Developing Botswana Spatial Data Infrastructure: From Concept to Reality

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SUMMARY

There is general agreement that spatial data is a key to sustainable resource management and overall economic development of a country. It follows therefore that the development of spatial data infrastructures (SDIs) provides an underlying information base for the decision-making process. While the basic concepts behind SDI might be understood by a fair majority of the people, there is still confusion as regarding the relationships among such terms as cadastres, geographic information systems (GIS) and spatial data infrastructures. Hence there is a need to clarify these concepts. We need to ask ourselves whether cadastres are really part of SDIs, or whether SDIs are nothing more than some kind of improved or advanced GIS network. These terminological confusions are not helping to raise the political support and level of awareness needed for the introduction of SDIs in developing countries. Although the attributes of SDIs are well defined and agreed upon, achieving such an ambitious concept has not been easy in Botswana and beyond.

This paper describes the concepts of a national spatial data infrastructure. It also reviews the developments in SDI that have taken place in Botswana, and assesses specific Botswana opportunities, challenges and implementation issues. The paper reviews SDI developments in the country using selected examples. The paper argues that even though Botswana is not prepared for a full online SDI implementation, organizational arrangements should be put in place to ensure full participation when the physical infrastructures become available.

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1. INTRODUCTION

There are myriad programs and projects aimed at the development and improvement of spatial data in the private, parastatals and government departments in Botswana. Some initiatives aim to create an environment that enables a wide variety of users to easily access and retrieve spatial data sets in a complete, consistent, reliable, and secure manner. Many more are tailored to the specific needs of a particular department or ministry. The main purpose of this paper is to examine some of these initiatives, in order to help identify particular challenges and opportunities within Botswana in developing a national spatial data infrastructure (NSDI). SDIs are more than just another mapping program or a geographic information system (GIS) or network. They provide the underlying framework of policies, standards, organizational arrangements, technologies, and spatial data for information services and products. SDIs also provide the foundation for ensuring that all citizens can actively and effectively participate in an information rich world.

An infrastructure is an enabling mechanism to allow the efficient, effective, and equitable sharing and use of existing data, as well as creation of value-added products and services. The premise of building SDIs is that without an environment in which all spatial data stakeholders (both users and producers) can cooperate and utilize information and technologies in a cost-effective way, objectives such as poverty alleviation, sustainable economic development, environmental planning and protection will be difficult to achieve. The objective of this paper is not to examine this assumption in particular but to review how conditions in Botswana offer special challenges and opportunities in SDI development.

This paper will address the following questions in order to provide an overview of NSDI in the Botswana context:

- What is an SDI - is it just a new term for existing activities?
- Why is the development of an NSDI important in Botswana?
- What are some of the current initiatives towards developing NSDI in Botswana?
- What are the specific Botswana issues?
- What should be done to address these issues?

At the moment, there are many programs and projects aimed at developing a national spatial data infrastructure (NSDI) in Botswana. All these spatial data infrastructure-related initiatives aim to create an environment that enables a wide variety of users to easily access and retrieve spatial

data sets in a complete, consistent, and secure manner. It can also be viewed as an environment in which all stakeholders, both users and spatial data producers, can cooperate with each other and utilize information and communications technologies in a cost-effective way. This is a basis for achieving the objectives of poverty alleviation, sustainable economic development, as well as environmental planning and protection.

Many countries in Africa for example South Africa, Botswana, Zimbabwe, Namibia, Zambia, Uganda, Morocco and Tunisia are developing SDIs to better manage and utilize their spatial data assets. A number of publications document the various aspects of the development of SDIs in recent years [Onsrud 1998; Bassole 2000; Ezigbalike 2000; 2001]. In several of these countries, initiatives to develop NSDIs are already underway, notwithstanding the terminology used in different countries to describe them, e.g. the National Geographic Information System in Botswana.

Current progress in SDI initiatives in Africa shows that after many years of effort, these initiatives still do not receive support from the highest level of government because of the low level of awareness of the importance of spatial data and information in decision-making (Ezigbalike 2001). This situation is also true in Botswana. This means that, despite all the interest and activities, SDI development in Botswana and other developing countries remains very much an innovative concept among specific user communities. A similar trend can be observed in many SDI initiatives in other African countries. Some reasons suggested for the limited support from most African national governments and other relevant institutions are:

- The lack of awareness of the value of SDI
- Confusions surrounding the definition of SDI
- Lack of policy and coordinating arrangements
- The complexity of national issues such as the political, cultural, and economic positions of most countries

Ezigbalike [2001] recommends the following short-term activities required to prepare African countries for national SDI development:

- Introduce the concept of information budgeting
- Identify a lead agency or person to coordinate the development of SDI including the establishment of formal coordinating mechanisms
- Use workshops and seminars to increase the level of awareness of SDI
- Perform national reviews of spatial data needs and available data
- Develop online learning materials on SDI

Based on this approach, it appears most of the basic challenges faced by African NSDI initiatives in developing and implementing NSDIs can be minimized.

One solution in addressing the problems faced by SDI initiatives in Botswana lies in increasing the level of understanding and awareness of people (both users and producers of spatial data, and concerns of relevant politicians) about the nature and value of SDI concepts in general and the differences between related concepts such as cadastres, geographical, and land information systems.

This paper will first review the concept of spatial data infrastructure and related concepts. It will proceed to review SDI initiatives in Botswana in terms of opportunities, constraints, and implementation problems and will end by recommending a strategy for SDI development in Botswana context. However, the paper will select a few SDI-related initiatives for illustration purposes.

