

Botswana – Department of Surveys and Mapping (DSM) Cadastral Information System

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SUMMARY

Botswana (DSM) is a government department within the Ministry of Lands and Housing. DSM was established to carry out Cadastral, engineering and geodetic surveys and produce topographic and thematic mapping.

DSM is also responsible for:

- Providing basic attribute and Geo-spatial data and information to Government, private and public users.
- Providing GIS derived products for several non-Technical departments within Government of Botswana (GOB).
- Advising on National and International boundaries.
- Responsible for delimitation, survey, demarcation and maintenance of the above boundaries.

The digital cadastre system for DSM, developed by Swedesurvey and QSIT, came after a comprehensive analysis for the current resources and legacy system and their set objectives, their current business' needs, which helped reach a precise image for the required system covering the agency needs being:

- Upgrading DSM technological capabilities by establishing a GIS based enterprise cadastral information system.
- Employing the state-of -the art technologies to allow for richer, faster and more accurate operations for handling the national cadastre survey and parcel management.
- Providing an integrated cadastral, geodetic and topographic database in place, which facilitates the provision of geographic information for cost-effective use in society.
- Providing the latest technology for interfacing to survey instruments and processing of surveying computations.
- Providing land information in various ways using the modern GIS tools and delivering them to different organizational levels for the purpose of municipal planning, and land reform for supporting decision-making.
- Training and qualifying DSM personnel from all sections through a comprehensive capacity building plan.

At the end of the project, the Department will have established standards and the design for all spatial databases and elaborated efficient systems for data dissemination and data capture.

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1. INTRODUCTION

The Cadastral System in Botswana is basically a fixed Boundary System controlled through the Land Survey Act and Regulations, similar to similar to the South African, Zimbabwean, Zambian and other Southern African countries. Botswana has three different types of Land Tenure over varying land areas; the Tribal or Communal Land (71%), State Land (23%) and Freehold Land (6%).

Over the years, albeit many surveys mainly over state and freehold land, the cadastral Information collected continued to be stored in analogue format both at the Department of Surveys and the Deeds Registry. As the pressure on land increase in all categories of land tenure, that is including the Tribal/Communal land it became necessary to legislate for a hybrid system of survey that permitted sporadic/piecemeal and systematic surveys in the rural areas. This meant that single or several existing pieces of developed or virgin land could be surveyed without planning or an approved layout plan of a few or several plots could be produced and implemented, especially in localities declared Planning Areas.

With cadastral surveys and the registration of surveyed rural land, under common law, and the its resultant qualification for use as collateral security in procuring loans for residential, and other developments, many surveys were carried out. This growth was also speeded up by Governments' decision to establish a guaranteed scheme for loans meant specifically for development that ensures the provision of shelter.

With a view to creating an enabling environment for the development of decent shelter in the rural areas, and in recognition of the vital role surveying played in the enhancement of Security of Title, Government decided to establish cadastral survey units in all thirteen major districts and sub-districts. These units were Funded through Technical Cooperation Agreement with the Chinese Government, which made available about thirty Surveyors for a period covering four two-year contracts. At the same time the Government of Botswana embarked on an aggressive localisation training scheme for Citizen. since at that time there were only about ten professional and 30 technicians in the Geomatics Profession in the country. Currently there are over 100 professional and 250 technical surveyors in Government and Land Boards and over forty registered surveyors in the private sector..

All cadastral surveys performed by private licensed surveyors, local and central Government Surveyors, are examined, approved, and archived at the Department of Surveys and Mapping. The records have traditionally been kept in analogue form in strong rooms in spite of advanced technology in Computer Aided Drafting (cad) and Automated Mapping Systems used in surveying and mapping over the years. As the amount of data far exceeds the existing

strong-room capacity, and the demand for data has increased manual searches have become too slow and cumbersome consequently there has been a move towards systematic conversion digital format. Whilst the computer aided drafting systems, automated mapping systems, non-spatial databases other complex soft and hardware have been used and the advantages of GIS have been known over time, Geodatabase System development is seen as the most suitable solution for the integrated management, analysis and dissemination of Geospatial data.

