

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

**CONCEPTUAL DESIGN OF A GIS-BASED LAND
INVENTORY MODEL FOR URBAN INFORMAL
SETTLEMENT LAND MANAGEMENT**

MSc Thesis

By

SAMUEL YAW YIRENKYI

September 2000

**Thesis submitted in partial fulfilment of the requirements for the
Degree of Master of Science in Engineering**

Department of Geomatics

University of Cape Town

DEDICATION

This thesis is dedicated to my dearest wife, Esther and my children, Maxwell and Jennifer; and also to my family and friends in Ghana and abroad, for their moral, spiritual and financial support.

University of Cape Town

TERMS OF REFERENCE

This half-dissertation is submitted in partial fulfilment of the requirements for the degree of Master of Science in Engineering in the Department of Geomatics, University of Cape Town. It has been conducted as the research component of a Masters programme in Geographic Information Systems by coursework and research. This research was supervised by Dr. Mike Barry (a Senior Lecturer at the Department of Geomatics, University of Cape Town).

DECLARATION

I certify that this thesis comprises only of my original work except where due acknowledgement is made in the document to all other materials used.

Samuel Yaw Yirenkyi

September 2000

University of Cape Town

ACKNOWLEDGEMENTS

While this thesis bears my name as the author, it could not have come about without a collaborative effort from many people.

First and foremost, I would like to thank the Almighty God for bringing me this far in my studies. I must say that the Lord had been my only source of hope and strength throughout my study at the University of Cape Town.

My sincere thanks go to my dearest wife, Esther and the children, Maxwell and Jennifer, for their wonderful support and encouragement. To my kids, I do really owe them my time and love. I also would like to express my greatest gratitude to my family, in-laws and friends in Ghana and Community of Love Church in Pietermaritzburg (Rep. South Africa) for their encouragement and prayer support. Perhaps, without their unceasing advice and prayers I would not have come this far with my studies. I say thank you.

My sincere thanks also go to my thesis supervisor, Dr. Mike Barry, for his constructive criticism, reading materials and support. His remarkable patience with me has finally paid off. I would also like to thank the following people at the Department of Geomatics, University of Cape Town for their wonderful support in diverse ways. These include Prof. Ruther (Head of Department), Prof. Merry, Mr. Martin (retired), Mrs Val Atkinson (retired), Mrs Sue Binedell, Mr. Dan Wilson and others. My special thanks go to Prof. Ruther for assisting me to secure a financial assistance from University of Cape Town. This was a great financial relief on my part.

I also want to extend my gratitude to Messrs. Michael Breare (MHP Geomatics, Durban), Harry Swatson (Ph.D student at the University of Natal, Pietermaritzburg), Steven Bonsu

(University of Natal, Pietermaritzburg) and Benson Okyere-Manu for the time they spent to edit this document. I also want to thank my fellow postgraduate students at the Department of Geomatics, University of Cape Town, for their contribution in diverse ways to keep me on track with this program. Their concern and support have really been remarkable. These include Messrs. Samuel Osei, Antwi-Adjei Danso, Eric Forkuo, Mufaro Chivasa, Lance Nel, Miss Erminia Vitali and other course mates.

Last but not the least, I would also like to thank all the Ghanaian friends in Pietermaritzburg and Cape Town for their prayer support and words of encouragement. These include Okyere-Manu's family, Oduro-Adjei's family, Dr. Danso's family (Cape Town), Osei Dwumfour (Cape Town), Ekow Joseph (Cape Town), Tham's family, Quartey's family, Prof. Kusi's family, Dr. Koranteng's family, Kafe's family, Swatson's family, Bro. Steve Bonsu, Amankrah's family, Doe's family, Addo's family and many others.

To all these wonderful people, I say THANK YOU. May the ALMIGHTY LORD bless you now and forever. AMEN.

ABSTRACT

This thesis describes a conceptual design of a computerized land inventory model, which is required to be implemented by local authorities in South Africa to record and maintain information about lands held in urban informal settlements. Specifically, it explores the use of a geographical information systems (GIS) application to design a prototype model of an informal settlement land database, which in essence would improve the way land information (*i.e.* spatial and non-spatial information) is stored, processed, queried and retrieved; and thus facilitate easy access to land information.

