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Ordnance Survey
Romsey Road
SOUTHAMPTON
SO16 4GU
United Kingdom

Botswana – Visionary Geo-Information Development Programming

B Morebodi
Director
Department of Surveys and Mapping
Botswana

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Director
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Abstract

This paper will devote itself to a wide appraisal of technological developments, perhaps taken for granted in other countries, by the National Mapping Organization – Department of Surveys and Mapping (DSM) in trying to cope with demands of development in the current globalised world. This will be done without getting technical.

Botswana being a small country; with respect to a small population and limited land for agricultural, use, is always ready to learn from others ways and means of effectively exploring and exploiting its fragile resource base. It is thus not surprising that the Government has taken a deliberate decision to join other countries on the Information highway, and adopt an all-encompassing National Vision for a prosperous nation.

The Department, has during the last decade embarked on modernization projects meant to provide appropriate Geo-Information to ensure that all possible efforts at Sustainable Development are enhanced. These efforts will be narrated and the effect on development given.

Introduction

At the end of the last decade Botswana launched The Nation's Vision 2016, a long term vision for Botswana whose aspiration is to move the Nation towards Prosperity for all:

“Botswana finds itself in a period of history when social attitudes and values around the world are changing at an unprecedented rate. In the future, the people of Botswana will need to adapt to the challenges of global society while retaining the positive aspects of their cultural values that distinguish them from other nations.

It is appropriate that after thirty years of independence we must take stock of our past aspirations, and the extent to which we have realised them. At the same time, we must formulate our aspirations and dreams for the future. What kind of society would we like Botswana to be by the year 2016, when we will be celebrating our fiftieth anniversary of independence” observed The Presidential Task Group – 1997.

The long-term vision was visualized and conceptualized to refocus the country's cardinal National Principles of Democracy, Development, self-reliance and Unity, to cope with the changing times.

The strategy for making the vision a reality called on the Botswana to work harder and aim higher whilst being “flexible and pragmatic” to cope with the challenges of a changing world. They are exhorted to rededicate themselves to the building of an Educated, Informed, Prosperous, Productive, Innovative, Compassionate, Just, Caring, Safe, Secure, Open, democratic, Accountable, Moral, Tolerant, United and Proud nation.

In the implementation of these ideals Government adopted throughout the public enterprise, a Performance Management System that would enable the alignment of strategic plans of all national establishments with that of the Nation.

The Department of Surveys and Mapping (DSM), Botswana's National Mapping Organisation, likewise, realigned its vision to "effectively and efficiently provide prompt and quality services in Geographic and Land Information, to meet the demands and expectations of a New World situation".

To meet the demands of the changing world a Strategic Plan has been developed positioning the organisation as the premier National Geo-Spatial Information producer and distributor in the quest for sustainable development. The designed Key outputs that constitute the framework for an organisation whose aim is not only to Survey and Map but to undertake this and other processes as part of making available in the most appropriate format spatial resource information are:

- i) Geodetic Information and Services,
- ii) Topographic Information and Services
- iii) Cadastral Information and Services
- iv) Information Management and quality service delivery
- v) Spatial Data Infrastructure

It is through these cardinal and fundamental strategic foundations that the Organisation intends to contribute towards the socio-economic transformation of the country envisaged in the National Vision 2016.

Background

The Department of Surveys and Mapping began the modernization route in the late 1980's after it became clear that rural development was being negatively affected by lack of maps required for land use planning in rural Botswana. The Swedish Government through Sida was then undertaking a major decentralization and rural development project in the country, and planning and decision-making was hampered by lack of geographic information. Studies conducted at the time indicated that the entire map production infrastructure in the country needed to be overhauled. The Strategy adopted was that of the digitization of all analogue data, modernization of production systems and intensive training of both the supervisory and operational staff. This strategy was to be implemented through an Institutional Cooperation between DSM and Swedesurvey (SWS) and funded by Sida whilst the recipient, procured modern equipment and software.