2. ORIGINS OF THE SPATIAL DATA INFRASTRUCTURE CONCEPT

2.1 First Principles

In 1991, *Scientific American* ran a special issue on the emergence of data infrastructures or what became better known as "information highways." In this issue various authors reviewed not only the technologies that were creating a new environment for work, for recreation, for learning etc., but also the reason why data infrastructures are different than databases, the internet, and the various conglomerations of communication networks, hardware and software that were emerging. It is from this broad perspective that we would like to view SDIs. Technologies and opportunities have changed considerably since even 1991, but the basic concepts behind developing of data infrastructures still remain.

This distinction is important because much of the current literature and thinking on SDIs in the world of Geomatics has tended to focus on an SDI as either a set of digital databases (e.g., cadastral, topographic) or as a super-network of GIS and web-based technologies focused on improving data sharing and data access. The term SDI is often therefore used to describe what various jurisdictions have already done (with some enhancements) or what they may have planned. We would like to challenge this notion by going back to the vision of an "information infrastructure" as a broader enabling platform for future applications and developments [e.g., McLaughlin, US Academy of Science, McLaughlin et al., 1993] After all, why invent the term *infrastructure* when *network, data warehouse, appliances, GIS, land information system (LIS),* etc., or a combination of these, may be sufficient to describe current ventures. We propose that the term infrastructure implies much more than data collecting, conversion, and management. What an infrastructure truly creates is the institutional, policy and organizational framework for using technologies and data more effectively.

The early analogy to a "highway infrastructure" or a "power infrastructure" may be simplistic but it serves to highlight some important characteristics of an infrastructure and why SDIs are in their infancy. In fact these characteristics are what make SDIs critical elements for economic development, environmental protection, and good governance. Among the important characteristics that distinguish an SDI from projects, technologies, or applications are [after Dertouzos, 1991]:

An infrastructure must be widely available. It is a national or even global strategy, not designed to serve the interests of one group of users (e.g., a single Ministry, level of government, or profession) but to serve society at large. Publicly accessible datasets and networks, with maximum user capacity, are essential if, for example, all citizens – from schoolchildren to financial advisors and politicians – are to participate effectively in an information society.

An infrastructure must be easy to use. Weiser [1991] notes that *"the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* Accessing an SDI must become as easy as turning on the lights in your home thereby tapping the powerful electrical infrastructure that spans jurisdictional and organizational boundaries. New technological capabilities just beginning to emerge in every country (e.g., cell phones, web browsers, and internet cafes) are an integral part of making data infrastructures a part of everyday life for an increasing number of people. Even complex spatial models must become as easy to access and use as e-mail text and chat rooms.

An infrastructure must be flexible. The infrastructure must be independent of specific technologies, types of data and database structures, and specific organizational arrangements. Standards and protocols must allow for a wide variety of technology configurations and the infrastructure must be built to meet unimagined as well as existing needs and organizational structures, i.e., there must be an innate capacity to anticipate and manage growth.

An infrastructure must be multipurpose. It should not be confined to the concerns and datasets of a particular program, department, or system. In terms of spatial data, the infrastructure must facilitate the use and sharing of data beyond departmental or even sector mandates. It is neither program nor agency dependent; SDIs should facilitate horizontal as well as vertical flow and integration of spatial data. Thus, for example, a cadastre or an information service can form components of an infrastructure, but they alone are not the SDI.

An infrastructure is the foundation for other activities. An SDI is not an end but a means. It facilitates the use of spatial information in a variety of applications and must be able to respond to new opportunities and new user communities. The purpose of the infrastructure is to foster and not to control new applications, services, and industries so that the full potential value of spatial information can be realized.

Therefore an SDI is much more than a national mapping program, or an organization providing a spatial data portal. If we are to capture the imaginations of politicians and technocrats and if we are to understand our own programs and projects within an SDI context, then we need to see the SDI as a platform, a springboard, an approach or strategy. It there to provide the basis for applications and ideas we do not yet possess or dream of, not simply to repackage the tools, techniques, and datasets we currently have or are trying to develop.

2.2 More Recent Developments in the SDI Concept

The goal of a spatial data infrastructure is to ensure that users will be able to acquire at the right time, adequate, complete, reliable, and consistent data sets. One objective of a SDI, therefore, is to provide an ideal environment in which all stakeholders (both users and producers of spatial information) can cooperate with each other in a cost-efficient and cost-effective way to better achieve their targets [Rajabifard et al., 2000]. Rajabifard *et al*. [2000] recognize that SDIs facilitate better management and utilization of spatial data assets. Masser [1998], for example, summarized the objectives of an SDI as the promotion of economic development, the stimulation of better government and the fostering of environmental sustainability. All the above stated objectives are very relevant to the African situation which is still very poor even though it is very rich in terms of natural resources.

According to Rajabifard et al. [2000], a national SDI is made up of inter-connected SDIs at corporate, local, state/provincial or national levels. In their model, a corporate GIS could be seen as an SDI at the corporate level, the base of the hierarchy. Going up the hierarchy, service New Brunswick in the Province of New Brunswick (Canada) and Land Victoria in the State of Victoria (Australia) provide major components of emerging provincial/state level SDIs. They further argue that each SDI at the local level or above is primarily formed by integration of spatial datasets originally developed for use in corporations operating at that level or below. In applying the hierarchy relationship model to SDI concept they use the part-whole property of a hierarchy structure which states that an element on a higher level, like a state/provincial level, consists of one or more elements on the lower level, such as different local SDIs. According to Rajabifard's et al [2000] argument, it follows that a corporate or advanced GIS network, a cadastral system, a land information system or an environmental information system if it has the basic components of an SDI qualifies as a subset of a SDI. Coleman and McLaughlin [1998] identified policies, technologies, standards and human resources as the basic components of a SDI (See for example, Figure 1 [after McLaughlin and Nichols, 1994]).

