance to Belize include:

- MM5 weather model forecasts at 24, 48 and 72 hour increments
- Project data. The organization maintains a repository of information for different countries and regions that have been compiled through funded project work

[75] http://www.nasa.gov/mission_pages/servir/

- Hot spot, actual or potential fire location maps are generated every 24 hours
- ASTER and EO-1 satellite data.

Aspects of this functional area that are relevant to GIS and BNSDI in Belize include, but are not limited to the following:

- Provide infrastructure and tools for the compilation, processing, discovery and dissemination of geospatial data
- Provide analytical and visualization tools to support the development and dissemination of specialized derivative information products
- Provide online access to data and application services in standardized formats

14.1.1.4 Support regional cooperation

CATHALAC provides support and coordination for several regional initiatives, including the following:

SERVIR (described elsewhere);

UNOOSA UN-SPIDER. Since 2010 CATHALAC has served as the Regional Support Office of the United Nations Platform of Space Information on Disaster Management and Emergency Response (UN-SPIDER) in Latin America and the Caribbean;

Water Learning Center. The organization supports the Water Learning Center function for the United Nations University, Institute for Water, Environment and Health for the region of Latin America and the Caribbean;

UNEP Technical Advisory Committee on Geospatial Information Systems and Earth Observations. CATHALAC is the regional coordinator for the TAC for the region of Latin America and the Caribbean.

Aspects of this functional area that are relevant to GIS and BNSDI in Belize include, but are not limited to the following:

- Participate in regional and international initiatives for disaster management and emergency response;
- Participate in regional and international initiatives for water and environmental management;
- Participate in regional and international technical advisory fora.

14.1.2 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting CATHALAC functions.

MM5 weather model forecasts. The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the

National Center for Atmospheric Research. The last major MM5 release (3.7) was December 2004, with the last bug fix release in October 2006. Email support has been discontinued, and online documentation and tutorials have been frozen. The Weather Research and Forecasting model (WRF) was designed as the successor to MM5 and includes all capabilities available within the MM5.[76]

Project data. CATHALAC maintains a repository of information for different countries and regions that have been compiled through funded project work. A metadata catalog of this information is maintained for internal use and only provide upon special request.

24 Hr Fire Hot Spot Maps. Actual or potential fire location maps are generated every 24 hours. These are derived from analysis of MODIS satellite data. The University of Maryland, Department of Geography (U.S.A.), provides access to archived and current fire locations on GIS-based interactive maps on its Fire Information for Resource Management System (FIRMS) website**.** Web fire maps can be retrieved for Brazil, Central and Southern, Africa, Continental U.S., Southeast Asia and at global level.[77]

ASTER Satellite Data. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an imaging instrument onboard Terra, the flagship satellite of NASA's Earth Observing System (EOS) launched in December 1999. ASTER is a cooperative effort between NASA, Japan's Ministry of Economy, Trade and Industry (METI), and Japan Space Systems (J-spacesystems). ASTER data is used to create detailed maps of land surface temperature, reflectance, and elevation.[78]

EO-1 Satellite Data. The Earth Observing-1 Mission (EO-1) satellite is part of NASA's New Millennium Program (NMP), to develop and validate a number of instrument and spacecraft bus breakthrough technologies designed to enable the development of future earth imaging observatories that will have a significant increase in performance while also having reduced cost and mass. Its Advanced Land Imager (ALI) measures nine different wavelengths simultaneously, instead of the seven measured by the imager in Landsat 7. This permits a greater flexibility in false-color imagery. Another improvement is that instead of having an imaging spectrometer that sweeps from side to side, the ALI has a linear array of spectrometers that each scan a strip of ground parallel to that of adjacent spectrometers. In order to compare the two imagers, EO-1 follows Landsat 7 in its orbit by exactly one minute.[79]

14.1.3 Existing Systems

The following systems are being used in the process of conducting this group's functions:

- Open Source: Linux, MapServer, GeoServer, MySql, etc.

[76] http://en.wikipedia.org/wiki/MM5_(weather_model)
[77] http://www.fire.uni-freiburg.de/current/MODIS.htm
[78] http://asterweb.jpl.nasa.gov/
[79] http://en.wikipedia.org/wiki/Earth_Observing-1

- Comercial: ESRI (desktop and server), Microsoft (desktop and server), ENVI, ERDAS, Adobe (desktop),

14.1.4 Computing Infrastructure

Information only available upon special request.

14.1.5 Other Issues, Opportunities and Constraints

The following are additional considerations for future engagement between CATHALAC and Belize:

- It would be advantageous to establish a permanent arrangement between the government of Belize and CATHALAC to help facilitate cooperation/

14.2 Inter-American Institute for Cooperation on Agriculture (IICA)

Person(s) Interviewed: Desk Study with Agency review

Interview Date(s): na
Desk Study Date(s): 9/20/2014

14.2.1 Organization and Mission

The Inter-American Institute for Cooperation of Agriculture (IICA) is a multi-national, regional entity that has grown from the "Inter-American Institute of Agricultural Sciences formed in 1942, to an organization now comprising every member country of the Organization for American States (OAS). When the OAS was created in 1948, IICA became the specialized agency for agriculture of the Inter-American System, consolidating its work by extending its action to every country in the hemisphere.

Today, 34 IICA offices the length and breadth of the hemisphere are working to meet the needs of the countries in areas such as: technological innovation, agricultural health and food safety, agribusiness and commercialization, territorial management and rural well-being, food security, natural resources and climate change.

The IICA carries out several activity areas that have some relevance to GIS in Belize and the Belize National Spatial Data Infrastructure (BNSDI) including the following:

1. Compile, analyze, manage and disseminate agriculture knowledge and information;
2. Support agricultural development strategies and projects

14.2.2 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

14.2.2.1 Compile, manage and disseminate agriculture knowledge and information

The IICA provides a variety of services for compiling and disseminating information regarding agricultural best practices, emerging methods and technologies and other material to its members. The website includes access to a digital library with a wealth of reports, bulletins, presentations and other information in the areas of biotechnology, trade, natural resources and environment, agricultural health and food safety, technology and innovation and sustainable rural development. The website also provides a general search function to access information regarding projects, workshops and other activities.

A search of the online library for "GIS" returned a list of 250 book resources with information about this topic. A search on "Spatial Data Infrastructure" returned only one resource. A search on the IICA website search engine yielded 90 resources for GIS and none for Spatial Data Infrastructure. A search through the "InfoAgro" portion of the site yielded a Technology Project Location map based on Google Maps.[80]

Figure 62 - IICA Technology Project Location Map

Specific ways that GIS and the BNSDI could support this type of program include, but are not limited to the following:

[80] http://infoagro.net/programas/CambioClimatico/default.aspx

- Provide access to information regarding the application of GIS and SDI to the agriculture sector;
- Provide a geographic framework for geo-referencing and accessing bibliographic information regarding projects, reports, technical bulletins, and other resources.

14.2.2.2 Support agricultural development projects

In Belize, the IICA had been involved in the development and implementation of the Belize Rural-Area Based Development Strategy. The Vision of the Strategy is: The rural areas of Belize have significantly improved quality of life; both human and of the ecosystems, through innovation, and informed decision-making capabilities of their populations, while appreciating and respecting their cultural identities and the potential of each rural area with robust and integrated institutions responsible for inclusive and sustainable development. The objective of this strategy is to make "rural areas a more attractive place to live and work in and where increasingly diverse people of all ages can find a better life " by providing them with the means to generate their own development, to adapt to new economic circumstances and to be valued as they deserve to by all of society. The Strategy includes projects to build local capacity for agriculture project formulation, finance and development in two communities, and then to use the methods developed to scale up the program for application nationally.

In 2012 the IICA and the European Union signed a €2.5 million cooperation agreement to fund a project aimed at strengthening the Sugar Industry Research and Development Institute (SIRDI). The objective of the project is to promote and support sustainable livelihoods, particularly in the rural communities of the “sugar belt” and, in this way, contribute to the reduction of poverty in Belize. More specifically, it is intended to increase the capability of SIRDI to address the technological, production and quality requirements of producers, manufacturers, and associations involved in the industry.

Throughout the three years of the project, efforts have been focusing on enhancing the capacities of SIRDI in the area of research and development related to sugar cane production. One component of this project seeks to address the challenge of limited information and lack of adequate information system to support improved production, productivity and cane quality. This project activity proposes the use of GIS technology as a tool to establish a comprehensive system of data collection, processing, analysis and dissemination to facilitate improved decision making by stakeholders of the industry.

After initial analysis of this program by stakeholders and assessment of information provided at a seminar on the use of GIS for information management in sugar cane production, it was determined that the proposed SIRDI- GIS program be expanded to a Management Information System for the Industry (referred to as SIMIS) to include the active participation of the mill (BSI), the Belize Sugar Cane Farmers Association (BSCFA), the Sugar Industry Control Board (SICB) and SIRDI. Given the role that the SIMIS will play in the region, it is vitally important to make a substantial commitment to the professional development of the technical staff.

Specific ways that GIS and the BNSDI could support this type of program include, but are not limited to the following:

- Provide access to comprehensive agricultural census and farm data;
- Provide access to population census at the community and neighborhood levels;
- Provide access to topographic and natural resources information;
- Provide access to geographically based natural hazard information;
- Provide access to climate change induced hazard forecast information;
- Support analysis of existing situation and identification of issues, opportunities and constraints;
- Provide tools and information infrastructure to support agriculture research and development activities;
- Provide geographic framework for working with local communities and compiling local knowledge about the current situation;
- Provide maps and information to support farming community meetings and workshops;
- Strengthen the formulation and assessment of proposed agriculture development projects;
- Provide tools and data to support community based problem identification and solution development;
- Monitor and evaluate program outcomes geographically over time.

14.2.3 Data Used or Generated

The following geospatial related document sets are being used and/or generated in the process of conducting IICA functions:

Technology Project Locations. The organization has geocoded the locations of agriculture technology projects, utilizing a Google Maps interface. There were not projects recorded for Belize at the time of this writing.

14.2.4 Existing Systems

The following systems are being used in the process of conducting this group's functions.

Google Maps. Google Maps is a desktop and mobile web mapping service application and technology provided by Google, offering satellite imagery, street maps, and Street View perspectives, as well as functions such as a route planner for traveling by foot, car, bicycle (beta test), or with public transportation. Also supported are maps embedded on third-party websites via the Google Maps API, and a locator for urban businesses and other organizations in numerous countries around the world. Google Maps satellite images are not updated in real time; however, Google adds data to their Primary Database on a regular basis, and most of the images are no more than 3 years old.

14.2.5 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the IICA:

- Establishment of a GIS and SDI technology for agriculture track and access to the wide variety of relevant data collected by government would be beneficial to many of the organization's members.

14.3 Caribbean Catastrophe Risk Insurance Facility

Person(s) Interviewed: Desk study

Interview Date(s): na
Desk Study Date(s): 9/9/2014

14.3.1 Organization and Mission

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is a not-for-profit risk pooling facility, owned, operated and registered in the Caribbean for Caribbean governments. It is designed to limit the financial impact of catastrophic hurricanes, earthquakes and excess rainfall to Caribbean governments by quickly providing short term liquidity when a policy is triggered. It is the world's first and, to date, only regional fund utilising parametric insurance, giving Caribbean governments the unique opportunity to purchase earthquake, hurricane and excessive rainfall catastrophe coverage with lowest-possible pricing. CCRIF represents a paradigm shift in the way governments treat risk, with Caribbean governments leading the way in pre-disaster planning. CCRIF was developed under the technical leadership of the World Bank and with a grant from the Government of Japan. It was capitalised through contributions to a multi-donor Trust Fund by the Government of Canada, the European Union, the World Bank, the governments of the UK and France, the Caribbean Development Bank and the governments of Ireland and Bermuda, as well as through membership fees paid by participating governments.

The CCRIF idea was prompted by Hurricane Ivan in 2004, which caused billions of dollars of losses across the Caribbean. In both Grenada and the Cayman Islands, losses were close to 200% of the national annual GDP. Following the passage of Ivan, the Caribbean Community (CARICOM) Heads of Government held an emergency meeting to discuss critical issues surrounding the need for the provision of catastrophe risk insurance for its members. Consequently, CARICOM resolved to take action and approached the World Bank for assistance to design and implement a cost-effective risk transfer programme for member governments. This marked the beginning of what would become the Caribbean Catastrophe Risk Insurance Facility.[81]

[81] http://www.ccrif.org/node/34

CCRIF was developed to help mitigate the short-term cash flow problems small developing economies suffer after major natural disasters. A critical challenge is often the need for short-term liquidity to maintain essential government services until additional resources become available. Although ex post disaster funding from bilateral and multilateral agencies can be an important component of a government's catastrophe risk management strategy, over-reliance on this approach has obvious limitations. Unfortunately, donor assistance often takes months to materialise, and usually supports specific infrastructure projects. CCRIF represents a cost-effective way to pre-finance short-term liquidity to begin recovery efforts for an individual government after a catastrophic event, thereby filling the gap between immediate response aid and long-term redevelopment.[82]

CCRIF offers parametric insurance which disburses funds based on the occurrence of a pre-defined level of hazard and impact without having to wait for an on-site loss assessment. This feature is quite different from traditional indemnity-based insurance products in which claims are paid based on formal confirmation of the amount of a loss through on-site verification.[83]

Sixteen governments are currently members of CCRIF including Belize. Others include Anguilla, Antigua & Barbuda, Bahamas, Barbados, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Trinidad & Tobago and the Turks & Caicos Islands.

CCRIF offers separate policies for hurricane (wind), earthquake policies and excessive rainfall. Caribbean governments may purchase coverage which triggers for a 'one-in-15-year' hurricane and a 'one-in-20-year' earthquake, with maximum coverage of US$100M available for each peril. The cost of coverage is a direct function of the amount of risk being transferred, ensuring no cross-subsidisation of premiums and a level playing-field for all participants.[84]

CCRIF is currently collaborating with the Caribbean Electric Utility Service Corporation (CARILEC) in developing an insurance programme to provide parametric wind coverage to electric utilities in the region to enable cost-effective protection of their highly vulnerable overhead transmission and distribution systems. With respect to the agricultural sector, CCRIF is closely monitoring activities by the World Bank and other development agencies with a view to ascertaining how CCRIF can be best utilised as part of the solution for the provision of index-based agricultural coverage, via governments or their agencies, to farmers. CCRIF is supportive of the efforts to bring such coverage into the pipeline and, if and when that happens, CCRIF would likely play a risk transfer role in the exercise and also provide technical support.[85]

The CCRIF carries out the following activity areas that have some relevance to GIS and BNSDI including the following:

[82] http://www.ccrif.org/node/35
[83] Understanding CCRIF's hurricane and earthquake policies, Caribbean Catastrophe Risk Insurance Facility, the (CCRIF), 2012
[84] http://www.ccrif.org/node/36
[85] http://www.ccrif.org/node/86

1. Calculate risk and establish policy;
2. Process post-disaster payout.

14.3.2 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

14.3.2.1 Calculate risk and establish policy

CCRIF calculates risk for the purpose of establishing the appropriate insurance policy on a country-specific basis. This assessment utilizes a second-generation hazard and loss modelling framework that has been developed to assist CCRIF in developing new policy formulations and in developing regional technical capacity in catastrophe risk modelling. It will enable a new approach to policy formulation - one of modelled loss instead of index parametric, the latter being the current basis for policies. This means that the new policy will be able to reduce the basis risk in the parametric loss estimates by modelling each loss as it happens, rather than reducing the loss estimation methodology to a series of equations. Furthermore, the new model uses the best definition available of the entire wind, storm surge and wave field for hurricane policies and earthquake shaking field for earthquake policies to drive its loss model. Instead of being estimated only at distinct measuring points, the new model estimates the level of hazard and consequent loss for every 1km grid square of a country's territory. The losses are then added up across the country to find the total country-wide loss.

Given the operational needs of CCRIF, its hazard and loss modelling framework must meet the Facility's objectives accurately and in a manner that provides the Facility with both reasonable calculation times and maximum flexibility in designing and costing contract options. The CCRIF Facility Loss Model (FLM) is a stand-alone tool designed to enable the Facility to:

- estimate loss probabilities for individual territories and a portfolio of territories with specific contract terms;
- price contracts for specific territories; and
- estimate site-specific hazard levels and losses for specific events — either historical or active events during the contract period.

Main strengths of the FLM are that it:

- is built upon a strong, validated hazard modelling base;
- uses the same techniques and code for both historical hazard assessment and loss modelling as well as real-time storm modelling and payout calculation;
- is implemented using open modelling techniques from the published scientific literature;
- is highly scalable and can be applied at a wide range of modelling resolutions; and
- is implemented on a geographic base, enabling straightforward generation of results in mapping formats.
- Starting in the 2008/09 hurricane season CCRIF offered members and supporting partner organisations access to Kinanco's Real Time Hazard and Impact Forecasting System (RTFS), which is a storm impact forecast tool, built on the core TAOS ('The Arbiter of Storms') modelling technology which also supports CCRIF's second-generation loss model.
- The RTFS provides countries with access to hazard and impact maps in Google Earth which show wind speed over terrain, wave height in open water, storm surge height and inundation along the coast, cumulative rainfall over the duration of the storm, and wind effects on vegetation, structures and electrical power.
- Through this platform, information is provided on expected impacts of storms/hurricanes on populations, land area, ports and airports. The Caribbean Institute for Meteorology and Hydrology (CIMH) provides outreach support to national meteorological and disaster management agencies, the latter in partnership with the Caribbean Disaster and Emergency Management Agency (CDEMA).[86]

CCRIF is involved in supporting the utilisation of financial tools as part of disaster risk management strategies within its member states. This is part of a broader regional strategy designed to support critical adaptation initiatives targeted at reducing the disproportionately high burden created by climate change on Caribbean countries. CCRIF's contribution has also extended to involvement in global discussions on the use of insurance mechanisms to address some of the risks posed by climate change, as part of the negotiation process leading up to 15th meeting of the UN Conference of the Parties in Copenhagen (COP15) in December 2009.

On a regional and national scale, CCRIF is investing significant resources in the development and enhancement of a quantitative knowledge base for key climate change risks and adaptation strategies for decision making across the region. One such initiative involves the implementation of the Economics of Climate Adaptation methodology, developed by Swiss Re and McKinsey, in the Caribbean. This initiative is being undertaken in conjunction with specialists from Swiss Re and McKinsey and will be supported by key regional partners,

[86] http://www.ccrif.org/node/94

Caribbean Community Climate Change Centre (5C's) and the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC).[87]

In undertaking the development of the CCRIF parametric insurance coverage, significant investment went into developing the underlying catastrophe model. Catastrophe models are essential tools in assessing the risk associated with catastrophe events. For the most part they are based on robust datasets containing:

- Hazard module
- Exposure module
- Vulnerability module
- Damage module
- Loss module

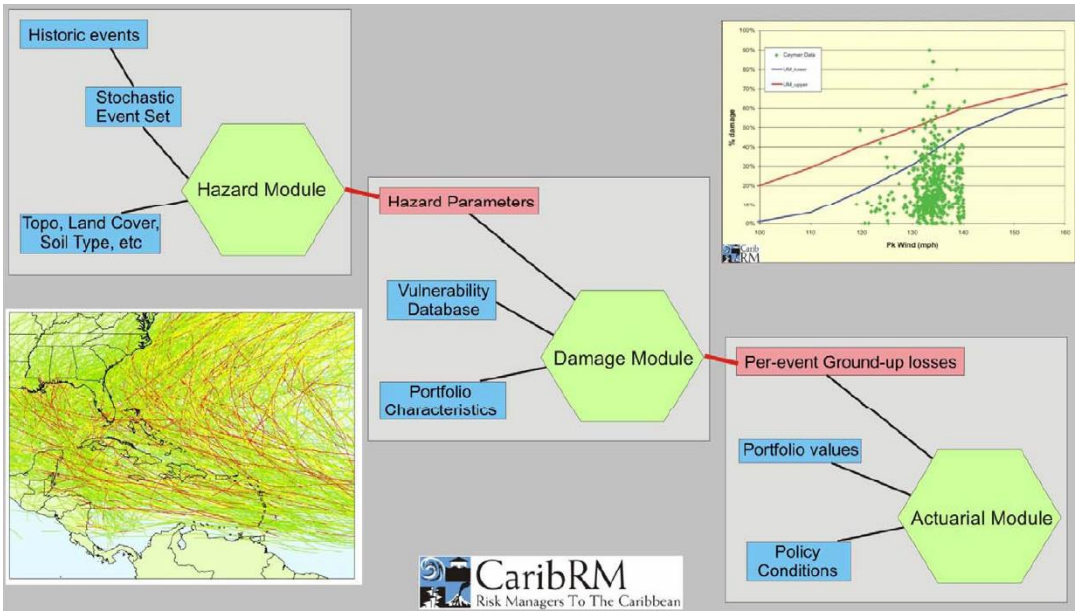

Figure 63 - Conceptual diagram for CCRIF loss modeling[88]

The hazard module defines the frequency and severity of a hurricane or earthquake, at a specific location. This is done by analysing the historical frequencies of the peril and reviewing scientific studies on the severities and frequencies in the region of interest. Using these historic data, simulated event sets are generated which define the frequency and severity of thousands of simulated cyclone or earthquake events in terms of their tracks/locations/ intensities.

This hazard module then calculates the hazard intensity at each location for each event in the simulated set. This is done by modelling the attenuation/degradation of the event from its

[87] http://www.ccrif.org/node/103

[88] CCRIF: Application of Risk Analysis and Modelling in the Insurance Sector – Technical Cooperation Workshop for Development of the Caribbean Regional Cooperation Program in Multi-Hazard Early Warning System, Caribbean Risk Managers Ltd, 2010.

location to the site under consideration and evaluates the propensity of local site conditions to either amplify or reduce the impact.

In developing the exposure module, the exposure values of "assets at risk" are estimated from available secondary data sources (including economic and satellite data) and from the population distribution. This "proxy" approach is used due to limitations in availability of site-specific asset data. Based on tested algorithms, the module computes the value of different asset types for each 1-km grid square across the entire country in question.

The population data is taken from the LandScan[1] data source. The LandScan is a satellite-derived database together with a statistical database which is compiled by several of the US agencies and it provides the total population count by country as well as the distribution of that population over the terrain of the country in each 1 km grid cell. However, the database may not be exactly correct in relation to the latest population count in the country but it is a very good close approximation. The currency of the data depends on when the agencies ask the country to provide that information but it is usually up to date within 1-3 years.[89]

Losses calculated are primarily focused on the built environment. However, CCRIF has some damage functions for the main crops in countries where agriculture plays a big role and therefore adds to the overall loss. It is important to remember what the CCRIF insurance scheme is designed for: it is designed to help *governments* overcome a temporary squeeze on their finances immediately after a disaster. They have to clean up, repair critical infrastructure, and help some people who cannot help themselves, all this while government revenue from tourism and exports is reduced. So the loss estimate is designed to give an estimate of what the charge to government accounts can be. The payout is designed to help governments in that short period between the disaster and 3-6 months later when they can get loans or other resources to reconstruct what has been damaged.[90]

Tourism is included within the loss model. One of the main drains on government accounts after a disaster is the fact that tourism drops or disappears and the government no longer can count on the tourism tax. Since CCRIF models the damage to physical infrastructure, including tourism infrastructure, and since this tourism infrastructure is often located on the coastline it will be affected by not only the wind but also the storm surge and wave action; all that is incorporated in the overall damage estimate that is done.

In terms of the vulnerability module, the starting point is to quantify the damage caused to each asset class by the intensity of a given event at a site. Estimation of damage is measured in terms of a mean damage ratio (MDR). The MDR is defined as the repair cost divided by replacement cost of the structure. The curve that relates the MDR to the hazard (earthquake shaking, wind or storm surge inundation) intensity is called a vulnerability function. Each asset class has a different vulnerability function for each hazard.

[89] http://www.ccrif.org/content/rtfs-faqs#Second-Generation
[90] http://www.ccrif.org/content/rtfs-faqs#_ftn1

To calculate the losses, the damage ratio derived in the vulnerability module is translated into dollar loss by multiplying the damage ratio by the value at risk. This is done for each asset class in each grid cell. Losses are then aggregated as required (e.g. at the administrative or national level). Government assets or assets that are likely to be financed with government resources can be isolated and an assessment of financial needs for reconstruction calculated.