The Institutional cooperation initially scheduled for termination in 1997, has been so successful that it has been continued albeit in a different form. This entire arrangement has yielded impressive results in skill and technology transfer.

The latest version of this relationship has been based on shared funding of the agreed development projects. Whilst initially the contribution, such as equipment, and software, by the recipient country was not specific, in the latter cooperation, fixed proportion for funding normally of 50/50, is agreed upon, and a contract established directly between the client and customer. It is our belief that the arrangement where both the donor and recipient governments make equal or substantive financial commitment creates a partnership which augurs well for the successful implementation of the projects, as both parties have an interest in seeing them through to a successful conclusion.

The major output from this partnership has been transfer of technology and skill. The Institutional Cooperation, which was conducted with mutual respect and professionalism, is in our opinion the best route to technology and skill transfer. The client designed the specifications for all projects with requisite advice coming from the consultant, with all production work being done by the staff of the Department.

In short the Department is continuing to find ways of providing the required information for sustainable Development, through the attainment of certain strategic objectives; based on high productivity advanced Geo-Information technologies.

Botswana National Geodetic Reference Frame 2002

It goes without saying that for Geographic Information to play a significant role in a changing world, it must be based on a global datum. This would ensure integration and interoperability of Geo-Spatial Systems without the need for elaborate transformations and conversions necessary in the yesterdays. The Geodetic Network constitutes a fundamental base for all Spatial Data Infrastructure and its currency, precision and compatibility ensures that disparate data and information systems can be converted to constitute a fully integrated operational model for maximum utilization in planning and developmental decision making.

In order to kick start the creation of a well coordinated Spatial Data Infrastructure, the National Mapping Organisation proposed and implemented a Zero Order Network based on the Geodetic Reference System 1980 (GRS), the International Reference Frame 2000 and EGM 96. In this project four fundamental monuments of the old Trigonometric Stations were observed continually over a period two weeks whilst simultaneously observing 21 other stations using 12 GPS receivers. The processing of the observations using both the Ashtec Suite (Geo-Genius) and the Bernese Software gave very good results. Currently the Network based on strategically positioned old trig stations is being systematically expanded in density and countrywide surface coverage.

The next step that is currently under consideration is the establishment of Permanent GPS Stations strategically placed countrywide but in localities with comparatively high potential for development.

In order to allow for optimal excess on Geodetic Data, to cope with the changing times, all data is or will be managed through Relational Data Base Management Systems with the ultimate aim of creating and installing an Enterprise Geo-Database.

Traditional uses of National Geodetic Networks, such as in cadastral, engineering, hydrographic, topographic and mining surveying, GIS and other project related works; have welcomed these changes, and have or are acquiring requisite high productivity technology. Global, and Regional Environmental Mapping, International Boundary resolution, natural resources management, transport management and emergency response, will benefit from the availability of a world Geodetic System in the country. Although there is only one non-IGS Permanent Station in the country, the entire network has through observations, been robustly connected with RSA and Namibian Stations.

The ultimate establishment of Permanent Stations, the existence of Geodetic Stations based on WGS84/GPS80 and ITRF 2000, do not only establish both the Horizontal and Vertical datum but also the standard on which all Geo-Spatial Data will be based in the country.

Cadastral and Land Information

The adoption of computerization in the country has led to almost all stakeholders including those concerned with planning and land development and management requiring their data and information in digital format.

Governance issues such as the equitable distribution of land and facilitation of basic shelter provision have put pressure on the creation of digital and analytical systems.

In rural Botswana the previous attitude that land is plentiful and everybody is entitled to a large piece of land, because land is free, has changed tremendously. There is even higher pressure on land in peri-urban areas, which has led to illegal self-allocation and the invasion of potentially rich pastoral and arable agricultural land.

With increasing population, changing priorities vis-à-vis the use of land and its market value the need for its judicious management has become even more vital and urgent. In the early 1990's the Government established Survey Units in thirteen Rural Land Boards responsible for allocation of land countrywide. The Surveyors were charged with the responsibilities of working closely with the DSM, in undertaking Cadastral Surveys, production of base maps for small settlements and the development of Land Inventory Systems that would help in the management and distribution of land.