2. INTEGRATED GEOGRAPHIC INFORMATION SYSTEM PROJECT

The IGIS project started in 1997 and ended in 2004. It was carried out in 2 phases and the main objectives in the first phase have been "to improve access to cadastral, geodetic and topographic information in order to speed up the land delivery and land information process in Botswana" and the "integration of cadastral, geodetic, and topographic databases to facilitate the provision of geographic information for cost-effective use in society" in the second phase.

The project was carried out in co-operation between the Department of Surveys and Mapping and Swedesurvey and was jointly financed by the Government of Botswana and Sida (Swedish International Development Corporation Agency).

The long-term or development objectives in I-GIS have been:

- To improve access to cadastral, topographic and geodetic information for users of such information as a means to speed up the land delivery and Land Information process in Botswana
- To cope with the demands for up-to-date mapping of the society
- To improve production through improved management at DSM

Most work in the earlier part of the project (until 2000) considered preparation of the databases and the routines for data management of the different databases. This work continued in the later stage, but the work was more focused on the technical development of the new integrated database.

Summary of achievements during the IGIS project:

- Zero Order Geodetic Network and the Botswana National Geodetic Reference System, BNGRS WGS84, established
- Systems for registering Cadastre Survey Diagrams developed in a MS Access Database
- System for capturing Cadastre Survey Records developed in a MS Access Database
- Design of new Integrated Geo-Database, containing Cadastre-, Topographic- and Geodetic Data
- Implementation plan for a new Geo-Database Solution developed
- Training of staff in the management of Cadastre, Geodetic and Topographic data and databases
- Staff training in Digital Orthophoto production

Apart from the training and competence improvement, the new Geo-Database is the most significant improvement, and is of high importance for the process of turning DSM into a modern mapping organisation. The solution designed for provides a state-of-the-art system that will secure an efficient and cost-effective use, management and delivery of geographic data within the Department, and also improve services towards the clients, as well as other government organisations.

1.1 Botswana National Geodetic Reference System 2002 (BNGRF 2002)

It goes without saying that for Geographic Information to play a significant role in regional matters such as environment, 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 past. 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.

A new Geodetic Reference System WGS584 was established in 2002 as a necessary step to ensure not only that the cadastral survey, and mapping were based on it, but also that for Global and regional environment and other purposes, seamless topographic and cadastral mapping could be attained. The Geodetic System whilst established on already monumented old Trigonometrical stations was carried out systematically across the country to allow for a strong network that would allow minimal deviations and progressive densification.

Suffice it to say that whilst the cadastral survey is still being compiled in both WGS84 and the old datum system, the conversion to WGS84 has been fully provided for. An integrated system will thus ensure dexterity in information enhancement through over laying of variable data sets, especially as the high accuracy of the system, gained through the use of GPS and modern sophisticated software, far surpasses that of the past.

The Land Survey Act requires that each parcel of land for cadastral survey in both urban and rural areas be tied to the Geodetic Network. The resultant erection of reference marks and Geodetic Stations in and around all settlements and other areas across the country, has also acted in favour of increased surveying for registration of title especially in rural areas.

1.2 Topographic Databases

As part of the IGIS project the entire country has been a flown and seamless digital orthophotomaps and line map at scales ranging from 10:00 to 100,000 produced. In addition to this, large scale 1:5000 digital orthophoto and line maps of about eighty settlements have been produced with about fifty to be added in the next two years.

The availability of coverage of the entire country enables extensive physical activities, in particular the land use zoning and the development of detailed layout plans for urban and rural settlements impact on land distribution development and cadastral surveys.

The integration of cadastral and topographic information under a common precisely determined Geodetic reference system constitute an indispensable prerequisite for judicious planning and development.