Another way of looking at SDIs is by using the umbrella view of a national SDI as encompassing all basic components of those at the lower levels. This view is consistent with the long-term development of the national SDI concept. However, this view has to be modified to avoid possible duplication of efforts, and to ensure co-ordination of SDI development at all levels. This national umbrella model might imply that each government department or region should establish its own SDI. However, these tasks should be overseen by a national SDI steering

committee. Multinational and global efforts add a further co-ordination layer. This hierarchical model emphasizes data sharing/trading, cross-referencing and partnerships and reduces the overall cost of data collection. This can be represented graphically by forming a pyramid of building blocks, from a local level to a national level.

2.3 Related Concepts

Are geographic information systems another type of an SDI? The answer is yes and no – "No" in the sense that GIS can be defined as the software packages and computer hardware that integrate spatial data and non-attribute data to produce the spatial information for decision-making. Here GIS is a **tool**. It is a set of procedures and techniques for analyzing and manipulating spatial data. The second meaning of GIS involves the creation, maintenance and continuous updating of a database. The resulting database created, maintained, updated, manipulated, analyzed by the GIS tool is itself referred to as a GIS. Here the GIS is used as a **resource,** no different from any other type of information system and does not qualify to be described as an infrastructure.

On the other hand, when the maintenance of this resource involves the organization, the cooperation, and the coordination of information from several government departments, private sector, research institutes, non-governmental organizations, community-based organizations, donor and multi-lateral agencies, then the answer is unequivocally and emphatically "Yes". This type of GIS implementation will require not only information

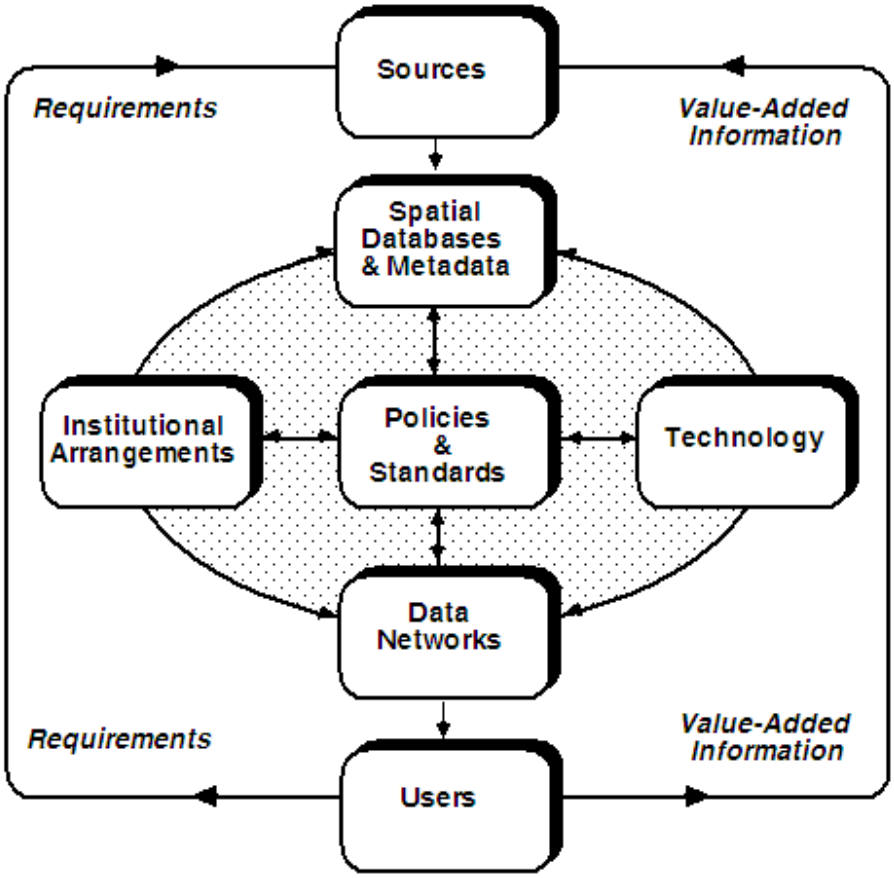

FIGURE 1: NSDI Components - A Systems Perspective

about how to operate a particular setup of hardware and software and knowledge of spatial analytic techniques but also legislations and policies, coordinating arrangements, common standards, common geodetic references, common base data to enable data to be accessed, traded or shared. Different users and/or suppliers would be assigned data custodian responsibilities for the subsets of data. With these arrangements in place, the users can now expect the spatial data to be available, accessible, complete, up-to-date, consistent and secure. At this stage, the GIS can be described as a significant component of an overall national or state **infrastructure**.

Others have argued that a cadastre is a basic building block of the SDI. Most economic and subsistence activities on land are organized around a land parcel. A cadastral system stores information about ownership rights, parcel extents or boundary information, land use, land value, and may provide an information component of land registration and land taxation. Over centuries cadastral reforms have been undertaken in response to the ever-changing needs of society. One of such reforms was the introduction of the multi-purpose cadastre concept which encompasses

both the fiscal and the juridical cadastres with the addition of other parcel-related information with the focus on providing integrated data at the local level [e.g., McLaughlin et al., 1977].