The National Mapping Organisation, on the other hand, provided aerial photography and mapping of almost all large settlements for a variety of purposes but especially to enable those responsible for the management of land in rural areas to have adequate and up to date Geo-Information.

As part of the need for provision of adequate shelter in both urban and rural areas, the Government introduced a Loan Guarantee Scheme for the construction of residential buildings. In addition funds were made available for an Accelerated Land Servicing Program in urban centers requiring a great deal of cadastral survey, mapping and land information. The mapping Organisation responded by procuring analytical and digital instruments accompanied by training of operational staff on the use of these high production technologies.

In order to cope with high demands on information on land, DSM converted all data in urban areas to digital format. The use of GIS, Total Stations, digitizers and scanners has enabled the Department to cope satisfactorily with the changing demands from both the public and private enterprises.

Topographic and Thematic Information

The availability of remotely sensed data through such high-resolution satellites as are currently orbiting the earth should theoretically provide all the topographic information that a developing country such as Botswana would require for its developmental programs. This is, however, not so due to the unaffordable prices of the imagery and lack of appropriate infrastructure for image processing.

There is, however, very high demand for digital Topographic maps as opposed to available analogue maps. This demand led to the mounting of a digitization program over the last decade with good results. The problem has, however, been that this has not been completed, but at the same time the demand on up to date maps has increased.

Consequently funds were secured to undertake aerial photography of the entire country and the production of a seamless digital Orthophoto-map coverage of Botswana. The mapping is designed for 1:50,000 coverage but will adequately cover the range 1:10,000 to 1:100,000. Even as this project is under execution some stakeholders are planning their programs on the bases of this. It is intended to archive, manage and utilize the massive data collected through a Geo-database system.

Botswana National Atlas

In fulfilment of the vision to create an informed nation and also demonstrate to the public the benefits of Geo-Information, a project for the production of the first ever Botswana National Atlas was planned and implemented. The project was co-sponsored by the Governments of Botswana and Sweden and implemented through the Swede-Survey/DSM Institutional Cooperation.

Technicians and technologists were trained in both Sweden and Botswana to constitute the production team. The Atlas specifications were to emulate those of the series of Atlases produced by Swede-Survey, but in a single Volume Book. The Atlas maps, graphics and text with manuscript sourced from various Governmental Institutions and the Academia.

The Book published in 2000, has been acclaimed as a Geo-Encyclopedia of Botswana. In addition to the Book Version, there are digital versions; the e-book in PDF format, and three other versions, two in ArcView and one in ArcExplorer. The latter has been distributed freely to several schools all over the country.

Although this was a single volume book the logistics involved in obtaining the manuscripts, the associated graphics and maps were extremely complex and required exacting coordination and project management. The disparate and some mostly unknown datum and projections on maps presented for inclusion, necessitated tedious conversions and transformations whilst in most cases new maps had to be reproduced. More than any other project, the Atlas project demonstrated the need for coordination of the production, standardisation, archival and utilization of Geo-Information. Despite the use of high-powered UNIX based ArcInfo to generate maps, the incompatible projections and datums slowed down the entire production system and making it even more expensive, than was initially envisaged.

Be it as it may the project has been highly instrumental in the transfer of technology and skill to several technologists, a benefit that has now positively impacted on other map production undertakings. The Atlas will remain an indelible demonstration of the virtues of Geographic Information and the technologies associated with its acquisition, archival, analysis, management, retrieval and dissemination. It stands out as the most appropriate media for informing the young and the old on their country.

Integrated Geo-Information System (IGIS)

The IGIS is an over encompassing project designed to create a Spatial Data Infrastructure at the Departmental level with ultimate solutions for migration to an enterprise Geo-Information System. Its major objectives are:

- Convert all analogue data to digital form.