Information that will be available through the BNSDI and the use of geospatial modeling and analysis tools will help greatly in refining otherwise generalized information sources to develop a more accurate estimation of the risk modeling and setting of the appropriate insurance policy measures for Belize. Those aspects of this function that are most relevant to GIS and the BNSDI are characterized in the following table:

Risk Model Function	**GIS and BNSDI Relevance**
Determine areas subject to hurricane wind exposure	▪ Compile historical hurricane wind data; ▪ Refine existing wind models with topography, land cover data and other relevant information; ▪ Assess extreme and average local hurricane wind exposure geographically utilizing refined wind model.
Determine areas subject to storm surge and wave exposure	▪ Compile historical storm surge data; ▪ Refine existing storm surge models with topography, bathymetry, and land use/land cover data for coastal areas; ▪ Assess extreme and average storm surge exposure geographically utilizing refined storm surge model.
Determine areas subject to flooding from excessive rainfall	▪ Compile historical flooding and stream gauge data; ▪ Refine existing wind models with topography and drainage data; ▪ Assess extreme and average flooding exposure geographically utilizing refined flooding model.
Identify built environment resources at risk	▪ Identify buildings and structures within areas exposed to wind, storm surge or flooding; ▪ Identify transportation routes, bridges and structures within areas exposed to wind, storm surge or flooding; ▪ Identify electrical, water, telephone and other critical infrastructure within high risk areas.
Identify government and other critical facilities at risk	▪ Identify critical government offices and facilities within areas exposed to wind, storm surge or flooding; ▪ Identify hospitals, schools, and other social critical facilities within high risk areas.
Identify touristic and other commercial facilities at risk	▪ Identify touristic and other commercial buildings, facilities and commercial enterprises within areas exposed to wind, storm surge or flooding that could be disrupted.
Identify populations at risk	▪ Identify population concentrations within high risk areas.
Identify agricultural resources at risk	▪ Identify agricultural farms, facilities and fields within areas exposed to wind, storm surge or flooding that could be damaged.
Calculate built environment vulnerability	▪ Determine the vulnerability of buildings and structures to wind, storm surge or flooding damage based on type and degree of

	exposure and the physical characteristics of the structures; ▪ Determine the vulnerability of transportation routes, bridges and structures to wind, storm surge or flooding damage based on type and degree of exposure and the physical characteristics of the roadways and structures; ▪ Determine the vulnerability of electrical, water, telephone and other critical infrastructure within high risk areas based on the type and degree of exposure and the physical characteristics of each utility network.
Calculate vulnerability of government and other critical facilities at risk	▪ Determine the vulnerability of government buildings and other critical facilities to wind, storm surge or flooding damage based on type and degree of exposure and the physical characteristics of the structures;
Calculate vulnerability of touristic and other commercial facilities	▪ Determine the vulnerability of touristic and other commercial buildings and facilities to wind, storm surge or flooding damage based on type and degree of exposure and the physical characteristics of the structures and facilities;
Calculate vulnerability of populations at risk	▪ Determine the vulnerability of populations within high risk areas based on the potential structural damage to homes and sources of employment. ▪ Assess socioeconomic situation and financial resilience and potential self-reliance of neighborhoods during an emergency.
Model predicted damage to built environment	▪ Calculate potential damage based on exposure and vulnerability assessments.
Model predicted damage to government and other critical facilities	▪ Calculate potential damage based on exposure and vulnerability assessments.
Model predicted damage to touristic and other commercial facilities	▪ Calculate potential damage based on exposure and vulnerability assessments.
Model predicted impacts to populations at risk	▪ Calculate potential loss of life and injury based on exposure and vulnerability assessments.
Model cost of damage to built environment	▪ Calculate cost of damage based on coefficients.
Model cost of damage to government and other critical facilities	▪ Calculate cost of damage based on coefficients. ▪ Calculate cost of restoring priority facilities to operational condition for disaster recovery.
Model cost of damage to touristic and other commercial facilities	▪ Calculate cost of damage based on coefficients; ▪ Calculate lost revenue and economic activity for each facility.
Model cost of impacts to populations at risk	▪ Calculate cost of emergency response to each neighborhood based on predicted loss and injury, access, and other issues.

14.3.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting CCRIF functions:

LandScan. Using an innovative approach with Geographic Information System and Remote Sensing, ORNL's LandScan™ is the community standard for global population distribution. At approximately 1 km resolution (30" X 30"), LandScan is the finest resolution global population distribution data available and represents an ambient population (average over 24 hours). The LandScan algorithm, an R&D 100 Award Winner, uses spatial data and imagery analysis technologies and a multi-variable dasymetric modeling approach to disaggregate

census counts within an administrative boundary. Since no single population distribution model can account for the differences in spatial data availability, quality, scale, and accuracy as well as the differences in cultural settlement practices, LandScan population distribution models are tailored to match the data conditions and geographical nature of each individual country and region.[91]

NOAA-NHC H*WIND algorithm. This algorithm rationalises all actual wind speed measurements collected on the ground and from flights and satellites. The H*WIND algorithm produces single wind footprints at a point in time. Also, the H*WIND estimates only surface winds over the open ocean, and therefore it does not include over-land friction and topographic effects (which the CCRIF model fully recognises).

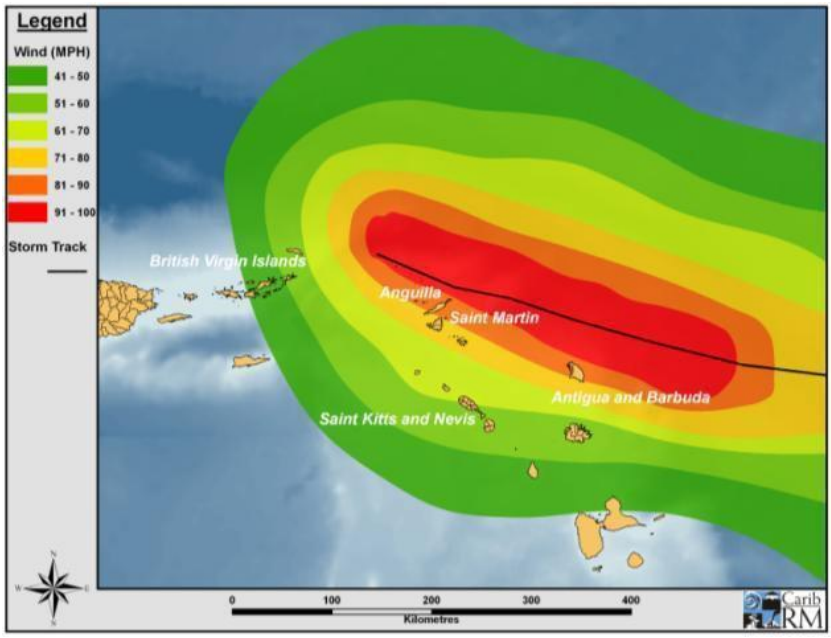

Figure 64 - H*WIND algorithm example output

Tropical Rainfall Measurement Mission (TRMM) Satellite Data. The Tropical Rainfall Measuring Mission (TRMM) is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall. Since December 1997, TRMM and the instruments it carries have provided valuable information to researchers, the applications community, and the public. On July 8, 2014, pressure readings from the fuel tank indicated that TRMM is at the end of its fuel. As a result, NASA has ceased station keeping maneuvers and TRMM has begun its drift downward from its operating altitude of 402 km. A small amount of fuel has been retained to conduct debris avoidance maneuvers to ensure the satellite remains safe during the drift down. TRMM observations will continue as the spacecraft descends to 335 km, at which time it will be shutdown prior to re-entry. This date is nominally estimated to be February 2016, but may change depending on solar activity. While TMI and LIS will continue operating during the entire drift down period, the TMI data will be affected. TMI incidence angle will be changing as will the field of view.

[91] http://web.ornl.gov/sci/landscan/

However, we expect useful data to continue especially for non-climate research.[92] JAXA has indicated that they may soon stop distribution of the radar data since useful science data is only possible within narrow altitude ranges near 400 and 350 km. When TRMM reaches 350 km (its original altitude), radar data may resume for a short period.

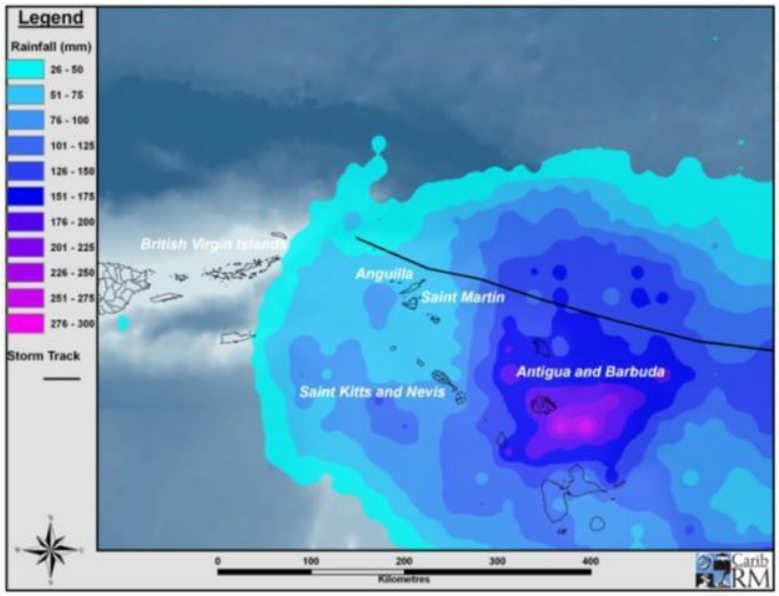

Figure 65 - TRMM rainfall totals example output.

14.3.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

Multi-hazard Parallel Risk Evaluation System (MPRES). Kinetic Analysis' pioneering hazard and loss modeling platform, the Multi-hazard Parallel Risk Evaluation System (MPRES), builds on nearly two decades of hazard and loss modeling research to answer challenging questions in the fields of hazard mapping, emergency management, property risk underwriting and natural hazard risk analysis and management. As a modeling platform, the MPRES incorporates multiple hazard assessment methodologies built from current science and hazard/loss modeling literature. Event-specific hazard and damage estimates can be produced using a single, selected set of model components, or by using permutations of available components, to produce accurate hazard and loss estimates with quantified statistical uncertainty. With the MPRES, the same modeling platform and components are applied to modeling of past, presently active, forecast, and potential future events, for any area of interest anywhere in the world. The conditions for potential future events can be based on extrapolations from history, or an analysis of the geology or climatology, including client-requested scenarios such as anthropogenic climate change, sea level rise, or alternative geologies. This consistent, integrated modeling base enables clients to better understand and

[92] http://trmm.gsfc.nasa.gov/publications_dir/trmm_fuel_status.html

compare risks for assets and portfolios across the globe and across hazard phenomena.[93] For use in determining contract triggers and payouts for tropical cyclone and earthquake events that occur during the contract period, Kinetic Analysis provided a stand-alone operational model to allow CCRIF to perform portfolio pricing and event-trigger calculations.[94]

14.3.5 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the CCRIF:

- Information from the BNSDI may provide more detailed information upon which to calculate more accurately the optimum emergency insurance policy for Belize;
- Parts of this same analysis will be useful input to disaster planning and management activities in the Country.

14.4 National Aeronautical and Space Agency (NASA)

Person(s) Interviewed: Desk study with agency review (review comments pending)

Interview Date(s): na
Desk Study Date(s): 9/9/2014

14.4.1 Organization and Mission

The National Aeronautics and Space Administration (NASA) is the United States government agency that is responsible for the civilian space program as well as for aeronautics and aerospace research.

NASA projects and programs that have some relevance to GIS and BNSDI in Belize include the following:

1. Collect and publish satellite remote sensing data;
2. Conduct and/or support special studies.

14.4.2 Activity Areas

Each of the abovementioned activities, projects or programs is further described in the following sections. These are not intended to be a comprehensive documentation of each, but rather a summary of the aspects of those that have some impact on the use of GIS and the BNSDI in Belize.

[93] http://www.kinanco.com/technology
[94] http://www.kinanco.com/caribbean-hurricane-and-earthquake-hazard-and-loss-assessment

14.4.2.1 Collect and publish satellite remote sensing data

NASA is involved in the planning, implementation and operations management of a variety of earth observation platforms and programs, many of which produce data that are relevant to Belize. The following outlines those that have the most significance for the BNSDI.

Earth Observing System (EOS). EOS is a program of NASA comprising a series of artificial satellite missions and scientific instruments in Earth orbit designed for long-term global observations of the land surface, biosphere, atmosphere, and oceans of the Earth. The satellite component of the program was launched in 1997. The program is centerpiece of NASA's Earth Science Enterprise (ESE).[95] The table below lists the earth observation missions involved.

Table 17 - NASA Earth Science Enterprise Missions

Satellite	Launch Date	Launch Site	Agency
SeaWiFS	1 August 1997		
TRMM	27 November 1997	Tanegashima	NASA / JAXA
Landsat 7	15 April 1999	Vandenberg	NASA
QuikSCAT	19 June 1999	Vandenberg	NASA / JPL
Terra (EOS-AM)	18 December 1999	Vandenberg	multiple
ACRIMSAT	20 December 1999	Vandenberg	NASA / JPL
NMP/EO-1	21 November 2000		NASA / GSFC
Jason 1	7 December 2001		NASA / CNES
Meteor 3M-1/Sage III	10 December 2001	Baikonur	
GRACE	17 March 2002	Plesetsk Cosmodrome	NASA / DLR
Aqua	4 May 2002	Vandenberg	multiple
ADEOS II (Midori II)	12 December 2002	Tanegashima	
ICESat	12 January 2003	Vandenberg	NASA
SORCE	25 January 2003	Cape Canaveral	NASA
Aura	16 July 2004	Vandenberg	multiple
CloudSat	28 April 2006	Vandenberg	NASA
CALIPSO			
Hydros	June 2006		
NPOESS	TBD		NASA / NOAA
OCO-2	2 July 2014	Vandenberg	NASA
Aquarius	10 June 2011	Vandenberg	NASA / CONAE
NMP/EO-3			
Landsat 8	11 February 2013	Vandenberg	NASA / USGS

[95] http://en.wikipedia.org/wiki/Earth_Observing_System

MODIS. Moderate Resolution Imaging Spectroradiometer (MODIS) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths (see MODIS Technical Specifications). These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere. MODIS is playing a vital role in the development of validated, global, interactive Earth system models able to predict global change accurately enough to assist policy makers in making sound decisions concerning the protection of our environment.
The uses of the various bands covered by MODIS are summarized in the following table.

Table 18 - MODIS Spectral Bands[96]

BAND #	RANGE nm	RANGE um	KEY USE
	Reflected	Emitted	
1	620–670		Absolute Land Cover Transformation, Vegetation Chlorophyll
2	841–876		Cloud Amount, Vegetation Land Cover Transformation
3	459–479		Soil/Vegetation Differences
4	545–565		Green Vegetation
5	1230–1250		Leaf/Canopy Differences
6	1628–1652		Snow/Cloud Differences
7	2105–2155		Cloud Properties, Land Properties
8	405–420		Chlorophyll
9	438–448		Chlorophyll
10	483–493		Chlorophyll
11	526–536		Chlorophyll
12	546–556		Sediments
13h	662–672		Atmosphere, Sediments
13l	662–672		Atmosphere, Sediments
14h	673–683		Chlorophyll Fluorescence
14l	673–683		Chlorophyll Fluorescence
15	743–753		Aerosol Properties
16	862–877		Aerosol Properties, Atmospheric Properties
17	890–920		Atmospheric Properties, Cloud Properties

[96] https://lpdaac.usgs.gov/products/modis_products_table/modis_overview

18	931–941		Atmospheric Properties, Cloud Properties
19	915–965		Atmospheric Properties, Cloud Properties
20		3.660–3.840	Sea Surface Temperature
21		3.929–3.989	Forest Fires & Volcanoes
22		3.929–3.989	Cloud Temperature, Surface Temperature
23		4.020–4.080	Cloud Temperature, Surface Temperature
24		4.433–4.498	Cloud Fraction, Troposphere Temperature
25		4.482–4.549	Cloud Fraction, Troposphere Temperature
26	1360–1390		Cloud Fraction (Thin Cirrus), Troposphere Temperature
27		6.535–6.895	Mid Troposphere Humidity
28		7.175–7.475	Upper Troposphere Humidity
29		8.400–8.700	Surface Temperature
30		9.580–9.880	Total Ozone
31		10.780–11.280	Cloud Temperature, Forest Fires & Volcanoes, Surface Temp.
32		11.770–12.270	Cloud Height, Forest Fires & Volcanoes, Surface Temperature
33		13.185–13.485	Cloud Fraction, Cloud Height
34		13.485–13.785	Cloud Fraction, Cloud Height
35		13.785–14.085	Cloud Fraction, Cloud Height
36		14.085–14.385	Cloud Fraction, Cloud Height

Shuttle Radar Topography Mission (SRTM). The SRTM is an international research effort that obtained digital elevation models on a near-global scale from 56° S to 60° N, to generate the most complete high-resolution digital topographic database of Earth prior to the release of the ASTER GDEM in 2009. SRTM consisted of a specially modified radar system that flew on board the Space Shuttle Endeavour during the 11-day STS-99 mission in February 2000, based on the older *Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar* (SIR-C/X-SAR), previously used on the Shuttle in 1994. The elevation models are arranged into tiles, each covering one degree of latitude and one degree of longitude, named according to their south western corners. The resolution of the raw data is one arcsecond (30 m), but this has only been released over United States territory. For the rest of the world, only three arcsecond (90 m) data are available. The elevation models derived from the SRTM data are used in Geographic Information Systems. They can be downloaded freely over the Internet, and their file format (.hgt) is supported by several software developments. The Shuttle Radar Topography Mission is an international project spearheaded by the U.S. National Geospatial-

Intelligence Agency (NGA) and the U.S. National Aeronautics and Space Administration (NASA).[97]

SRTM Water Body Data (SWBD). SWBD is a geographical dataset encoding high-resolution worldwide coastline outlines in a vector format, published by NASA and designed for use in geographic information systems and mapping applications. It was created by BAE Systems ADR for the US National Geospatial-Intelligence Agency (NGA) as a complementary product during editing of the digital elevation model database of the Shuttle Radar Topography Mission (SRTM). SWBD data covers the Earth's surface between 56° southern latitude and 60° northern latitude. It is distributed in ESRI shapefile format, divided into 12,229 files, each covering one 1°-by-1° tile of the Earth's surface. SWBD data is in the public domain and is made available online for free download by NASA.[98]

This functional area can be supported by GIS and the BNSDI in several ways that include, but are not limited to the following:

- Provide integrated tools to discover and assess available geospatial data and imagery
- Provide online access to data and applications services for basic and derived data

14.4.2.2 Conduct and/or support special studies

NASA provides technical and/or financial support for various research projects in and outside of the U.S. The following projects involved NASA support in one form or another in or related to Belize in recent years:

Millennium Coral Reef Mapping Project. A first-of-its-kind survey of how well the world's coral reefs are being protected was made possible by a unique collection of NASA views from space. A team of international researchers compiled an updated inventory of all "marine protected areas" containing coral reefs and compared it with the most detailed and comprehensive satellite inventory of coral reefs. The global satellite mapping effort is called the Millennium Coral Reef Mapping Project and was funded by NASA. The assessment found that less than two percent of coral reefs are within areas designated to limit human activities that can harm the reefs and the sea life living in and around them. Countries around the world have created these protected ocean and coastal zones where human activities such as shipping, fishing, recreation and scientific research are restricted to varying degrees.[99]

[97] http://en.wikipedia.org/wiki/Shuttle_Radar_Topography_Mission
[98] http://en.wikipedia.org/wiki/SRTM_Water_Body_Data
[99] http://www.nasa.gov/vision/earth/lookingatearth/coral_assessment.html

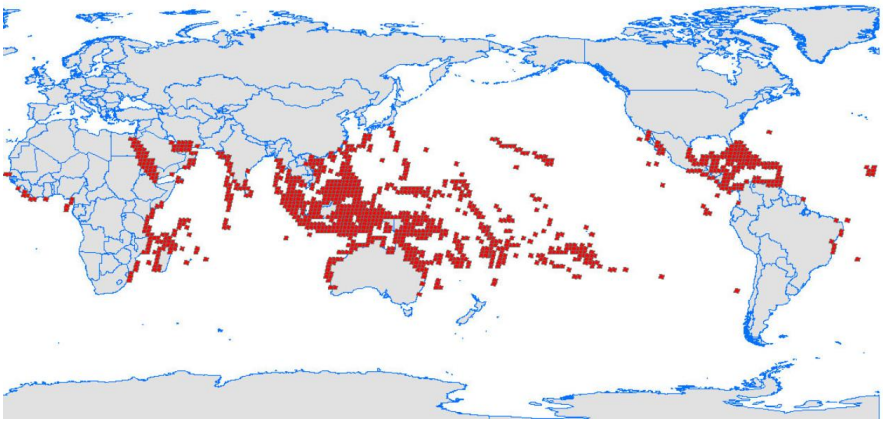

Figure 66 - 1700 Landsat images compiled for coral reef areas

Terra-i. Terra-i detects land-cover changes resulting from human activities in near real-time, producing updates every 16 days. It currently runs for the whole of Latin America and is being expanded over the next year to cover the entire tropics. Terra-i is a collaboration between the International Center for Tropical Agriculture (CIAT - DAPA, based in Colombia), The program on Forestry, Trees and Agroforestry (FTA) ,The Nature Conservancy (TNC, global environmental organization), the School of Business and Engineering (HEIG-VD, based in Switzerland) and King's College London (KCL, based in the UK). The system is based on the premise that natural vegetation follows a predictable pattern of changes in greenness from one date to the next brought about by site-specific land and climatic conditions over the same period. A so-called computational neural network is 'trained' to understand the normal pattern of changes in vegetation greenness in relation to terrain and rainfall for a site and then marks areas as changed where the greenness suddenly changes well beyond these normal limits. Running on many computers this analysis is refreshed with new imagery every 16 days and for every 250m square of land.[100]

Forest Cover and Deforestation in Belize. A remote sensing study conducted by the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) and NASA, in collaboration with the Forest Department and the Land Information Centre (LIC) of the Government of Belize's Ministry of Natural Resources and the Environment (MNRE), and published in August 2010 revealed that Belize's forest cover in early 2010 was approximately 62.7%, down from 75.9% in late 1980.[5] The USAID-supported SERVIR study by CATHALAC, NASA, and the MNRE also showed that Belize's protected areas have been extremely effective in protecting the country's forests. While only some 6.4% of forests inside of legally declared protected areas were cleared between 1980 and 2010, over a quarter of forests outside of protected areas had been lost between 1980 and 2010. As a country with a relatively high forest cover and a low deforestation rate, Belize has significant potential for participation in initiatives such as REDD.

Belize Forest Cover 2012. UN-SPIDER's Regional Support Office CATHALAC (Water Center for the Humid Tropics of Latin America and the Caribbean) has just developed the first

[100] http://www.terra-i.org/terra-i/about-us.html

version of a 2012 forest cover map of Belize. This research was carried out in collaboration with the Ministry of Forestry, Fisheries, and Sustainable Development of the Government of Belize, Lancaster University of the UK and the Environmental Research Institute of the University of Belize. The work was developed using NASA Landsat-7 imagery, and follows on the heels of an earlier 2010 USAID- and NASA-supported study assessing changes in forest cover in Belize over the period of 1980-2010. The current study indicates that Belize's forest cover declined from 62.8% in early 2010 to approximately 61.6% in early 2012. A technical report detailing the assessment's methodology and major findings will be released shortly.[101]

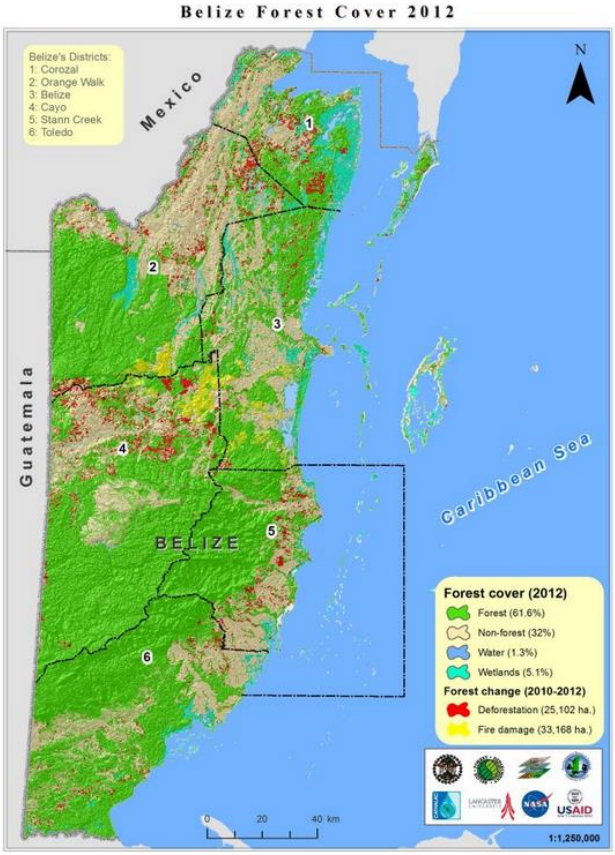

Figure 67 - Belize Forest Cover 2012 Map

This functional area can be supported by GIS and the BNSDI in several ways that include, but are not limited to the following:

- Provide access to specialized technical expertise and infrastructure;
- Technical cooperation and sharing of information and methods for environmental modeling and analysis;
- Technical cooperation and sharing of information and methods in multiple disciplines
- Provide funding and technical support for special studies

14.4.3 Data Used or Generated

[101] http://www.un-spider.org/news-and-events/news/rso-cathalac-develops-forest-cover-map-belize

The following document sets are being used and/or generated through NASA supported programs that have some relevance for the use of GIS in Belize and the BNSDI:

Global Distribution of Coral Reefs. A new global coral reef database was released by the United Nations Environmental Programme World Conservation Monitoring Center (UNEP-WCMC). It represents the global distribution of tropical, sub-tropical coral reefs. It was created from multiple sources, including USF's Millennium Coral Reef Mapping Project Seascape database and merged together by UNEP-WCMC and the WorldFish Centre in collaboration with WRI and TNC. It should be seen as an "interim" global product. The Approximate % coverage of data sources are as follows - Millennium Coral Reefs (Unvalidated) 50% - Millennium Coral Reefs (Validated) 30 % - Other sources 20%.[102]

Terra-I habitat change. Terra-i detects land-cover changes resulting from human activities in near real-time, producing updates every 16 days. It currently runs for the whole of Latin America and is being expanded over the next year to cover the entire tropics. This data is in RASTER ARC ASCII format at 250m spatial resolution, in decimal degrees and datum WGS84. It is derived from the USGS/NASA MODIS data. CIAT processed this data to provide habitat change maps. The detections were made using algorithms described by Reymondin et al. (2012). The data represents yearly cumulative detections of land cover change since 2004. The value 0 means that the pixel remained unchanged, whilst the other values represent on which 16 days period a given pixel has been detected as converted. For example if in the grid for 2004 you find a pixel with the value 1, it means it has been detected as converted the 2004.01.01 and with the value 2 it has been detected on the 2004.01.17.[103]

Belize Forest Cover 2012. UN-SPIDER's Regional Support Office CATHALAC (Water Center for the Humid Tropics of Latin America and the Caribbean) has just developed the first version of a 2012 forest cover map of Belize. This research was carried out in collaboration with the Ministry of Forestry, Fisheries, and Sustainable Development of the Government of Belize, Lancaster University of the UK and the Environmental Research Institute of the University of Belize. The work – now pending field validation – was developed using NASA Landsat-7 imagery, and follows on the heels of an earlier 2010 USAID- and NASA-supported study assessing changes in forest cover in Belize over the period of 1980-2010. The current study indicates that Belize's forest cover declined from 62.8% in early 2010 to approximately 61.6% in early 2012. A technical report detailing the assessment's methodology and major findings will be released shortly.[104]

SRTM Water Body Data (SWBD). SWBD is a geographical dataset encoding high-resolution worldwide coastline outlines in a vector format, published by NASA and designed for use in geographic information systems and mapping applications. It was created by BAE Systems ADR for the US National Geospatial-Intelligence Agency (NGA) as a complementary product during editing of the digital elevation model database of the Shuttle Radar Topography Mission (SRTM). SWBD data covers the Earth's surface between 56° southern latitude and

[102] http://imars.marine.usf.edu/MC/
[103] http://www.terra-i.org/terra-i/data.html
[104] http://www.un-spider.org/news-and-events/news/rso-cathalac-develops-forest-cover-map-belize

60° northern latitude. It is distributed in ESRI shapefile format, divided into 12,229 files, each covering one 1°-by-1° tile of the Earth's surface. SWBD data is in the public domain and is made available online for free download by NASA.[105]

14.4.4 Existing Systems

Not Applicable

14.4.5 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to NASA:

- None identified.