However, in most African countries, cadastral information is mainly limited to urban jurisdictions. This is partly a legacy of colonialism whereby only a tiny segment of the population was allowed access to cadastral records. For example, only 1.2% of the population in Zimbabwe was allowed access to cadastral information before independence in 1980 [Chimhamhiwa and Lemmen, 2001]. Cadastral systems in their present form are not usually as relevant to rural Africa as they are biased towards functioning land markets and land taxation. In rural Africa, there are very few land transactions to justify the costs of setting up a very expensive cadastral system [e.g., Fourie and Nino-Fluck, 1999].

When is a cadastral system an infrastructure? If the cadastral system satisfies the basic characteristics of an SDI it can be said to be a subset of the SDI. Once the cadastral system has realized the visions of data sharing/trading and partnerships and helps in reducing costs of data collection by minimizing duplication of efforts, then it forms part of the building blocks of a national SDI.

3. POTENTIAL BENEFITS OF AN SDI IN BOTSWANA

Governments around the world are beginning to realize that geographic information is one of the most critical elements underpinning analysis and decision making for environmental, economic and social development. Much of this development is concerned with how people interact with land and space. Without knowledge of spatial relationships among, for example, demography, natural resources, and socio-economic constraints, those responsible for land policies are limited to addressing issues in isolation. Information collection and management programs have been costly and have had limited success (as for example, measured in terms of completeness, maintenance, and integration), especially in developing countries. Governments are therefore searching for better ways to allocate resources in the spatial information sector. New technologies hold out some promise but the human resource and organizational issues are still largely unresolved.

One solution has been to emphasize on the development of data infrastructures that can allow other information activities to evolve over time in a more cost-effective and cost-efficient manner. Many countries in Africa are just now beginning to explore this idea.

Some potential benefits that an SDI can offer to Botswana are:

– Enhancing the sharing and open access to data/information by different users for a variety of environmental, natural resource management and development planning applications.

- Enhancing the scope for efficient use of human and natural resources in the country while making the distribution of data and social dimensions associated with data access more transparent.
- Increasing knowledge about Botswana's natural resources thereby increasing the chances of investment.
- Increasing the general level of knowledge and access to information within the Botswana society (e.g., in schools, in communities, and organizations) and thereby stimulate to economic growth and more democratic participation in national and local processes.
- With SDI in place, new poverty alleviation programs can more efficiently target problem areas and solutions using geographic information and analysis tools without having to begin the programs with extensive data collection schemes.
- SDIs can help provide the foundation for badly needed monitoring programs (for environmental, economic, and social changes) in a more cost-effective and consistent manner.

4. SDI INITIATIVES IN BOTSWANA

4.1 Background

Botswana like many other countries bought into the notion of Spatial Data Infrastructure as a mechanism for providing effective access to spatial data five year ago. In realizing the benefits that could be derived from such an infrastructure, the government of Botswana embarked on a project of establishing a National Spatial Data Infrastructure in 2002. The project was co-funded by the Botswana Government and the Swedish International Development Agency, hence consultants from Swedesurvey (Swedish company) were engaged to kick start the project. The project was divided into two phases. The first phase involved providing the first technical facility (metadata) services, establishment of institutional bodies and setting of first standards. This phase has just been completed and would be evaluated in terms of meeting its objectives. The second phase was to ensure that all the institutional bodies formed in the first phase are up and running more especially the secretariat. The secretariat is supposed to provide administrative support to working committees so that they execute their work efficiently. Some key activities of the project were identified as follows:

- Prepare a Master Plan and recommendations for the implementation of the National GIS;
- Prepare for organisational bodies for a National GIS;
- Establish foundations for National GIS;
- Implement a Botswana metadatabase on geographic data;
- Carry out workshops ad seminars related to the use of GIS and standardisation issues.

4.1.1 Development of an SDI Vision

In one of the initial workshops of the project the stakeholders agreed to have a vision shared by all. The following statement was adopted as the vision for the project [Swedesurvey, 2004, p.4]:

> *We will have a fully fledged National Spatial Data Infrastructure for Botswana. It will be easy to find, access and integrate geographic data from different sources in order to improve efficiency and effectiveness of governance and provide new business opportunities.*

The workshop went on further to expand the vision and made it more realistic by providing six guiding principles. These were identified as follows (Swedesurvey, 2004, p.11):

- to implement the shared vision on the NSDI concept and the main principles behind the vision;
- to co-ordinate activities which are of importance for the development of the NSDI;
- to encourage the development of fundamental geographic databases of importance as a reference for other kinds of geographic information;
- to improve knowledge about what GI currently exists and encourage easier access to it;
- to enable easier integration of GI through the use of standards and guidelines;
- to encourage more widespread of geospatial information;
- to provide users with assurance that information is consistent and of defined quality;
- to provide advice to government on geospatial information.

4.1.2 Institutional Bodies

The Botswana National Data Infrastructure was launched on the 31st of January 2003 by the Minister of Lands and Housing. The launch of the project by the minister signified the importance that government attached to the project. As already stated earlier the project started in 2002 with the formation of the GIS coordination unit envisaged in phase one of the project, its responsibilities among others were: administration of meetings, workshops and seminars; administration of documents; dissemination of information and overall coordination of the activities of project. This unit was meant to offer administrative support to the working groups. The unit was housed at the then government computer bureau now Department of Information and Technology. The department was tasked with the responsibility of sourcing funds from government for the unit. In addition to the GIS unit a technical coordinating committee derived from stakeholders was formed. The stakeholders were derived from those organizations that used GIS at their work places. This committee known as the National GIS Coordinating Committee (NGCC) was formed from representatives of the following organizations: Government computer bureau (GCB), Department of Water Affairs, Department of Lands, Central Statistics Office (CSO), Botswana Power Corporation (BPC), Department of Surveys

and Mapping, Department of Crop production, Department of Town and Regional planning (DTRP), Botswana Telecommunication Corporation (BTC), Ministry of Local Government and then University of Botswana. The overall goal of the NGCC was to establish a well functioning NSDI that will provide all GI users in Botswana with qualitative geographic information [Swedesurvey, 2003].