1.3 Cadastral Database

The meticulous archival of all cadastral survey manual records, over several decades, made it easy to convert or capture almost all surveyed properties into a Database. Despite teething problems experienced as a result of different units of measurement, undefined projections and generally inconsistent and non-precise coordinate systems previously employed, a project to capture all land parcel coordinates was successfully concluded.

In deciding to digitize existing analogue cadastral data a strategy was adopted to develop a field and office workflow that would deliver digital products through the development of a database system. Consequently it was decided that software that could be used for survey field observations, storage and manipulation of data stored in a relational and geo-spatial database systems was most appropriate.

Initially the Geodetic, Topographic and Cadastral data were all stored in either filing systems or databases such as microsoft access that were not spatially enabled. The extended use, over several years, of computer aided design (cad) software for survey calculations and mapping, as opposed to GIS in handling cadastral data, in a way slowed the development of automated and interactive systems in the manipulation of cadastral data through the use of databases.

1.4 Automation of Cadastral Systems

Six sub systems for the manipulation of the cadastral database were developed to handle data capture, reservation of plot numbers, report generation, handing over of plots to allottees, administration and Survey Record Processing. The latter is by far the most complex sub-system used to track progress of the processing of cadastral surveys from their receipt from the professional surveyor through examination to final Approval and Compilation.

The combination of these systems allow for high productivity in the processing of examinations and timely delivery of approved surveys to customers for registration and other uses. The system also allows for quick retrieval of information and to a great extent the avoidance of errors and consequently disputes over land.

It does, however, have several drawbacks that militate for its replacement by a better structured and enterprise system. Major drawbacks are that there is a limit to the number of plots that the system can handle, have been experienced loss of data. The system is not capable of the analytical capabilities of a GIS or topologically structured geo-spatial database

system. Except for minor problems here and there, the system has served the Department well and the amassed data will be used in the upgrade of the system to a fully fledged Digital Cadastre Information System operating under a Geodatabase System.

1.5 The digital cadastral information system

With a view to upgrading the current survey and Land Records Processing System to an enterprise fully fledged Digital Cadastral Information System with the capability of integration with Geodetic and topographic information, a project to upgrade all the three database systems is being undertaken by Swedesurvey under contract to Government of Botswana.

The implementation strategy envisages the attainment of the set objective through some milestone tasks carried together with departmental staff in accordance with an agreed skill transfer strategy that ensures staff involvement at all levels of development until hand-over of completed project.

Some of these tasks are:

- (a) Development of cadastre Handling System
 - Streamlined field and office workflow for all cadastral survey and Land records processes within the Department.
- (b) Development of Cadastral Geodabase Storage
 - Spatial and non-spatial data storage within a Geodabase System. This will be a dynamic system that allows for the creation of new products.
- (c) Development of the Digital Archive System
 - This system will archive scanned and/or digitized data. This will handle mainly legal documents but also reports for ease of storage and retrieval.
- (d) Development of the Cadastre Dissemination System
 - This system will publish all data and information processed through the other systems.
 - It will also provide the linkage between the Topographic and Geodetic Geodatabases.
 - Will give access to internal and external Government users and private users.

