

LAND INFORMATION SYSTEMS DEVELOPMENT AND THE NATIONAL SPATIAL DATA INFRASTRUCTURE IN BOTSWANA

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ABSTRACT:

Botswana recently embarked on an effort to improve its National Spatial Data Infrastructure (NSDI). This paper takes an example of the country's effort to improve information for land administration and the problems this effort has had because of a poor spatial data infrastructure. It then discussed how the current effort is likely to have impact on the organization of information for land management in Botswana. For long, various Departments of Government have been acquiring their own land information for their operations although they realized that they were duplicating this acquisition and that a standardized coordinated land information system would improve data exchange among them. The NSDI provides a basis for coordination.

1. INTRODUCTION

Success in introducing geographical information science in general has been slower in Africa when compared to other continents. Apart from the general social, political, economic and other problems discussed by Hastings and Clark (1991), lack of a coordination base to provide cumulative and exchangeable experiences have been strongly pointed out. More recent advice to Africa as a whole has been directed at encouraging the development of national spatial data infrastructure (NSDI) for spatial data management (Ezighalike, 2001). Individual countries have had various experiences (see for example Tomoulali (2001), Gavin and Gyamfi-Aidoo (2001) and Morebodi (2001)). This paper discusses the problems that Botswana has experienced in attempting to develop a system for land administration over a 25-year period. Without a NSDI the country has found it difficult to coordinate the efforts made to develop land information systems (LIS) and to integrate this with other spatial data relevant to the development effort. The proposed NSDI is expected to make a significant difference.

Botswana is a large semi-arid country of 582,000 km² (about the size of France). The population census of 2001, however, showed the country has only 1.8 million (compare with France which is 55 million) giving it a population density of 3.46 persons/km². The distribution of this population is mainly along a narrow south to north corridor following the rail line from Johannesburg in South Africa to Harare in Zimbabwe leaving the western part of the country with population densities as low as 1 person per 5 km². These contrasts are reflected in the distribution of natural resources, the most important of which is water, except for the wildlife wetland world famous Okavango region in the northern part of the country which has a lot of potential but very low population densities. The contrasts also make the use of geographical information science ideal for land management at the national level with careful integration of databases necessary because of the different scales that have to be used. The more important contrast, however, is between rural and urban areas. Urbanization is growing rapidly, having risen from 4% at independence in 1966 to 45.7% currently. The rate of growth of urban areas seems to have slowed down. For the city of Gaborone, for example, between 1971 and 1981 the population of Gaborone grew at an annual growth rate of about 12% declining to about 8% in the 1981 to 1991, and to 3% between 1991 and 2001. However, the growth was just re-

directed to the city's peri-urban villages each of whose population increased by from 1.8 to 2.7 times with annual growth rates ranging from 8% to 12%. Up to the early 1970's development was concentrated in major settlements although the majority of the people were in rural areas. A change in the strategy of resource allocation and regional planning was expressed in 1972 to give more attention to rural areas (Government of Botswana, 1972, 1973). The Sixth National Development Plan (1986 to 1991) emphasized "social justice" as a guiding principle in spatial development stating that equitable access to resources and opportunities for rural areas would be a planning goal for consecutive planning periods (Ministry of Finance and Development Planning, 1985, p. 56). It was decided that the most appropriate information for carrying out this new approach to planning would be at the local level (Rural Development Unit, 1982) and massive investments were planned in the rural areas to support this view. Several major programs started in the rural areas at this time (Silitshena, 1982) were directed at increased production and coordination of rural development. However, lack of basic spatial information limited the success and sometimes was the basis of failures for many of the programs started. The most difficult programs were those that introduced competition for the basic resources of land and water; required information on the better management and conservation of the environment; or were designed to create jobs and reduce unemployment. Two implications of the new approach to planning were recognized. Firstly, spatial information had to be available at the local level to enable planners to make decisions for local interests. Secondly, all essential information had to be coordinated at district and national levels to make sure the perspective of overall development and planning was maintained. The range of scales required because of the contrasts in spatial activity in different parts of the country, the massive amounts of data to be collected and the organization of that data, and the complex relationships to be analyzed, all required a new technology. Of particular interest was information on land, a key resource in rural areas. In particular the Government of Botswana wanted information on how much land was "free" i.e. unoccupied for new developments. In view of the sparse population, it was expected that a lot of rural land was available for development. On the other hand, in urban, peri-urban areas and large villages, increasing densities of population had created intensive demand for land parcels and better techniques for organizing land information was required to reduce land disputes. Several