Accordingly, black South Africans were persistently denied equal access to land for urban housing and as a result informal settlements have been evolved in and around the major cities in South Africa. According to the present South Africa Constitution, local authorities in South Africa are required to recognize the existence of informal settlements within their areas of jurisdiction, and then supply them with basic services. Presently, some of the local authorities in the country have not been able to manage urban informal settlements effectively and efficiently due to lack of land tenure information. It has been reported that informal dealings in lands held in urban informal settlements have not been recorded in the existing cadastral records, which are maintained at the deeds registry offices throughout the country, and thus unavailable to the local authorities. Local authorities in South Africa require this vital information for a number of reasons. It includes monitoring the growth of urban informal settlements that are within their jurisdiction, determining the existing land use pattern and identifying lands in urban informal settlements for developments.

One possible solution to the above scenario is to implement a land inventory model with community participation in the recording and maintenance of land records at the settlement level. This thesis therefore describes the technical processes that could be put in place at the settlement level to compile and expedite the flow of land tenure information between local authorities and the urban informal communities. In this regard, the study has focused largely on addressing the question as to **who** is occupying **what site** in an urban informal settlement, and **where** (location) and by **what de facto** vested rights or capacity are they held. This aspect has been dealt with in the design of the prototype informal settlement land database model. The proposed land database model was implemented using ArcView GIS to examine its flexibility. Also, land allocation and registration models suitable for providing legally enforceable lands rights in urban informal settlements have been addressed.

Finally, the strength and weaknesses of the system design have been analyzed, and the thesis ends with some recommendations, which prompt for further investigation to be conducted on this subject.

TABLE OF CONTENTS

Dedication.....	i
Terms of Reference.....	ii
Declaration.....	iii
Acknowledgements.....	iv
Abstract.....	vi
Table of Contents.....	viii
List of Figures.....	xi
List of Tables.....	xii
Glossary of Terms.....	xiii
1. Introduction.....	1
1.1 Background to the Study.....	1
1.2 Objective of the Study.....	2
1.3 Research Method and Procedure.....	3
1.4 Data Sources.....	4
1.5 Scope of the Study.....	4
1.6 Assumptions and Limitations of the Study.....	5
1.7 Organisation of the Thesis.....	6
2. Concept of land Tenure and Land Management Framework.....	8
2.1 Introduction.....	8
2.2 Land Rights and Land Tenure.....	9
2.2.1 Land Rights.....	9
2.2.2 Land Tenure.....	10
2.3 Land Registration and Overview of South Africa Approach.....	13
2.3.1 Overview of South Africa Deeds Registration System.....	13
2.3.2 Land Tenure practice in the Informal Settlements in South Africa.....	18
2.3.2.1 Probation.....	19
2.3.2.2 Allegiance and Affiliations.....	19
2.4 Land Management.....	20
2.5 GIS and its relevance in Land Management.....	22
2.6 Land Inventory (or Community Register).....	25
2.6.1 The Need for a Computerised Land Inventory System.....	25
2.7 Discussion.....	27
3. Computerised Land Inventory System.....	29
3.1 Introduction.....	29
3.2 Benefits of the proposed Land Inventory Model.....	30
3.3 Information/Data to be recorded.....	31
3.4 Data Collection Methodology.....	33
3.4.1 Inventory (or Community) Map.....	33
3.4.1.1 Proposed Site Numbering System.....	36