[105] http://en.wikipedia.org/wiki/SRTM_Water_Body_Data

15 UTILITIES

At present many of the major utility companies in Belize are majority government owned. These play a significant role in the generation and use of GIS data in the country, and can both benefit from, and contribute to the BNSDI. The following sections explore GIS and BNSDI potential within selected major utilities in the Country.

15.1 Belize Electric Limited

Person(s) Interviewed: Rolando Santos, Senior Manager rolando.santos@bel.com.bz
Navid Ahmediyeh, Engineer 1 navid.ahmediyeh@bel.com.bz

Interview Date(s): June 26, 2014

15.1.1 Organization and Mission

Belize Electricity Limited (BEL) is the primary distributor of electricity in Belize. The Company, serves a customer base of approximately 82,400 accounts and is regulated by the Public Utilities Commission (PUC).

BEL meets the country's peak demand of about 84.3 megawatts (MW) from multiple sources of energy. These sources include electricity purchases from Belize Electric Company Ltd. (BECOL), which operates the Chalillo, Mollejon and Vaca Hydroelectric Facilities in Western Belize; from Hydro Maya Limited located in Southern Belize; from Comisión Federal de Electricidad (CFE), the Mexican state owned electricity company; from Belize Cogeneration Energy Limited (Belcogen) and from BEL's gas turbine unit and diesel fired generators. All major load centers are connected to the country's national electricity system, which in turn is connected to the Mexican electricity grid, allowing BEL to optimize its power supply options.

Approximately 65% of the energy distributed by the Company in 2010, was sourced from renewable energy sources. The Government of Belize and the Social Security Board currently holds 70.2 per cent and 26.9 per cent, respectively, of the ordinary shares issued by the Company. The remaining ordinary shares are held by just over 1,500 small shareholders. BEL currently has 296 employees.[106]

The BEL conducts several functions that relate most directly to GIS and the BNSDI, including the following:

1. Electric utility systems planning

[106] http://www.bel.com.bz/

2. Electrical network design and construction
3. Electrical network operations and maintenance
4. Customer care
5. Manage ICT systems

15.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

15.1.2.1 Electric utility systems planning

BEL conducts systems planning at two levels. One level involves system-wide holistic planning for the overall utility including plans for future expansion. The second level of planning addresses the expansion and renovation of the electrical distribution network.

For long-range planning, BEL monitors trends that will impact future demand, such as population growth, commercial and industrial growth, changes in land use distribution, changes in electrical consumption over time and other such factors. Key to this planning is understanding how growth is happening, where and how electrical production and consumption is changing over time.

In the past, the Utility did not have the capability to perform load forecasting in a geographic manner. To address this situation, the utility developed an ***Electric Meter Database*** indicating the location and feeder information of nearly 98% of the meters across Belize. Geographic locations were determined with handheld GPS.

Nearly 90% of all buildings are supplied with electricity in the Country, and the Utility is actively assessing options for supplying the remainder, but these are often in remote locations and such services need to be considered in the context of other system expansion plans. Developers approach the utility to determine or request access to electrical services, often after they have already invested significant time and effort in processing plans through the government only to find that service cannot be cost-effectively provided. In addition, the government will often conduct land use planning without consulting with BEL which can result in areas that have been approved for development even though there are no plans in place to provide electrical service. In regards to government expansion plan, BEL often learns of these through information provided by the Ministry of Finance and Economic Development MoFED) ***Public Sector Investment Programme Reports***.

At present there is a lack of an integrated capital improvement planning approach across all sectors to ensure that land use, utility, and other community facility and service matters are coordinated within the 3-5 year, medium term timeframe. BEL has started working more closely with sister utility providers to address this matter. It is recognized that the BNSDI could help immensely in this area by allowing the government and each of the utilities to better understand development activities and trends and to better coordinate their respective activities.

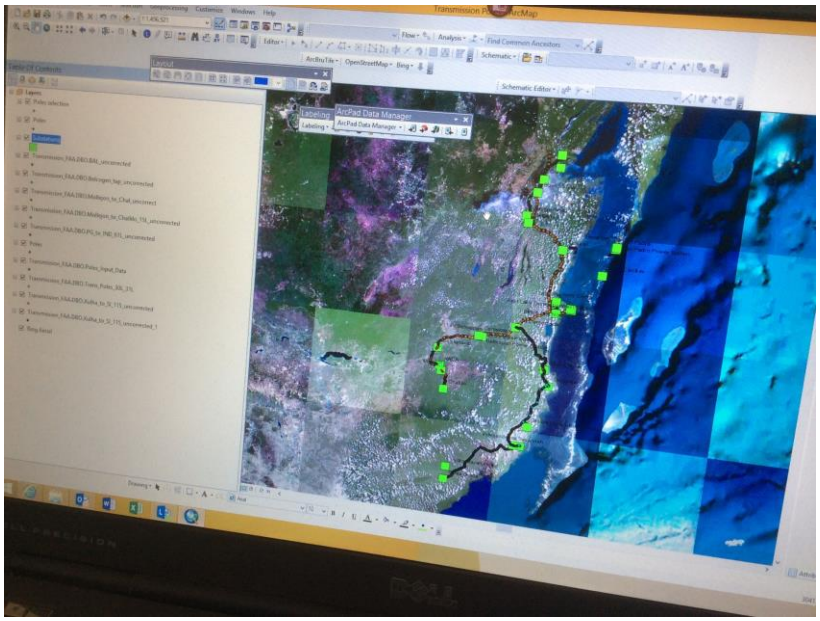

Figure 68 - National Electrical Transmission Network

With the 2011 reorganization the electrical utility is no longer vertically integrated, thus energy is purchased from a variety of sources, as outlined in the introduction to this write-up. A TOR was published in 2014 inviting companies to bid for the provision of expanded energy sources in the Country over the next 15 years, with an emphasis on renewables. This is being carried out as a collaborative effort with the Ministry of Energy, Science and Technology and Public Utilities (MESTPU – also see MESTPU stakeholder survey write-up).

Examples of how GIS and the BNSDI can support this functional area include:

- Monitor urban development plans and changes in land ownership;
- Monitor population growth, densification and expansion geographically;
- Monitor power consumption rates and trends geographically;
- Monitor socioeconomic trends;
- Monitor long term climate trends and assess impacts on hydroelectric power generation;
- Monitor the adoption of local power generation from renewable sources (solar, wind, etc.);
- Track new highway and road development;
- Model all of the above to assess potential future demand and load growth scenarios geographically over time;

- Assess feasibility of supplying powers to more remote communities;
- Assess emerging technologies and methods for smart power management;
- Conduct utility siting opportunity and constraint modeling to determine best potential routes for future power transmission and substation facilities;
- Conduct spatial analysis to determine optimum routing for distribution networks;
- Plan for land acquisition to accommodate power facilities;
- Environmental impact assessment for planned facilities;
- Develop and illustrate defensible future electrical utility expansion plans in a compelling manner that can be easily understood by the utility Board, Public Utilities Commission (PUC), policy makers and the general public;
- Develop renewable energy atlas for Belize to support planning, design and development of sustainable energy for the Country (also see MESTPU stakeholder survey write-up);
- Monitor, assess and recalibrate plans proactively over time based on changing conditions and trends.

15.1.2.2 Electrical network design and construction

The BEL is involved facilitating and managing network design and construction for electrical transmission and distribution networks. Minor system design work is carried out in-house by BEL staff utilizing either manual sketch or ***AutoCAD drawing***.

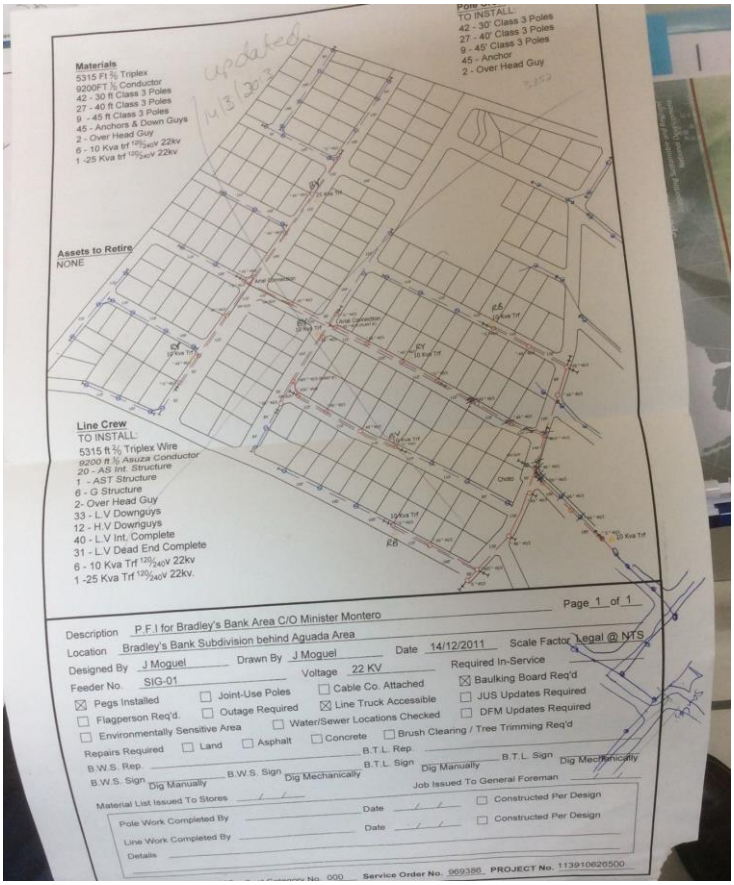

Figure 69 - In-House Design of Electrical Distribution System for New Subdivision

A majority of the major design and construction works are carried out by private sector firms based on competitive tenders, but these are carried out according to BEL standards and under the supervision of the Utility. Each of these requires a field survey to document current conditions. For larger projects this is carried out by a licensed surveyor.

BEL has maintained ***Electrical Distribution Network As-Built Drawings*** in AutoCAD format. These are not prepared in real-world coordinates, and typically use parcel maps from the MNRA LIC as a basemap. These digital files are organized by load center and feeders. In anticipation of updating the GIS information staff are no longer updating these maps, but continue to update the single-line schematics in support of the SCADA system.

BEL staff often use ***Bing Maps*** and ***ESRI GIS Software*** for mapping purposes. Bing maps is used as a general background reference when investigating an area for potential service and other matters. The Utility two years ago purchased ***GeoEye*** high resolution satellite imagery for all the urban areas in the country and uses the ESRI software to view that information.

Examples of how GIS and the BNSDI can support this functional area include:

- Base mapping – providing up to date and accurate information concerning existing roads, buildings, and other infrastructure;
- Land ownership and land use;
- Demand load forecasting and system modeling;
- Facility siting analysis;
- Alternative network design analysis;
- Construction drawings in real world coordinates, usable with other information in GIS;
- Construction management and status tracking;
- Utility coordination and site clearance "call before you dig"
- As-built data consolidation;
- Transfer of as-built inventory to fixed asset inventory.

15.1.2.3 Electrical network operations and maintenance

BEL operates the electrical transmission and distribution networks and conducts both preventive and emergency maintenance and repair works.

Work orders are managed through a paper-based process, but there are plans to automate this in the future.

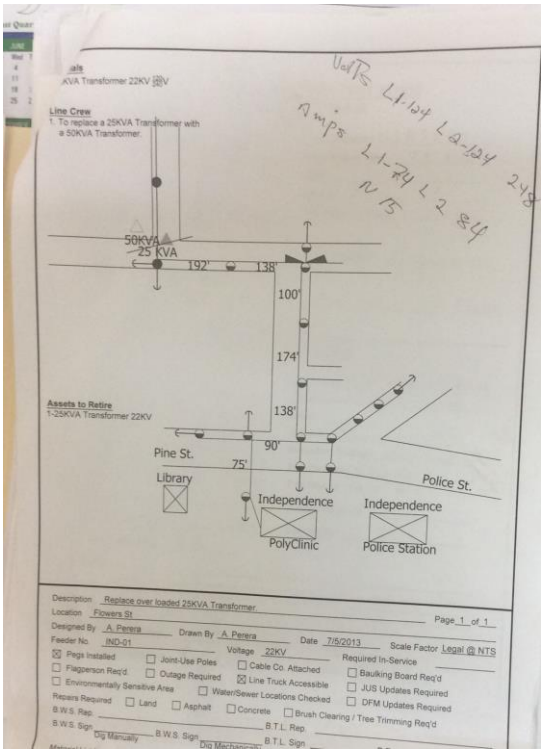

Figure 70 - Example Paper Work Order

There is a SCADA system in place for monitoring the performance of the network. This is supported with an ***Electrical System Single Line Schematic Diagram*** depicting all the major system components produced as an AutoCAD drawing file.

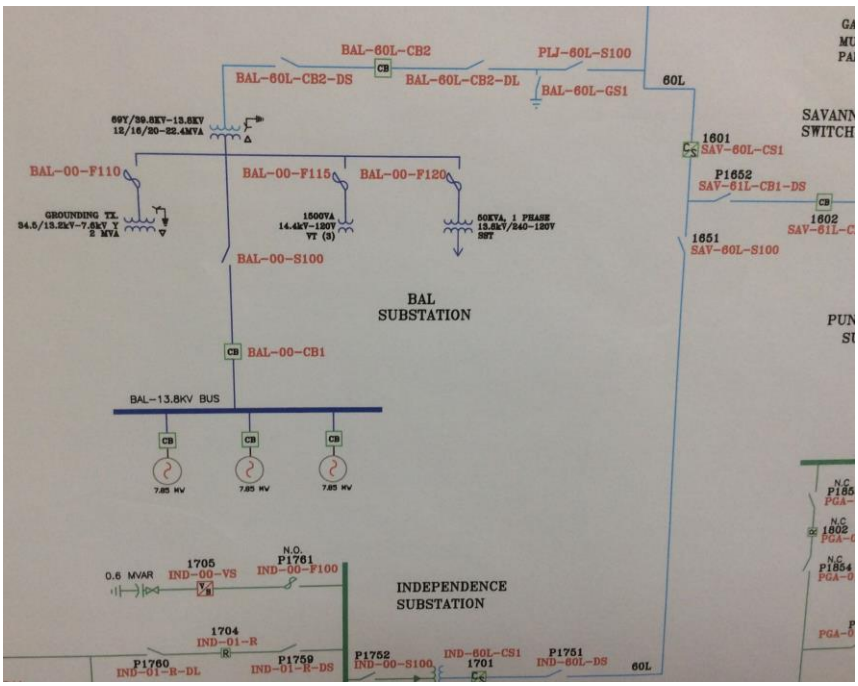

Figure 71 - Electrical System Schematic Diagram

Aspects of this functional area that can benefit from GIS and the BNSDI include but are not limited to:

- Provide a complete geospatially located fixed asset inventory;
- Common fixed asset registry between mapping, financial and maintenance management system components;
- Schedule and route preventive maintenance activities, and tie work orders to specific maintained assets;
- Identify and route ad hoc maintenance activities and tie work orders to specific maintained assets;
- Rapid outage analysis and response support;
- Tie customer complaint calls to location;
- Utility coordination and site clearance "call before you dig"
- Automatically generate schematic diagrams for SCADA visualization and control from the GIS maps, thus eliminating redundant data maintenance and ensuring systems data is consistent and up to date;
- Provide mobile devices to field crews to access as-built network data and record redlining and other observations in the field to correct or update the facility mapping database;
- Assess historical maintenance activities to identify repeat problem areas or devices;
- Provide geospatially enhanced view of all fixed assets and preventive and reactive maintenance and trends over time for planning and PUC reference.

15.1.2.4 Customer care

The BEL maintains information regarding each of it's over 82,000 customers. A ***BEL Customer Care Database*** includes information about each customer including the location of the metered account by street address or location description, the mailing address of the property owner, current and past electricity consumption and billing information and a record of any significant complaints or other communications.

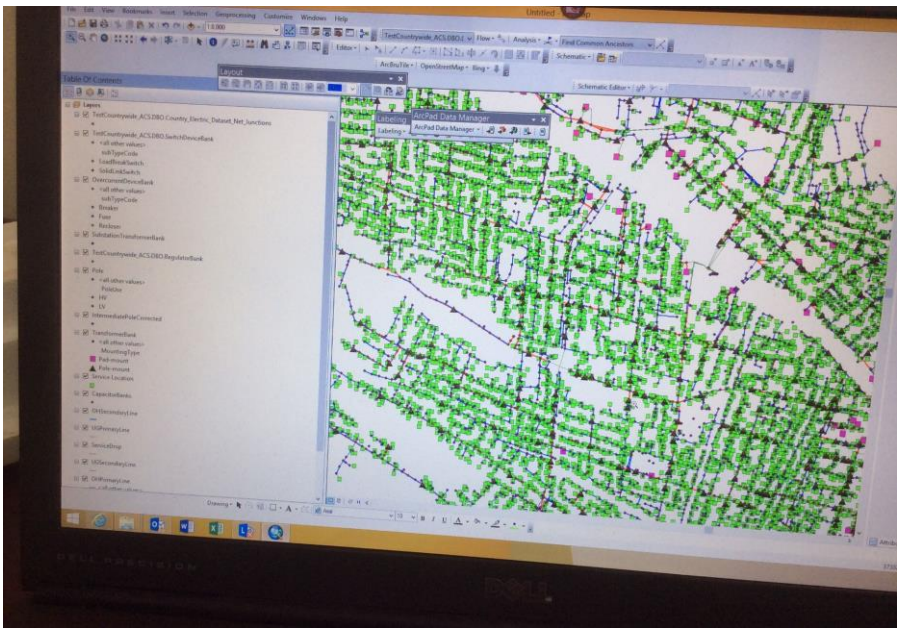

Figure 72 - GIS Electric Meter Location Map

Aspects of this functional area that can benefit from GIS and the BNSDI include but are not limited to:

- Geospatially located meters and ability to tie customer information to locations and to analyze and visualize the character and distribution of consumption, complaints and other transactions over time;
- Route meter readers;
- Cluster and route complaint follow-up activities for more rapid and efficient response;
- Maintain geographically enhanced customer satisfaction profiles and monitor key performance indicators over time

15.1.2.5 Manage ICT systems

The BEL IT Department is responsible for the planning, design, development, operations and maintenance of the Utility's Information and Communications Technology (ICT) systems. The Utility has recognized the benefits of GIS and has been moving towards full implementation over the past 5 years. In 2011, the government took over the company and one of the key initial requirements was to develop a complete inventory and assessment of the Utility's assets. It was decided that GIS would be an appropriate technology for supporting this effort and the company spent the next 2.5 years capturing over 99% of the fixed assets at that time. This entire effort for the development of the ***BEL Electrical Asset Map and Database*** was carried out through direct field survey due to lack of confidence in the completeness and accuracy of record drawings maintained in the office. Main poles were surveyed with GPS to a sub-meter accuracy, and intermediary poles between them were interpolated. The acquisition of meter location information was done with handheld GPS and the horizontal accuracy is expected to be in the range of 3 meters. This effort was carried out with the support of 6 contractors, involving approximately 9 people over a 16-month effort. This database was completed in 2012 and is stored in ESRI's Arc SDE software. It has not been updated since that time.

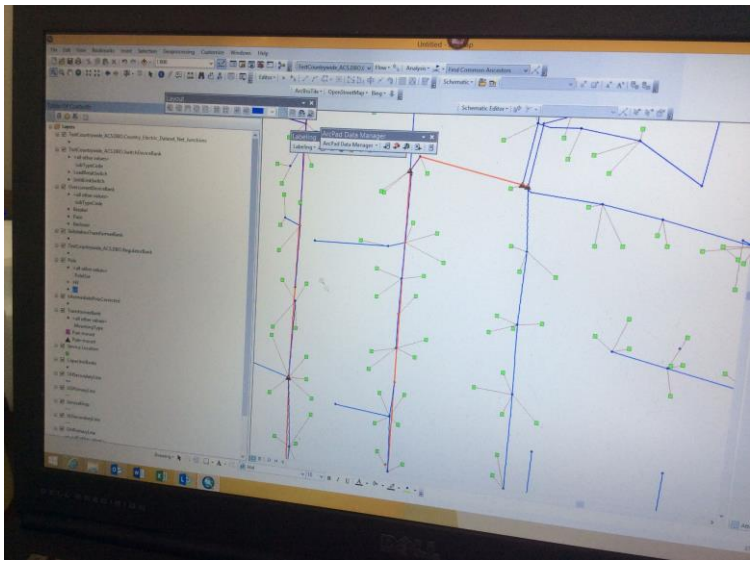

Figure 73 - Electrical Distribution System in GIS

Although the original survey was intended to support only the asset inventory matter, it was recognized that if structured correctly this information could be expanded in the future to a full enterprise GIS form. The BEL ICT staff developed a data model for the information to be captured in the field effort utilizing the ***MultiSpeak*** standard. MultiSpeak is a specification / standard that defines standardized interfaces among software applications commonly used by electric utilities. It defines details of data that need to be exchanged between software applications in order to support different processes commonly applied at utilities. MultiSpeak effort is funded by National Rural Electric Cooperative Association (NRECA).[107]

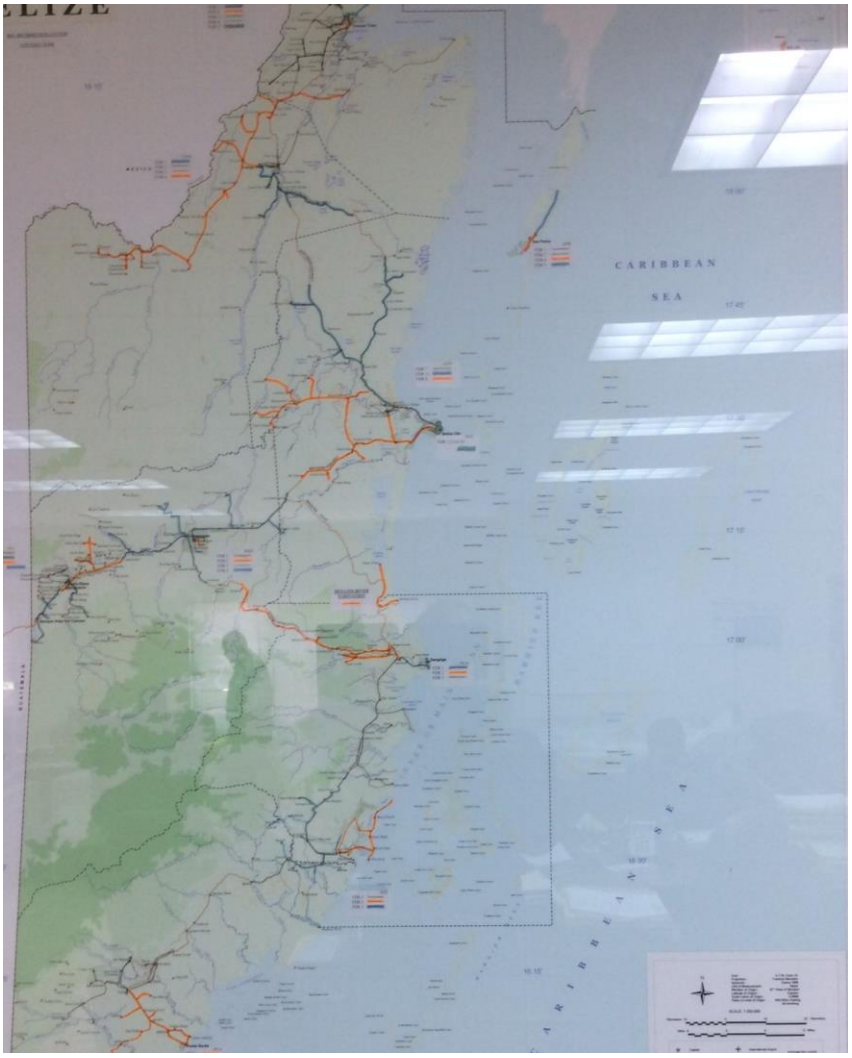

Figure 74 - National Electrical Transmission Network On MNRA LIC National Base Map

A major effort is being undertaken now to explore the incremental development of a complete enterprise management platform that would tie all of the Utility's systems together in an interoperable framework. BEL is discussing this matter with a major international software vendor with extensive professional service experience in the design and development of

[107] http://en.wikipedia.org/wiki/MultiSpeak

enterprise systems for electrical utilities. Under discussion are how to expand the current system to cover all the important facility mapping requirements while also considering how this database can be linked and integrated with all other major business systems across the utility (maintenance management, network modeling, SCADA, financials, customer care, fleet management, outage management and others). The original GIS database at the time of this writing is nearly two years old and has not been updated in the meantime. Part of the upgrade effort planned will involve confirming and updating the system information, again through direct field inspection.

