DESIGNING A LAND INFORMATION SYSTEM FOR RURAL LAND USE PLANNING IN ZIMBABWE:

A Situational Analysis and Feasibility Study Report

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ABSTRACT

The objective of this project was to investigate the feasibility of constructing a national Land/Geographic Information System (LIS/GIS) for the purposes of rural land use planning that would be easily accessed by different stakeholders. Existing institutional structures of organisations that use spatial data were looked at. These were the Department of Agricultural Research and Extension, the Department of the Surveyor General, the Deeds Registry, the Department of Natural Resources, Forestry Commission, and the World Wide Fund for Nature. Issues pertaining to data acquisition, human resources, computer hardware and software capabilities were investigated. The Department of the Surveyor General came out as the leading supplier and source of digital data in Zimbabwe. As a result, it was suggested as the most logical choice for housing the Land/Geographic Information System, and consequently would oversee all issues on digital data.

(Key words: Zimbabwe, LIS/GIS, situation analysis, feasibility)

Abbreviations: Arex – Department of Agricultural Research and Extension; **CBNRM** – Community-based natural resources management; **DDF** – District Development Fund; **DNPWM** – Department of Natural Parks and Wildlife Management; **DSG** – Department of the Surveyor General; **GIS** – Geographic information system; **LIS** – Land information system; **MoLARR** Ministry of Lands Agriculture and Rural Resettlement; **SARDC** - Southern African Research and Documentation Centre; **SARPO** – Southern African Regional Programme Office; **SPTD** – schedule of properties transferred database; **TM** – transverse mercator; **UTM** – Universal transverse mercator; **WWF** – World Wide Fund for Nature

1. INTRODUCTION

Management of information is an important task that is linked to the ability of institutions to make decisions. Important information about land relates to the characteristics of land resources and related productive capacity of the land. This aspect of land management and planning relies on information on soils and soil chemistry, terrain, people's production culture and socio-economic objectives of agricultural production. Each of the aspects in the foregoing is related to many classes of information that can be represented spatially by a number of layers or related maps. Other attributes of land that are important in land management are land ownership, soil type, and slope. Seamless GIS databases are capable of handling different layers, hence making GIS an effective tool in landscape modelling (Mugabe, 1994).

Landscape models are useful tools used in the prediction of changes in land conditions that are a result of human activity. Aerial photographs taken at different periods provide a tool for analysing landscape changes related to land use and ecological phenomena (Avery and Berlin, 1985). Integration of aerial photographs and GIS modelling has enabled analysis and increased understanding of the impact of humans on the ecosystem (Turner and Ruscher, 1988). This could be useful in Zimbabwe where changes are taking place because of the Land Reform Programme.

Information analysis and management is critical to decision-making on land use. Classes of information important to this are parcel sizes, quality of land in terms of production potential, biological and chemical characteristics, and physical attributes of land. Ownership records that identify current ownership by name, economic group, and issues related to gender are important in the process of making decisions on parcel reallocation. The Zimbabwean government has embarked on a land redistribution exercise in an effort to reduce pressure in over-populated parts of the country. This has seen new farms emerging as the large farms are subdivided and redistributed, and consequently the land transaction incidence has increased.

Problems requiring information management services have become more complicated in recent times due to the land reforms taking place. Applications in agriculture now require high-level analytical capabilities for which manual approaches have become almost irrelevant. Analysis of spatial landscape data needs to be integrated into an analysis that has specific applications in economics, land management, and social planning. These are applications that are difficult to manage outside computerised land information management systems (Mugabe, 1999).

Computer applications have improved the quality of information management and its accessibility to users. Computers have increased the capacity to store, manipulate and analyse large amounts of data. Information in computers is easily accessible through query processes. GIS are computerised systems that have a capability of storing attribute data that is linked to the spatial dimension of land (Aronof, 1988). Current GIS technology manages databases on feature attributes in linkage with graphic displays, and analysis of landscape applications into software packages that are user friendly (Kustari *et al*., 1989)

Data is stored in GIS in three-dimensional format, that is *x*, *y*, and *z*. The ability of GIS to handle three-dimensional data makes it a suitable tool for analysis of landscape data (Muzik, 1988). Three dimensional digital terrain modeling in GIS has been very useful in watershed analysis where elevation and slope are important factors (Jenson and Domingue, 1988). The usefulness of GIS is further enhanced by computer capacity to analyse data at high speeds. GIS enables users to capture change without changing the whole map, as is necessary with paper maps. Applications benefiting from GIS data management and analytical capabilities are many and varied. It is a tool that can handle data from fields such as economics, agriculture, and social sciences. The data is stored in a manner that it can be queried for various applications that include feature attribute display. GIS can perform calculations that are important in data analysis. The length of a portion on a road, river or other linear features can be calculated easily. GIS can also calculate areas of different shapes of features (Environmental Systems Research Institute, 2000). The versatility provided by GIS for spatial data manipulation, storage and retrieval on request makes it an appropriate tool for the Fast Track Land Reform process currently underway in Zimbabwe.

