BOTSWANA-TOWARDS A NATIONAL GEO-SPATIAL DATA INFRASTRUCTURE

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Key words:

ABSTRACT

The paper will review geo-spatially-related work over the last ten years with particular reference to the contribution towards a National Spatial Data Infrastructure.

An overview of projects undertaken to computerise and modernise all production systems, the acquisition of geographic data and the creation of a Geo-Information Framework will be given. It will give attention to issues such as standards, metadata, information distribution and sharing.

Capacity building through Institutional Cooperation in these endeavours will be related including participation in global initiatives.

INTRODUCTION

The Botswana Department of Surveys and Mapping is a Government Department within the Ministry Lands, Housing and Environment. It is responsible for Cadastral, Engineering and Geodetic surveys, Topographic and thematic mapping, it is a major producer and user of survey and mapping, GIS, Remote Sensing and other Geo-Information products. Its main task, however, is to provide basic attribute and geospatial data and information to government, private, and public users with particular responsibilities to national land management and the implementation of development policies and strategies.

Within its portfolio responsibility as A National Mapping and Survey Organisation the Department is the designer and major user of survey and mapping standards, procedures and policies. The Department has taken initiatives in the establishment of coordinated standardisation, production, archiving, distribution and utilisation of geographic data in the country. An Information technology Organisation, the Government Computer Bureau, has been charged with the responsibility of establishing a Geo-Spatial Data Coordinating Unit and has recently embarked on this task with appreciable zest. This move will mark the crystallisation of a formal National Data Infrastructure.

The Department of Surveys and Mapping has gone a long way to create the framework from which a formal National Data Infrastructure will emerge. It is therefore necessary to relate in some details the Department's efforts at the creation, structuring, standardisation, archiving and distribution of Geo-Spatial data for the development of the Country.

BACKGROUND

From 1990 the Department has migrated from purely manual methods of map production to digital. The conversion of analogue stereoplotters to analytical and their complete generation of digital data has heralded the beginning of automated map production not only in the Department but in the entire country.

In conjunction with digital photogrammetry existing conventional maps were digitized and improved cartographic products generated. Over the last decade a massive amount of digital data has been produced and archived.

During the same period conventional survey methods were gradually modernized. This began with the use of distance measuring instruments, from Tellurometers through EDMs to the current total stations and Global Positioning Systems.

The Department benefited greatly from technical assistance offered by Sida and administered through an Institutional Technical Cooperation. The Institutional Cooperation between Swedesurvey and the Department has proven to be the most effective methodology of skill and technology transfer. There can be no question but that it has influenced the progression towards the digital production and effective utilisation of geo-spatial data in the country.

ORGANIZATIONAL STRUCTURE

During the early 1990's, the Government of Botswana undertook a national project on Organization and Methods restructuring of all Departments and Ministries. The then Department of Surveys and Lands was restructured resulting in the formation of three fully-fledged departments of Lands, Housing and Surveys and Mapping. The Department of Surveys and Mapping was in turn organized into three main divisions namely Surveys, Mapping and Geo-Informatics. The two divisions of Surveys and Mapping were designed to be production centres within the Department whilst the Geo-Informatics Division was to provide support to all computerized GeoInformation technologies, the quality testing of survey and mapping products, information dissemination and sales.

SURVEY DIVISION

The Survey Division is responsible for all geodetic, topographic, engineering and cadastral surveys. It supports the Mapping Division by providing ground control, it is also responsible for the administration of the Land Survey Act and Regulations.

MAPPING DIVISION

The Division is composed of the Photogrammetric, Photographic and cartographic sections. It is responsible for all base and thematic mapping at large, medium and small scales.

GEO-INFORMATIC DIVISION

The Department's Geo-Information systems' division is responsible for both spatial and non-spatial information technologies. Other duties include the examination and storage of cadastral and other surveys, sale of maps and other information on land and the administration of all Departmental Computers and embedded systems.

GEO-INFORMATION FRAMEWORK

The concept of a geo-Information framework must be seen in the context of a national Cadastral and Mapping Agency that is moving from a pure base data provider to the one that is a purveyor of a hybrid but information biased derived products. The Geo-Information framework constitutes the base foundation from which a National Geo-Spatial Infrastructure is developed. The development of such a framework is also of pivotal importance, as it constitutes an essential element of the Geo-Spatial component of a Global Geo-Spatial Data Infrastructure.