In order to make work more efficient six working permanent groups were established under NGCC. The working groups were established in line with the four major components of the SDI. The groups were identified as in Table 1 below [Tembo and Manisa, 2003]:

Table 1: Working groups and their functions

Working Group	**Functions**
Fundamental data	• analyse the need for fundamental datasets; • make specifications for the dataset; • put requirements for production, maintenance and updating routines of the fundamental datasets; • disseminate information on fundamental datasets.
Standards	▪ analyse in what areas standards are needed for the NSDI ▪ find suitable standards and seek agreement about these in the geospatial information community; ▪ disseminate information about and promote the use of established standards; ▪ review established standards and propose any necessary changes or additions.
Metadata	▪ establish the metadata services; ▪ monitor and support the development of metadata services ▪ promote and advertise the use of metadata services.
Institutional Framework	▪ analyse how GI stakeholders should cooperate with government; ▪ analyse what responsibilities between stakeholders should contain and be assigned; ▪ seek financing for the NGCC and its activities; ▪ review the general performance of the NGCC and the NSDI initiative.
Architecture and Infrastructure	▪ establish requirements on GI and GIS activities on institutional level ▪ develop guidelines for establishing GI and GIS infrastructure at institutional level; ▪ develop guidelines for proper GI and GIS maintenance.
Education and Human Resource	▪ analyse the present GIS knowledge on different levels and in different GIS related positions, mainly in government organisations; ▪ review the existing GIS education and training course provided by training institutions is Botswana; ▪ analyse requirements on future staff needs of the NSDI

3.1.3 Achievements of Phase I

The first phase of the project came to an end in November 2004 and the second phase was to commence immediately. Unfortunately this did not happen, and we are still awaiting the commencement of the second phase of the project. In this section the paper will seek to review the achievements of the first phase.

- One of the tasks of this phase was to set up the committees which it successfully did. The coordination unit and the technical committees were formed and are operational. The coordination unit has a full-time staff member who looks at the affairs of the project.
- The unit has developed routines for its day to day tasks such as preparation for meetings, seminars and workshops.
- The unit has also developed a website and an online metadata services. The website is also used to coordinate the activities of working groups by providing information and work plans for each activity. Currently the web site is hosted in Sweden and arrangements are underway to transfer the site to Botswana once the infrastructure is in place.

- The staff at the unit has been trained on daily routines of the unit. The unit can now perform the following tasks independently: request for quotation; meeting invitations; coordinate presentations; preparation of programme, preparation for meetings/seminars; take minutes and preparation and dissemination of workshop/seminar proceeding through the website and CDs.

- As already stated in the previous sections, the technical committee and its working groups were successfully established. Five of the six working groups are functioning and have regular meetings. Working groups have managed to design some questionnaires to solicit information from the GI community on the status of their thematic area.

- The working group on Fundamental Data has proposed a number of datasets which they believe could be considered for fundamental datasets. A demonstration tool which is map based has been developed to assist the user to view and interact with the proposed fundamental datasets. The interactivity allows users to select individual features in the map and get information about proposed attributes and specifications of the datasets.

- A document to be used as a guide in drafting the framework document on pricing policy for geographic data has been prepared. The document was presented at one of the NSDI seminars. Another document prepared is the one on how to implement Standards on Geographic Information. The document is intended to be an input to the Working Group for Standards and consists of set of standards used by the GIS community.

- A proposal for data exchange between the GI users and producers has been defined and

prototyped. The proposed solution is rather simple with small hardware and software requirements for distributor and client.

- A GIS projects and organizations database has been developed to keep record of all GIS activities taking place in the country.
- Tender documents for the second phase of the project have been developed.

4.2 Past and Current GIS Initiatives

4.2.1 Tribal Land Integrated Management System (TLIMS)

Land in Botswana is classified into three main types, which are customary, state land and freehold land. Customary land is what is commonly known as communal or tribal land. This type of land is managed and administered by autonomous bodies known as Land Boards. The country is divided into twelve tribal regions and each region has got its own independent Land Board. The Tribal Land Integrated Management System (TLIMS) project is ostensibly for tribal land management functions, which is the core business Land Boards and their respective subordinate offices, i.e. Sub Land Boards (SLB). The TLIMS application is an online, multi user, GIS based, Web enabled land management system. This implies that, a Land Board and its respective subordinate offices in this instance will constitutes a resource site that will be communicating with the main repository located at the Department of Lands. TLIMS is a computerized land information system that is developed to assist the Land Board to manage land effectively and efficiently and improve service delivery in general. TLIMS also facilitates data sharing between land Boards and Sub land Boards as well as other government departments. The system performs two main functions, namely:

- The day to day transaction data processing and management of the land Board
- Spatial data management based on a geographical Information System (GIS) that will assist in decision making required for land management.