In Zimbabwe, activities on managing data related to land management are predominantly manual. The Office of the Surveyor-General handles data related to land use, aerial photo coverages of the nation, and is responsible for production of maps covering a broad range of themes including, agricultural production, relief, urban development, land classification, climate, and land use. Most of the information is currently in hard copy, however the department is in the process of converting the hard copy maps into digital format Manual processes of managing land information present problems related to capacity of handling large amounts of data, and the difficulties of updating such information. It is not easy to change information related to an individual parcel that appears with other parcels. If one farm changes ownership, a new ownership map would have to be generated to reflect this change. This can be easily overcome by operating a digital spatial database. As noted above, GIS provides an advanced tool to capture, manipulate or analyse and string spatial data. This functionality replaces the tedious process of overlaying various maps in land analysis (Wolfe and Neale, 1988).

2. STUDY OBJECTIVES

The goal of this study was to investigate the feasibility of constructing a GIS/LIS for the purposes of rural land use planning by looking at the existing institutional set-ups that use GIS and other forms of spatial data analysis in the country. Data acquisition, human resource capacity, computer hardware and software capabilities were considered in the study.

The specific objectives were to:

a) Identify and assess types of information that are important for land use planning processes and activities, and other applications of LIS;
b) Identify digital and analogue data sets that have relevance and application in land use planning;
c) Determine the technical or institutional issues, if any, which would impede the co-utilisation of existing databases;
d) Define the structure of LIS for rural land use planning constructed from existing data bases (i.e. what layers would it contain) and specify what rural land use planning questions could be addressed with such an LIS; and
e) Identify data gaps that interfere with efficient application of LIS/GIS in land use planning activities, and how they could be dealt with.

3. METHODOLOGY

Data collection started with a stakeholder workshop that focused on the study objectives. Participants at the workshop were drawn from organizations, which, from our experience, had been part of a GIS network that existed in Zimbabwe before the study commenced. The network was used for sharing ideas and carried out seminars and discussions on GIS applications. It was coordinated from the Institute of Environmental Studies of the University of Zimbabwe.

Respondents to interviews were selected at national, provincial, and local area levels and selected on the basis of their knowledge and involvement in the land reform and planning activities. These interviews were carried out partly to obtain information on activities dealing with land reform and land use planning. It was also done to get views on information requirements for application of LIS and GIS in rural land use planning. The research process sought to establish possibilities for collaborative work, and integration of data acquisition and analytical activities.

An inventory of existing LIS/GIS, and data layers already developed by public, NGO, and other organizations, which would have relevance for a rural land use planning LIS/GIS was compiled. This task was done in collaboration with the Ministry of Lands Agriculture and Rural Resettlement (MoLARR), Forestry Commission, Department of Natural Resources, Deeds Registry, and World Wide Fund for Nature (WWF).

The foregoing process was also used to identify data and information requirements that could not be satisfied locally. Questionnaires were used to collect more quantitative information that included hardware capacities, staff numbers, levels of training, and periods of relevant experience in the organizations. They were used to document data requirements and sources of information by organisation. Key informants in the data collection process were from the Department of the Surveyor General (DSG) Harare and Bulawayo offices, Deeds Registry in Harare and Bulawayo, Geological Survey, Forestry Commission, WWF, Ministry of Lands Agriculture and Rural Resettlement and the Department of Physical Planning.

4. FINDINGS

The data collected revealed that there are organizations whose primary activities were related to production and generation of information that fed into digital data production. Other organizations were grouped as users of information. In this study we worked more with organizations whose legal mandate was to generate spatial data, although some effort was spent on data user organizations. This section outlines findings from each of the organizations that participated in the study.

a) Department of the Surveyor General

The DSG falls under the Ministry of Lands Agriculture and Rural Resettlement. The Department was established through an act of parliament, the Land Survey Act (Chapter 20:12). The Act outlines the duties of the Surveyor General as well as those of land surveys; it also outlines the procedures for the survey of land for registration of title in Zimbabwe. The DSG's main responsibility is to supervise the survey and charting of land in Zimbabwe (Rugube *et al.*, 2003). The Department is divided into Administration, Research and Development, Geodesy, Cadastral, and Cartography sections. It compiles geodetic, photogrammetric, cadastral and topographic layers. Cadastral data is predominantly analogue. The few layers that are in digital form are in the Universal Transverse Mercator (UTM) projection system and the analogue compilations are in Gauss (metres).