- Create Geo-databases of cadastral, geodetic, topographic and other datasets ensuring compatibility.
- Develop or acquire hard and software systems that allow for ease of data integration.
- Provide in-service education and on-the-job training to develop a corp of technologically competent staff.
- Create an enterprise system that will provide users with up-to-date data in agreed standards, and appropriate format.
- Provide the necessary linkages to the National Data Infrastructure.

This is a continuous project that is designed to bring together and improve the information technology base of the main production activities of survey and mapping. Its successful implementation will place the Department in a position to cope with the changing demands on Geo-Information.

National Spatial Data Infrastructure

As far back as 1994 the Department took a lead in the Commissioning of a study of the Government of Botswana's countrywide use of GIS. The major objective was to investigate the nature of, and bring together the disparate systems, projections, and standards used with a view to avoiding duplication of effort. It was found that there was a proliferation of GIS software, using different or unknown formats and projections resulting in the incompatibility of data that encouraged duplication of effort. It was recommended then that a GIS Coordinating Committee or Agency be established, preferably through an Organisation that was in the IT discipline but did not itself produce or use spatial data to avoid impartiality, in resource distribution.

The Government Computer Bureau was confirmed as the most appropriate Organisation as it was tasked with the introduction and promotion of IT in the entire Government of Botswana structures. Unfortunately there was a serious delay due to a variety of factors principal of which was the difficulty in recruiting and employing experienced and qualified GIS experts. It was only recently, through the Sida/Botswana co-funding that a project, which recommended the establishment of the National Spatial Data Infrastructure (NSDI), was undertaken.

The 1994 Countrywide Use of GIS study and the National Atlas projects whilst revealing the disparity in formats and standards of the geo-data, did also show the main producers and users, in the country. Thus Working Groups have been formed and constituted by these role players targeting those activities that would ensure the cost-effective and appropriate production and wide use of Geo-Information.

At the same time the Work Groups aim not to re-invent the wheel but to study, adopt and adapt appropriate International Standards. A close follow-up of the GSDI, FGDC, ISO TC211, and the Open Consortium and similar organisations working towards the effective use of Geo-Information, will be made.

The basis of the National Spatial Data Infrastructure is to position the Geo-Information sector to collectively and effectively contribute to the National effort at sustainable development, in a Globalised World.

Conclusion

The Mapping Organization's work over the last few years has impacted positively, and developments in both urban and rural areas are testimony to a working land development program possible only with proper geo-information. In addition there are some cardinal examples of use of appropriate Geo-Information to solve problems in accordance with the expectations of modern times.

- Recently, appropriately scaled colour and resultant Orthophoto-mapping has been pivotal in the peaceful resolution of Boundary disputes with Namibia.
- Automated mapping and Geographic Information System have been employed to produce, under great pressure, Constituency Mapping and local Government election wards, within a very short time. The improved modern production systems quelled the political outcry of the opposition parties for constituency gerrymandering as the demographic and other statistical evidence was graphically and geographically demonstrated.
- Development monitoring through Geo-Information and mapping resolved the problems of land self-allocation in the capital's peri-urban areas.
- The production of the Atlas and variety of maps in analogue and digital form is decisive in informing the young and the old alike on the country, its history, development and potential.
- Participation in Global environmental and Geo-Information Organisations such as the GSDI, FIG, ISPRS ICA and the Global Map has helped a great deal in meeting the demands of our changing world. Botswana has benefited greatly from these global associations.

With a small population and a limited resource base for skilled manpower, the Botswana Mapping Organisation has opted for the adoption of modern high production Mapping and Geographic Information Technologies. The acquisition of these new technologies must of necessity be accompanied by intense training in all relevant fields. Short and long-term formal in-service and on the job training has been relentlessly pursued, and has paid good dividends.

The bringing together of the entire Governmental and Academic machinery during the production of the National Atlas brought into focus the great need and potential of mapping or Geographic information in all spheres of development. This has brought home the need for a visionary approach to the development of Geo-Information in our changing world.

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