efforts were made to improve spatial data acquisition and organization for the new planning approach in the late 1970's and 1980's. It was obvious, however, by the early 1990's that while policy had been successfully developed, no technique had been effective in solving the problems of information availability and relate this to spatial development policy. Land Information Systems (LIS) were deliberately and consciously looked at to solve this problem. The rest of this paper outlines the many efforts that were attempted and why Botswana eventually has focused on the improvement of NSDI as support for better land management.

2. EARLY UNCOORDINATED EFFORTS TO DEVELOP SPATIAL INFORMATION SYSTEMS IN GENERAL

Computerization of spatial data in Botswana was not attempted until recently, but it was properly started with problems that definitely required its use as described above. In other words it was clearly user driven. Efforts to develop coordinated spatial databases in general were made at a very early stage. The most outstanding of these were two. Firstly, as few other countries in Southern and Eastern Africa have done, Botswana attempted to obtain professional advice on the path the national effort to develop geographic information systems in general would take. In 1991 the Government of Botswana engaged a consulting firm to advise it on the proper development path for an effective spatial data infrastructure. The recommendations of the consultants included some very good advice on coordination, standardisation of data, preliminary regulations on data exchange formats etc. etc. Unfortunately, there were very limited skills in the country at the time to clearly follow the advice given. The mandate to develop the national spatial data infrastructure (SDI) was given to the Government Computer Bureau, Ministry of Finance, whose main responsibility up to that point had been to advise Government Departments on the purchase of computers, instead of the Department of Surveys and Mapping, Ministry of Local Government and Lands, which had had a long history in surveying, and the general development of graphic databases. The latter only needed to change to digital data handling. The former was at the time starting the development of a national policy on Information technology. Secondly, lack of coordination between the ministries and the University of Botswana's Department of Environmental Science killed the latter's effort to provide leadership in the development of a coordinated effort to develop GIS in general. A design developed in 1990 as a resource utilization and regional planning information system (RURPIS) (Nkambwe, 1991) attempted to provide an overall framework with four modules which were part of a mega spatial database. Without a coordinated effort and a poor spatial data infrastructure, effectiveness in developing GIS could not be achieved. Instead, individual ministries developed independently, making it impossible to exchange data or create an environment in which lessons learned could provide cumulative experiences.

Although development policy as discussed above was directed at all resources, agricultural, wildlife and water resources have received the greatest attention. These were also the resources whose management would be improved with a coordinated land information system. Instead, each of the Ministries responsible for one of these has developed a special unit for the development of spatial data created in response to the overall effort to shift emphasis from urban to rural development. The Ministry of Agriculture has developed a mega-databases

relevant to agricultural development including sub-databases of soils, vegetation various climatic variables, range resources etc. etc. The soils database was based on extensive fieldwork reported in several volumes carried out with technical and financial assistance from the FAO. The Botswana Range Inventory and Monitoring Project (BRIMP) carried out with assistance from the British Department for International Development (DFID) office has been one the most significant projects in setting up a system that can be used to monitor range resources with remote sensing and GIS (Lindsay et al., 1998). Since the livestock industry is the most important economic activity in the rural areas, the evaluation and monitoring of the country's range resources made a significant contribution to understanding the potential for rural investments after a number of errors had been committed in this regard. However, field application of the results from this research requires information on land ownership and lack of this information has limited the effectiveness of its scientific success. The Department of Water Affairs (Ministry of Mineral Resources and Water Affairs), with the assistance of Swedish International Development Agency (SIDA) used GIS to develop a National Water Master Plan which included a model of water consumption patterns with population growth throughout the country. Although the original database was re-designed from the mid-2001, the basic concepts in spatial data management for planning water resources were important in improving data organization for rural development. The Department of Wildlife and National Parks (DWNP) (Ministry of Commerce, Wildlife and National Parks), engaged consultants to work with the Department's local staff to develop spatial databases on wildlife resources, mapping out important fauna and flora. The information so obtained has been used to promote rural community-based natural resources management under which local communities are assisted to manage their own resources, especially wildlife, with the proceeds from the management being used for developing the local community in question. Of the Departments directly dealing with land resources and ownership, namely, the Departments of Town and Regional Planning (DTRP) (for planning settlements in general); Lands (for the allocation of land parcels), and Surveys and Mapping (for surveying and demarcation of land parcels) attempted to develop spatial databases but without coordination. In particular DTRP has used GIS to plan individual settlements and to organize data for the country's National Settlement Policy which promotes the development of rural settlements by linking them to bigger settlements in a hierarchy that is supposed to ensure greater access of rural areas to services and national commerce. Working in isolation, however, without coordination with the other Departments reduced the usefulness of the databases developed because they could not be linked to other available information relevant to the planning of settlements and their hierarchy.