The Department collects data from various sources, which include aerial photography, land survey, satellite imagery and global positioning systems. They share data with any organisation that is prepared to honour copyright requirements. Data is sold in the form of maps and aerial photographs to members of the public. The Department generates digital data using aerial photographs and maps. Themes captured by this are administrative boundaries at international, provincial, district, and local area classifications, topography, land use, and cadastral sets that are in field or source books. Source books are field books that the surveyor records all measurements done in the field. A summary of the data available at the DSG is shown in Table 1.

The Geodetic and Cartographic sections of the Department frequently update their information outputs. Most of the data they generate is now digital. This is converted from aerial photography mainly. Metadata bases that are regularly updated exist in these sections. The Geodetic section updates its database as soon as changes are made to the geodetic coverage in Zimbabwe and the Cartographic section updates its maps after each aerial photograph coverage of the country. This is supposed to be done every five years. The last full coverage was done in 1997. Tables 1 and 2 show the classes of data that are available from the Surveyor General's Department.

Table 1: Data layers available in the Cadastral and Geodetic sections of the Department of Surveyor General

Data layer	Scale	Ref. System	Format	Date of production	Data source
Cadastral layers	1:1 250;1:2 500; 1:5 000; 1:10 000; 1:25 000: 1:50 000; 1:250 000	Gauss/UTM	Analogue and digital	Continuous	Field surveys
Administrative boundaries	1:1 250 to: 1 000 000	Gauss	Analogue	Continuous	Local government
Town survey marks	1:1 250 to 1:5 000	Gauss	Analogue	Continuous	Geodetic branch
Trigonometric beacons	1:10 000 to 1:50 000	Gauss	Analogue	Continuous	Geodetic branch
Servitudes and boundaries	1:1 250 to 1:50 000	Gauss	Analogue	Continuous	Field surveys
Electoral boundaries	1:30 000 to 1:250 000	Gauss	Analogue	Every 5 years	Registrar General
Trigonometric beacons	National	UTM, Gauss, Geographical and WGS 84	Analogue and digital	Digital from 1998	Field surveys and DSG archives
Benchmarks	"	"	"	"	Field surveys, DSG archives
International boundaries Zim	"	"	"	"	Field surveys and boundary
Town survey marks	"	"	"	"	Beacons and relevant international treaties

Table 2: Data layers available in the Cartographic section of the Department of the Surveyor General

Data layer	Scale	Ref. System	Format	Date of production	Data source
Roads	1: 1 000 000	UTM	Digital	On going	Ministry of roads
Relief and streets	1:1 000 000	UTM	Digital	On going	Geodesy
Land classification, soils and natural regions	1:1 000 000	UTM	Digital	On going	MoLARR
Administrative	1:1 000 000	UTM	Digital	On going	Physical planning
Tourist map	1:1 000 000	UTM	Digital	On going	Natural resources
Aeronautical map	1:1 000 000	UTM	Digital	On going	Civil aviation
Vegetation and woody cover	1:1 000 000	UTM	Digital	On going	Forestry commission
Population map	1:1 000 000	UTM		On going	Central statistics

The Department is being commercialised. The commercialisation process has seen the Department moving towards provision of demand driven services and products. This makes it difficult for them to satisfy some of their statutory obligations that may not necessarily be profit generating. Some activities that have suffered due to this are production of adequate maps for educational purposes, and production of maps adequate for government operations.

The Department has pride in being the sole custodian and owner of spatial information in the country. It determines the types and nature of symbols used in publication of maps. Their symbols provide a guide that organizations producing maps should follow strictly. These are used in representation of map features like scale, rivers, mountains, roads, footpaths, boundaries, and settlements. They manage the process of adaptation of international cartographic standards in Zimbabwe. They also administer copyright regulations as they apply to circulation of spatial data contained in maps and other forms of digital information.

Enforcement of copyright law is handled through an officer who advises the public and other members purchasing data on restrictions to circulation. This is just information on what could happen in the event of illegal passing of data to unauthorised users. This falls short on the follow-up that would be necessary in enforcement of such regulations. There is a requirement that makes it a responsibility of individuals to notify the Department when they come across maps circulating outside copyright provisions.

The Copyright Act authorizes use of digital data in organizations outside the DSG upon payment of purchase fees, or annual licence fees, whichever is applicable. The DSG can use digital data internally. Conversion of data from analogue to digital should only be done with permission from the DSG. The DSG permits organizations to go into special arrangements with it for manipulating data. The Forestry Commission has taken advantage of this and obtained a permit to produce vegetation data including baseline features like roads, railway lines, topography and administrative boundaries in digital format.