The main objectives of the system are:

- To assist the Land Board in equitable distribution of land;
- To efficiently manage Land Board administration data;
- To capture, manage and provide access to spatial data available for each land board;
- To produce meaningful reports to assist Land Board decision making;
- To interface with national identification system (Omang), State land Integrated Management System, Aquillium Billing system, Botswana Housing Corporation, Deeds Registry, Court of Appeal, High court, Land Tribunal, Department of Surveys and Mapping, Department of Town And Regional Planning, Department of Geological Survey, Department of Water Affairs, , Ministry of Agriculture, provided that the required computerised system exists;
- To allow secure access to the Land Board records by users and other stakeholders;

– To give members of the public access to download the necessary information and application forms from the Internet.

The system development is complete and the project is at a stage of populating and testing. The system is expected to create a country wide land information management system that will allow information to be safe, easily accessible and easily updated. This involves converting data from existing sources and uploading onto the new land management system. Spatial data and its attributes are being collected on pilot sites.

4.2.2 State Land Management System (SLIMS)

State Land Integrated Management System SLIMS is a system analogous to TLIMS but designed for management of State Land which falls under the Department of Lands. State land comprises of the National parks, Game reserve and all urban areas. The functionality of the system is similar to TLIMS but with application bias towards state land administration. The SLIMS application provides the following functionality in support of the land administration and management processes that are carried out at Department of Lands (DoL), Self Help Housing Agency (SHAA) and Deeds Registry. (See, for example, table 2 below for details).

Table 2: Application of SLIMS

Process	**DoL**	**SHHA**	**Deeds Registry**
Land inventory maintenance	✓		
Process Plot applications	✓	✓	
Waiting List allocation	✓	✓	✓
Direct Plot Allocation			✓
Title Deed Registration			✓
Change of Land Use	✓	✓	✓
Transfer Title		✓	✓
Conversion (Certificate of Rights to Fixed Period State Grant)	✓	✓	✓
Development Control and compliance	✓		✓
Acquisition & Compensation	✓		✓
State and Private Lease Management	✓		
Valuation Roll Maintenance	✓	✓	
Land Revenue Building Material Loans (BML)		✓	

[Source: Department of Lands, 2005]

SLIMS back end sit on Structure Query Language (SQL) Server 2000 and the front end was developed using Visual studio. Net .SQL Server as one of the relational Database Management

System (RDBMS) was used as it supports large volumes of data. The increasing support of SQL Server and its easiness to use also contributed in the selection of this database system. The GIS component make use of the customized off shelf ESRI products. These include the following:

- ArcGIS mainly used at the Department of Lands for capturing plot information.
- Arcview used at the client side for viewing plot information
- ArcSDE which is a spatial Database Engine responsible for translating queries from clients and fetching information from the back end (database) and relaying the information back to the client in correct format.

The GIS data is derived from the Department of Surveys and Mapping where it is maintained on paper as well as digital formats. The digital data from DSM appear in various formats which require conversion to ESRI shape format. The shape file are used in SLIMS to create requisite spatial database. The data capture for town included the following datasets: general plans, survey diagrams, base maps indicating rivers, roads and other important features, layout maps and orthophoto maps.

4.3 GIS at Botswana Power Corporation

Botswana Power Corporation started the GIS and Mapping division in 1998 after realizing the need to fit information on facilities and customer together. Prior to this information about whom they had connected was provided in schematics as well as AutoCAD sketch plans showing locations of power connections without any spatial reference system. This schematic could normally be drawn in AutoCAD. As the client base grew it became imperative to change the system so that instead of relying on institutional memory, the new system would be able to provide information on the exact location of their services. BPC decided to move from AutoCAD based system to a GIS based system. The entire electricity network was now planned in GIS. A private consulting company was initially contracted to collect data on pilot site which was used to model the whole network and manage infrastructure. The initial introduction of GIS was more like a mapping exercise because it focused on mapping all the facilities as they existed without any spatial analysis [Tembo, 2005].

BPC intends to come up with a system architecture that will at least support simultaneous use of the database. It is currently managing its data using Spatial Database Engine (SDE) and runs the GIS using Arc Info. The current system uses a database server running ArcSDE with Arcview 3.1 and ArcGIS terminals.

BPC expects to introduce two systems that share the same database and also communicate with each other [Mashumba, 2005]. It is expecting a new management a system and proprietary customer information system (PCIS). It is hoped that with the new system in place it will be able to attend to outages more efficiently. The implementation of an integrated work management

system would facilitate operations in the organisation because all the departments within the organisation will migrate to the new system which merges them to a single server system. To ease maintenance operations of power lines at BPC the new SDE based system allows for easy detection of outages without notification of customer, provides accurate information of outages and reduces costs of operations. It is hoped that the new system will be linked to the customer information system so as to allow the geographic location to be linked to the account information [Tembo, 2005].

The success of the project implementation is dependent on the availability of data. BPC has captured a lot of spatial and attribute data for most villages in the country and the data capture is still on going. Data is captured using sub metre accuracy GPS systems. Data collected includes electrical reticulation, cadastral plots and other related topographical data. The fundamental data is obtained from DSM. This data is in form of maps over which BPC overlay their infrastructure. All new infrastructures have to be captured as built by the contractor whenever the new infrastructure is built. Due to the magnitude of the work involved in data capture, BPC out sources data capture to private surveying firms.

4.4 GIS at the Department of Water Affairs (DWA)

The Department of Water Affairs is responsible for water distribution in major villages of the country. Feasibility studies to establish GIS at Water Affairs was carried out in 1995 and 1996. In 1997 a GIS system was introduced. Currently there 17 villages managed using GIS. The department has also set up a Water Resource Information System (WRIS). The system links databases through the intranet. The department intends to upgrade WRIS to a National GIS, which is expected to incorporate data from other organisations into one system for ease of accessibility [Tembo, 2005].