1.5.1 DSM Business Environment

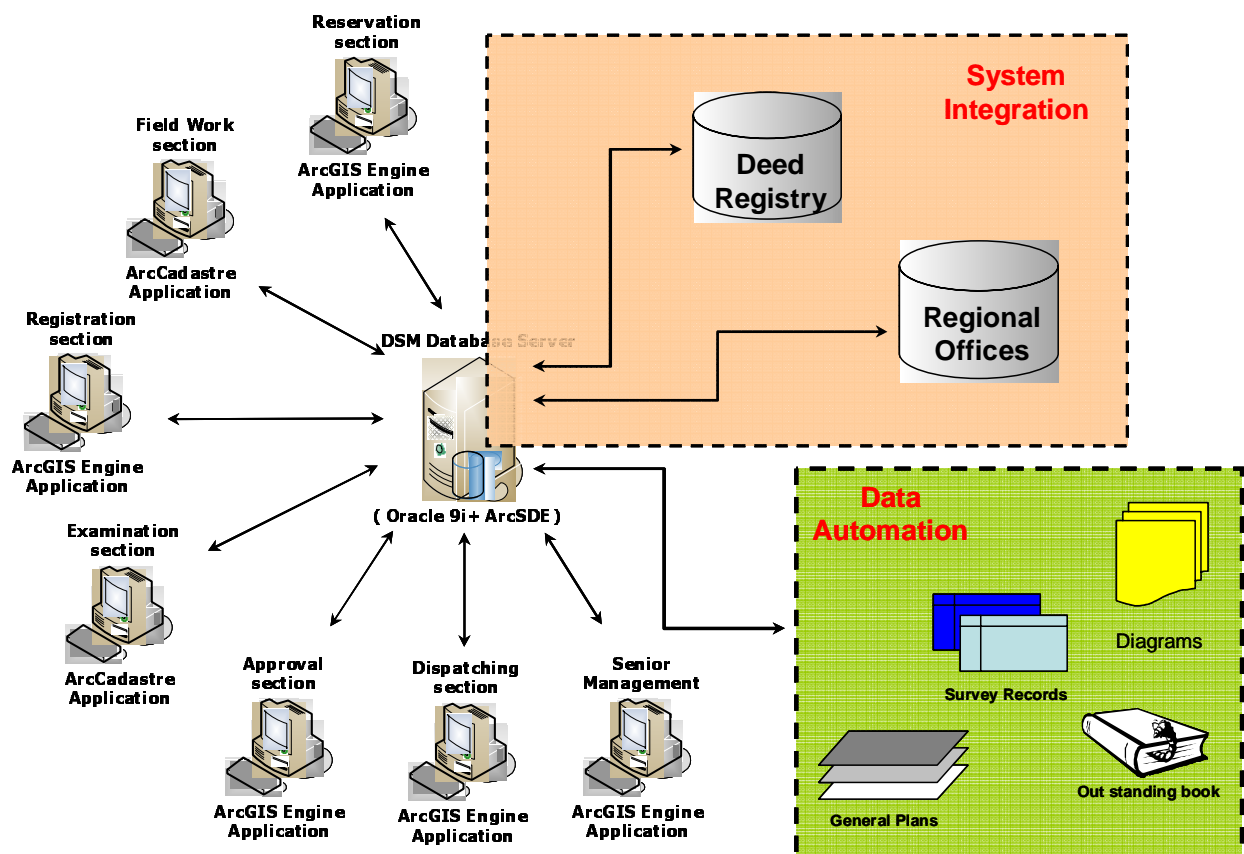
Botswana DSM project integrates and connects the seven internal sections existing in DSM and The Deeds Registry office, these sections, as shown in the following figure are:



- Reservation Office
Reservation Office is responsible for reservation of parcel numbers according to the surveyor request
- Field Survey Office
Field Survey Office is responsible for surveying of State lands and Survey of Geodetic Control Stations.
- Registration Office
Registration office is responsible for recording incoming jobs and assigning job number, survey records no., general plan no., data plan no. , diagram no. and DSM no. into the system.
- Examination Office
Examination Office is responsible for examining and validating the proposed land survey within the survey records as well as the disposal process

- Approval Office
Approval office is responsible for approving examination
- Completion Office
Completion Office is responsible for checking the survey records & updating the compilation sheets with the surveyed lots and recording the delivery of the survey records
- Archiving Office
The Archiving Office is responsible for archiving the survey records after updating the office maps, Filing the survey Records and indexing the lot diagrams in the strong room
- Deed Office Registration
The Deeds Registry office is the agency responsible for carrying the legal transactions by conducting the following:
 - Registration of the title deeds as per the approved diagrams & approved general plans from DSM.
 - Sending the registration data of the newly registered title deed to DSM