Procedures for updating maps have been established in the Department. All new cadastral data coming into the Department is incorporated into map compilations. The same is done with geodetic data. Boundary maps are updated when descriptions change. All updates done to maps are also done on digital data sets. The Department enforces accuracy standards on their products. All data that comes out of the Department must comply with these accuracy requirements. All maps are checked for accuracy before they are passed for circulation. When the required updates to maps are found to be accurate the data is captured and changes on maps are effected. The system for updating maps is still being developed. Old maps are all backed up in digital format during updating.

Admissible error ranges on manually drawn points placed on maps should not exceed 10 mm in terms of variation from verified actual location. Root Mean Square Error on digital data is limited to 0.025. This is a statistical measure of error which is obtained from the square root of the total sum of the deviation of points from their true position. Accuracy and quality are maintained across the organisation through adherence to minimum standards.

Information that is of importance, especially that concerning state security, such as maps showing military bases, is highly classified and confidential. Only a selected group of civil servants is allowed to have access to that type of information. This category includes descriptions of other sites that are regarded as security risks. The Official Secrecy Act controls circulation of security information.

Geodetic data has an error margin of a maximum of one centimetre for Gauss and UTM, and three centimetres for latitude/longitude positional coordinates. Data is categorised into primary, secondary, tertiary and quaternary classes. Heights are given to a maximum of 1 cm and 10 cm for trigonometric beacons. The Geodetic section has a statutory obligation to collect and update national geodetic data. The data held by the DSG falls short of the complete set that they should hold as per the provisions of their statutory requirements. Some cadastral and topographic maps have not as yet been converted to digital format as required. This operational problem is due to insufficient funds being made available to the Department by the government treasury. The Department concentrates personnel efforts on production of items that clients require the most. Much less effort is put to production of data for public and national interest. With the land reform exercise by government, the Department has put focus on some areas that are considered problem areas.

The DSG is part of a nation wide public service network that links all government departments to the Ministry of Finance. All organizations consulted DSG for the supply of spatial data. This means that there is an existing network of partnerships that could be enhanced for increased functionality. The Department has not yet undertaken a survey of information requirements by their clients. This means that the DSG is not able to tell gaps in the data they provide and how it could be improved to meet specific requirements of their clients. Their knowledge of the size of their market is just based on purchases and enquiries handled through its office.

Sale prices for DSG products are set by the Department and are sent to the MoLARR for approval. This can be a long process, in some cases it has not been efficient. We observed that consumers of digital data were still very few. The small size of the market means that consumers have not started to benefit from economies of scale, consequently data was still relatively more expensive than it could be. Users continued to share information illegally because of the high market prices that made costs unbearable, especially for small users.

b) Deeds Registry

The Deeds Registry falls within the Ministry of Local Government, Public Works and National Housing. It is mandated to keep records of all land transactions in Zimbabwe. The Registry receives information from lawyers, building societies, chartered accountants, individuals and anyone involved in land transactions. They supply information to anyone who would like to use it. Their information system, be it manual or digital is public domain. Any interested party only needs to pay a search fee to access information. Information at the Registry is descriptive and is on the transactions that take place on land parcels. The bounds of the land parcel are stored in the form of a cadastral diagram at the DSG Cadastral section. Diagrams and descriptive statements are used to differentiate land parcels.

The Registry has both manual and digital systems. The digital system has two databases, the Alpha and Oracle systems. The Alpha system replaced the manual indexing system and the Oracle database is the digital land register that replaced the manual registers. There are data capture clerks whose job at the Deeds Registry office is to enter data into these database systems. Data is derived from the deed itself. The land register keeps a record of all transactions that may have occurred for a particular land parcel. This means that although the Deeds office has digitalized its land register and indexing system, it still has to digitalize the transaction process, which includes the workflow of a deed of transfer across the board up to the storage of the deed at the Deeds Registry.

The processing of the deed of transfer, from buying to final transfer and storage of information, can take up to three months. A deed lodged with the Deeds office will take eight working days to process. This information when lodged with the office is examined to see whether it complies with the Deeds Registry Act and the Deeds Register Regulations. The Deeds Registry office has a very impressive quality control and compliance system in operation.

The office runs a back up system for digital information. Deeds are manually filed and there is no electronic storage for these. The Alpha database is backed up weekly and the Land register is backed up when the storage space on the server has reached a certain level. These back up copies are kept off site. The back up system is, however, not adequate, it only effectively backs up the indexing system and does not take care of the most important component of the Deeds Registry process.

The Deeds Office maintains some confidential data sets. These include the statistics database, which includes all land transactions, and their value, and the schedule of properties transferred database (SPTD). These two databases are in Microsoft Access.

The Registry has never done a user needs analysis. This is a very important department in terms of land transfers and property holdings in the country. No other organizations hold the type of information they have. It was reported that it might be a good idea to improve the applicability of the Registry's information; regular consultations with clients could help in this direction. Price adjustments at the Registry have to be approved by the Ministry of Finance but this usually takes long.