The various sections that use GIS include Operation and Maintenance, Design and Construction, Ground Water and Water quality. The Operation and Maintenance uses the system in meter reading and water billing. The purpose of the utility in metre reading is for the reader to optimise routes in reading metres. The advantage of the system being that when the metre reader is not available, a location map can be printed out from GIS and be used as a guide to whoever will carry out the metre reading exercise. At the moment GIS is being used for mapping and location purposes, but this does not stop other applications to be developed in future. Data capture in an ongoing exercise. The data collected is in the form of pipeline networks. This data is usually supplied by the contractors who are hired to build the pipeline networks. Base data is obtained from DSM and water lines are then overlaid on it.

4.5 Botswana Range Inventory and Monitoring Project (BRIMP)

BRIMP is a unit established in 1996 and initial funded by the Department of International Development (DFID) (UK) grant and located at the Ministry of Agriculture. The aim of the

project was come up with a national range and monitoring programme that will provide reliable technical and sociological information on the use and condition of the rangeland. This information was meant to be used in addressing issues of land degradation within the country. Part of the data collected by this project included mapping and sampling of vegetation. Data was collected on 300 permanent monitoring plots of 30m x 30m in size. BRIMP also generated various degradation maps and datasets, based on ground monitoring and the interpretation of Landsat images, aimed at addressing desertification questions.

4.6 Development of Environment Information Systems in Botswana

The Environment Support Programme (ESP), based at the Department of Environmental Affairs (DEA), is a collaborative activity between the Government of Botswana and the United Nations Development Programme (UNDP). It aims to enhance the effective protection and management of Botswana's environment and natural resources and is sub-divided into three components: (i) Environmental Governance; (ii) Natural Resources Management; and (iii) Environmental Information. It spans across various governments departments. This project falls within the component of Environmental Information which aims at establishing a national environmental information management system with a core set of environmental indicators.
Information management and information technology are vital components in the delivery of government programmes and, when planned and managed properly, it improves services delivery to the public; it increases productivity and reduces costs to government. The effective management of information enables government to support decision making, reduce costs and meet legal and accountability requirements.

As a result there is need to put in place an Information Technology infrastructure to enable efficient data storage, manipulation, viewing, questioning interpreting and understanding of information. This systematic approach to information management will help improve services to the public, increase productivity, reduce costs to government and provide better decision making tools and policy analysis in the pursuit of sustainable development principles.

This project addresses itself to a number conventions and strategies that require establishment of Environmental Information and Monitoring Systems. Botswana Government participated in the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil in 1992 that came up with Agenda 21 for sustainable development which hinges on three pillars of Economic, Social and environmental protection. The Environmental Information System and Environmental Indicator (EIS/EI) project, in its implementation addresses execution of targets towards achieving the objectives as set forth by principles of sustainable development. Botswana's Vision 2016 of prosperity for all, set seven pillars which incorporates the environment, sustainable growth and an informed nation as key components. The Botswana Environmental Keynote Paper for National Development Plan 9 captures the importance of Environmental Information in accurate reporting on all key environmental issues. This shows the Botswana government's recognition that information systems and networks are vital "ingredients" in a productive and politically stable nation.

The Millennium Development Goals (MDGs) state that countries must e*nsure environmental sustainability* (MDG-7) and this can only be achieved if there is information available and if there are monitoring strategies in place. Once developed, the EIS/EI will serve to orient the environmental policy, improve natural resources management, and contribute to initiatives of sustainable development. It will aid in the preparation of the National Development Plans and specifically NDP10 (2009-2015) for the main streaming of the environmental, natural resource management and conservation strategies in the planning process.
The specific objectives of this project are:

- to develop an indicator database information (management) system on the basis of which SOERs will be prepared
- to provide public environmental information necessary for public consumption including EIAs, SOERs, research inventory, data, acts, policies etc.
- to provide an information service to decision makers for environmental awareness, policy formulation, and implementation.

4.7 Integrated GIS at Department of Surveys and Mapping (DSM)

In the early 1990's the Geographic Information user became seriously concerned with the proliferation of different land and geographic information systems that were introduced in the country. There were a lot of different mapping and GIS software used with no regard to compatibility and possibility of customization. In response to this outcry, a country wide study on GIS was conducted. The study which investigated the users and potential users of GIS, made far reaching recommendations on policies, standards, technologies, organizational responsibilities, financial and manpower resources [Morebodi, 2001].

Following the countrywide GIS study, several studies were conducted on the possible route DSM could follow in adapting to the new technologies. These studies were jointly funded by the Botswana Government and Swedish International Development Agency (SIDA). The advantage of this was that consultants with different fields of expertise were pooled from a large and much more advanced similar establishment, the National Land Survey of Sweden. Some of the studies were:

- Study on LIS/ GIS
- Establishing Cadastral, Geodetic and Topographic Database structure
- Feasibility study concerning a common Topographic Database structure
- Recommendations for the establishment of a GIS

The studies listed above led to the vision for the integration of surveys, mapping and remote sensing data in a GIS environment. These datasets put together was considered to constitute a geoinformation framework. The complete computerization, automation, collation, structuring

and formatting of these data sets under a relational database atmosphere formed the basis of Integrated Geographic System (IGIS) project at DSM. The major components of the envisaged system are the cadastral, geodetic and topographic databases [Morebodi, 2001].