3.4.2	Non-Spatial Data Collection.....	37
3.5	Establishment of Local Land Office and Local Land Allocation Board.....	38
3.5.1	Local Land Office.....	38
3.5.2	Local Land Allocation Board.....	40
3.5.3	Data Transfer and Access.....	41
3.6	Land Allocation Model.....	42
3.7	Land Registration Model.....	43
3.7.1	Starter Title.....	43
3.7.2	Landhold Title.....	45
3.7.3	Application to the proposed Land Inventory Model.....	45
	3.7.3.1 Registration procedures in respect of Starter title and Landhold title rights at the Local Land Office.....	47
3.8	Maintenance of the Local Land Record.....	49
3.9	Implementation Plan.....	49
3.10	Conclusion.....	50
4.	Conceptual Design of Informal Settlement Land Database.....	53
4.1	Introduction.....	53
4.2	Design Phases of the Informal Settlement Land Database Model.....	53
4.2.1	External Modelling: Requirements Collection and Analysis.....	55
4.2.2	Conceptual Modelling: Entity-Relational Approach.....	55
4.2.3	Mapping of Conceptual Design into Relational Model.....	56
4.2.4	Physical (or Internal) Modelling.....	58
4.3	Construction of the Informal Settlement Land Database with ArcView GIS.....	59
4.4	Retrieving Data from the Informal Settlement Land Database.....	61
4.5	Conclusion.....	63
5.	System Design Analysis.....	65
5.1	Introduction.....	65
5.2	Strengths and Problems of the System Design.....	65
5.3	Advantages and Disadvantages of Implementing the Proposed Land Inventory Model.....	67
5.3.1	Advantages.....	67
5.3.2	Disadvantages.....	68
5.4	Integrating the Proposed System with South Africa Deeds System.....	68
5.5	Conclusion.....	70
6.	Summary Conclusion and Recommendations.....	72
6.1	Introduction.....	72
6.2	Summary and Conclusions of the study.....	73
6.3	Recommendation.....	76
	References.....	77

Appendices

Appendix A: Entity Data Description.....84
Appendix B: Entity-Relationship Diagram of the Informal Settlement
 Land.....90
Appendix C: Conceptual-to-Relational Mapping.....91
Appendix D: Sample Queries.....92
Appendix E: Solutions to Queries.....93

University of Cape Town

LIST OF FIGURES

Figure	Title	Page
2.1	Locations of Deeds Registry Offices in South Africa (After Jones, 1964; McLachlan, pers. com, 2000)	15
2.2	Flow Chart showing the registration procedure of deeds and other documents	17
3.1	Sample of a Differential GPS data of an Informal Settlement with aerial photograph as a backdrop image	35
3.2	Hierarchical Site Numbering Structure	36
3.3	Functional relationship between Local Land Office, Local Authority and Deeds Registry Office	39
3.4	Possible route for upgrading the existing land tenure system in urban informal Settlement (After Christensen et al, 1999)	46
4.1	Phases of a relational database design (After Elmasri and Navathe, 1989)	54

LIST OF TABLES

Table	Title	Page
3.1	Example of the proposed numbering code	37
4.1	Entities and their spatial representation	57

University of Cape Town

GLOSSARY OF TERMS AND ABBREVIATIONS

Active Table	Selected table(s) in ArcView's table document.
Active Theme	Selected theme(s) in ArcView's view document.
Adjudication	The process whereby the ownership and rights in land are officially determined.
Attribute	Description of the properties of entities.
Boundary	Either physical objects marking the limits of a property or an imaginary line marking the division between two legal estates.
Cadastral Map	A map showing land parcels boundaries.
Cadastre	A type of land information system that records land parcels.
Customary Tenure	The holding of land in accordance with customary law.
Data	A raw collection of facts.
Database	An organized, integrated collection of data.
DBMS	A set of computer programs for managing a database.

Deed	A legal document laying out the conditions under which a land is transferred.
Deed of Transfer	A legal document laying out the conditions under which a land is transferred from the government to private individuals or groups.
<i>de facto</i>	The situation as it appears upon the ground.
Demarcation	The marking out of the boundaries of each land parcel on the ground.
Entity	An object about which information is stored in a database.
Feature Attribute Table	Contains descriptive information about geographic features that they represent.
Formalised Tenure	Tenure that has been clearly defined, statutorily registered and guaranteed by the State or government.
Freehold Tenure	A free tenure in which the owner has the maximum rights permissible within the tenure system.
Grant	A word used to describe the transfer whereby rights pass from the 'grantor' to the 'grantee'.

Geographical Information Systems (GIS)	A system for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced.
Global Position System (GPS)	A system for fixing positions on the surface of the earth by measuring the ranges to a special set of satellites orbiting the earth.
Hotlink	ArcView function that allows users to access virtually any data or application directly from a view.
Induna Ward	Tribal ward.
Informal Settlement	Settlement that develops outside the formal urban areas established in terms of conventional town-planning procedures.
Information	Data transformed into a form suitable for the user.
LAN	A communication system that allows several processing devices that are nearby to be linked together.
Landhold Title	A statutory form of tenure with all of the most important aspects of freehold ownership but without the complication of full ownership.
Land Inventory System	A less formal record of landholding and ownership.