GEO-INFORMATION TECHNOLOGY

Advancements in Geo-Information technology have greatly and positively influenced not only productivity but also the seemingly unstoppable migration to digital production. The Department being the principal producer of base geo-spatial products has taken this progression with great care, ensuring that advancement does not far outstrip the learning curve. The integration of data sets previously regarded as disparate, has now been made possible by the current powerful PC computers and high technology systems. Consequently the conduct of both survey and mapping has changed tremendously. In response to this technology driven revolution it has been necessary to automate existing surveys and mapping operational frameworks. This conversion, commonly known as spatial or geo-spatial data infrastructure is the integration of all geographically identifiable entities and the organizational support behind it.

With respect to survey and mapping within the country the movement from existing framework entails not only digital production but the conversion of manually produced data and information. The advancement in geo-information technology has greatly simplified the interpretation and use of geo-spatial products such that the range of users has greatly increased and most of the improvements have become more user-driven than before.

TOWARDS A NATIONAL GEO-SPATIAL DATA INFRASTRUCTURE

RESEARCH AND DEVELOPMENT

In the early 1990's the Geographic Information user society became seriously concerned with many but differing land and geographic systems being introduced in the country. There were a lot of different mapping and GIS softwares with no regard to compatibility and possibilities of customization.

In response to this outcry for some order and uniformity standards, a countrywide study on GIS was conducted. The study which investigated the users and potential users of GIS, made far reaching recommendations on Policies, standards, systems technologies, organizational responsibilities, financial and manpower resources.

Preceding and following the countrywide GIS study, several studies were conducted on the possible route that the Department of Surveys and Mapping could follow in adopting new geo-information technologies for high productivity user driven products. These studies were jointly funded by Sida through Swedesurvey and Botswana Government through the Department of Surveys and Mapping. 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. In all these consultants and local staff worked together to achieve the set goals. The Institutional cooperation worked very well as both parties were interested in the success of the projects.

Some of these studies were:

- Study on LIS/GIS at Surveys and Lands.

- Establishing Cadastral, Geodetic and Topographic Databases at the Department of Surveys and Mapping.

- Feasibility study concerning a common Topographic Database structure at the Department of Surveys and Mapping.

- Recommendations for the establishment of a GIS at the Department of Surveys and Mapping

The studies led to the vision for the Integration of surveys, mapping, and remote sensing data in a GIS environment. This in our opinion will constitute a major Geo-information framework for Botswana.

THE INTEGRATED GEOGRAPHIC INFORMATION SYSTEM (IGIS)

DSM in fulfillment of its mission must ensure that its products enable optimal capability for the implementation of National development policies. Some of the major users of DSM geo-spatial and non-spatial products are Town and Country Planning, Roads and other Civil Engineering Organizations, Local Government, Land Boards, Utilities, Tourism and many others. These different users require different spatial products formatted in ways that best suit their tasks. DSM has a variety of products which include, analogue aerial photographs, topographic, and thematic maps, cadastral diagrams, General plans, index or compilation sheets, street Plan maps, beacons coordinate list, Reference marks, Trigonometric stations, District and International boundary beacons benchmarks, Place Names and digital Orthophoto maps. These data sets put together constitute a geo-information framework.

The complete computerization, automation, collation, structuring and formatting of these data sets, which are elements of the DSM mission, under a Relational Geo-spatial Database system, is the basis of the vision of the Department in the new millennium. The crystallization of this vision whilst still a long way ahead, is being undertaken through a National Development Project. This project is the Integrated Geographic Information Database system, whose major components are the Cadastral, Geodetic and Topographic database systems.

SPECIFIC OBJECTIVES

- Convert all old maps, cadastral plans and other records to digital form. This is achieved through manual digitization, scanning and conversion of data from raster to vector.

- Creation of an automated streamlined production system, with digital products organized as elements of the system.

- Create attribute and spatial relational database systems.

- Assemble diverse geo-spatial data into an integrated form, with a view to enhancing its conversion to that type of information that will optimally support decision making.

- Maintain a comprehensive up-to-date repository for geo-spatial multi-purpose developmental information.

- Create high-powered analytical systems that expeditiously integrate the various data sets to generate thematic products depicting a variety of scenarios in support of decision making.

- Provide dexterous tools in the dissemination of pertinent information to the public, the private sector and others.

- Provide in-service education and training to create a Corp of competent technologically efficient local staff.