According to Morebodi [2001], the specific objectives of the project were:

- Convert all old maps, cadastral plans and other records to digital form. This is achieved through manual digitizing, scanning, and conversion of data from raster to vector.
- Creation of an automated production system, with digital products organized as elements of the system.
- Create attribute and spatial database systems.
- Assemble diverse geo-spatial data into an integration form, with a view to enhancing its conversion to that type of information that support decision making.
- Create high powered analytical systems and expeditiously integrate the various sets to generate thematic products depicting a variety of scenarios in support of decision making.
- Provide vide dexterous tools in dissemination of pertinent information to the public, the private sector and others.
- Provide in service education and training to create a crop of competent technologically efficient local staff.

The implementation of the project has been going on for a while, the geodatabase with its three main databases have been developed, and conversion of manual data into digital formats is ongoing. The project could not be completed within its scheduled duration hence the extension. Some of the activities scheduled for the extension period are: operation of the new geodatabase; training of DSM staff in fields relevant to the new geodatabase; implementation of a new geographic database, integrating topographic, cadastral and geodetic databases.

4. 8 SDI Initiatives: Challenges and Opportunities

Most of the SDI initiatives were carried out following the recommendations of some feasibility study and all of them had noble objectives. None of the initiatives have been carried out to the end; some are still on going while others have been abandoned. Another observation that the paper has made is that implementation takes longer than anticipated. Most organisations lack capacity to implement GIS project. Organisation hire consultants to implement these initiatives and once consultants are gone at the end of their contract there is nobody within organisation capable to take over from where they left. In other words organisations do not emphasize skill transfer. Organisations should design an exit strategy so that when consultants leave the project does not collapse. Understanding of GIS at top management level is still low, GIS is just seen as a tool for making beautiful maps. Organisations do not invest in human personnel; the level of GIS training is very low, with staff just having the basic training in operations of GIS software. There is need for training of GIS personnel to the level of GIS experts.

With so many SDI/GIS initiatives taking place, NGCC should take more responsibility in coordinating the various spatial data projects to ensure that maximum benefits are reaped. This co-ordination must include setting national priorities. The development of policies, laws and standards to encourage, rather than discourage, the use of data and information technologies will also contribute to the sustainability of major investments in data collection and management by all spatial data users.

5.1. Capacity and Awareness Building

Capacity building is needed to overcome the personnel and the awareness problems. Specific recommendations to provide education and training in information, communications and knowledge (ICK) technologies to alleviate the shortage of skilled and experienced personnel include the following:

- Study visits to developed and other developing countries could play a major role in terms of skills sharing.
- Develop web-based self-learning material on spatial data utilization and SDI advantages [Ezigbalike 2001].
- Conduct a series of workshops and seminars to explain and publicize the SDI concepts
- Development of regional centers of the UN Economic Commission for Africa (RECTAS, Ile-Ife; RCMRD, Nairobi); SADC-FSP, Harare; AOCRS, Algiers; and other similar organizations to coordinate and mediate the sharing of expertise between countries;
- Funding of research within the University of Botswana to examine and develop SDI concepts and applications.

5.2 Cost Recovery versus Cost Management

Cost recovery prices are expected to cover such costs as data collection, storage, maintenance and distribution. The price could also be determined by quality of data e.g. the level of details, correctness, up-datedness, completeness, topological continuity and usage. In the case of usage, some countries charge lower fees for the government, non-governmental organizations and academic institutions and set higher fees for the private sector.

Correct pricing is difficult to achieve. If prices are set too high, users will probably produce their own data; if prices are too low there are no funds to keep data up-to-date. There are various models of cost recovery ranging from full cost recovery to no cost recovery. ***Countries that have tried cost recovery like Canada have admitted that cost recovery in spatial data infrastructure was a mistake***. The issue of cost-recovery should be addressed in the Botswana context and not in terms of European-American contexts where the information and knowledge society is more "mature" as this may distort the "development" of an infrastructure in a developing country such

as Botswana. ***However, in the Botswana context, there should be no cost recovery for the foundation data sets, and data should be made available to everybody at the price of maintenance.***

Current thinking today is that there is little point in cost recovery of 100% for public data [Norplan AS, 2001]. For instance, there are cases whereby data might be required for monitoring natural disasters (environmental data) or national security reasons and even though this data is very important it might be of very little commercial interest. Despite the low commercial demand, those who benefit most from such data should pay and ease the burden of taxpayers.

6. CLOSING REMARKS

The key success factors of a national SDI in Botswana are the following:
- The spirit of cooperation among the agencies involved in SDI development is critical.
- The presence of a reliable and trusted coordinator and driving force ("the champion factor") in the SDI development effort.
- The establishment of a functioning and effective network among the SDI stakeholders.
- The availability of base or foundation data and skilled and experienced personnel.
- The support of the donor community is critical.
- The identification of SDI development as a national priority issue.
- The sustained support of politicians, decision-makers and senior management involved in national SDI development.

What are the priorities for SDI in the context of Botswana? There is need to understand what the requirements are for the development of SDI in the context of Botswana. If we know what the constraints are and what the opportunities are for SDI development, we will then be in a better position to build the principles for a national spatial data infrastructure program for Botswana. However, we should remember that SDI is not a panacea for all the economic and social ills this country is facing and that most approaches that have been taken with regard to the development of SDI have tended to emphasize the point that "Botswana had better get along with it and adopt (not adapt) what the rest of the world is doing".

As Dertouzos [1991] defined the problem:

> *...we, the designers and users of this information infrastructure, bear a serious responsibility: we must understand the value and role of information so that we may better channel our technological miracles into useful rather than frivolous, if not dangerous, directions.*

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