GIS and the BNSDI are relevant to the function area in the following ways:

- Provide geospatial data and tools as an integral component of the utility's information infrastructure
- Provide user assistance and technical support for geospatial matters
- Provide programming tools for the integration of geospatial functions within enterprise business application software systems
- Utilize geospatial dimension as a mechanism for integrating and associating disparate databases together
- Provide specialized tools and methods for the administration of geospatial data

15.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting BEL functions at present:

Electric Meter Database. Compiled in 2012 by the Belize Electric Ltd. (BEL) this database includes a geographic coordinate for each meter, collected through handheld GPS and estimated to be within 3 meters actual accuracy. The database was completed for approximately 98% of the customer meters nationwide. This database is to be updated under a GIS/ICT modernization program that has been proposed.

Public Sector Investment Programme Reports (PSIP). The PSIP reports are compiled by the Ministry of Finance and Economic Development and provide a listing and description of all approved projects annually. Projects may include a community name or other general reference to location, but not precisely located or indicated on a map.

National Electric Transmission Network. The Belize Electric Ltd. (BEL) in 2012 generated a GIS database indicating the location and characteristics of the national electric transmission network. This database is to be updated under a GIS/ICT modernization program that has been proposed.

Electric Distribution Network As-Built Drawings. Belize Electric Ltd. (BEL) has maintained Electrical Distribution Network As-Built Drawings in AutoCAD format. These are not prepared in real-world coordinates, and typically use parcel maps from the MNRA LIC as a

basemap. These digital files are organized by load center and feeders. In anticipation of updating the GIS information in the near future staff are no longer updating these maps.

GeoEye High Resolution Satellite Imagery. In 2012 the Belize Electric Ltd (BEL) purchased GeoEye High Resolution Satellite Imagery for all the urban areas in Belize. The GeoEye-1 satellite sensor provides a resolution of 0.46 meters.

Bing Maps. Bing Maps (previously Live Search Maps, Windows Live Maps, Windows Live Local, and MSN Virtual Earth) is a web mapping service provided as a part of Microsoft's Bing suite of search engines and powered by the Bing Maps for Enterprise framework. Users can browse and search topographically-shaded street maps for many cities worldwide. Maps include certain points of interest built-in, such as metro stations, stadiums, hospitals, and other facilities. It is also possible to browse public user-created points of interest. Searches can cover public collections, businesses or types of business, locations, or people. Five street map views are available: Road View, Aerial View, Bird's Eye View, StreetSide View, and 3D View. Bing Maps allows users to share maps and embed maps into their websites. By clicking the e-mail icon in the bottom-left corner of Bing Maps, a window will open that displays a shareable URL so others can access the map currently being viewed. This window also provides HTML code to embed a small version of the map onto any web page.[108]

Electrical System Single Line Schematic Diagram. Belize Electric Ltd. (BEL) maintains an Electrical System Single Line Schematic Diagram depicting all the major system components produced as an AutoCAD drawing file. This diagram is used to depict the networks and control devices monitored by the Utility's System Control and Data Acquisition (SCADA) system.

BEL Customer Care Database. The Belize Electric Ltd. (BEL) maintains a digital database that includes information about each of its over 82,000 customers including the location of the metered account by street address or location description, the mailing address of the property owner, current and past electricity consumption and billing information and a record of any significant complaints or other communications.

BEL Electrical Asset Map and Database. In 2012 the Belize Electric Ltd. invested in the development of a GIS database in order to create an up to date and accurate accounting of the Utility's fixed assets nationwide. The entire database was developed through a 100% field survey due to lack of confidence in the completeness and accuracy of record drawings maintained in the office. Main poles were surveyed with GPS to a sub-meter accuracy, and intermediary poles between them were interpolated. The acquisition of meter location information was done with handheld GPS and the horizontal accuracy is expected to be in the range of 3 meters. This effort was carried out with the support of 6 contractors, involving approximately 9 people over a 16-month effort. This database was completed in 2012 and is stored in ESRI's Arc SDE software. It has not been updated since that time. Although the

[108] http://en.wikipedia.org/wiki/Bing_Maps#Sharing_and_embedding_maps

original survey was intended to support only the asset inventory matter, it was recognized that if structured correctly this information could be expanded in the future to a full enterprise GIS form. The BEL ICT staff developed a data model for the information to be captured in the field effort utilizing the ***MultiSpeak*** standard. The entire database is to be expanded, refined and updated as part of a proposed integrated enterprise systems development effort in the near future.

15.1.4 Existing Systems

Existing systems used by the BEL are outlined below.

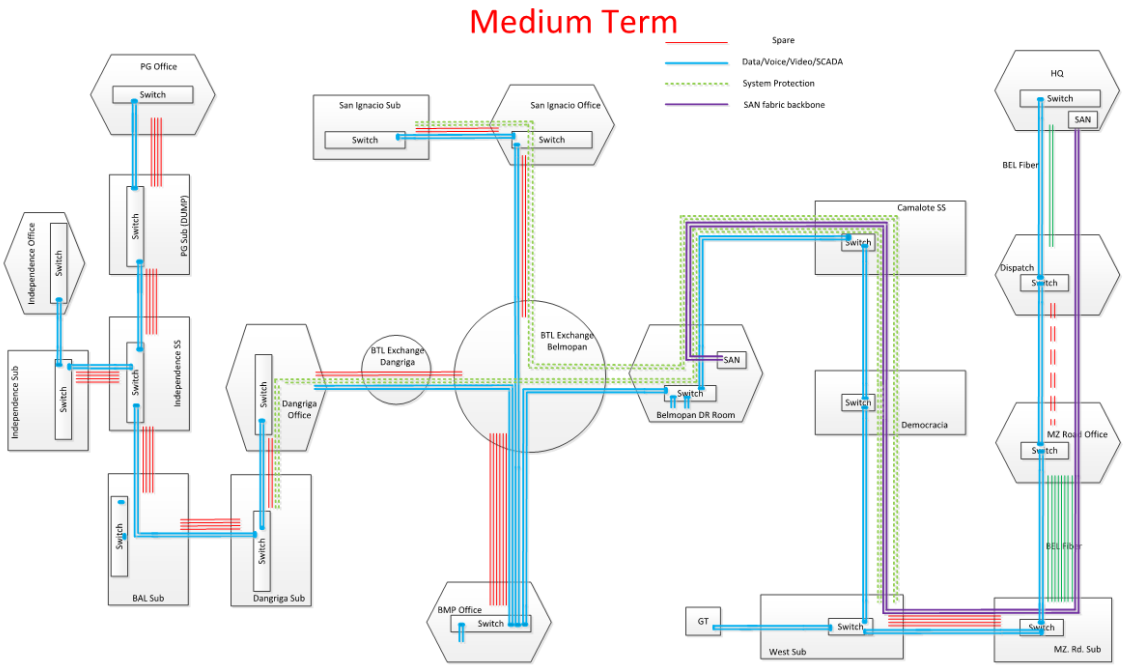

Figure 75 - BEL ICT Systems Diagram

ArcGIS. Esri's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.[109] The bel is utilizing ArcGIS as its primary tool for accessing and using the electrical system network database that was created in 2012.

Microsoft SQL Server is being used as the main database for the Institute. Microsoft SQL Server is a relational database management system developed by Microsoft. As a database, it is a software product whose primary function is to store and retrieve data as requested by

[109] http://en.wikipedia.org/wiki/ArcGIS

other software applications, be it those on the same computer or those running on another computer across a network (including the Internet).[110]

15.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- BEL is exploring the development of a comprehensive, integrated enterprise information management framework covering all aspects of the Utility's business. There is a significant amount of data from other organizations that can support this development and likewise some of the data developed by the Utility will be useful to others. Further consideration of two-way information exchange should be incorporated to the Company's enterprise system planning process.

15.2 Belize Water Services Ltd.

Person(s) Interviewed: Nicolyn Parks, Strategic Planning and Development Coordinator, nicolyn.parks@bwsl.com.bz
Jean Bouh-Nahra, Help Desk Technician jean-baptiste.bou-nahra@bwsl.com.bz
Sanjay Keshwani, Technical Services Manager, sanjay.keshwani@bwsl.com.bz Hugo Rancharan, Operations Assistant Manager, hugo.rancharan@bwsl.com.bz
Gina Sosa, Accountant, gina.castillo-sosa@bwsl.com.bz
Gerardo Castaneda Sr. Engineering Technician gerardo.castaneda@bwsl.com.bz
Elias Torres, Sr. Engineering Technician elias.torres@bwsl.com.bz

Interview Date: June 25, 2014

13.1.1 Organization and Mission

Belize Water Services Limited is the water and sewerage utility for the country of Belize, serving the larger municipal areas of the country. As part of a privatization initiative of the Government of Belize ("GOB"), BWS was formed in January 2001 and vested with the assets and liabilities of the former Water and Sewerage Authority in March 2001. Some 83% of the shares of BWS were acquired by Cascal, a joint British-Dutch company, via an investment agreement with the GOB. In October 2005, GOB repurchased the majority shares from Cascal, thereby ensuring Belizean ownership.

The regulatory controls include a statutory regulator, the Public Utilities Commission, the Water Industry Act (2001), an operating License issued by the PUC and a "Codes of Practice" agreed by the Regulator and BWS in 2004.

[110] http://en.wikipedia.org/wiki/Microsoft_SQL_Server

BWS currently serves approximately 51,433 customers with a total average water demand of some 175 million US gallons per month. Over 60% of the water supplied is produced using conventional water treatment processes with rivers as its sources. Satellite water wells are used for the majority of the other water systems. In San Pedro, BWS distributes water which has been treated by Reverse Osmosis, the conversion of sea water to drinking water. Since 2001, BWS has increased its investment in Assets and implemented improved procedures and controls to increase its efficiency.

The Company's headquarters is in Belize City and it administrates operations via (10) ten offices throughout the country.[111]

BWS conducts several functions that relate most directly to GIS and the BNSDI, including the following:

1. Water and sewer utility systems planning
2. Water and sewer network design and construction
3. Water and sewer network operations and maintenance
4. Customer care
5. Participate in emergency preparedness and response activities.
6. Manage ICT systems

13.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

13.1.2.1 Water and sewer utility systems planning

BWS is involved in planning for new or extended water and sewer systems for served communities across the Country.

[111] http://www.bws.bz/about-us/bws/

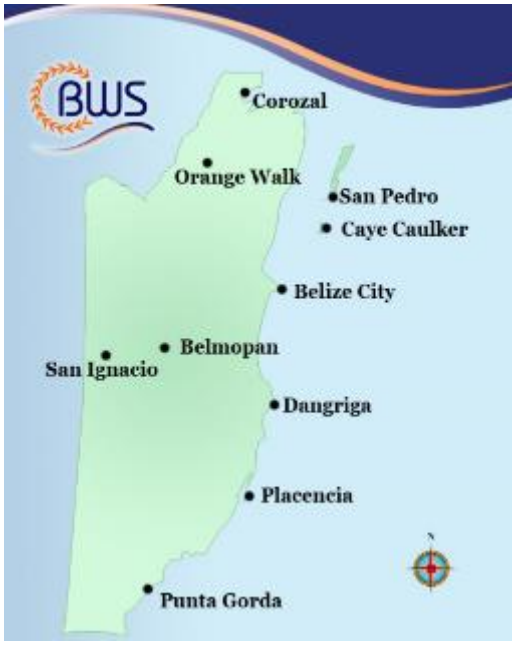

Figure 76 - BWS Service Areas

BWS provides potable water service to all the cities and towns in Belize, as well as a few villages, with 13 standalone systems throughout the Country. Three of the towns have sewer systems, but these are not covering all developed areas in each town.

BWS performs new and expansion system project planning depending on annual budgets and priorities. Requests for new system development are submitted by private developers, public entities (eg. Social Investment Fund) and the Government of Belize. (for example the Social Investment Fund). Budgetary estimates covering all legitimate requests are submitted for review by the PUC and ultimately to the Ministry of Finance and Economic Development. Final plans for system renovations and expansion are then based upon the approved budgets each year.

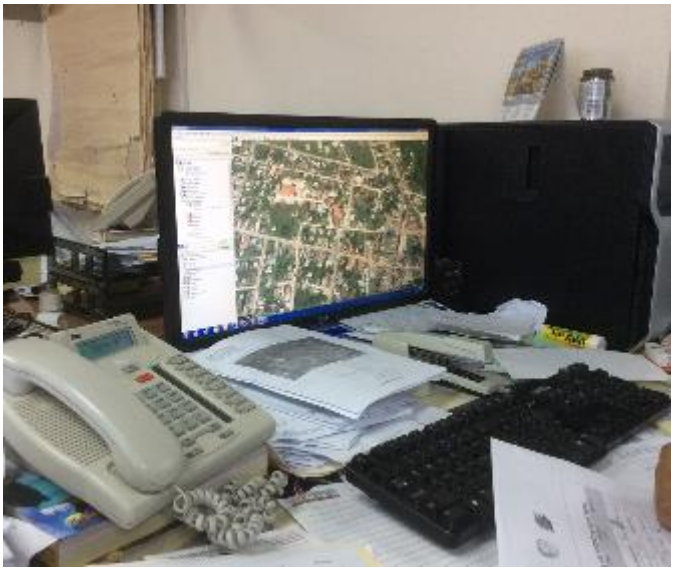

Figure 77 – Satellite Imagery Accessed through Google Earth

In 2007, BWS embarked on consolidating & digitizing all as-built for Water Network Drawings information in AutoCAD digital format. The process of converting the Sewer Network drawings to AutoCad is partially completed. These files are organized by zones for each system. The original ***Sewer As-Built Drawings*** on vellum have been scanned to digital images that are maintained on the server where they are organized in a file system.

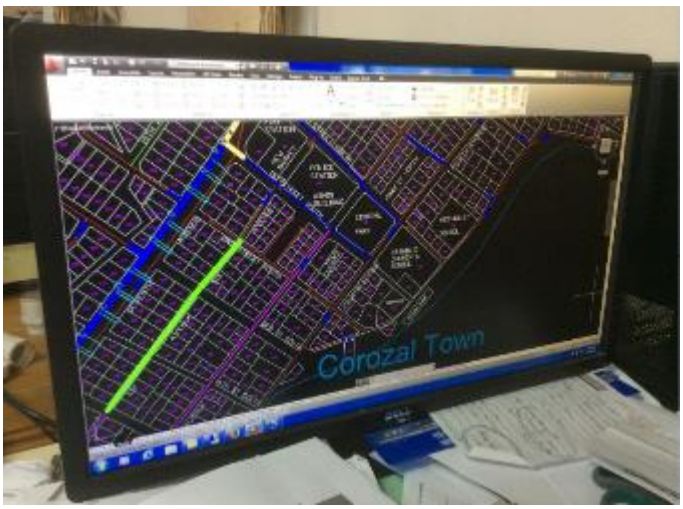

Figure 78 - Water Distribution Network in AutoCAD

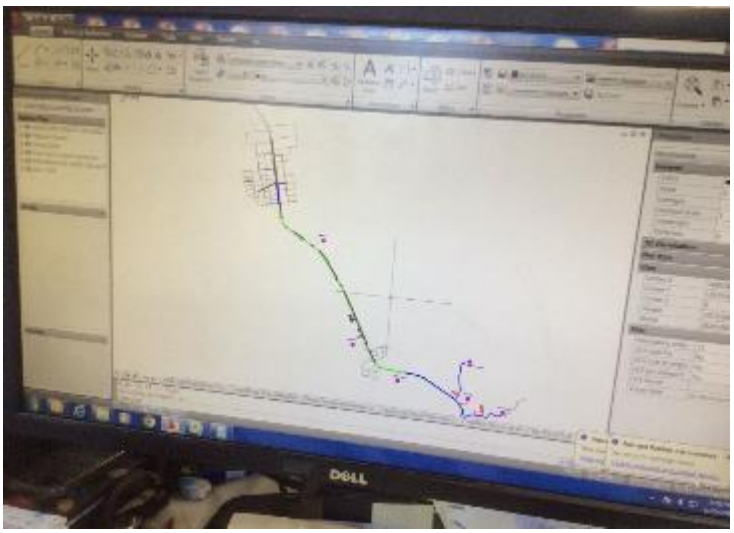

Figure 79 - Planned Water System Expansion

Private developers request service for new subdivisions and developments. They are required to provide a letter from BWS as part of the development approval process. However the process is not well followed and there are many circumstances of developments being built without water service, nor immediate plans to provide it.

Subdivision plans may be submitted in digital form, typically in AutoCAD. Developer's consulting engineering firms acquire the survey control and surrounding plot information from the MNRA Land Information Center (LIC). This data is in UTM NAD27 geographic projection and datum and is converted to AutoCAD format for design and delivery of design

or as-built drawings to the Utility. BWSL engineers will then layout a system to support the development in AutoCAD and these are maintained in the system along with other existing water network and/or sewer information, but differentiated in line size and color. This same convention is used for other system expansion or renovation activities as well, such as when the network is to be extended to provide services to a new neighborhood (see Figures above). In the latter case, BWSL staff do their own site studies to determine the service area, structures to be provided with water service and optimum routing for the new service. BWS staff has access to and frequently utilizes GPS technology, along with Google Earth to do initial research and rudimentary mapping. The AutoCAD information is used to calculate material take-offs and costing.

The digital water network data includes the lines, valves and other appurtenances of the system. Assets are identified to a project. An asset-specific numbering scheme is utilized on sewer network assets only and none on water network assets. It is recognized that explicit asset identification will be needed in the future to integrate and optimize the organization's information infrastructure when BWS makes a move to convert the existing as-built record information to GIS and the use of this database as a spatially enabled fixed asset register (see later section on ICT Management) supporting multiple aspects of the Utility's business (facility mapping, financial accounting, maintenance management, etc.).

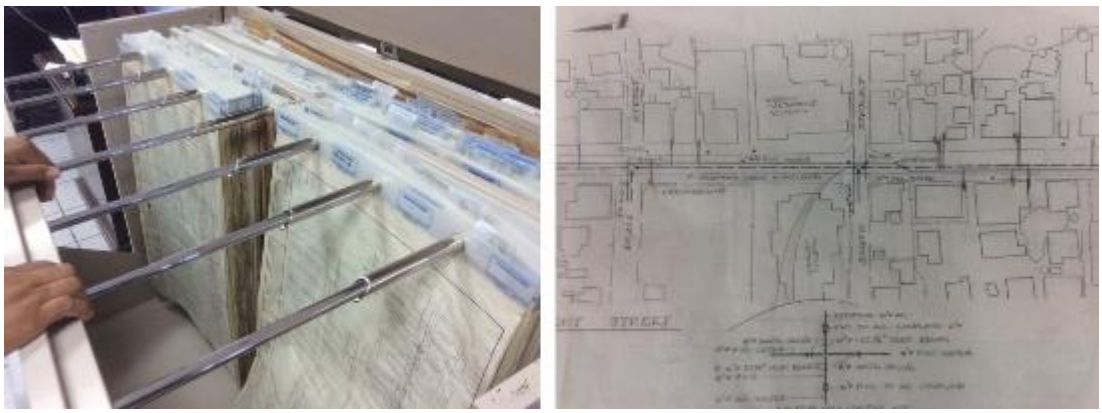

Figure 80 - Manual Water Network Map Archive

Figure 81 - Renovation Project Initiation Form

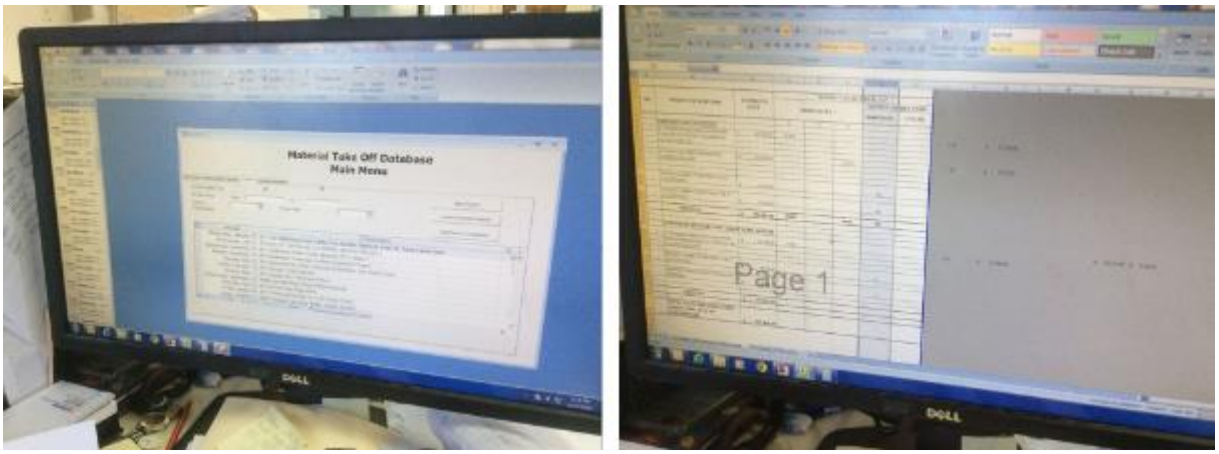

Figure 82 - Quantity Take-off for Water Network Expansion

All projects are recorded to a ***BWSL Projects Database*** in ***SQL Server***. This database is maintained on the main BWSL server. Each project is identified by a number that is a concatenation of several codes indicating that the project is for clean water, city where it is located, asset key, funder, year of the project, project number (assigned sequentially each year). This information is passed to the Accounting Department where the basic project information is imported to the Sage 350 system. There is no direct linkage between the Access database and the Sage database (utilizing SQL Server relational data base management system) however an integration of these databases is planned for the future.

Examples of how GIS and the BNSDI can support this functional area include:

- Monitor urban development plans and changes in land ownership;
- Monitor population growth, densification and expansion geographically;
- Monitor water consumption rates and trends geographically;
- Monitor socioeconomic trends and their impacts on water consumption;
- Monitor long term climate trends and assess impacts on water resources;
- Track new highway and road development;

- Model all of the above to assess potential future demand and demand growth scenarios geographically over time;
- Assess feasibility of supplying water and sewer services to more communities;
- Assess emerging technologies and methods for smart water and sewer system management;
- Conduct utility siting opportunity and constraint modeling to determine best potential routes for future water source and transmission facilities, sewer treatment plant and related works;
- Automate design and as-built record management;
- Conduct spatial analysis to determine optimum routing for distribution networks;
- Plan for land acquisition to accommodate water production and sewer treatment facilities;
- Environmental impact assessment for major planned facilities;
- Develop and illustrate defensible future water and sewer utility expansion plans in a compelling manner that can be easily understood by the utility Board, Public Utilities Commission (PUC), policy makers and the general public;
- Monitor, assess and recalibrate plans proactively over time based on changing conditions and trends.

13.1.2.2 Water and sewer network construction

BWSL is involved in the construction of medium-sizedwater and sewer network projects, and overseeing the work of contractors. All system designs and resource procurement are performed in-house. Project status information is updated to the previously listed BWSL Projects Database until completion.

Examples of how GIS and the BNSDI can support this functional area include:

- Base mapping – providing up to date and accurate information concerning existing roads, buildings, and other infrastructure;
- Land ownership and land use;
- Demand and contribution calculations and system modeling;
- Facility siting analysis;
- Alternative network design analysis;
- Construction drawings in real world coordinates, usable with other information in GIS;
- Construction management and status tracking;
- Utility coordination and site clearance "call before you dig"
- As-built data consolidation;
- Transfer of as-built inventory to GIS-enabled fixed asset inventory.

13.1.2.3 Water and sewer systems network operations and maintenance

BWS operates and maintains the water and sewer utilities. Most of the maintenance is performed as-needed, and there are a few preventive maintenance activities undertaken.

Complaints and report are made through a customer support line. A ***Water Main Break Pinmap*** is maintained to visualize where breaks have occurred. Breaks are identified through visual inspection or non-revenue water analysis. The latter is conducted by analyzing water consumption within zone districts which are themselves metered. The difference between water supplied to the district versus what was consumed and billed then represents non-revenue water that may be caused by system leakage or illegal tapping.

Figure 83 - Water Delivery Zones

Once a main break is identified staff determine what valves need to be shut to isolate the break so that maintenance can be conducted. At present staff use their experience and knowledge of the system to determine what valves to shut, how many turns required to shut a valve, whether or not the valve is normally open or shut and other matters that could affect decision making in this activity.

Every BWSL water customer is metered. Meters are read most months and calculated in-between if a month is skipped for any reason and the difference caught up at the next reading. Meter readers have standard routes and most have been on the job for a long time so are very familiar with their routes. There are no route meter reader route maps maintained but there is a ***Meter Card*** for each meter that provides more specific information regarding the meter location and related information. Meter readings are entered to the ***Meter Reader Database*** within the customer service system for the calculation of utility bills according to a standardized set rate.