Most of the data available at the Deeds Registry is that pertaining to property of people with money to purchase property for investment purposes. It is not a good idea to subsidise the production and sale of this information since the clients can afford to pay for it. The Deeds Registry is one of the biggest revenue collectors for the national treasury.

c) Forestry Commission

The Forestry Commission is a Government Parastatal falling under the Ministry of Environment and Tourism. The Commission runs commercial forest operations including nursery establishment and logging, and also has a State Forest section that deals with Community Forestry and extension. Compilation and maintenance of an inventory of national vegetation resources is an activity that is handled by the research section at the Commission's head office. This activity has expanded in the last few years to include mapping and production of digital data, and analogue analytical vegetation maps. The list of maps identified at the Commission is given in Table 3 below. They hold a very comprehensive metadata base in digital format for all maps they have produced.

Table 3: Data available at the Forestry Commission

Data System	Scale	Reference production	Format	Date of	Data source
Woody cover map	1:250 000 1:1 million 1:3 million	UTM TM TM	Digital & Analogue	1996	Land Sat TM 1992, aerial photos 1992 and local knowledge
Land classification 1st phase resettlement	1:1 million	TM	Digital & Analogue	1995	DSG
Agro-Ecological zones	1:1 million	TM	Digital & Analogue	1995	DSG
Vegetation type maps	1:2.5 million	TM	Digital & Analogue	2000	Wild and Barobosa 1968/VegRis 1996
Rivers & roads topographical maps	1:1 million	TM	Digital	1994	DSG
Silvicultural zones	1:3 million	TM	Digital	1995	DSG

As shown in Table 3, the Forestry Commission obtains most of their data from DSG, Spot Image, Satellite Application Centre in South Africa, District Development Fund (DDF) and the MoLARR. The DDF is a unit operating under the Ministry of Local Government. It has a specific function of land use planning in communal areas. The other activities of the DDF relate to development projects like road construction, water development, provision of rural amenities, and planning of settlements. The unit produces maps and spatial data that is meant to service their activities and interests.

The Research unit at Forestry Commission has in the past produced data for requirements by environmental consultants both local and foreign, international educational institutions like International Institute for Geo-Information Science, and Earth Observation (ITC) Holland, three German institutions, forest companies, and government departments. Most of their activities in vegetation maps are in response to requirements by clients who are expected to bear the full cost of the activity. The clients also own the products they fund. Circulation of data paid for by a client can only take place with the permission of the respective client Mapping is not a primary activity at the Commission. Production of updates is dependant on client requests and preparedness to pay.

The DSG and Forestry Commission have established protocols for sharing data and these are guided by formal agreements. Forestry Commission relies on other organizations like DDF for primary data that they use for baselining maps. This brings about problems related to data compatibility and raises questions on accuracy. Accuracy of Commission maps varies between 80% and 90% depending on resolution. High resolution maps are more accurate than the low resolution maps. Symbols used correspond to those adapted by the DSG. The Forestry Commission has strict quality control requirements on data and accuracy that are taken very seriously. All data that is obtained from other organizations goes through accuracy tests and verification before internal use.

There is a high demand for vegetation data by organizations working in areas of ecology and agriculture. Government departments requiring this type of information include Arex, Department of Natural Resources, and the Agricultural and Rural Development Authority. The University of Zimbabwe requires vegetation information in teaching. The WWF uses this data for ecological analysis. A number of NGOs in the environmental sector need this data as well. Data is available at very high costs at the moment. Some of the remotely sensed data that the commission has is quite old and most organizations are unlikely to buy it for analytical work.

d) Worldwide Fund for Nature

The WWF is an international non-profit organisation with a mission to save life on earth. Central to their mission is the strategic approach to accommodating nature in sustaining human livelihoods. Management of ecosystems, human and ecological interactions, and environmental governance are issues central in the design and execution of their activities. In Zimbabwe, they have been very active in the management of the Zambezi River Basin, an ecosystem that is marginal and fragile. This is a region rich in hardwoods, and providing a habitat to a wide range of wildlife species. They have also done work in many other parts of the country and continue to hold interest in the expansion of their natural resource conservation programme.

Among the data sets are [illegible] metadata base held in Microsoft Access, which is over 15 megabytes in size, conservancies, for[illegible]eas, CBNRM areas, livestock densities, large herbivore distributions, veterinary fences, tsetse [illegible] and major minerals. The data sets that are available are shown in Table 4. There is a comprehensive metadata base of all the information that is available at the WWF Harare office. Most of their data is obtained from detailed studies by scientists, and produced as maps overlaying baseline data sets from the DSG as such there is a feeling that there should be a data custodian for the nation so that data can be readily available to the public at an affordable price through government. The WWF has undertaken a national survey of commercial farms in Zimbabwe with an ecological characterisation on the basis of soils and eco-regions. GIS maps have been generated and these are held in their digital database.