1.5.2 DSM System Architecture



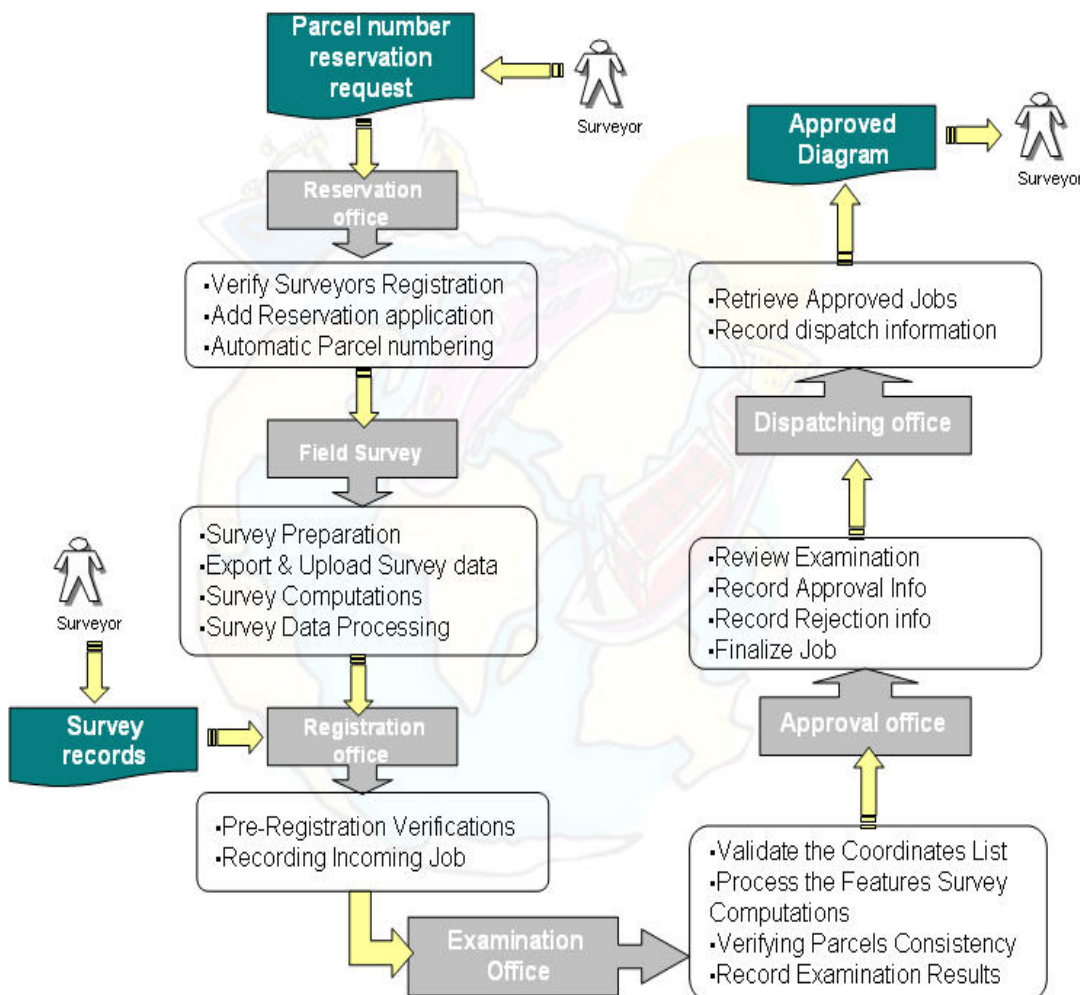
Botswana DSM Project is implemented through a Central architecture, where each entire section has access to the same database with different privileges

As shown in the system layout figure, DSM host unified cadastral databases where land properties tabular data is stored in an enterprise edition of Oracle 9i.

Each DSM section has access to land properties geographic and tabular database stored in a Unified Cadastral Database (UCD) based on an enterprise Geodatabase built on Oracle Enterprise edition with ArcSDE 9.1. ArcCadastre is utilized for performing cadastral operations through workflow and job concept, while the senior management application has been implemented as a light GIS application for monitoring various activities taking place in the office.