BWSL staff conduct water quality testing on a daily and weekly basis. There are known locations where these tests are conducted, but they are indicated in digital map form. The test results are stored in our Lab Information System which was launched in 2014. Prior to 2014,

test results are available **on paper** copies of lab records as far back as 1980, and **electronically**(Excel Spreadsheet), as far back as 2002. There is a plan to digitize these locations, and to conduct hydraulic modeling to help identify and isolate problem areas in the network for flushing and other remedial actions. There is no requirement at present for water quality issues to be reported publicly.

On the sewer side, maintenance is likewise carried out mainly in response to problems when they surface. At present there is no structured preventive maintenance program in place. Only Belize City sewer system has been digitized in AutCad.

Any works concerning the water and sewer systems are coordinated closely with Belize Telephone Ltd (BTL) due to many crossing lines underground. There are no designated utility corridors per se and the utilities can choose to put their lines on either side of the street within the public right-of-way. There is a "Call Before You Dig" informal procedure when either utility will undertake works in all areas, paritularly the municipal areas. All utilities are notified via email or in writing, accompanied by drawings of works to be completed and the designated areas. Once all the necessary informaon is shared, a meeting is held prior to the commencement of digging, primarily with BTL, the telecommunications utility.

Aspects of the water and sewer operations and maintenance functional areas that can benefit from GIS and the BNSDI include but are not limited to:

- Provide a complete geospatially located fixed asset inventory for all water and sewer systems;
- Common fixed asset registry between mapping, financial and maintenance management system components;
- Schedule and route preventive maintenance activities, and tie work orders to specific maintained assets;
- Access up to date and accurate land use, cadastral, detailed aerial photography, high resolution satellite and other information from other entities;
- Identify and route ad hoc maintenance activities and tie work orders to specific maintained assets;
- Rapid main break analysis and response support;
- Tie customer complaint calls to location;
- Utility coordination and site clearance "call before you dig"
- Automatically generate schematic diagrams for water control system from the GIS maps, thus eliminating redundant data maintenance and ensuring systems data is consistent and up to date;
- Provide mobile devices to field crews to access as-built network data and record redlining and other observations in the field to correct or update the facility mapping database;
- Assess historical maintenance activities to identify repeat problem areas or devices;
- Provide geospatially enhanced view of all fixed assets and preventive and reactive maintenance and trends over time for planning and PUC reference.

13.1.2.4 Customer care

Customer information is maintained by BWSL in different databases at present, including requests for new connections, billing and complaint systems.

Requests for new connections are made through the customer service department. The department issues a work order request through the ***Job Tracking System (JTS)***. Customers can phone the department or visit the customer service desk at headquarters or one of the district office locations. A location is indicated initially by a street address or a physical description. Customer service performs a physical inspection prior to issuing a work order and collects a GPS geographic coordinate for the proposed service location. The coordinate is entered to ***Google Earth*** to indicate requested services on a map, and this information is used to schedule new service installations. These maps are being printed out, but the digital information is not being saved.

Figure 84 - Customer Information Counter at Headquarters

The JTS was written by an independent consultant in Visual Basic and utilizing an MS SQL Server Database backend. The source code was not provided to BWSL and it has not been maintained and they are exploring migrating the system to the ***Utility Star*** system produced by AbleSoft. Utility Star is a customer information system (CIS) and utility billing system developed using Visual Basic's 2005 programming language and compatible with the Microsoft SQL Database platform. There is some concern about the quality of customer data in the existing JTS and it is recognized that rigorous quality assurance and quality control measures will be needed to identify and resolve any data issues as part of the system migration effort. There will also be the need to establish pick lists for things such as street names to avoid misspelling that can happen when staff are entering this information directly instead of typing it in partially and then completing the entry from a list of valid names.

Aspects of this functional area that can benefit from GIS and the BNSDI include but are not limited to:

- Geospatially located meters and ability to tie customer information to locations and to analyze and visualize the character and distribution of consumption, complaints and other transactions over time;
- Cluster and create routes for complaint follow-up activities for more rapid and efficient response;
- Maintain geographically enhanced customer satisfaction profiles and monitor key performance indicators over time

13.1.2.5 Participate in emergency preparedness and response

BWS is involved with the National Emergency Management Organization in carrying out emergency preparedness and response activities. Access to clean water and sanitation is critical to the health and safety of the population during and following a natural disaster. BWSL is collaborating with other teams through NEMO to identify vulnerable infrastructure and to develop mitigation and contingency plans for disaster response and recovery.

The applicability of GIS and the BNSDI to the emergency contingency planning and response role of BWS includes, but is not limited to:

- Pre-identify specific neighborhoods and water and sewer infrastructure that is likely to be damaged in major events. Work this information into contingency and response plans;
- Record sources and measures for temporary potable water supply and sanitary accommodation post disaster;
- Manage water and sewer system status information during response;
- Track and manage field staff activities during response;
- Manage and track damage repair and mitigation activities;
- Record activities and assess effectiveness for post-disaster refinement of contingency plans.

13.1.2.6 Manage ICT systems

BWS has an ICT team that maintains and supports the Utility's information infrastructure. This infrastructure spans across the entire country to all 10 branch offices, providing access to the company's main customer and water operations information system.

When installation or repair projects are closed out, the material take-off from the construction activity is used to populate the fixed asset information within the ***Sage 300 ERP*** system. Sage 300 ERP is the name for the mid-market Sage ERP line of Accounting Applications (formerly Sage ERP Accpac), primarily serving small and medium sized businesses. Sage 300 ERP is a

Windows based range of ERP software, available with a variety of database backends. This can run under a Windows environment and has an option of being hosted by Sage. Sage 300 ERP has the following modules/features:

- Multi-Company and Global Operations Management
- Customer Relationship Management
- Intelligence Reporting
- Accounts Payable
- Accounts Receivable
- Alerts and Alerts Server
- Fixed Asset Management
- General Ledger
- Project and Job Costing
- Return Material Authorization
- Transaction Analysis and Optional Field Creator
- US & Canadian Payroll
- Inventory Control
- Purchase Orders
- (Sales) Order Entry
- Intercompany Transactions[112]

BWS has only started populating the Sage 300 system one year ago. About 95% has been completed. Only the Project Job costing module is still in its testing phase. All other modules are fully implemented and utilitised, except for the US & Canadian Payroll and Sales Order Entry which are not applicable to the company's business structure.

Sage 300 modules are integrated such that warehouse inventory that is requisitioned for system construction moves physically and digitally from being a warehouse component to a fixed asset. Likewise, the fixed asset and financial systems are linked to allow system depreciation and valuation calculations to be conducted, and for maintenance work orders to be tied to the same specific assets. GIS offers the opportunity to link those systems to geographic locations in a form that can also support water and sewer system modeling, capacity analysis and many other important capabilities.

[112] http://en.wikipedia.org/wiki/ACCPAC

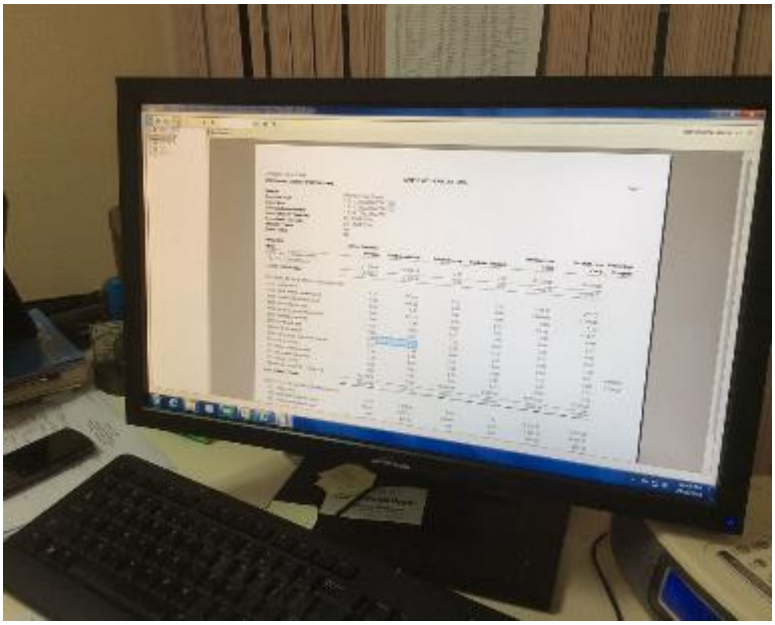

Figure 85 - Job Cost Control within Sage 300 ERP

GIS and the BNSDI are relevant to the function area in the following ways:

- Provide geospatial data and tools as an integral component of the utility's information infrastructure
- Provide user assistance and technical support for geospatial matters
- Provide programming tools for the integration of geospatial functions within enterprise business application software systems
- Utilize geospatial dimension as a mechanism for integrating and associating disparate databases together
- Provide specialized tools and methods for the administration of geospatial data

13.1.3 Data Used or Generated

The following document sets are being used and/or generated in the process of conducting BWSL functions at present:

Water Network Drawings. BWS has maintained all of its as-built map information for Water Network Drawings information in AutoCad digital format. Parcel boundary information from the MNRA Land Information Center (LIC) is used as the base map. Water network information is then updated in reference to the land base information in real world coordinates. Planned and in-progress additions to the network are likewise maintained in these files, differentiated by line size and color.

Water Network As-Built Maps. BWS has maintained a copy of the original water network maps that were created in the 1980's for reference. These are transcribed to vellum and managed in a vertical hang filing system. These maps were delineated at various scales between 1"=40' (1:480) and 1"=100' (1:1200) based on those map sheets observed.

Sewer Network Drawings. BWS has converted some of the as-built sewer network information to an AutoCAD format. Of the 3 sewer zones, only the Belize City zone has been converted to AutoCAD format.

Sewer Network As-Built Maps. BWS has maintained a copy of the original water network maps that were created in the 1980's for reference. These are transcribed to vellum and managed in a vertical hang filing system.

Parcel Land Base. BWS utilizes digital parcel information from the MNRA Land Information Center (LIC) as the land base for mapping of the water and sewer networks. This information is converted to AutoCAD format maintaining the real world coordinates for use by BWS.

BWSL Projects Database. All projects are recorded to a BWSL Projects Database in MS Access. This database is maintained on the main BWSL server. Each project is identified by a number that is a concatenation of several codes indicating that the project is for clean water, city where it is located, asset key, funder, year of the project, project number (assigned sequentially each year), along with the material take-off for the project and other pertinent information. This information is passed to the Accounting Department where the basic project information is imported to the Sage 350 system.

Water Main Break Pin Map. A Water Main Break Pinmap is maintained to visualize where breaks have occurred. Breaks are identified through visual inspection or non-revenue water analysis followed by further analysis. The latter is conducted by analyzing water consumption within zone districts which are themselves metered. The difference between water supplied to the district versus what was consumed and billed then represents non-revenue water that may be caused by system leakage or illegal tapping.

Water Delivery Zones Map. A map of the water delivery zones in each city is maintained by BWS in AutoCAD format. This map depicts the zone boundaries and the main connectors, valves and meter locations between zones. Water delivered into each zone is metered and used to determine the difference between water delivered to the zone versus that consumed at metered customer locations, thus implying non-revenue water loss to system leakage or illegal tapping.

Meter Card File. This is a paper Meter Card for each meter that provides more specific information regarding the meter location and related information.

Meter Reader Database. BWSL water meter readings are entered to the Meter Reader Database within the customer service system for the calculation of utility bills according to a standardized set rate.

Job Tracking Database. BWS utilizes a Job Tracking System (JTS) with information regarding the location and other information regarding every new service or construction project. Customer service performs a physical inspection prior to issuing a work order and collects a GPS geographic coordinate for the proposed service location. The coordinate is entered to Google Earth to indicate requested services on a map, and this information is used to schedule new service installations. These maps are being printed out, but the digital information is not being saved. The JTS database is planned for migration to a new system in the near future (according to interview during July 2014). There is some concern about the quality of customer data in the existing JTS and it is recognized that rigorous quality assurance and quality control measures will be needed to identify and resolve any data issues as part of the system migration effort.

13.1.4 Existing Systems

BWSL maintains servers and a number of PC's throughout the headquarters building and remote offices. Not available.

Other core technology and application software being used by BWS that has some relevance to GIS and the BNSDI includes:

AutoCAD. AutoCAD is a commercial software application for 2D and 3D computer-aided design (CAD) and drafting. As Autodesk's flagship product, by March 1986 AutoCAD had become the most ubiquitous CAD program worldwide. As of 2014, AutoCAD is in its twenty-ninth generation, and collectively with all its variants, continues to be the most widely used CAD program throughout most of the world.[113]

Google Earth. Google Earth is a virtual globe, map and geographical information program that was originally called EarthViewer 3D created by Keyhole, Inc., a company acquired by Google in 2004. It maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and geographic information system (GIS) 3D globe.[114]

Microsoft Access. Microsoft Access, also known as Microsoft Office Access, is a database management system from Microsoft that combines the relational Microsoft Jet Database Engine with a graphical user interface and software-development tools. It is a member of the Microsoft Office suite of applications, included in the Professional and higher editions or sold separately. Microsoft Access stores data in its own format based on the Access Jet Database Engine. It can also import or link directly to data stored in other applications and databases.

Microsoft SQL Server is being used as the main database for the Institute. Microsoft SQL Server is a relational database management system developed by Microsoft. As a database, it is a software product whose primary function is to store and retrieve data as requested by

[113] http://en.wikipedia.org/wiki/AutoCAD
[114] http://en.wikipedia.org/wiki/Google_Earth

other software applications, be it those on the same computer or those running on another computer across a network (including the Internet).[115]

Sage 350. Sage 300 ERP is the name for the mid-market Sage ERP line of Accounting Applications (formerly Sage ERP Accpac), primarily serving small and medium sized businesses. Sage 300 ERP is a Windows based range of ERP software, available with a variety of database backends. This can run under a Windows environment and has an option of being hosted by Sage. Sage 300 ERP has the following modules/features:

- Multi-Company and Global Operations Management
- Customer Relationship Management
- Intelligence Reporting
- Accounts Payable
- Accounts Receivable
- Alerts and Alerts Server
- Fixed Asset Management
- General Ledger
- Project and Job Costing
- Return Material Authorization
- Transaction Analysis and Optional Field Creator
- US & Canadian Payroll
- Inventory Control
- Purchase Orders
- (Sales) Order Entry
- Intercompany Transactions.

BWS has only started populating the Sage 300 system one year ago.

Job Tracking System (JTS). Requests for new connections are made through the customer service department. The department issues a work order request through the Job Tracking System (JTS). BWSL Customers can phone the department or visit the customer service desk at headquarters or one of the district office locations. A location is indicated initially by a street address or a physical description. The JTS was written by an independent consultant in Visual Basic and utilizing an MS SQL Server Database backend. The source code was not provided to BWSL and it has not been maintained and they are exploring migrating the system to the Utility Star system produced by AbleSoft.

Utility Star. Utility Star by AbleSoft is a customer information system (CIS) and utility billing system developed using Visual Basic's 2005 programming language and compatible with the Microsoft SQL Database platform. BWSL is planning to migrate their Job Tracking System (JTS) to Utility Star.

13.1.5 Other Issues, Opportunities and Constraints

[115] http://en.wikipedia.org/wiki/Microsoft_SQL_Server

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- Migration of the water and sewer network information to a GIS form will provide the opportunity to integrate GIS with many other aspects of BWS enterprise system.
- It will be important that the implementation of the Sage 300 system be done with consideration of the important role that GIS and the BNSDI can play in adding value to BWS enterprise system, and to avoid costs where base mapping, imagery, and other information is available from others, now and in the future.
- There is currently no official policy or practice for sharing data between BWS and other utilities or the government. Data and information is shared upon written request.

16 PRIVATE SECTOR

The private sector plays a big role in the formation and growth of the Belize economy. In North America, the private sector is a major user of GIS technology, often developing new businesses and jobs through the innovative use of information that may have started out as government data (e.g. car navigation systems and GPS). The private sector is also an important partner to government in planning and adapting to climate change vulnerabilities, disaster resistant community and infrastructure development, disaster response and recovery. The needs and concerns of the private sector in regards to GIS and the BNSDI are explored in the sections following.

16.1 Total Business Solution Ltd.

Person(s) Interviewed: Loretta Palacio

Interview Date(s): May 15, 2014

16.1.1 Organization and Mission

TBSL is an established Belizean IT solutions company that provides high quality and cost-effective business solutions to the corporate market with a management team of 20 years of GIS and business solutions experience combined. We offer business solutions in an array of fields, including GIS, GPS, remote sensing, hospitality, and accounting.

As part of the Esri and Trimble Distributorship, TBSL is a member of a strong network of companies providing cutting edge GIS and GPS solutions in over 160 countries. We enjoy immediate access to some of the world's leading experts in field of GIS, GPS, and information management technologies, and have a vast wealth of resource pertaining to these fields available for our use.

Having worked on numerous enterprise level projects in Belize, TBSL understands the challenges Belizean businesses face when implementing a mission critical system. We are customer focused and responsive to customer needs. We provide unique customer service experience and think outside the box to help customers find new approaches to achieve their strategic objectives.

The TBSL conducts several functions that relate most directly to GIS and the BNSDI, including the following:

1. Provide geospatial consulting and technical services
2. Provide geospatial computing infrastructure and software products
3. Support geospatial awareness, education and training

16.1.2 Activity Areas

Each of the abovementioned business activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that are most relevant to GIS and the BNSDI.

16.1.2.1 Provide geospatial consulting and technical services

TBSL became a distributor of ESRI GIS software in 2009, and has been building and providing geospatial consulting services since that time. Depending on the scope and thematic focus of each engagement, these services may be provided by in-house staff or in collaboration with other consultants and subject matter experts (SME's). Specific service areas include:

- Enterprise requirements analysis and implementation planning;
- System design and development;
- Database design and development;
- Application software design and development;
- Conduct special projects;
- Capacity assessment and training program design.

Specific relevance of this activity area to GIS in Belize and the BNSDI includes but is not limited to:

- Provide stakeholders with technical consulting support;
- Support GIS users in developing and maintaining their GIS infrastructure;
- Support geospatial database development projects;
- Support geospatial application software development projects;
- Conduct geospatial analysis and visualizations projects on behalf of clients;
- Prepare capacity building and training programs.
- Work with Esri to Develop a National Basemap for Belize

16.1.2.2 Provide geospatial computing infrastructure and software products

TBSL provides computing hardware and software as well as GIS software and Trimble GPS equipment. This includes the design and setup of new installations as well as installing and integrating GIS software to work within existing systems.

Specific relevance of this activity area to GIS in Belize and the BNSDI includes but is not limited to:

- Provide stakeholders with quality hardware and software products and support;
- Introduce and promote new emerging products to the marketplace;
- Expand the geospatial technology user community through marketing and sales activities.

- Provide immediate access to Esri's growing Partner Community for required software

16.1.2.3 Support geospatial awareness, education and training

TBSL has dedicated significant time and resources to building awareness of geospatial technology and its benefits to many sectors throughout the Country. It has also been active in supporting the introduction of GIS to schools and the University of Belize, through software donations and heavy educational discounts. The company has supported many GIS events and workshops, including bringing in subject matter experts in key areas such as environmental resource management, utility management, land cadastre and others. The company also provides technical training in the use of all the software and hardware products that it distributes.

Specific relevance of this activity area to GIS in Belize and the BNSDI includes but is not limited to:

- Build awareness and appreciation for geospatial technology across all sectors in Belize;
- Support GIS incorporation to all levels of the education system by hosting events (World GIS Day, My Virtual City Competition, Presentation to Teachers) to support its GIS Education for Primary and Secondary Schools initiative
- Provide technical geospatial software and hardware training;
- Provide student internships for gaining practical skills in a private sector setting;

16.1.3 Data Used or Generated

TBSL has invested significant time and resources to mapping various Point of Interest countrywide. These include Schools, Gas Stations, Hotels, Stores, Supermarkets, Bars, Restaurants, Government Offices, etc.

Specific relevance of this activity area to GIS in Belize and the BNSDI includes but is not limited to:

- Commercial Layer – includes stores, restaurants, etc.
- Develop A Geocoding Service for Belize

16.1.4 Existing Systems

ArcGIS. Esri's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. The system provides an infrastructure for making maps and geographic

information available throughout an organization, across a community, and openly on the Web.[116]

ArcGIS
ArcGIS is a platform for designing and managing solutions through the application of geographic knowledge.

ArcGIS 3D Analyst
ArcGIS 3D Analyst is an extension to ArcGIS that provides powerful visualization, analysis, 3D data maintenance, and surface generation tools allowing you to manage and analyze your data in a realistic 3D perspective.

ArcGIS Data Interoperability
ArcGIS Data Interoperability is an extension to ArcGIS that enables you to easily use and distribute data in many formats. Spatial extract, transform, and load (ETL) capabilities are used to eliminate barriers to data sharing.

ArcGIS Data Models
These freely downloadable database design models help you rapidly implement your GIS projects. They provide a great starting point for geodatabase projects in a wide variety of industries.

ArcGIS Data Reviewer
ArcGIS Data Reviewer is an extension to ArcGIS that automates and facilitates the otherwise resource-intensive process for data quality control.

ArcGIS Defense Solutions
ArcGIS Defense Solutions consist of three free downloadable products that provide specialized tools for defense and intelligence to help drive faster, more informed decision making and response.

ArcGIS Engine
ArcGIS Engine is a collection of GIS components that allow developers to add dynamic mapping and GIS capabilities to existing applications or build new custom applications.

ArcGIS Engine Extensions
Extensions add more capabilities to ArcGIS Engine such as 3D, spatial, and network analysis; schematic data management; data interoperability; and asset tracking in time and space.

ArcGIS Explorer Desktop
ArcGIS Explorer Desktop is a free GIS viewer for exploring, visualizing, and sharing geographic information.

ArcGIS for Desktop
ArcGIS for Desktop is the part of the ArcGIS platform for creating, editing, and analyzing geographic knowledge to examine relationships, test predictions, and ultimately make better decisions. ArcGIS for Desktop has three license levels—Basic, Standard, and Advanced—that

[116] http://en.wikipedia.org/wiki/ArcGIS

share the same core applications, user interface, and development environment. Each license level provides additional GIS functionality as you move from Basic to Standard to Advanced.

ArcGIS for Desktop Extensions
Extensions add more capabilities to ArcGIS such as raster geoprocessing, 3D analysis, and map publishing. In addition to ArcGIS, many extensions are also offered for ArcGIS for Server and ArcGIS Engine.

ArcGIS for Electric
ArcGIS for Electric is a set of configurable maps and apps that meet the special needs of electric utilities.

ArcGIS for Home Use
ArcGIS for Home Use makes ArcGIS for Desktop Advanced (ArcInfo) and most of the desktop extensions available to anyone for personal, noncommercial use at the affordable price of $100 per year.

ArcGIS for Local Government
ArcGIS for Local Government is a set of configurable maps and apps that meet the special needs of local government agencies and departments.

ArcGIS for Mobile
ArcGIS for Mobile provides a variety of mapping applications to help improve field operations.

ArcGIS for Server
ArcGIS for Server is used to deliver and manage GIS, map, image, and data services across the enterprise and the web. ArcGIS for Server has three editions: Basic, Standard, and Advanced. Each edition is available at two levels: Workgroup and Enterprise.

ArcGIS for Server Extensions
ArcGIS for Server extensions add more specialized capabilities to the core functionality of ArcGIS for Server, including advanced geoprocessing and data modeling, as well as tools for managing and processing spatial data, imagery, rasters, networks, and workflows.

ArcGIS for Transportation Analytics
ArcGIS for Transportation Analytics allows you to optimize your enterprise fleet operations.

ArcGIS for Windows Mobile
ArcGIS for Windows Mobile consists of a ready-to-deploy field data collection and inspection application and a custom Software Development Kit (SDK). It is tailored to organizations' specific workflows and synchronizes directly with ArcGIS for Server, making data updates instantly available to field staff as well as everyone in the office.

ArcGIS Geostatistical Analyst
ArcGIS Geostatistical Analyst is an extension to ArcGIS that allows you to probe your data with advanced statistical tools, bridging the gap between geostatistics and GIS analysis. It enables you to model spatial phenomena, assess risk, and accurately predict values within your study area.

ArcGIS Network Analyst
ArcGIS Network Analyst is an extension to ArcGIS that helps you dynamically model realistic network conditions to solve sophisticated vehicle routing problems, look for closest facilities, and create service areas.

ArcGIS Online
ArcGIS Online is a cloud-based mapping platform for creating, managing, and sharing maps, apps, data, and other geographic information.
Tags: Apps, Cloud, Data Sharing,Hosted Services, Web Services, Web Mapping, Web Maps Online, ArcGIS Online

ArcGIS Publisher
ArcGIS Publisher is an extension to ArcGIS that lets you create Published Map Files (PMFs) that can be viewed, explored, or printed by anyone with the free ArcReader application.

ArcGIS Runtime SDKs
ArcGIS Runtime SDKs includes scalable developer tools to create lightweight mapping applications for desktop and mobile devices.

For a full listing of ESRI products that are distributed by TBSL, please visit – http://www.esri.com/products/products-alpha.