3. LAND INFORMATION SYSTEMS AS A BINDING LINK IN BOTSWANA'S SPATIAL INFORMATION NETWORK

The process of development to LIS in Botswana spatial databases is here given some detailed discussion for three reasons. Firstly, while the different ministries insisted on various aspects of spatial data base development on subjects relevant to their various mandates, they recognized that the basic information on land was a special and common element to be developed for all by the Department of Surveys and Mapping. Consequently, LIS has been the starting point for coordinated development of Botswana's spatial data

infrastructure. Secondly, information on land resources and their utilization was critical in the promotion of "social justice" and the desire to increase production under the new approach to planning discussed above. Thirdly the earliest attempts to improve availability of data for planning were on land parcels in villages with the hope that techniques used here could be applied to land parcels elsewhere. However, latter developments have been more advanced in urban and peri-urban areas. LIS development has been complicated by Botswana's land tenure systems. The country has three types of tenure: freehold tenure accounting for 6% of the total land area of the country; State land (national parks, game reserves, forest reserves, towns and townships) which is 23%; and tribal land (customary tenure) which is 71%. Developing land records in the three categories has required different levels of effort. Records of land parcel ownership under freehold tenure have been available for individuals as proof of ownership. Similarly for state land, records and maps to show demarcations and areal extent of different land uses have been in existence for most areas, while in urban areas all land leased had recorded. Because it has been rare to have boundary disputes on freehold, the Government of Botswana has been satisfied with records of title deeds in this category deposited at the Deeds Office in the Attorney General's Chambers. Efforts to develop spatial databases for State Lands have varied greatly. For national parks, game reserves and forest reserves, the main interest has not been in recording land parcels, but the fauna and flora to be found in these sanctuaries. Land parcel information is only obtained as a by-product in developing these databases showing distribution and re-distribution of different species of fauna and flora.

Insufficient and incomplete records on land parcel use or "ownership", in areas practising customary land tenure have been the biggest problem in developing land information systems in Botswana. Although over the years land information for land administration in these areas has improved greatly, it still is not good enough to provide a sound basis for land administration. Before 1968, the tribal chiefs were the custodians and administrators of tribal lands. Their main responsibility was to make sure that all male tribesmen had sufficient land to raise crops to feed their families, build a house and have access to tribal grazing and hunting areas (Schapera, 1943). As long as population numbers were small, and land was plentiful, the information system required to keep data relevant to parcel ownership could be very simple. For tribal land it consisted of the recollection of allocations by witnesses who had been present at the time of the allocation, or recollections by witnesses who had been told about the allocation by those who were originally present. With several generations, layers of informants became unreliable and several disputes over occupancy developed. In 1968, The Tribal Land Act was introduced to improve land information and administration in the Tribal Territories by introducing District Land Boards (with several sub-Land Boards in the sub-districts) which, according to Section 13 (1) of the Act had the responsibility of:

- Granting the right to use any land under each Board's jurisdiction;
- Revoking the right of use from any grantee including those who had been granted land before the Act was introduced;
- Imposing restrictions on the use of land within the area of jurisdiction of any Land Board;

- Hearing appeals, and making decisions on land allocations and disputes

Introduction of the Land Boards improved the information base for land administration in the Tribal Areas because they were supposed to keep a paper folder file for each allocation they made. In addition they encouraged all users of land parcels to get their previous allocations surveyed and recorded. However, the Land Boards have never had, nor are they likely to have, sufficient personnel to record land allocations made over many decades in addition to the new ones they are making. Thus their records are incomplete.