Table 4: Data layers produced at WWF-SARPO

Data layer	Scale	Ref. System	Format	Date prod.	Data source
Cities	1:1 million	TM/lat long	Digital	1998	Acheological Data Services (ADS)
Wetlands	1:1 million	TM/lat long	Digital	-	ADS
Vegetation	1:500 000; 1:250 000;1:50 000; 1:5 000 000	TM/lat long	Digital	Varied 1996-98	Cunliffe & Timberlake, Flora Zambezia, Whites, WWF-USA, WWF-USA
Rainfall	1:2 500 000	Lat long	Digital	1996-98	DSG, Hussein (Agroclimatological analyst)
Protected areas	1 1.2,3.5 million	Lat long	Digital	-	ADS, Alcom (DNPWM), DSG, UZ, Vet Dept, WWF
Butterflies	1:1 000 000	Lat long/utm	Digital	1998	A Gardener & McKinnon
Amphibians	1:2 000 000	Lat long	Digital	1997-98	Meussian & Crowe
Rivers	1:1 million; 1:25 000; 1:50 000	Tm, Utm, Utm	Digital	1995-2000	DSG, ADS, MOE (Nam) AGRITEX, WWF and UZ
Soils	1:50 000	Lat long	Digital	1996-98	Hunley & Walker, DR & SS, WWF, UNESCO, FAO, ILRAD, Vet dept.
Railways	1:million; 1:250 000	Lat long	Digital	1998	ADS
GMAs	1:3 million 1:500 000	Lat long	Digital		DSG, FAO, Alcom, Baison, WWF, FEWS
Powerlines	1:250 000	Lat long	Digital	1998	ADS
Wards	1:250 000	Lat long	Digital	1995-1997	DR & SS, Cunliffe and Timerlake, DSG, WWF, FEWS
Land tenure	1:1 million	Lat long	Digital	1996-2000	Anderson, DSG, WWF, UZ, CSIR
Elevation	1:250 000	Lat long	Digital	1995-1998	DSG, Vet, ADS, WWF, UZ
Catchment	1:1 million	Lat long	Digital	1996-98	FAO, Alcom, DSG, WWF-USA, Whites

The WWF obtains most of its baseline data from the DSG, Central Statistics Office, DNPWM, Forestry Commission, and Geological Survey. The data is not collected on synchronised time periods and differs in terms of thematic focus. Organizations receiving data generated by WWF include Central Statistical Office, IUCN-ROSA, students the world over, CIRAD (a French research organisation working on rural livelihoods and management of natural resources), Southern African Research and Documentation Centre (SARDC), and DNPWM.

The WWF carries out surveys on an annual basis. Information generated from the foregoing is used to update data held in form of digital maps. This makes them one of the few organizations with data that is current. The process of editing is responsive to the requirements of other sections of WWF. Requests are made to the GIS unit from respective user sections and the process of editing is done on that basis. The WWF has a policy guiding distribution and use of their data. This policy deems all information produced by WWF confidential. There are provisions for sharing and purchasing data from WWF that are clearly

spelt out in the policy framework. Users of data are, among other things, required to acknowledge the source of data as WWF.

Symbols used on WWF maps are borrowed from the DSG. This makes it easy for collation of baseline data that WWF gets from DSG Data produced by WWF is required to have an accuracy level of not less than 90%. Management of data quality is a final responsibility of the head of the GIS unit.

The feeling within WWF on the value of information is that information should be shared freely. They advocate for a pricing system that facilitates payment of the GIS staff rather than cost recovery on the production of the data since the data will have been paid for by the projects. Ultimately they want to help foster a data sharing culture in Zimbabwe and Southern Africa.

e) Agricultural Research and Extension

The Department of Lands and Rural Resettlement falls within the MoLARR. The Department has sections, which include those undertaking activities in mapping and planning. The planning section is responsible for allocating land to specific activities while the mapping section captures the distribution of these on paper for visual analysis. Village and other forms of area plans are captured on maps as well. Their responsibility spans across all facets of rural land use planning. They mainly produce farm plans, ward plans and village plans, at representative fractions ranging from 1:12 500 to 1:25 000. They get most of their basic data from Arex, a sister organisation in the MoLARR. Organizations getting data from them include the DSG, Rural District Councils, Ministry of Local Government. Department of Water and Sanitation Department of Natural Resources, NGOs, and community members.