16.1.5 Other Issues, Opportunities and Constraints

The following issues should be considered in the further development of GIS and BNSDI involvement for the future:

- The GIS market in Belize has been very small and mostly focused around natural resource management in the past;
- The private sector can play an important role in raising awareness and promoting the use of GIS across all sectors, especially if this can be carried out in direct partnership with government;
- The private sector can provide high quality specialized services across multiple organizations that may not be justifiable for in-house development by any one of those organizations alone;
- Opening up access to data for use by the private sector to build new products and provide new types of services can help to grow and diversify the economy;
- Expanding the type and numbers of GIS users will also increase
- Restricting access and/or charging for government data constrains its use;
- Public/private partnerships can be used to optimize the return on investment of public funds while helping to build and diversify the economy.

16.2 Association of Real Estate Brokers of Belize

Person(s) Interviewed: Desk study

Interview Date(s): na
Desk Study Date(s): 1 September, 2014

16.2.1 Organization and Mission

The Association of Real Estate Brokers of Belize (AREBB) represents the top real estate professionals in Belize, with a growing membership that includes not only brokers and sales associates, but developers, attorneys, consultants, surveyors, appraisers, and other professionals intimately involved in the industry. AREBB members are the experts in their field and cover the entire country operating under strict standards of ethics and professionalism.

AREBB is actively involved with the Government of Belize in the development of the Real Estate Bill and in formulating and managing training, licensing and other resources for professionals in the industry. Its membership represents a wide scope of stakeholders allowing them to formulize and plan with all pertinent perspectives in mind. The legal framework of how to operate as real estate brokers and real estate sales associates in Belize is currently being developed by AREBB and will provide all Belizeans with the opportunity to seek and receive training in real estate and with licensing, allow them to operate legally, ethically and successfully - improving the level of service available in this growing industry.[117]

AREBB currently carries out the following activity areas that have some relevance to GIS and BNSDI:

1. Lobby relative to policies and regulations affecting the real estate market;
2. Disseminate information regarding real estate in Belize;
3. Build capacity of real estate professionals in Belize

16.2.2 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of all activities or each activity, but rather a summary of the aspects of those that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

16.2.2.1 Record and promote membership.

[117] http://www.arebb.com/

The AREBB promotes for new members and makes membership information available to others. There are over 40 members active in the Association today. The Association's website provides a small map of District boundaries by which to retrieve information for member brokers, as shown in the Figure below.

Member Directory

Company	Owner	Membership Type	Details
Ceiba Realty Ltd.	Jonathan Lohr	Corporate Member	
CPC Real Estate Solutions Ltd.	Petra Wolf	Corporate Member	
Diamond Realty	Daphine Vega	Corporate Member	
In Sites Real Estate	Marta Hendrikx	Corporate Member	
Jaseth M. Jackson & Co.	Jaseth M. Bassaragh	Affiliate Member	
RE/MAX Belize Property Center	Brian Cullerton	Corporate Member	
RE/MAX Belize Property Center	Tiffany Swift	Corporate Member	
RE/MAX Belize Property Center	John Acott	Corporate Member	
Vista Real Estate	Manuel Ayuso	Corporate Member	

Figure 86 - Real Estate Broker Map and Listing by District

Ways that GIS and the BNSDI could be relevant to this functional area include, but are not limited to the following:

- Provide member with access to selected government data that are relevant to the Real Estate industry;
- Provide real estate geographically based information services that attract new membership to the association.

13.2.2.2 Lobby relative to policies and regulations affecting the real estate market

AREBB was formed in early 2006 to address issues that were detrimental to the real estate industry in Belize. Chief among those issues was the Government of Belize's implementation of the GST (General Sales Tax) in 2006. Through aggressive lobbying, AREBB managed to reduce stamp duty (transfer tax) on property sales to 5% across the board for all purchasers, whereas before, stamp duty was 15% of selling price for non-Belizeans. Government went further and offered to charge stamp duty only on purchases above $20,000 BZD or on the portion of selling price above that amount.

AREBB is now actively engaged with the Government of Belize in formulating the legal frame work for operating as real estate brokers and salespeople in Belize. This legislation is known as the Real Estate Bill currently in the process of becoming the Real Estate Act.

Ways that GIS and the BNSDI could be relevant to this functional area include, but are not limited to the following:

- Lobby for access to government geospatial information that is relevant to the real estate industry;
- Analyze the potential impacts of policies and regulatory proposals and options on development and real estate;

- Monitor and evaluate the impacts of policies, regulations and activities on the real estate market over time.

13.2.2.3 Disseminate information regarding real estate in Belize

The AREBB is involved in compiling and providing information affecting real estate in the country. This is currently limited to policies, regulations, practices and news affecting the real estate market. Information is shared not only with real estate brokers, but also with other professions that engage in real estate matters including banking, law, and tourism and building industry professionals.

Ways that GIS and the BNSDI could be relevant to this functional area include, but are not limited to the following:

- Provide member with access to selected government data that are relevant to the Real Estate industry;
- Provide a geographically enabled multiple listing service to track properties for sale;
- Provide a geographically enabled method for tracking real estate sales and analyzing comparable properties for market valuation purposes;
- Provide an ability to track development projects and analyze development and property value trends over time;
- Provide access to natural hazard information and identification of vulnerable properties;
- Identify properties that may be impacted by climate change over time;
- Provide access to real estate information over the internet, both to support local as well as international users;
- Forecast the likely impacts of policies, regulations and trends on the real estate market over time and make this information available to association members.

13.2.2.3 Build capacity of real estate professionals in Belize

AREBB provides it members with access to training programs, licensing, meeting, workshops and news regarding new issues that are relevant to the real estate industry.

Ways that GIS and the BNSDI could be relevant to this functional area include, but are not limited to the following:

- Conduct workshops to raise the awareness regarding how GIS and BNSDI can be used to support real estate activities;
- Provide access and training in the use of GIS enhanced tools for real estate marketing, valuation, trend analysis, development tracking and other relevant issues.

16.2.3 Data Used or Generated

The following document sets relevant to GIS and the BNSDI that are being used and/or generated in the process of conducting AREBB functions currently:

AREBB Member Database. This is a listing of the business name, owner name, address, website URL, telephone and other basic information about AREBB members.

16.2.4 Existing Systems

The following systems are being used in the process of conducting this group's functions.

No additional information provided.

16.2.5 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the AREBB:

- Acquiring land ownership information from the government is expensive.

17 NON-GOVERNMENT ORGANIZATIONS

Non-government and private, not-for-profit organizations (NGO's) are a critical facet of society in Belize. Major parts of the Country are under the stewardship of non-government conservation groups, and still others provide important functions in research and provision of specialized services to government. Other special interest organizations also play an important role across many socioeconomic sectors. The following sections explore the needs and potential contributions of several NGO's relative to the BNSDI.

17.1 Belize Tropical Forest Studies

Person(s) Interviewed: Jan Meerman

Interview Date: June 21, 2014

17.1.1 Organization and Mission

Belize Tropical Forest Studies (BTFS) is a Non-Governmental Organisation, registered in Belize in 1997. The mission of Belize Tropical Forest Studies (BTFS) is to collect and disseminate biodiversity information in and about Belize. BTFS's activities are mainly oriented towards biodiversity assessments of protected areas and private lands. BTFS is involved with selected regional projects (*e.g.*, MesoAmerican Biological Corridors Project, Selva Maya Ecoregional Assessment Project) and technical partnerships (*e.g.*, Programme for Belize, Forestry Department, TransNatura LLC). Data collection activities focus on the surveys of terrestrial biodiversity, species occurrence and distributions. BTFS plays a lead role in the aggregation and dissemination of spatial (GIS) data and biodiversity and environmental data via the Biodiversity and Environmental Resource Data System of Belize (BERDS).[118]

Much of the information included in this write-up has been copied or paraphrased directly from the BTSF website and/or derived from information provided by Mr. Jan Meerman.

BTFS is involved in several primary activity areas that have particular relevance to GIS and BNSDI including the following:

1. Develop and maintain BERDS
2. Conduct biodiversity assessments of protected areas and private lands
3. Participate in technical partnerships
4. Conduct research

17.1.2 Activity Areas

[118] http://www.green-hills.net/btfs/

Each of the abovementioned activity areas is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI, and representing the potential interests and contributions of NGO's to the BNSDI program.

15.1.2.1 Develop and maintain BERDS

The Biodiversity & Environmental Resource Data System of Belize (BERDS) is a community-driven biodiversity and environmental data warehouse and research tool set. What makes BERDS unique is its integrated spatial approach to data analysis, management and dissemination. BERDS merges a wide array of useful data resources (*e.g.*, documents, people, organisations, projects, specimen collections, datasets, multimedia) with an integrated and comprehensive GIS mapping and analysis capability to form a powerful data visualization and investigation toolset for research and monitoring efforts.

BERDS is hosted and maintained by Belize Tropical Forest Studies, however, the growth of its data holdings and its long-term financial sustainability are driven by the participation of BERDS' national, regional and international partners. Since its launch in 1997, BERDS has grown to become the preeminent environmental data resource for Belize, including comprehensive and detailed baseline information on the 120 ecosystems, 92 protected areas and 35 watersheds found in Belize and data holdings including over 7,100 species records, 113,000 data records and providing visual and textual access to over 41 accurate spatial data sets as well as a unique visual-based search facility. There are 5 research case studies explaining how to use the system to solve real-world conservation problems and 11 step-by-step tutorials on using the BERDS facility itself. 30+ national and international organisations and the private sector have joined as active participants and the system has reached levels of financial self-sustainability.[119]

[119] http://www.biodiversity.bz/

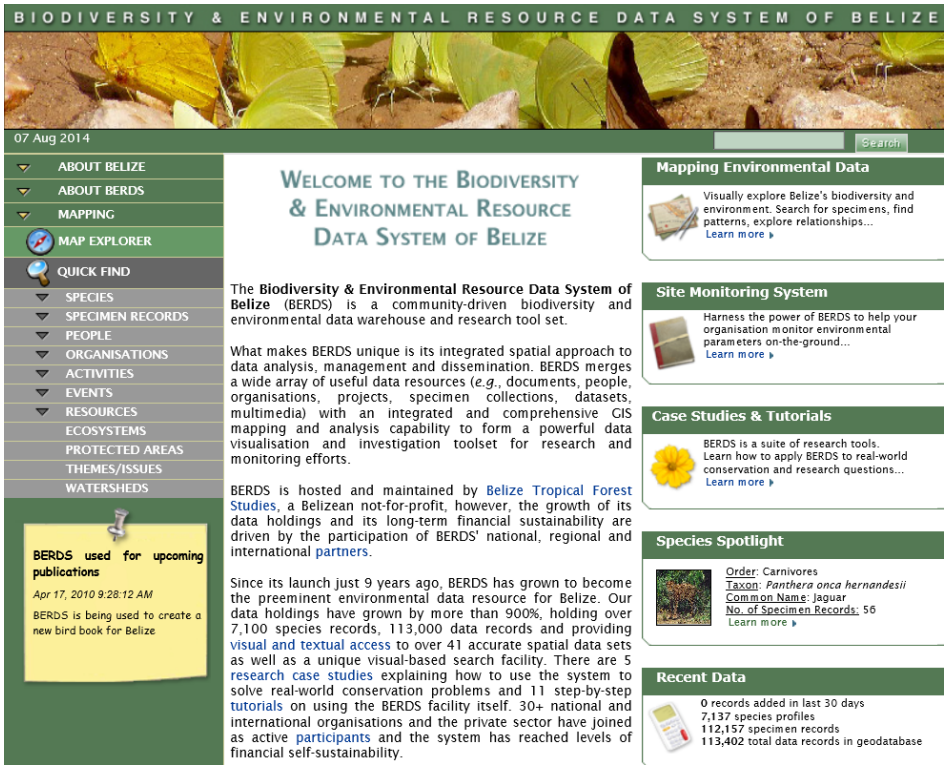

Figure 87 - BERDS Website < http://www.biodiversity.bz>

BERDS evolved out of the Belize Biodiversity Mapping Service (BBMS), a simple demonstration of Internet Mapping Server technologies to the Belize Biodiversity Clearing-House Mechanism Working Group in early May 2004. What started out as a simple Internet Mapping demonstration with 5-10 GIS layers has rapidly grown into a full-fledged data warehousing system and research investigation tool developed through a public-private partnership.

Internet Map Server technologies have been enhanced and integrated throughout the system in a unique fashion to allow for the visualisation, discovery and analysis of any data records. Regardless of their type (*e.g.*, documents, people, specimens, websites, etc.), data records can be easily georeferenced with UTM coordinates. This allows the system to include traditional and non-traditional data types in spatial overlays and analyses. These data can be visualised on maps using the Map Explorer application or viewed as embedded map images anywhere within the system. This capability also allows all data types to be located ('discovered') using the unique visual search engine technology built into the Map Explorer application. Additionally, non-image-based GIS-based spatial data analyses can be undertaken on the fly.

The BERDS project team strives to provide a comprehensive and thorough resource base through the continued aggregation of new data and through the enhancement of the system's usability. The system is designed to allow multiple organisations, working as 'data providers' to easily contribute their own data and resources to the system, using only a web browser.

BERDS Members have access to their own customised Map Explorer Application, site monitoring system, private library catalog database and more.

BERDS members include a variety of organizations and individuals who are using this framework for the sharing of environmental information and data. Those listed on the website include:

Founders

- Belize Tropical Forest Studies;
- Transnatura LLC;

Collaborating Networks

- Clearing-House Mechanism;
- InterAmerican Biodiversity Information Network (IABIN);
- Invasive Species Specialist Group (ISSG);
- NatureServe;
- National Geographic Society (NGS);
- SERVIR;

Sponsoring Members

- Belize Audubon Society;
- Birds Without Borders;
- Galen University ;
- The Natural History Museum;
- The Nature Conservancy;
- Department of Anthropology, University of Calgary;
- Wildlife Conservation Society;
- WildTracks;
- Ya'axche Conservation Trust (YCT);

Data Providers

- American Crocodile Endangered Sanctuary
- Belize Botanic Gardens
- Belize Foundation for Research and Environmental Education
- Belize Fisheries Department;
- Belize Forest Department;
- Belize Lodge and Excursions;
- Beyond Touring;
- Coastal Zone Management Institute (CZMI);
- H. Lee Jones;
- Mesoamerican Barrier Reef System Project (MBRS);
- Programme for Belize (PfB);
- Royal Botanical Gardens, Edinburgh;
- University of Belize;
- Utah State University;
- Virginia Tech University;

BERDS Supporters

- Eco-Index – Rainforest Alliance

BERDS is a good example of a data sharing community that includes a spatial data infrastructure focused on the environmental sector. However it is important to note that it goes beyond basic data sharing to provide a broader framework of information, technical and institutional resources intended to strengthen the efforts of those organizations and individuals involved in the biodiversity matter in Belize. This is a good example of taking NSDI beyond the "supply side" orientation of classical NSDI to add the elements that will ensure that the information becomes a part of a "demand side" application of that information in addressing critical national development issues.

Areas of the BERDS function that are particularly relevant to GIS and the BNSDI include:

- Provide a geospatial data warehouse for the storage and management of commonly needed information;
- Provide metadata catalog and tools to allow stakeholders to locate useful information;
- Provide online mapping services to allow stakeholders to access and use geospatial information for their own purpose;
- Provide help desk and technical support for BERDS stakeholders;
- Link geospatial location data with other information media (sample, photo, observation, sound, video, etc.).

16.1.2.2 Conduct biodiversity assessments of protected areas and private lands

BTFS is involved in the preparation of biodiversity assessments of protected areas and private lands through consulting arrangements with government and private land owners. These are often included within environmental impact assessment (EIA) studies that are required as part of the government development approval process.

Areas of this function that are particularly relevant to GIS and the BNSDI include:

- Access and compile geospatial and related information from multiple sources;
- Conduct and record environmental species observations;
- Delineate habitat and other environmental resource data based on image interpretation combined with ground truthing;
- Observe species movement with tracking devices;
- Assess species habitat, population and population status and trends information;
- Assess and delineate species ranges, including migratory patterns;
- Conduct environmental issue, opportunity and constraint analysis;
- Prepare environmental impact assessment analyses and reporting.

16.1.2.3 Participate in technical partnerships

BTFS engages in a variety of technical partnerships where these are in alignment with other activities and areas of interest. Examples include partnerships with organizations such as the Programme for Belize, the Forestry Department and TransNatura LLC, all of whom have long term interests in different aspects of the environment in Belize. These partnerships involve long term regular engagement on areas of mutual interest as well as collaboration on funded projects.

Areas of this function that are particularly relevant to GIS and the BNSDI include:

- Coordination and alignment of activities and resources where shared interests are involved;
- Sharing of geospatial data resources among partners;
- Conduct joint research;
- Jointly lobby for changes in policies and practices affecting GIS or BNSDI.

16.1.2.4 Conduct research

BTFS has been involved in a variety of research studies over the years.

15.1.3 Data Used or Generated

BTFS as a founding member and major contributor to BERDS makes most of its data available through the platform. Primary data currently available through BERDS includes the following:[120]

Spatial Layer:	BASEMAP
Source:	Meerman, J. C. 2010 Belize Base-map featuring country and district boundaries including correct placement of offshore cayes. This dataset corrects several errors and inconsistencies in the "district" basemap commonly used in Belize. Specifically it has the various offshore cayes projected in their proper location and also provides greater detail for the district boundaries. Metadata included.
Projection:	UTM Zone 16
Datum:	NAD 27 Central
Spheroid:	Clarke 1866
EPSG Code:	26716
Spatial Layer:	DISTRICTS
Source:	Land Information Centre Spatial Layer [Made public through Paseo Pantera Consortium Univ. of Florida/USAID *Digital Geographic Database: Maya Forest Region: Mexico, Guatemala, Belize. Version 1, August 19110.*] Note: further modified by Jan Meerman
Projection:	UTM Zone 16
Datum:	NAD 27 Central
Spheroid:	Clarke 1866
EPSG Code:	26716
Spatial Layer:	BIOLOGICAL CORRIDORS (proposed)
Source:	Meerman, J. C. 2001.
Projection:	UTM Zone 16
Datum:	NAD 27 Central

[120] http://www.biodiversity.bz/mapping/metadata/

Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: BIOLOGICAL FIELD STATIONS
Source: 2005. Belize Tropical Forest Studies
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: ECOSYSTEMS (incl. Agricultural Encroachment, Agricultural Use, Forest Types, Land Use, Mangroves, Marine Habitats and Wetlands Layers) - Updated 02 Feb 2012
Source: Meerman, J. C. and W. Sabido. 2001. Central America Ecosystems Map: Belize. CCAD/World Bank/Programme for Belize. Major Revision by J. Meerman and posted 02 Feb 2012
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: ELEVATION (200m intervals)
Source: 1980 DOS 1:50,000 Topographic Maps
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: ELEVATION (100m intervals + Bathymetry)
Source: 1980 DOS 1:50,000 Topographic Maps
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: EXCLUSIVE ECONOMIC ZONE - updated 11 Nov 2004
Source: Belize Maritime Areas Act 1992

Note: Generated by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: FIRE RISK - added 27 Nov 2004
Source: Belize Fire Risk Map is a digital approximation of wild fire risk to natural areas in Belize. The data was compiled using a variety of parameters obtained from a number of different sources. Scale: 1:250,000

Note: Generated by Jan Meerman

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: 2005 FIRE SEASON DATA - added May 2005
Source: Belize Fire Season data was compiled using the NASA MODIS Satellite System

Note: Generated by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: GEOLOGY
Source: Cornec, J. 1986. Notes on the provisional geologic map of Belize, scale 1:250,000. UNDP/BZE/83/001. Petroleum Office, Ministry of Natural Resources, Belize. 22pp and fig. (unpub).
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: GROUNDWATER PROVINCES
Source: USAID. 1984. Belize: Country Environmental Profile: A Field Study.
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: 2001 HURRICANE IRIS DAMAGE
Source: Meerman, J. C. 2001.
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: HYDRAULIC GAUGING STATIONS
Source: Belize Meteorological Service. 2005 http://www.hydromet.gov.bz/Hydro_station_page.html
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: LAND DEGRADATION RISK - added 05 Apr 2006
Source: J. Meerman. - Dataset combines a total of 8 variables to assess the potential for land degradation in Belize. These variables include; Soil pH, Shallow depth, Soil Fertility, Fire Risk, Slope, Geology and Rainfall. Within these, the soil pH and slope weigh heaviest. In general, those areas with a high combined land degradation value should be considered unsuitable for development, particularly agricultural development.
Projection: reprojected to UTM Zone 16

Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: 1990 LANDSAT IMAGES - updated 27 Jun 2004
Source: 1990 Orthorectified Landsat Thematic Mapper Mosaic. 8-bit 256 colour and b&W GeoTIFF images with WorldFiles; created from composite 32-bit MrSID image https://zulu.ssc.nasa.gov/mrsid/mrsid.pl
Projection: reprojected to UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: 2004 LANDSAT IMAGES - added 06 Sept 2005
Source: 2004 Orthorectified Landsat Thematic Mapper Mosaic (bands 453). 8-bit 256 colour and b&W GeoTIFF images with WorldFiles; created from composite 32-bit MrSID image. Emil Cherrington and Jan Meerman. 2005.
Projection: reprojected to UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: PROTECTED AREAS - updated 12 Apr 2005
Source: GOB Gazettes

Note: Generated by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: RAINFALL
Source: Walker, S. H. 1973. Summary of climatic records for Belize. Land Res. Div. Surbiton, Surrey, England, Suppl. No. 3

Note: further modified by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: RIVERS & STREAMS - Updated 14.10.2005
(including riverine types, water sources, clarity and salinity layers)
Source: Land Information Centre Spatial Layer

[Made public through Paseo Pantera Consortium
Univ. of Florida/USAID *Digital Geographic Database: Maya Forest Region: Mexico, Guatemala, Belize. Version 1, August 19110.*]

Note: further modified by Jan Meerman & Peter Esselman

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: ROADS & TRACKS - updated 30 Jun 2004
Source: Spatial Presentation of Belizes Road system describing paved, unpaved roads and the most important tracks and trails

Note: Generated by Jan Meerman
Updated 30 Jun 2004

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: SETTLEMENTS - updated 21 Jun 2004
Source: Int'l Travel Map of Belize (1:350,000), 2000 GOB Census, 2001 CSO Abstract of Statistics

Note: Generated by Jan Meerman and Jerod Clabaugh
Updated: 20 Jun 2004

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716
CSDGM Metadata: HTML

Spatial Layer: SOILS
Source: Based on Wright, A. C, et al, 11109. Land in British Honduras. Colonial Res. Publ. No. 24.