The regional offices and deed registry are integrating with DSM Cadastral system.

1.5.3 DSM System Workflow



1.5.4 DSM System Modules

In Botswana DSM Project various modules are required to serve the different needs of DSM offices. The main modules to be developed are as follows:

1. Capture Cadastre Data Module

This module contains all the functions that provide the means for capturing existing cadastre data to populate the new Geodatabase. These functions are:

- Capture Registration Divisions data
- Capture Districts data
- Capture Townships data
- Capture Villages data
- Capture Township Lots data
- Capture Village Lots data
- Capture Farms data
- Capture Farms Portions data
- Capture Leases Area data
- Capture Tribal grant data
- Capture Beacons data
- Capture Geodetic Stations data
- Capture Reference Marks data
- Capture Servitudes data
- Capture Township Extension data
- Capture Roads data
- Capture Land Surveyor data
- Capture Tribal Territory data

2. Cadastre Process Automation Module

This Module contains all the required functions for automating the daily cadastre process within DSM. These functions are:

- Parcel Number Reservation
- Job Field Survey
- Job Registration
- Job Examination
- Job Approval
- Job Dispatching
- History Tracking
- Query/Search
- Reports
- Issuing Certificates
- Surveyor Accounting

3. Data Exchange Module

This Module contains all the required functions for supporting data exchange between DSM and other stockholders, by providing means of importing and exporting spatial data from/to the Geodatabase. These functions are:

- Provide spatial data
- Import Spatial data

4. Future Integration to Regional Offices Module

This Module contains the functions supporting possibilities for future extension to support regional offices. The Module contains two functions:

- Retrieving Cadastre Data
- Processing Cadastre Records

2. LAND ADMINISTRATION AND GOVERNANCE ISSUES

Botswana's long-term National Vision 2016, calls for its Citizens to work harder and aim higher 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.

The commissioning of a major project - the Integrated Geographic Information System (IGIS) sought to create an environment where the availability of geo-spatial data was widespread and also its use maximized by ensuring that information was available in appropriate format for a wide spectrum of users.

Recently a Land Policy Review exercise has been undertaken with a view to bringing together Land related disparate practices and policies developed over the past several years, with a view to aligning them with the Nation's long-term Vision 2016. One of the cardinal governance issues being addressed by the policy is the fair and equitable distribution of land.

Land Policy being developed is among other things meant to control the allocation of land, by state or local authorities, to individuals and companies to ensure equity. In order to monitor the implementation of the policy it is not only necessary to apportion land judiciously, through mapping, planning and demarcation surveys, it is also essential to put in place the type of infrastructure that will help in the administration of the policy. To this end Government of Botswana has made available funds for the creation of Integrated Land Management Systems for both rural and urban land. Thus a view of Information Systems related to the Cadastre have and are being created in the country with a view to ensuring equitable land distribution and sustainable development.

There is also the issue of security of title. Whilst land may be owned without a cadastral survey and the registration of property, its use as collateral for loans requires that it be cadastrally surveyed and registered. On the basis of this the Government of Botswana guarantees loans from Banks specifically for the development of residential land. The availability and easy assessibility of well-structured, accurate and uptodate cadastral

information enhances investment on land, ensures fair land distribution, enables informed decision making in planning and development.

3. CONCLUSION

The concerted effort at the development of a Digital Cadastral Information Enterprise System that will interface with other systems in the Country to optimise information that enhances security of title, equity in land distribution, environmentally conscious land use, poverty alleviation and sustainable economic development is consistent with the Nation's Vision.

Government of Botswana has put in place several Institutions to ensure that pursuit of the Nation's development and democratic ideals are achieved and jealously guarded. It has given due cognizance to the fact that information is an invaluable resource and has made the use of Information Technology, in the attainment of the National Vision, a high priority.

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