WHY INTEGRATION

The integration of information is an important aspect of GIS as a tool for decision making, for example, in Town and Regional Planning, the planners require Topographic mapping with both natural and man-made features, contours, place names and other attributes. Additional information required includes the ownership and current use of the land, cadastral plans, thematic maps such as; population (census maps), soil geological, hydrological, and environmental maps. The planner needs to bring all these and other socio-economic data together for good planning. Integration of most of the spatial or graphic data sets will enable expeditious and informed decision-making.

DSM produces Topographic and cadastral plans, DTRP plans the layout of Towns and extensions, and DSM directly or indirectly sets out plot layouts and approves surveys. The

Department of Lands, which is responsible for the administration of land, then takes the responsibility of land allocation and its acquisition. The Deeds Registry then registers title to land. The necessary attribute and spatial data generated within these activities could be brought together and further integrated with other data sets to constitute an enterprise database system. Such an enterprise would have great advantage over the otherwise disparate data sets:

ADVANTAGES OF IGIS

The benefits that are perceived as accruing from the integration of diverse information within a GIS and which have motivated the visioning and implementation of the DSM IGIS Database project, are:

- A much wider spectrum of applications exist in an integrated and well-structured system than from a collection of uncoordinated data sets. e.g: Topographic and cadastral maps on different projections and scales may not be too helpful.

- Linkage of data sets through common identifications on attributes enhances spatial consistency and add value to existing data.

- Integration of multi-disciplinary geo-spatial data sets creates value added multi-purpose geo-information framework.

- Integrated information is of great value to users especially those who may not have the skills to appropriately prepare the requisite products for their purpose.

- A seamless information environment resulting from integration precludes the need for transformation, conversion, compatibility and translation of data sets.

- Duplication of effort in an enterprise system is eliminated and consequently the cost implications.

- The mission of the Department will move beyond the confines of survey and mapping only.

- Constitutes the basis of a geo-information framework, as a base component of a National geo-spatial data infrastructure

INTEGRATED GIS DATABASE SYSTEM

As mentioned above the major components of the IGIS Database system project are the Geodetic, Cadastral and Topographic databases. A brief introduction on implementation of these follows

GEODETIC DATABASE SYSTEM

- All elevation values and coordinates for zero-order down to quaternary trigonometric stations, reference marks, benchmarks, and other control points are being digitally maintained in a database system.

- GPS measurements for a zero-order GRS 80/WG S84 Geodetic datum network has now been undertaken and post processing and adjustment is under verification.

- Determination of geoid model is on going for most precise conversions and transformations.

- Geo-spatial database with GIS functionalities will be designed and implemented in the next two years.

- Integration linkages to cadastral, Topographic and other similar databases within a GIS environment.

- Ensure streamlined automated production systems

CADASTRAL DATABASE

- Computerization of all records, general plans and diagrams and maintenance in a digital geo spatial cadastral database system.

- Streamlined automated cadastral production to be maintained within a database system.

- Generation of spatial products within GIS environment

- Create linkages with Geodetic and Topographic databases and other Information systems on property ownership, property values and lands registration and inventory.

- National Atlas projects which has been developed using purely GIS methods will constitute a major visible GIS product. This will also constitute a component database of the IGIS database system. This has resulted in the creation of a comprehensive metadata base primarily of all maps included in the Atlas.

- The electronic version of the National Atlas, the PC Atlas, will expand the metadata base and further enhance the analysis and distribution od digital data on Botswana.

TOPOGRAPHIC DATABASES

- Continued digitization through manual and scanning of all analogue maps.

- Migrate digital map data files to topologically structured spatial database systems.

- All systems of production converted to digital production.

- The storage of seamless Digital Elevation Models, Digital Orthophoto and line maps at medium to large scales, covering the entire Country.

- Develop and populate subsidiary databases such as Place Names, Aerial Photography and Remote Sensing databases.

- Create linkages with the cadastral and the Geodetic Databases within a GIS Environment.

- Provide open valves for linkages to multi-disciplinary geo-information systems hydrology, geology, etc.

CONCLUSION

The formal establishment of a National Geo-information Coordinating Unit within in the Country will be of great value to national development efforts especially with regard to duplication of efforts and consequently rampant nugatory use of scarce resources. The participation by DSM in relevant Global initiatives such as the Global Map and Global Spatial Data Infrastructure will be of great advantage in ensuring that requisite internationally accepted standards are adopted.

Botswana is indeed moving towards establishing a National Data infrastructure, however, the recent successful production of the Botswana National Atlas through the cooperation of several participants some of who are data producers and users under the coordination of DSM, has clearly shown the potential need of a National Spatial Data Infrastructure. The use of disparate formats, standards, datum and conventions works against optimal exploitation

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