Various efforts were made between 1970 and 1990 to develop techniques and methods that could be used to provide information to solve an increasing number of land disputes (McCormick, 1982; Swedeplan, 1990; Maphanyane, 1993; Zhao, 1993). The earlier of these used very simple techniques such as the visual interpretation of aerial photographs used for updating data on land parcel allocations in Barolong Farms in 1975 and in Kgoro-Bethel in 1980. In the early 1990's more sophisticated methods were used and computerization of data was done as was the case of Maun (SwedePlan, 1990); Ramotswa (Maphanyane, 1993) and Goodhope (Zhao, 1993). Altogether ten pilot projects were carried out. Characteristically, in both manual and computerized efforts, a ward of a settlement would be selected as the starting point of the effort to acquire data and improve the information base for decision making in tribal land administration in a particular area. It was expected in all cases that a follow-up to the pilot would expand the techniques used for the acquisition of data to the rest of the area in question and that comparison would be made among various pilot projects to decide on the most effective techniques for this purpose. Unfortunately, no follow up or comparison among different methods and techniques used were ever made. A lot had been learned in four decades of effort but very little had been achieved in terms of providing an improved database and information for decision making in land administration.

4. CURRENT ATTEMPTS TO MAKE LAND INFORMATION SYSTEMS PART OF A NATIONAL SPATIAL DATA INFRASTRUCTURE

The outline of development given above shows the frustrations in developing improved databases that have been experienced in Botswana. The lessons learned from the various pilot projects did not seem to provide cumulative experience. The fact that none of them were completed as they had been originally designed (i.e. beyond the original ward used to design and test the techniques to be used) left, all these limited the value of the lessons learned even in individual pilot projects. The problems experienced in developing LIS in the 1990's have received a lot of attention recently. The new approach to the development of LIS takes up concerns of spatial data integration and SDI development that were expressed in the early 1990's and makes them the key elements in the development with leadership from the appropriate Department of Surveys and Mapping (DSM). Technological transfer for the development of NSDI has now been focused on this Department. In preparation for a the NSDI, DSM has transformed itself from graphic to digital data and has taken on the responsibilities of creating, structuring, and standardizing and archiving the nation's spatial data. The various divisions of DSM which previously worked independently have been streamlined to produce coordinated and standardised data sets. Surveying (geodetic, topographic, engineering and cadastral); photogrammetric and cadastral

mapping, and the acquisition of aerial photographs for mapping at all scales; all these have been streamlined for the production of standardized data sets. Data for LIS development has been included in DSM's responsibilities to produce standardized data sets for the country and is not being carried out in isolation. Although some resistance still exists to use the data already produced, it is clear that of all the databases that will be developed under the new NSDI, LIS is likely to be the most effectively changed because of its relevance to the strategy to increase opportunities in the rural areas and the necessity to solve land dispute problems in areas of increasing population densities.

5. CONCLUSION

Many lessons may be learned from Botswana's experience to develop an information base for land management over a period of twenty-five years (1975-2000). Firstly, the original isolated simple manual efforts of the late 1970's and 1980's did not have a framework within which they could have provided cumulative experience to improve land information. Latter experiences showed that this was an important consideration. Secondly, it is important to develop some minimal level of skills to use advice on the development of spatial information systems in general. The advice sought by the Botswana Government and provided by consultants at the beginning of the development of GIS in general was used after ten years mainly because technologically the country was not ready for what had been proposed. The most important lesson may be on the importance of a national spatial data infrastructure that may be used by various groups developing spatial information systems. The probable impact of attempting to develop this infrastructure in Botswana has so far shown high positive promise for the overall integration of spatial databases in the country.

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