Maps are drawn manually and there is no digital processing. The department still goes through the painstaking process of manually updating maps as and when necessary. The map filing system used is manual as well. There is no felt need for improving the system. Employees in the Bulawayo office felt the system in place was adequate for the activities of the Department. This suggests that the biggest benefit they get from GIS and computerised processing of data is improvement in the quality of outputs and efficiency.

It was felt that information available from other organizations in the country is adequate for the operation of the planning section. However the section experienced problems related to currency of data obtained from the DSG. It also noted that data from the Forestry Commission was produced at a resolution that is too coarse for detailed ward and village planning and analysis.

The Chief Agricultural Extension Officer in Arex handles requests for data produced by the planning section. This is the office that decides on release of information to the public and manages information distribution. The information sharing process is not formalised, and copyright procedures are handled through provincial Arex heads.

Symbols used on hard copy maps produced in both the planning and mapping sections are borrowed from the DSG. There are variations in colour symbols but these do not distort information represented by signs or symbols. The Department has some computers to run a GIS unit but staff attrition and failure to train have kept this on hold for a long time.

The Department is historically an agricultural extension unit. This has meant that its staff complement is largely in the technical fields of agricultural sciences. Qualification levels range from first degrees to Masters level. The Department trains spatial data analysis and management to all its new staff members. This is part of the technical skills officers get on joining the Department.

An assessment of the client base is necessary to focus activities and outputs of the Department. Such a survey would tremendously improve the processes of planning. The Department has never done a user needs analysis and so does not fully know the extent of their clientele base. It is central government dependent and so produces information on request from other government departments. It has not seen a need to do a user needs analysis because it is a monopoly in the provision of plans for rural land use. Its client base is mainly composed of communal farmers who can barely make ends meets and so the Department feels that its information should be subsidised to make it affordable to clients.

f) Geological Survey

The Geological Survey is under the Ministry of Mines. It is mandated to collect, store and maintain all data pertaining to the geological formations of Zimbabwe. The Department has two sections that deal with spatial information; these are the cartographic section and the data management section. Most of the data they deal with is obtained from the DSG, companies and other government departments. All the data at the Geological Survey is in digital format as well as analogue format. There is a metadata base, which is maintained in separate database software on the departmental server. The data maintained at the Geological Survey is as shown below in Table 5.

Table 5: Data layers supplied by the Geological Survey

Data layer	Scale	Reference System	Format
Geology	1:1 000 000	UTM/latitude/longitude	Digital-SHP
Regional geology	1:100 000	UTM/latitude/longitude	Digital-DXF
Rivers	1:1 000 000	UTM/latitude/longitude	Digital-MIF
Roads	1:1 000 000	UTM/latitude/longitude	Digital-MIF
Faults	1:1 000 000	UTM/latitude/longitude	Digital-MIF
Towns	1:1 000 000	UTM/latitude/longitude	Shp,DXF,MIF
Mines	1:1 000 000	UTM/latitude/longitude	Shp,DXF,MIF
Border	1:1 000 000	UTM/latitude/longitude	Shp,DXF,MIF

The Department supplies data to mining companies, educational institutes, government departments, the military the police, United Nations organizations, geo-sciences organizations, local and international libraries, local authorities, and individuals. Most of the data is at a scale of 1:1 000 000 but it can also deliver at any scale required by the client. Its data is in digital form and so it is easy to produce it in hard copy at any scale. The data include geological maps as well as exploration data.

The data that is produced by the Department is mainly supplied by the DSG, Department of Water, mining companies and primary sources such as surveys by geologists. This data is obtained mainly in analogue format but is converted into digital form. The Department has a comprehensive updating process because it is mandated to keep up to date data on the geology of Zimbabwe. The Department queries the database for expired exploration permit orders (EPOs) and also takes note of new EPO applications so that these are plotted onto an updated EPO geological map. To ensure accuracy all digitising maintains a maximum RMS error of 0.025. All members of staff involved in the collection, processing and presentation of geological data in the Department are responsible for quality control. To ensure greater accuracy on the 1:100 000 and 1:1 000 000 scale, they work from a larger scale topographic map.

The Department feels that the information system, staff members included, it has is adequate for its purpose. The metadata base is maintained within the spatial database and this database is resident on the departmental server.

5. DISCUSSION AND RECOMMENDATIONS

Globalisation has seen the dawn of an era driven by technology and knowledge. These developments have called for necessary integration of existing information systems to take advantage of economies of scale and give broader choices to users. Development of GIS, particularly in Zimbabwe, is purpose-specific and affects lives of very few people. It is important that at this stage where everyone is moving towards integration of information systems for effective management of resources that informed policy debates should take place. It is important to realize the full potential that GIS has and how this could be applied to benefit the population of the country in terms of cheaper access to more accurate data that is easily reachable to them.