Note: Generated by PRONATURA for the TNC-led Selva Maya Project (draft form)
Further modified to include information from *Baillie, et al. 1993. Revised Classification of the Soils of Belize. NRI Bulletin No. 59.*

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: WATERSHEDS
Source: based on *NARMAP 19110. Environmental water quality monitoring report. Final Report and Annexes. Department of the Environment, Belize.*

Note: further modifications using altitude, stream and ecological data by Jan Meerman and Jerod Clabaugh

Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866

EPSG Code: 26716

BTSF has recently provided technical assistance to the World Bank in the collection and processing of information needed to support the preparation of a Caribbean-wide natural disaster assessment pilot project. Geospatial data that have been compiled for this effort by BTSF includes updated or refined versions of some of the information listed above, as well as additional layers that have been compiled or derived specifically for the CRIP pilot:

Filename	Alternate Title	Description	Credits	Citation Contact Organization
landuse_2011	Belize Land Use - Land Cover Map 2011	Based on the map of the Ecosystems of Belize version 2011, from which all Agriculture Classes were identified. Using March 2013 Landsat imagery, an attempt was made to distinuish between smallholder agriculture (Mostly subsistence) and Large Scale Intensive Agriculture (market oriented). Agricultural incursions originating from Guatemala are identified as a separate class	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	Belize Tropical Forest Studies
Aquaculture	Belize Land Use - Land Cover Map 2011	Isolated from the Map of the Ecosystems of Belize version 2011 which is an update from the 2001 Belize Ecosystems Map (Meerman & Sabido, 2001) and the subsequent 2004 version of the same. has been enhanced using a substantial set of new data. The data quality of the 2011 version has greatly improved over the 2001 and 2004 versions. The classification still follows the UNESCO system developed for the Central American Ecosystems Map and is thus completely consistent with that product.	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	Belize Tropical Forest Studies
Banana Fields 2004	Banana Fields 2004	Demonstration dataset based on the extent of Banana Plantations in 2004 - Source: Banana Growers Association. With additional data from Landsat Imagery 2013-03-24	Banana Growers Association Jan Meerman	
Citrusbelt	Citrusbelt	Polygon dataset based on the point dataset of Citrus Plantations in 2010 (as far as mapped) - Source: Citrus Research Institute.	Citrus Research Institute Jan Meerman	Belize Environmental Consultancies
Sugarbelt		Polygon dataset based on the extent of Sugar Cane Plantations as mapped by 2010 - Source: Belize Sugar Industries. Polygons were joined in order to	Belize Sugar Industry Jan Meerman	

		show broad suger cultivation zones in Northern Belize		
Aster_DEM_BZE_clip.tif	Aster_DEM_BZE_clip.tif	DigitalElevation Model	NASA	NASA
Belize Airfields		Point Database of Belize Airfields and Airstrips	Civil Aviation Authority	
Archaeological_sites	Archaeological sites	Principal data extracted from the more than 6,000 archaeological sites in the database of the Electronic Atlas of Ancient Maya Sites. 2010 copyright Walter R. T. Witschey, Longwood University, and Clifford T Brown, Florida Atlantic University: http://mayagis.smv.org/google_earth_data.htm (2010). The geo-referencing of many sites was later modified for a better geographical match using field data gathered by Jan Meerman	Walter R. T. Witschey, Longwood University, and Clifford T Brown, Florida Atlantic University: http://mayagis.smv.org/google_earth_data.htm (2010)	
Border_Ports	Border Ports	Point Database of Belize Border Crossings and Ports	Jan Meerman	
Newsreport events		Disaster data (large or small, based on more than a decade of newscasts (Channel 5, Channel 7 and Love FM) (Since 1998 through 2012, but older events were less reported on). Most are flooding events but also hurricane and other. The point data are positioned as accurate as possible based on information from the various news casts.	Channel 5, Channel 7. Love FM	
River_Rain Flood_ARA	River_Rain_ Flood_ARA	Based on 1999 Hazard and Risk Assessment - Institutional Strengthening of NEMO	ARA Consulting Group, KPMG LLP (CANADA): KPMG Project; NEMO, LIC	
Flood_ Events_ Total	Flood_Events_ Total		Channel 5, Channel 7. Love FM	
Flood October 2008	Flood October 2008	Vector dataset depicting areas of water (open water + flooded) after tropical Depression 16 in early October 2008. Based on Landsat TM7 20081105	Jan Meerman	BERDS
bz_ floodrisk_nri_	Belize Land Systems King et al.	The dataset is the culmination of the work by King, Baillie, Abell, Bissett, Dunsmore, Gray, Grimble, Johnson, Silva, Pratt, Versey, Williams, Wright and Zisman 1986-1992. Land Resource Assessment of the Toledo District, Stann Creek District and Northern Belize. The dataset provides detailed	King, Baillie, Abell, Bissett, Dunsmore, Gray, Grimble, Johnson, Silva, Pratt, Versey, Williams, Wright and Zisman 1986-1992. Land Resource Assessment of the Toledo District, Stann Creek District	

		information on the physical land systems of Belize and its associated soil and agriculture attributes.	and Northern Belize.	
Belize_ Rivers layer	Belize Stream Layer	This dataset contains vector streamlines for all of the domestic watersheds of Belize. The lines were hand digitized from 1:50,000 maps from Belize that were scanned and georectified. Each stream segment has attributed indicating stream order, elevation, slope and where available names	1:50,000 Ordinance Survey Maps (UK); Jan Meerman (stream orders, names); Sandor Rickets (digitizing); Peter Esselman (project rationale), Climate Resiliance Project under the Global Facility For Disaster Reduction and Recovery" (2013).	Belize Tropical Forest Studies
land degradation	land degradation	Dataset combines a total of 8 variables to assess the potential for land degradation in Belize. These variables include; Soil pH, Shallow depth, Soil Fertility, Fire Risk, Slope, Geology and Rainfall. Within these, the soil pH and slope weigh heaviest. In general, those areas with a high combined land degradation value should be considered unsuitable for development, particularly agricultural development.	Jan Meerman, Emil Cherrington	
landuse_2011	Belize Land Use - Land Cover Map 2011	Map of the Ecosystems of Belize version 2011 is an update from the 2001 Belize Ecosystems Map (Meerman & Sabido, 2001) and the subsequent 2004 version of the same has been enhanced using a substantial set of new data. The data quality of the 2011 version has greatly improved over the 2001 and 2004 versions. The classification still follows the UNESCO system developed for the Central American Ecosystems Map and is thus completely consistent with that product. Some of the Ecosystem variants as used in the 2004 version have been collapsed and integrated in the parent classification.	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	Belize Tropical Forest Studies
BZE_Roads_2010	Belize Roads Shapefile 2010	Road Shapefile for Belize based on 2008 Landsat Image	Jan Meerman, Belize Tropical Forest Studies	Belize Tropical Forest Studies

Belize_ seismic_ total_risk	Belize_ seismatic total_risk	These are generalized maps, showing Ground Acceleration, Ground Velocity and Modified Mercalli Intensities. This file combines the 3 methods into one relative risk map. Prepared for Belize Climate Resilient Infrastructure Project. The original maps were produced for the OAS/CDMP Regional Seismic Hazard Assessment Project in 1998. Source: http://www.oas.org/CDMP/document/seismap/belize.htm. No original metadata found	http://www.oas.org/CDMP/document/seismap/belize.htm Caribbean Disaster Mitigation Project Implemented by the Organization of American States Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance and the Caribbean Regional Program	
settlements _point_2010_pop	Point Dataset Belize Settlements	Point dataset of Belize Towns, Cities, villages and communities. Point locations are approximate centres of densest infrastructure patterns and do not indicate any legal center of a community. Principal Source of information is the National Association of Village Councils of Belize (NAVCO): http://navco.org.bz/village_council.html and further strengthened with actual fieldwork recording settlements with the use of a GPS. Population data are based on the 2010 Population Census and have been provided by the Statistical Institute of Belize (SIB)	Jan Meerman	Belize Tropical Forest Studies
settlements _poly_2010	Belize Polygon Settlement Map 2010	Polygon dataset of settlements in Belize based on 2010 Landsat 30 resolution data. Derived from 2010 Landuse map	Jan Meerman (Biodiversity and Environmental Resource Data System of Belize - Belize Tropical Forest Studies)	Belize Tropical Forest Studies
Watersheds Belize		Watershed layer for Belize originally prepared by Emil Cherrington for SERVIR (CATHALAC) using SRTM data sources. His origianal dataset was modified for most coastal watersheds based on field surveys and topography interpretation by Jan Meerrman. Many boundaries of coastal watersheds were simplified. Errors (many slivers) were removed	Emil Cherrington SERVIR CATHALAC Jan Meerman	CATHALAC

Wildlife_ casualties	Wildlife_ casualties in relation to Belize Roads Shapefile 2011	Document impact of the national roadsystem upon wildlife. Belize is home to many endangered species, and several of these are at risk from traffic accidents. 2011 update from a road Shapefile for Belize based on 2008, 2010 and 2011 Landsat Images. Principal change with previous versions lies in the classification of roads.	Jan Meerman, Belize Tropical Forest Studies	Belize Tropical Forest Studies
Earthquakes		U. S. G E O L O G I C A L S U R V E Y E A R T H Q U A K E D A T A B A S E FILE CREATED: Tue Nov 27 14:48:54 2012, Geographic Grid Search Earthquakes= 1288 Latitude: 20.000N - 14.000N Longitude: 83.000W - 92.000W Catalog Used: PDE; Date Range: 1973 to 2012; Data Selection: Historical & Preliminary Data	USGS	
faultlines_ all	Goeological Fault Lines Belize	Contains the mapped geological fault lines for Belize based on various sources, most importantly Cornec (1993), the Geological Fault Map of Belize and various internet resources. The map contains the Geology of the Cayman Trough and the Motagua Valley in Guatemala as well as this is the most seismically active zone affecting Belize	Cornec, J. 1986 Notes on the provisional geologic map of Belize, scale 1:250,000 Petroleum Office, Ministry of Natural Resources Cornec, J., 2003. 1:750.000 Geology map of Belize. Privately published - updated vector files received by personal communication in 2007 Geological Fault Map for Belize (source? year?)	
Belize Fire Risk Map		Basis for the map is the 2004 updated version of the Belize Ecosystems Map (Meerman, 2004). This in its turn was based on January and February 2004 Landsat TM satellite images. The process took 9 different variables into account. Social, Physical and Ecological. Each of these variables is represented in its own attribute	Jan Meerman	Belize Tropical Forest Studies
firerisk.jpg				
bz_fires_modis_2001-6				
2007_mar-may				
fires_2008				
fires_2009				

fires_2010				
fires_2011				
fires_2012				
Flood_ Roads_ Toledo		Catalog of road flooding issues in the Toledo District, Belize	Mr. Moore, MOW, Punta Gorda Toledo	
Events_ Total				
Newsreports _joined				
Hillshade.tif	Aster_DEM_BZE_clip.tif	Digital Elevation Model	NASA	NASA
Belize Landsystems	Belize Land Systems King et al.	The dataset is the culmination of the work by King, Baillie, Abell, Bissett, Dunsmore, Gray, Grimble, Johnson, Silva, Pratt, Versey, Williams, Wright and Zisman 1986-1992. Land Resource Assessment of the Toledo District, Stann Creek District and Northern Belize. The dataset provides detailed information on the physical land systems of Belize and its associated soil and agriculture attributes.	King, Baillie, Abell, Bissett, Dunsmore, Gray, Grimble, Johnson, Silva, Pratt, Versey, Williams, Wright and Zisman 1986-1992. Land Resource Assessment of the Toledo District, Stann Creek District and Northern Belize.	NRI
Wind Hazard Map: Hurricane category 1		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. A series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

Wind Hazard Map: Hurricane category 2		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	
Wind Hazard Map: Hurricane category 3		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

Wind Hazard Map: Hurricane category 4		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir/Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	
Wind Hazard Map: Hurricane category 5		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

Wind Hazard Map: Stormsurge category 1		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	
Wind Hazard Map: Stormsurge category 2		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

Wind Hazard Map: Stormsurge category 2		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	
Wind Hazard Map: Stormsurge category 3		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

Wind Hazard Map: Stormsurge category 4		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir/Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	
Wind Hazard Map: Stormsurge category 5		The General Secretariat of the Organization of American States (OAS), under an agreement with the Office of Foreign Disaster Assistance of the U.S. Agency for International Development (USAID), is executing a five-year Caribbean Disaster Mitigation Project (CDMP). One component of this project is the assessment of potential hazards generated by tropical storms in terms of storm surge, coastal flooding, and extreme wind. This report documents the "national level" assessment of the wind and coastal storm surge hazards for Belize. Series of five wind hazard maps, showing the probable surface winds for each of the five Saffir/Simpson hurricane categories; and, A series of five coastal storm surge maps, one for each of the Saffir /Simpson hurricane categories.	Storm Hazard Assessment for Belize: The Caribbean Disaster Mitigation Project OAS/USAID	

15.1.4 Existing Systems

The following systems are being used in the process of conducting this group's functions:

ArcGIS. GIS software by ESRI.

15.1.5 Computing Infrastructure

No additional information provided.

15.1.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the BTFS:

- BTFS has relied on its consulting activities for financial support, including the provision of data resources. With more access to data through the BNSDI the demand for data provision services may diminish, however it is expected that the demand for higher level GIS services will increase.

17.2 Friends for Conservation and Development

Person(s) Interviewed: Derric Chan, Manager, Chiquibul National Park
dchan@fcdbelize.org

Interview Date: August 15, 2014

17.2.1 Organization and Mission

FCD is a membership non-profit, non-governmental organization based in Belize, Central America whose primary goal is to motivate the public to protect the environment through conservation awareness while enhancing the development of the human resource. Since its establishment in 1999, FCD has made significant achievements in environmental awareness, protected areas co-management, community support programs, sustainable livelihoods, monitoring, research, policy recommendation, and bi-national cooperation aimed at the protection of the Chiquibul/Maya Mountain Key Biodiversity Area. The membership of the FCD Board of Directors come from grassroots organizations in Western Belize, and have a clear conviction to the cause of people-centered natural resources management.

Today, FCD is a respected organization whose role in the national conservation agenda has been fully recognized by both the Government and the general public. It continues to build its networking capabilities both locally and internationally, while capitalizing on its strengths as a reputable community-based conservation organization.[121]

[121] http://www.fcdbelize.org/

FCD has 30 persons in the organization. This includes 15 park rangers, 3 karst rangers, 2 research station administrators, 4 field research assistants, 1 park manager, 1 biologist, 1 environmental educator and three administrative personnel.

Functional areas that have relevance to the use of GIS and participation of the organization in the BNSDI include the following:

1. Conduct co-management of the Chiquibul National Park and Cave System;
2. Conduct environmental education and awareness;
3. Conduct community support programs;
4. Conduct environmental monitoring and research;
5. Development and promotion of policy recommendations;
6. Conduct bi-national cooperation;
7. Conduct cave management;

17.2.2 Activity Areas

Each of the abovementioned environmental conservation activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

17.2.3 Conduct co-management of the Chiquibul National Park and Cave System

The FCD is involved in the co-management of the Chiquibul National Park and the Chiquibul Caverns through a formal agreement with the Forest Department and separately with the Institute of Archaeology. While the co-management agreement with the FD is specifically for the park, FCD has a conservation footprint across the larger ecological unit of the Chiquibul Forest which includes the Chiquibul Forest Reserve and the Caracol complex.

Most of the FCD staff are involved in continuous patrols to identify and stop illegal activities. This responsibility is shared with the Police and Belize Defense Force (BDF) who assign 24 soldiers in groups of 8 to work along with FCD rangers. This is especially important in border areas where most illegal activities are concentrated and where there may be security concerns.

FCD rangers, Police and BDF personnel monitor and address environmental security concerns on a daily basis. ***Incident reports*** are presently compiled in paper reports. GPS units have been issued to most teams and **Cybertrak** ***software*** is used to compile the location information. Collected information covers discovered trails, hunting camps, illegal logging, slash and burn areas, locations where people have been detained and other issues. ***GPS locations*** in the past have been downloaded and used along with ***Landsat satellite imagery*** to associate observed issues with land cover change, such as illegal logging and farming.

Illegal activity information has been collected for nearly 30 years. About 60% of the patrols since 2005 have included FCD rangers, and about 90% of those incidents have been recorded. 40% of the patrols are carried out by BDF alone, and information recorded by those teams is not always provided to FCD, except by special request. Police staff patrol areas near roads and existing settlements and usually have good records, but the more remote areas may only be patrolled by BDF whose main priority is security related, and the reports from these are less available. There is not currently a formal program to convert existing paper reports to digital form, but this is desired for the future.

The FCD has utilized some data acquired through the MNRA-LIC and uses this through the ArcGIS software. This included the ***streams data*** which FCD staff have found does not always accurately represent the location of permanent, year-round streams. Staff have been recording field observations to correct the stream information, but that is only being used for their own purposes and has not been submitted to MNRA-LIC or others.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Map and record inventory of ecological resources of the National Park and surrounding bio-geographical region;
- Map and record communities and other human land use;
- Analyze park development issues, opportunities and constraints;
- Conduct ecological analysis and identify conservation issues, opportunities and constraints;
- Maintain ongoing geographically referenced record of incidents;
- Monitor land use change;
- Coordinate and share incident information with Belize Defense Force and Police;
- Utilize geo-enabled social media for two-way exchange with local communities;
- Coordinate and share information with other stakeholders;
- Prepare and record national park management plan;
- Monitor and assess ecological and biodiversity status over time;
- Produce tourism maps and information for the National Park;

15.2.2.1 Conduct environmental education and awareness.

Over the last three years FCD has hired two educators. Only one is hired today, due to financial constraints. Education programming is more aimed at primary and high schools.

In addition, the FCD conducts ***community surveys***, often in communities where it is suspected that poachers and participants in other illegal activities are living to get a better idea of why people are doing such activities, what is known to the community, how they feel about these resources, and what can be done to alter behavior. The two Educators are trained in how to design and conduct such surveys and utilize a ***specialized software package*** for tabulating this information.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Produce education and awareness materials;
- Link surveys to locations where they were conducted;
- Link education and awareness programs to specific communities where these have been conducted.

15.2.2.2 Conduct community support programs.

FCD becomes involved in targeted community support programs where these are needed to support conservation objectives. Strategies have been changing regarding the best techniques for addressing illegal activities, and community engagement is seen to be more effective than policing alone. An example of this was the de-reservation of over 12,000 acres in the Vaca Forest Reserve. This resulted in a significant influx of farmers that if left unchecked could significantly impact the ecological context of the national park. To avoid this, the FCD hired an agricultural extension office to assist the farmers to develop farming and land management techniques that would be compatible with the local environment, minimize adverse impacts, and result in financially and environmentally sustainable practices among the new local farming community.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Share population census information for communities that affect the National Park on both sides of the border;
- Plan and track community outreach programs;
- Establish location aware social media channels for two way interaction with communities;
- Provide geographically based recording of community based conservation success stories.

15.2.2.3 Conduct environmental monitoring and research

FCD has a biologist and four field assistants. BRIM means “Biodiversity Research Inventory and Monitoring framework. This is used as the roadmap for our research component. Research is oriented towards studying and monitoring conservation targets for an improved management program in the Chiquibul National Park. This is mostly conducted to support government dictated biodiversity strategies focused on specific target species. The biologist has some latitude to investigate additional issues, for example the monitoring of aquatic invertebrates to understand what is happening with water quality and its impact on the local ecology.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Monitor biological resource conditions and trends;
- Monitor ecosystem health and landscape change;
- Track locations and associated information regarding specific research studies;
- Utilize environmental monitoring and research results for conservation planning and policy making.

15.2.2.4 Development and promotion of policy recommendation.

FCD is involved in the development and promotion of policy recommendations based on their experience in the field. An example of this has been the identification of a need to control illegal harvesting of Xate palm, the fishtail shaped leaves of which are popular for floral arrangements internationally. These small palms occupy a niche role in the understory ecosystem, and are often indiscriminately harvested without consideration to sustainable yield. The leaves can be easily harvested and represent a good income not only for the forest collectors but for other middlemen between the forest and the markets in places like the United States and Holland. In addition to the direct impacts of harvesting, there are also secondary impacts such as the introduction of new trails and roads and the introduction of other illegal activities. As a result, the population of this palm is being decimated and areas where "Xateros" are active are being degraded. The FCD has become involved in promoting policies to better regulate this practice as has been done in neighboring Guatemala where Xate culture is now certified for sustainable culture.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Monitor and report biological resource conditions and trends, and identify priority issue "hot spots";
- Solicit opinions regarding community based conservation ideas and priorities;
- Model the likely outcomes of various policy and plan scenarios;
- Utilize geographic information and visualization tools to explain complex issues to decision makers and the public.

15.2.2.5 Conduct bi-national cooperation.

The Chiquibul Forest and its ecosystems cross into Guatemala. Effective conservation of this important ecological zone requires close coordination on both sides of the border. Coordination is being carried out in terms of community education and other activities as needed to ensure an adequate level of conservation, protection and practices on both sides. FCD has a formal agreement with Guatemalan counterparts that facilitates conservation working programs across borders.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Support sharing of geographic information across national borders;
- Share incident and related security information;
- Plan and implement coordinated community education programs and monitor outcomes;
- Share research information and research program planning and execution.

17.2.3 Conduct cave management.

FCD is also involved in the co-management of the Chiquibul Cave System, at 540,000-square-foot the largest in Belize, the longest in Central America, and a treasure trove of geological and archaeological wonders.[122] Although very remote, the Cave System is threatened by agricultural activities, fires, illegal logging, wildlife hunting, looting of cultural artifacts, and vandalism of both cultural and geological assets. The FCD cooperated with others in the development of a management plan for the Cave System. Some of the cave area has been mapped, but a majority of the system is yet to be recorded.

Areas of this function that are relevant to GIS and the BNSDI include, but are not limited to the following:

- Develop and record comprehensive inventory of the cave system and related information;
- Conduct issue, opportunity and constraint analysis for use of portions of cave system for touristic development, ongoing research, and other uses or conservation;
- Support cave system environmental monitoring and assessment;
- Utilize cave data to support education and awareness programs.

17.2.4 Data Used or Generated

The FCD presently uses and/or generates a variety of GIS or related data that could have some relevance to the BNSDI:

Illegal activity incident reports. Both the Friends for Conservation and Development (FCD) rangers and patrolling Belize Defense Force (BDF) soldiers document significant observations and incidents of illegal activities that they encounter within the Chiquibul National Park area, including recording location information. GPS units have been issued to most teams and Cybertrak software is used to compile the location information. Collected information covers discovered trails, hunting camps, illegal logging, slash and burn areas, locations where people have been detained and other issues. This information has been recorded for nearly 30 years, but formal recording of incidents has been inconsistent. There is not currently a formal program to convert existing paper reports to digital form, but this is desired for the future.

[122] http://www.nature.org/ourinitiatives/regions/centralamerica/belize/explore/chiquibul-cave-system.xml

Landsat satellite imagery. Landsat satellite imagery has been used as a basemap for displaying incident information concerning illegal activities encountered in the Chiquibul National Park.

Hydrology. The Friends for Conservation and Development (FCD) have utilized river and streams data from the MNRA-LIC. They have found that some of the streams are not actually existing on the ground, and have been updating their own copy of the data to reflect conditions that have been field verified, but there has not been a program established for this information to be provided back to the LIC.

Community surveys. The Friends for Conservation and Development (FCD) conducts community surveys in communities where it is suspected that poachers and participants in other illegal activities are living to get a better idea of why people are doing such activities, what is known to the community, how they feel about these resources, and what can be done to alter behavior.

Chiquibul Cave System Map. A small portion of the 540,000 square-foot Chiquibul Cave System has been mapped. With new technology it is important to conduct another mapping exercise of the cave system. FCD's karst management unit has started more to document the features but it does not have the financial nor training to map the area. A CCS Technical Working team is being set up to assist and mentor FCD in appropriate management of the caverns and surrounding features.

17.2.5 Existing Systems

The following application software systems are or have been used in conducing FCD business:

Cybertrak. CyberTrak is a GPS-based vehicle monitoring system. Real-time GPS tracking and interactive user functions are directly accessible 24 hours a day/7 days a week through any PC or telephone. These features combined with CyberTrak's specialized reporting functions have enabled a broad array of applications. This is being used by Friends of Conservation and Development (FCD) rangers to record the locations of illegal activity reports within the Chiquibul National Park.

"Biodiversity Research Inventory and Monitoring" framework (BRIM). The BRIM is not for conducting limited monitoring and research – but instead it is focalized on conservation targets. This is not a software. This is a roadmap. Based on what conservation targets are being studied then the methodology is developed and followed through by the biologist.

17.2.6 Computing Infrastructure

The FCD currently has limited computing infrastructure. Data is not stored on personal hard drives. These laptops and hardware belongs to FCD. We do not have however a centralized one stream where all information is maintained and stored. We need a tighter and efficient system.

17.2.7 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the FCD:

- There is a desire to compile, digitize and organize the information resources of the organization, but there has been limited financial resources or staff capabilities to do so.
- There is a desire to add a geographic dimension to much of the information being collected, but limited resources to do so.
- FCD's management plan recommends the hiring of a data entry technician but has not been possible to fill yet due to financial limitations
- Partnerships with LIC and CEMEC (from Guatemala) requires strengthening
- Instituting a central base for information storage and management is essential and urgent

17 ACADEMIC AND RESEARCH INSTITUTION

Academic institutions provide the infrastructure for educating the next generation of Belizeans as well as a valuable resource for research. This section explores the needs and potential contributions of example education institutions relative to GIS and the BNSDI.

18.1 Environmental Research Institute

Person(s) Interviewed
Or Providing Information: Dr. Elma Kay, Wildlife Director **ekay@ub.edu.bz**
Nicole Weatherburne, Database Administrator
nweatherburne@ub.edu.bz
Ivanna Waight-Cho, Biodiversity Monitoring Officer

Interview Date: July 2, 2014

18.1.1 Organization and Mission

The University of Belize Environmental Research Institute (UB ERI), inaugurated in January 2010, was created primarily to address the large gap in local capacity for research and monitoring that exists within Belize. Belize has a wealth of natural resources, including the longest barrier reef in the Western Hemisphere, which supports the country's most important industries, including tourism and agriculture. Recognizing this, the work of the University of Belize Environmental Research Institute is focused on producing results that are directly relevant and applicable to the sustainable management of Belize's natural resources and building local capacity for this. At a finer but equally important scale for Belize's development, the University of Belize Environmental Research Institute was created as a semi–autonomous department of the University of Belize (UB), with transparent and efficient management of projects at its core, in order to provide a much needed mechanism for research within the University.

The mission of the University of Belize Environmental Research Institute is to continuously build national scientific capacity for the effective management, sustainable use and conservation of Belize's natural resources.

As the premiere environmental research institute in Belize and highly respected in the region, UB ERI provides sound science and creates a culture of evidence-based decision–making in the public and private sector in areas relevant to national development.

Major program areas include:

Research and Monitoring. The Research and Monitoring program is one of the main programs of the ERI. The program focuses on work under four main areas: Research and monitoring guided by the National Environmental and NRM Research Agenda which highlights the most urgent gaps in research knowledge needed to inform management decisions regarding the use of natural resources and to safeguard the environment; Inventories and environmental assessments aimed at cataloguing the country's natural resources and biodiversity and assessing their status based on key threats or level of use; Biodiversity and environmental monitoring to monitor and track Belize's biodiversity status and health of the environment; Restoration and rehabilitation focused on the identification of destroyed or degraded natural areas that provide important ecosystem functions and services, in order to develop and pilot feasible restoration or rehabilitation projects.

Training and Fellowship. The Training and Fellowships program is ERI's main capacity-building program. It involves the design and implementation of short-term training opportunities aimed at meeting the needs of professionals in the field of natural resources management and the development of long-term training in the form of graduate programs in related fields. Research opportunities for local students and fellowships for resident and visiting researchers are also offered as part of this program to enrich existing programs at the University and enhance the research capacity of the institute.

Communication and Outreach. The Communication and Outreach program is the Institute's third core program and is aimed at mainstreaming the results of ERI's work in order to influence decisions made for the management of the country's natural resources. One of the main components of this program is the translation of research data into user–friendly formats for use by key decision makers involved in the creation of policy and legislation, and the management of natural resources, as well as for use by students, the private sector and public at large. In addition, through this program, the ERI produces, updates and disseminates key national reports and coordinates programs, including a national NRM research agenda and a national biodiversity monitoring program. A part of communication and outreach involves the private sector in which ERI reaches out to the direct users, especially large–scale users, of Belize's natural resources, who impact or have the most potential to impact the sustainability of these resources and the public sector through the ERI partnering to assist in the implementation of national plans and policies that support sustainable development.

The UB ERI currently has 12 technical staff, 3 admin staff, and 8 field staff. Most have professional training in various environmental sub-sectors.