Activities of the government departments cited in this paper are far reaching in terms of sectors of the country's society that deal directly with them. Participants in all these sectors require a more efficient and

reliable service sector. Introduction of fully-fledged GIS applications would benefit more people than is currently the case. The public sector, which through its creation has a social mandate to provide baseline spatial information for public use, is highly fragmented. There are different government arms dealing with land and land information in Zimbabwe. To further complicate the situation these departments are housed in different ministries, which have different objectives. This results in competition for clients and increased costs of generating data through duplication of activities.

The DSG is on an aggressive commercialisation drive. It has begun operating on a cost recovery basis. Individuals interviewed said that information distributed should be at break-even cost to offset inefficiencies created by lack of funding from the national fiscus. It was further suggested that the allocation of funds should consider the whole stream. For example, in the process of registration of a deed of transfer, the Deeds Office, which is one of the largest revenue collectors for the country's treasury, obtains data from the DSG. For a deed of transfer to be issued there is need for a document that accurately describes the land parcel that is being transacted. A deed of transfer that is submitted into the deeds office has to have a cadastral diagram produced by the DSG. Most interviewees felt that it is important for those involved in ensuring that a deed of transfer is registered are paid with costs being shared proportionately by all departments involved. For example, the DSG does most of the work in the registration of a deed but the Deeds Office collects all revenue from a deed of transfer.

Funding is an important element to development of LIS from existing data layers. It is important to identify key result areas such as the survey and charting of land for registration and fund these separately. These should be the areas that increase efficiency in information management for purposes of land use planning. Not all users of digital data need subsidies to access it. Users that can afford to pay for services and those that need public support should be identified and differential pricing implemented.

Policy in the development of information systems should dwell on legal issues, financing, copyright, standards, data quality and cultural issues. Policy will determine the effectiveness of GIS/LIS applications in Zimbabwe. Development of the GIS policy framework should take into consideration acquisition of data, standards, and how cost saving approaches could be taken in the public sector. The overall impact of wholesale application of GIS as a data management approach will streamline the institutional framework in spatial data handling in Zimbabwe. This process will make some effort redundant due to its ability to update maps with faster speed and better precision. In the long run, the system should be able to absorb the initial capital costs. This is capital spent on acquisition of equipment and training of personnel. Benefits from a more efficient system will outweigh this cost in the long term. It will, therefore, be possible to reduce the number of people working in spatial data development. This might lead to a reduction in government departments involved in this activity.

The application of copyright law continues to be highly theoretical. Data still informally moves around within and across many institutions. Appropriate technology, data quality, data acquisition, and distribution are guided by standards. According to the Land Survey Act, land surveys are deemed a correct representation of the dimensions of a land parcel if and only if they have been inspected and passed by the Surveyor General. In Zimbabwe, there are several operational spatial databases within organisations such as the DSG, Geological Survey, Forestry Commission, civic organisations and the private sector. Production of geo-spatial data in Zimbabwe is characterised by examples of problems that hinder integration of information systems for rural land use planning. These problems stem from inefficiencies due to incompatibility, lack of interoperability and portability, resulting from a lack of or use of existing standards.

It is important for GIS experts to agree on some level of tolerable error beyond which data is deemed unacceptable. This is most applicable to situations where organizations generate digital maps of their own through digitisation in a number of ways. There is need to satisfy the requirement of accuracy standards. This also goes with currency of data. All digital data generated by such secondary methods should indicate date of truthing.

The scenario outlined above illustrates that formulation of standards and their implementation are logical pre-requisites for development of LIS for rural land use planning in Zimbabwe. Researchers and policy makers should review lessons from other countries in order to formulate appropriate standards for

Zimbabwe. Information users in a small market like Zimbabwe are likely to benefit through centralized purchasing processes that buy in bulk, and hence reduce costs. This is the case with remotely sensed satellite data. Costs in the market are high and it is the rich users that can afford to purchase data. Public users such as university departments cannot get data for student training because of this problem. This aspect of the process of acquiring data needs urgent attention.

It is apparent that all the organisations that produce or use geo-spatial data use baselines from the DSG; therefore, the DSG is the most appropriate organization at which any LIS could be developed. Other organizations that have appropriate data sets could be part of the network that has its hub at DSG. Planners could, therefore, access all the data they need from any one of the organisations connected to the LIS/GIS network. However, it was also suggested that Zimbabwe has distributed databases that are independent of each other but not duplicated. Supported with the evidence that all spatial data production is dependant on the DSG as well as by the law, the DSG would be the most appropriate organization to supervise conformity to geo-spatial data standards in Zimbabwe. Some datasets that have been reproduced by civic organisations could in future be produced by the public sector. The DSG could take up the role of coordinator and be a repository of records of data available in the country.

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