The UB ERI is carrying out several primary activity areas that have particular relevance to GIS and BNSDI including the following:

1. Manage the National Biodiversity Monitoring Program (NBMP)
2. Manage the Belize Spawning Aggregation Working Group (SPAGS)
3. Support the National Coral Reef Monitoring Network (NCRMN)
4. Conduct Terrestrial Mapping
5. Assess Potential Impacts of Climate Change on Belize Water Resources
6. Conduct Sea Turtle Nest and Wildlife Monitoring
7. Conduct National Training Program for Protected Areas Management (NTPPAM)

18.1.2 Activity Areas

Each of the abovementioned activities is further described in the following sections. These are not intended to be a comprehensive documentation of each activity, but rather a summary of the general framework of each activity, with additional focus and detail provided for those components that can most effectively be supported by GIS technology and engagement in sharing information with other stakeholders through the Belize NSDI.

18.1.2.1 Manage the National Biodiversity Monitoring Program (NBMP)

The National Biodiversity Monitoring Program (NBMP) is being developed by the University of Belize Environmental Research Institute in collaboration with the Forest Department, Fisheries Department and the National Protected Areas Secretariat. The development process was commenced in January 2012 and is now approaching its final stage of development. Four national workshops have been held so far which have been instrumental in the development of the goal and objectives of the program; suggesting tentative indicators and ranking and prioritizing those to derive a final list of indicators; reviewing tentative protocols for the finalized indicators and suggesting several variables for consideration when selecting monitoring sites. Several indicators will require the use of spatial data especially those that will be utilizing GIS and Remote Sensing. In order to complete the development process, site selection, resources, protocols and sampling scheme will be articulated.

The NBMP system is still at planning stages and has not yet been developed but will involve spatial data and analysis. In regards to future work for the National Biodiversity Monitoring Program, the Implementation Phase to commence in 2015 will include training of stakeholders in the use of the NBMP protocols and database. Data collection will also be initiated across the National Protected Area System and Belize, and this is where we will start utilizing spatial data as it relates to the indicators. This effort (data collection) will be repeated, data will be analyzed and periodic reports will be produced.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Analyze and establish monitoring priorities and sites;
- Develop and disseminate data collection and content standards;
- Collect, manage and disseminate biodiversity management data;
- Provide data analysis and visualization maps and reports regarding biodiversity conditions and trends;
- Provide access to wide range of contextual data from other BNSDI stakeholder organizations;
- Identify and monitor threats to biodiversity and habitat;
- Monitor biodiversity issues, opportunities and trends and provide input to the formulation of policies, plans and projects.

18.1.2.2 Manage the Belize Spawning Aggregation Working Group (SPAGS)

The Belize Spawning Aggregation Working Group (SPAGS) was established in July 2001 in response to a nation-wide survey of spawning aggregations of the Nassau grouper in early 2001 that revealed very low numbers of spawning fish. The main aim of this program is to keep stakeholders, particularly fishermen, informed of management progress and the results of the monitoring, to publicize the vulnerability of fish spawning aggregations and the conservation measures taken in Belize to preserve them through full protection of the sites and a closed season for the Nassau Grouper.

Seven sites are monitored as regularly as possible. The monitoring teams are guided by the Reef Fish Spawning Aggregation Monitoring Protocol for the Mesoamerican Reef and Wider Caribbean.

The SPAGS Working Group has a Database developed and maintained by ERI-UB in which all monitoring data collected by SPAGS members is managed. The SPAGS Information System allows for registered users to enter data and provides reports for analysis of data. Use of the database is governed by a data sharing agreement, which has been signed by participating members. This data is housed and maintained in a MySQL database. A national web based PHP database application was developed and maintained by the ERI for easy management and reporting of collected data. Data collected by marine biologists pertains to fish spawning observations and also other fish data. There are several standard data forms used nationally. GPS points of areas that are monitored are maintained and used for mapping summary results.

The Working Group's members are representatives from the following 13 organizations: Belize Audubon Society, Belize Fishermen Co-operative Association, Belize Fisheries Department, Coastal Zone Management Authority and Institute, Green Reef Environmental Institute, Hopkins Fishermen Association, Placencia Fishermen Co-operative,

Southern Environmental Association, The Nature Conservancy, Toledo Institute for Development and Environment, University of Belize, Wildlife Conservation Society, and World Wildlife Fund.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Provide geographic base for the management, monitoring and patrolling of spawning aggregation sites;
- Develop location aware social media applications to help support the involvement of multiple stakeholders in monitoring, research an patrolling of spawning aggregation sites;
- Collect, manage and disseminate spawning aggregation data;
- Provide geospatial and statistical analysis tools to assess spawning conditions and trends, identify pressures, and monitor enforcement actions;
- Formulate and provide recommendations for conservation, protection and sustainable use of spawning aggregation sites;
- Support development of educational materials for stakeholders and the public;
- Produce analysis and visualization outputs to advocate and build support for the management, conservation, protection and sustainable use of the spawning aggregation sites;
- Provide data and analysis results for input to the formulation of related policies, plans and activities of other organizations.

18.1.2.3 Support the National Coral Reef Monitoring Network (NCRMN)

The National Coral Reef Monitoring Network (NCRMN) is comprised of various government agencies responsible for marine protected areas, co-management NGOs that have daily oversight of marine protected areas, other NGOs involved in coral reef conservation, independent individuals that conduct research on coral reefs in Belize, and international NGOs that provide support to coral reef management and academic institutions that conduct research, monitoring and training. The NCRMN is focused on addressing new and developing concerns, including coral bleaching and disease.

Data collected by the National Coral Reef Monitoring Network is housed and maintained in a MySQL database. A national web based PHP database application was developed and maintained by the ERI for easy management and reporting of collected data. Data collected by marine biologists pertains to monitoring of coral reef bleaching activities and diseases. There is a standard data form used nationally. GPS points of areas that are monitored are maintained and used for mapping summary results.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Provide geographic base for the compilation, management and sharing of coral reef monitoring data;
- Utilize location aware social media applications to help support the involvement of multiple stakeholders in monitoring and reporting coral reef observations;
- Provide geospatial and statistical analysis tools to assess coral reef conditions and trends, identify pressures, and monitor interventions;
- Formulate and provide recommendations for conservation, protection and sustainable use of coral reefs;
- Support development of educational materials for stakeholders and the public;
- Produce analysis and visualization outputs to advocate and build support for the management, conservation, protection and sustainable use of coral reefs;
- Provide data and analysis results for input to the formulation of related policies, plans and activities of other organizations.

18.1.2.4 Conduct Terrestrial Mapping

In 2014, Belize signed on signed on with 18 other countries to a memorandum of understanding which is an official commitment from Government and its environmental partners to collaboratively implement science-based conservation initiatives that secure and connect jaguars and their habitats in Belize and beyond its borders, facilitate land development that is both ecologically sustainable and economically profitable, and mitigate human-jaguar conflict throughout the country.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Provide geographic base for the compilation, management and sharing of coral reef monitoring data;

18.1.2.5 Assess Potential Impacts of Climate Change on Belize Water Resources

The ERI has partnered with the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) and CARIBSAVE to assess the potential impacts of climate change on Belize's water resources. The project is expected to last 15 months and its goal is to utilize modelling to assess the potential impacts of climate change on the supply and demand for water and water quality in Belize, across different climate change and land use change scenarios. Specific objectives of the project include:

- Determine the current demand for and supply of water (i.e. water balance) in Belize's major and minor watersheds
- Assess future supply and demand, against the range of future land use scenarios and future climate change scenarios
- Examine how water quality might change as a result of climate change and land use change scenarios

- Determine which areas are highly vulnerable to climate change, and to what magnitude
- Support the development of national-level policies on adaptation to climate change
- Develop sustained capacity within Belizean institutions to iteratively model / assess climate change impacts on water resources and in other sectors
- Contribute to the regional body of knowledge on the potential impacts of climate change

Workshops were conducted in cooperation with the MNRA NIWRA program and the Caribbean Community Climate Change Center (CCCC). Also see the write-ups for those organizations for more detail regarding their involvement in this issue.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Provide geographic base for the compilation, management and sharing of surface and groundwater quantity and quality information;
- Provide access to current and historical weather data and forecasts;
- Provide access to water extraction permits and monitoring information;
- Provide access to topographic, land use, land cover, soils and other data available from the BNSDI community;
- Provide geographic-based tools for the assessment, monitoring and reporting of water resource conditions and trends;
- Develop and model the potential impacts of water resource management policy and plan options;
- Produce easy to understand analysis output maps and reports to help communicated water resource management issues to decision makers and the public.

18.1.2.6 Conduct Sea Turtle Nest and Wildlife Monitoring

A Sea turtle monitoring database and application is currently being developed. This application will also be a web based app for managing data and providing data analysis of collected sea turtle data through graphs and maps. GPS points of areas monitored and sea turtle nests will be maintained.

The wildlife database is also currently under development. This web based application will be used to manage camera trap images and in addition this data will be analyzed and used for determining other results. This application will incorporate in the future some GIS functionality such as e.g. mapping Jaguar occurrences.

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Provide geographic base for the compilation, management and sharing of wildlife monitoring data among qualified stakeholders;
- Provide tools for the analysis and visualization of wildlife monitoring data and trends;
- Assess threats and pressures to wildlife populations;

- Generate analysis maps and reports regarding wildlife population issues and trends for decision makers and the public;
- Provide wildlife consideration inputs to the policies, plans and activities of other organizations.

18.1.2.7 Conduct National Training Program for Protected Areas Management (NTPPAM)

The National Training Program for Protected Areas Management (NTPPAM) is a program dedicated to develop and enhance the sustainable management of Belize's National Protected Areas System as envisioned in the National Protected Area System Plan. With funding from PACT and the program managed by the University of Belize Environmental Research Institute, Year 2 of the 2-year program kicked off this year. The course set out to expose and equip PA staff with little or no background in science with basic data collection and data handling skills to assist in the collection of monitoring data. There was some taxonomic training for the identification of major groups of organisms will be provided. Students reviewed the use of standard field sampling and monitoring protocols and were given the opportunity to apply this knowledge through field exercises.[123]

Specific ways that GIS and BNSDI have relevance to this program include, but are not limited to the following:

- Incorporate geospatial tools and methods to the Protected Areas Management program;
- Provide access to wide range of environmental and related contextual GIS data from the BNSDI community;

18.1.3 Data Used or Generated

Data sources currently maintained by the UB ERI includes the following:

NCRMN Database. The NCRMN database holds all data collected nationally regarding coral bleaching activities and disease. Raw data collected by biologists. Data is collected on a seasonal basis at monitored sites around the country. The data collected is then entered by biologists in formatted excel sheets and uploaded to the database through the online application. GPS points of areas stored as WGS84 UTM (Zone 16N). Data added seasonally. There are specific monitoring seasons where biologists monitor and collect data.

SPAGS Database. The SPAGS database holds all data collected regarding Fish spawning. Raw data collected by biologists. Data is collected on a seasonal basis at monitored sites around the country. The data collected is then entered by biologists in formatted excel sheets and uploaded to the database through the online application. GPS points of areas stored as WGS84 UTM (Zone 16N). Data added seasonally. There are specific monitoring seasons where biologists monitor and collect data.

[123] http://eriub.org/latest-news/training-for-pam.html

Camera Trapping Data. A camera trap is a remotely activated camera that is equipped with a motion sensor or an infrared sensor, or uses a light beam as a trigger. Camera trapping is a method for capturing wild animals on film when researchers are not present, and has been used in ecological research for decades. In addition to applications in hunting and wildlife viewing, research applications include studies of nest ecology, detection of rare species, estimation of population size and species richness, as well as research on habitat use and occupation of human-built structures. The wildlife team is mostly interested in Jaguar sightings. Conducting this monitoring activity, can assist in wildlife species conservation efforts. Estimation of population size and species, occupancy and capture analysis, can be made among many other results. GPS coordinates and date/time stamps of captured images are stored in Excel spreadsheet files. (HOW MANY CAPTURED IMAGES ARE CURRENTLY IN THE COLLECTION? ARE THE RECORDS ALL IN ONE EXCEL FILE OR MULTIPLE?)

Jaguar Attack Incidents. This database managed by the UB ERI maintains the location of Jaguar attacks on farms, locations of farms, boundary lines of pastures, jaguar scat observations and related information. Due to unavailability of wildlife team and time, details not specified. (PLEASE REQUEST ADDITIONAL SUMMARY INFORMATION FROM THE WILDLIFE TEAM)

18.1.4 Existing Systems

The following application systems are being used in the process of conducting this group's functions:

ArcGIS. To support current GIS functions and analysis for generation of maps and remote sensing functions, stand-alone software is used such as Arc GIS 10.1 (particularly used by Biodiversity Officer).

ERDAS. The Institute is looking into acquiring licenses for ERDAS and ENVI software which would be used for processing and analyzing geospatial imagery. ERDAS is a remote sensing application with raster graphics editor abilities for geospatial applications.

R. R is a free software environment for statistical computing and graphics (see: http://www.r-project.org/),

Geospatial Modeling Environment (GME). GME provides a suite of analysis and modeling tools, ranging from small 'building blocks' that can be used to construct a sophisticated work-flow, to completely self-contained analysis programs. It also uses the extraordinarily powerful open source software R as the statistical engine to drive some of the analysis tools. One of the many strengths of R is that it is open source, completely transparent and well documented: important characteristics for any scientific analytical software. It incorporates most of the functionality of its predecessor, Hawths Tools, but with some important improvements. It has a greater range of analysis and modelling tools, supports batch processing, offers new graphing functionality, automatically records work-flows for future reference, supports geodatabases, and can be called programmatically.

Coral Bleaching Application. This is an internally developed application of the UB ERI which provides analysis of collected coral bleaching data in order to monitor the status of coral reefs and improved conservation efforts. This is written in PHP, MySQL, HTML, CSS, JavaScript, JQuery PHP, MySQL, and utilizes Google Maps, XML for mapping. Analysis and reporting routines include:

- Mean monthly coral bleaching percentages
- Overall coral bleaching statistics
- Species and sites highest bleaching occurrences
- Reports, maps, graphs are all end results of analysis.

Spawning Aggregation Working Group (SPAGS) Application. This is an internally developed application of the UB ERI which provides analysis of collected Fish spawning data primarily for the Nassau Grouper in order to improve conservation efforts. This application is written in PHP, MySQL, HTML, CSS, JavaScript, JQuery PHP, MySQL, and utilizes Google Maps, XML for mapping. Fish spawning data are input to the system, and the system is used to generate web-based graphs and maps that are included in an annual newsletter.

18.1.5 Computing Infrastructure

The UB ERI maintains two physical servers that are connected locally and externally via wired 4MB DSL line. These servers host all applications that are accessible on the web. The ERI are looking into upgrading the servers in the near future. The Institute will also be acquiring Windows licenses, and is currently running only Ubuntu Linux OS.

The Institute has 14 desktop PC's for staff that are connected locally and externally via wired 4MB DSL line

The Institute currently uses open source tools for the housing and management of data and applications. There is one running physical server on which two virtual machines have been installed to act as web servers. One web server hosts the Institute's publications repository which contains natural resource and environment focused publications produced by scientists or organizations that have conducted research in Belize, as well as publications produced by the ERI or the University of Belize. The other hosts an Apache web server, MySQL database server, FTP server. This web server primarily hosts the Institute's custom built PHP database applications that are accessible from the website. Both physical and virtual machines run Ubuntu Linux Operating systems.

18.1.6 Other Issues, Opportunities and Constraints

The following are additional considerations for the future development of GIS and BNSDI engagement relative to the UB ERI:

- There is a need for additional GIS/remote sensing technology training and modeling, especially to improve in areas such as: mapping assets geographically, distribution, scenario modeling;
- There is a need to upgrade and acquire proper hardware and software resources for proper hosting of applications;

- Data sharing concerns: If proper data is not shared and available the system will not be as useful;
- Sustainability and continuity of the BNSDI will be critical if multiple organizations are to rely on this for their mission critical activities;
- Human resource limitations need to be considered in how the BNSDI is implemented;
- The BNSDI should include well defined procedures and protocols to avoid duplication of efforts and to maximize the resources and contributions of all the stakeholders.

APPENDICES

Appendix A - Glossary of Terms and Acronyms

APAMO		Association of Protected Areas Management Organizations
BACONGO		Belize Association of Conservation NGOs
BAD		Belize Archives Department
BAHA		Belize Agricultural Health Authority
BAS		Belize Audubon Society
BBIS		Belize Biodiversity Information System
BCB		Banana Control Board
BCC		Belize City Council
BCCI		Belize Chamber of Commerce and Industry
BCS		Belize Country Strategy for Adaptation of the Sugar Industry
BEL		Belize Electric Company Limited
Bmp CITCO		Belmopan City Council
BNSDI		Belize National Spatial Data Infrastructure
BERDS		Biodiversity and Environmental Resource Data System of Belize
BEST		Belize Enterprise for Sustainable Technology
BLPA		Belize Livestock Producers Association
BNCC		Belize NSDI Coordination Center. Function or unit proposed to provide the facilitation, coordination, promotion and support that is needed to build and operate an NSDI
BNE		Belize Natural Energy Ltd.
BNSDI		Belize National Spatial Data Infrastructure
BRDP		Belize Rural Development Programme
BSI		Belize Sugar Industry
BTB		Belize Tourism Board
BWSL		Belize Water Service Limited
CARDI		The Caribbean Agricultural Research and Development Institute (CARDI) was established in 1975 to serve the agricultural research and development needs of the member states of the Caribbean Community (CARICOM).
CATHALAC		Water Center for the Humid Tropics of Latin America and the Caribbean (in Spanish ¨CATHALAC¨- Centro del Agua del Trópico Húmedo para America Latina y el Caribe) is an autonomous international organization dedicated to promote sustainable development through applied research and development, education, and technology transfer in the areas of integrated watershed management, climate change, environmental modeling and analysis, and risk management in Latin America and the Caribbean
CARICOM		Caribbean Community
CBA		Central Building Authority
CBD		Convention on Biological Diversity
CBO		Community Based Organization
CCB		Citrus Company of Belize
CCCCC (5C's)		Caribbean Community Climate Change Center
CDB		Caribbean Development Bank
CEO		Chief Executive Officer / Chief Environmental Officer
CFR		Chiquibul Forest Reserve

CGA		Citrus Grower's Association
CH4		Methane
CIARMP		Community Initiated Agricultural Resources Management Project
CITES		Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNP		Chiquibul National Park
CO		Carbon Monoxide
CO2		Carbon Dioxide
CPA		Country Poverty Assessment
CPACC		Caribbean Planning for Adaptation to Climate Change
CRIP		Climate Resilient Infrastructure Project.
CZMAI		Coastal Zone Management Authority and Institute
DfID		Department for International Development (formerly ODA)
EIA		Environmental Impact Assessment
EPA		Environmental Protection Act.
ERI		Environmental Research Institute of the University of Belize
ESTAP		Environmental and Social Technical Assistance Project
EU		European Commission / Union
FAO		The Food and Agriculture Organization of the United Nations leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information. We help developing countries and countries in transition modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all. Since our founding in 1945, we have focused special attention on developing rural areas, home to 70 percent of the world's poor and hungry people.
FCD		Friends for Conservation and Development
FD		Forest Department
FGDC		Federal Geographic Data Committee (USA)
FGDS		Fundamental Geospatial Data Set. This is any data theme or topic that is needed in common across a stakeholder community.
FIRMS		Fire Information for Resource Management System
FPMP		Forest Planning and Management Project
GBIF		Global Biodiversity Information Facility
GDP		Gross Domestic Product
GEF		Global Environment Facility.
GeoNode		GeoNode is an open-source, web-based application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI)
GEO		Group on Earth Observations
GEO		Global Environment Outlook
GHG		Green House Gas
GIS		Geographic Information System. A Geographic Information System is a computer system designed to allow users to collect, manage, and analyze large volumes of spatially referenced and associated attribute data. The major components of a GIS are: a user interface system; data base management capabilities; data base creation/data entry capacity; spatial data manipulation and analysis packages; and display/product generation functions.
GoB		Government of Belize
GPA		Global Programme of Action for the Protection of

		the Marine Environment from Land-Based Activities (UNEP)
GPS		Global Positioning System
HDI		Human Development Index
HIV/AIDS		Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
Hydromet		Belize National Meteorological Center
IABIN		Inter-American Biodiversity Information Network
ICRAN		International Coral Reef Action Network
ICT		Information and Communication Technologies
IDB		Inter-American Development Bank
IICA		The Inter-American Institute for Cooperation on Agriculture (IICA) is a specialized agency of the inter-American system, and its purposes are to encourage and support the efforts of its Member States to foster agricultural development and rural well-being in their territories.
IP		Internet Protocol
IPCC		Intergovernmental Panel on Climate Change
ISO		International Organization of Standardization
ISP		Internet Service Provider
IT		Information Technology
IUCN		International Union for Conservation of Nature
IUU		Illegal, Unreported and Unregulated
IWRM		Integrated Water Resource Management
KB		Kilobyte
KCB		The Ke'kchi Council of Belize
LIC		Land Information Centre
LLES		Limited Level Environmental Study.
MAR		Mesoamerican Reef
MARPOL		International Convention for the Prevention of Pollution from Ships
MBRS		Mesoamerican Barrier Reef System
MDG		Millennium Development Goals
MEA		Millennium Ecosystem Assessment
Metadata		Standardized catalog of information about each geospatial data set
MFED		Ministry of Finance and Economic Development
MFFSD		Ministry of Forestry, Fisheries and Sustainable Development
MLGRD		Ministry of Local Government and Rural Development
MNRA		Ministry of Natural Resources and Agriculture
MoESTPU		Min of Energy, Science & Technology, and Public Utilities
MoFED		Ministry of Finance and Economic Development
MoH		Ministry of Health
MoWT		Ministry of Works and Transport
MPAs		Marine Protected Areas
MPRFR		Mountain Pine Ridge Forest Reserve
NASA		The National Aeronautics and Space Administration (NASA) is the agency of the United States government that is responsible for the nation's civilian space program and for aeronautics and aerospace research
NAVCO		National Association of Village Councils Organization
NBII		National Biological Information Infrastructure (USA)
NBSAP		National Biodiversity Strategy and Action Plan
NCB		National Coordinating Body
NCCC		National Climate Change Committee was established to advise government

		on issues regarding climate change
NCRIP		National Climate Resilient Investment Plan
NEAC		National Environmental Appraisal Committee. The Committee was established to review development projects in the context of the national environment.
NEAP		National Environmental Action Plan
NEMO		National Emergency Management Organization
NFAB		National Fisheries Advisory Board established to provide guidance on fisheries commodities extraction strategies and policies
NFP		National Focal Point
NGO		Non-Governmental Organization
NICH		National Institute for Culture and History
NMS		National Meteorological Service
Node		A facility that is connected to other facilities over the Internet for the purpose of publishing and sharing data
NPAC		National Protected Areas Committee. This Committee was established to advise the government of Belize on issues concerning the national protected area system
NREPS		Natural Resource and Environmental Sub- committee was established to increase the national understanding and acceptance of the linkages between natural resource and environmental protection and socio-economic development
NSDI		National Spatial Data Infrastructure. An institutional and technical framework for coordinating and sharing geospatial information across a stakeholder community.
OAS		Organization of American States
ODA		Overseas Development Administration
OIRSA		The International Regional Organization for Plant and Animal Health (OIRSA) is a technical organization established to provide administrative and technical support to the Ministries or Secretariats of Agriculture from its member countries, to protect and develop their agricultural resources in order to achieve a healthy production to satisfy population's demands and provide well-being. OIRSA's assistance is focused on its member countries' projects and plans for plant and animal health, food safety and facilitation towards agricultural commerce
PACT		Protected Areas Conservation Trust
PAHO -		Pan-American Health Organisation
PCPU		Policy Coordination and Planning Unit
PEU		Programme Execution Unit
PFB		Programme for Belize
PUC		Public Utilities Commission
QuickStart		An activity that is an accelerated portion of a longer term initiative, intended to result in near-term, visible and compelling results.
RAMSAR		Convention on Wetlands of International Importance Especially as Waterfowl Habitat
REDD		Reduction of Emissions from Deforestation and Degradation
SERVIR		Regional Visualization and Monitoring System
SIB		Statistics Institute of Belize
SICB		Sugar Industry Control Board
SIF		Social Investment Fund
SIRDI		Sugar Industry Research and Development Institute
SISE		San Ignacio/ Santa Elena Town Council

SPAGs		Spawning Aggregation Sites
Spatial Data Clearinghouse		Common repository of geospatial information, often composed of data provided by multiple custodians
SIG		Special Interest Group. A permanent multi-stakeholder body that is established to provide communication, coordination and support around a particular common interest or practice.
Stakeholder		Any organization or person that will be involved in the development and/or use of the Belize NSDI
SCADA		System Control and Data Acquisition
SWMA		Solid Waste Management Agency
SWOT		Strengths, Weaknesses, Opportunities and Threats
TBSL		Total Business Solutions Ltd.
TNC		The Nature Conservancy
TOR		Terms of Reference
UB		University of Belize
UN		United Nations
UNCBD		United Nations Convention on Biological Diversity
UNCCD		United Nations Convention to Combat Desertification
UNDP		United Nations Development Project
UNEP		United Nations Environment Program
UNESCO		United Nations Educational, Scientific and Cultural Organization
UNFCCC		United Nations Framework Convention on Climate Change
USAID		United States Agency for International Development
WB		World Bank
WCMC		World Conservation Monitoring Centre
WCS		Wildlife Conservation Society
WMO		World Meteorological Organisation (UN)
Working Group		A temporary body, normally consisting of representative members from multiple concerned organizations, assigned to address a particular subject over a certain period of time
WRI		World Resource Institute
WWF		World Wildlife Fund
XML –		eXtensible Markup Language