Land Registration	The process of recording rights in land either in the form of registration of deeds, or else through the registration of title to land.
Land Tenure	The mode of holding rights to land.
Land Transfer	The transfer of rights in land.
Leasehold Tenure	Land held under a lease, which is a contract by which the right of exclusive possession of land is granted by a landlord (the lessor) to a tenant (the grantee) for an agreed amount of money for an agreed period of time.
Multi-Purpose Cadastre	A register including many attributes of land parcels.
Network (computer)	A system consisting of a computer and its connected terminals and devices. The term is also used to describe two or more interconnected computer systems.
Plot	A land parcel.
PTO	Short for 'permission to occupy'. Under this context, it means that an identifiable site has been allotted to the holder in an informal settlement, and the holder has a personal right to occupy the said land.
Shapefile	A simple, non-topological format for storing the geometric location and attribute information of geographic features.

Spatial Analysis	Operation available in ArcView to find features based on their closeness, intersection, etc. to others.
Spatial Join	Joining of two attribute tables in ArcView based on the spatial relationship between the features in the themes.
Starter Title	A statutory form of tenure registered in respect of a block of land.
Theme	A collection of features drawn on ArcView's view document.
Unformalised Tenure	Tenure that has not been clearly defined, statutorily registered and guaranteed by the State or government.
Vector-based GIS	Stores map or geographic features as points, lines and polygons with high accuracy.
View	A view document or window provides a means to display and query a collection of user-defined themes.
Ward	A section or an area of an informal settlement.

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Primarily, the study aims at designing a conceptual model of a land inventory/registration model, which could be implemented by local authorities in South Africa to record and maintain information about lands held in urban informal settlements within their jurisdictions chiefly for land management purposes. Specifically, the study explores the use of a geographical information systems (GIS) application to design a prototype model of an informal settlement land database, which in essence is required to improve the way in which this information is stored, processed, queried and retrieved. According to Davies (1998), local authorities in South Africa do not have a mechanism in place at the moment to record and maintain information about lands held in urban informal settlements that are not in the process of being regularized or formalized. He explains further that the lack of this information is severely hampering the ability of local authorities in South Africa to manage urban informal settlements effectively.

In South Africa, the land policies of the past apartheid government have contributed greatly to the development of informal settlements in and around urban cities throughout the country. According to Davies (1998) and Thomas *et al* (1998), for many years, black people in South Africa were denied equal access to the land in the country, and as a result very little land was made available for black urban housing. Subsequently, Durban Metro Housing Department (2000) has reported that there are about 139 908 informal dwellings in Durban Metropolitan Area. Davies (1998) has also acknowledged the existence of over 100 informal settlements in East London Metropolitan Area.

It has been stated that lands held in most urban informal settlements in South Africa were originally invaded by the settlers and have since remained their properties without any

formal (or legal) registration of land rights (Fourie, 1994). Nevertheless, taking into account the factors underlying the development of urban informal settlements in South Africa, the present democratic government is duty-bound to recognize the existence of informal settlements in the country and then supply them with basic services and social amenities. These requirements have so far been enshrined in the present South Africa Constitution (Act 108 of 1996)(Section 152 (1a) & (1e)), and local authorities have been mandated to supply basic services such as water, garbage and sewerage removal, etc. to informal settlements within their jurisdictions, and also to provide them with a secure land tenure model which will protect the existing *de facto* vested land rights of the informal dwellers (South African Government, 1997:47).

According to Davies (1998), local authorities in South Africa depend extensively on the existing cadastral record, which is maintained at the deeds registry offices throughout the country, to provide basic services to the people. Seemingly, information about lands held in urban informal settlements in South Africa has not as yet been recorded in the existing cadastral record, and thus not readily available to the local authorities. It is against this background that a land inventory model has been proposed in this study to facilitate readily access to information about lands held in urban informal settlements for land management purposes.

1.2 OBJECTIVE OF THE STUDY

The primary objective of this study is to contribute to theory building concerning the use of geographical information system (GIS) in urban informal settlement land management. In order to achieve this objective, the following tasks were targeted:

- A literature review of the statutory requirements and examination procedure of the existing deeds registration system in South Africa (Chapter 2).
- A literature review of the existing land tenure practices in urban informal settlements

in South Africa based on examination of the literature (Chapter 2).

- Development of a *needs* analysis in respect of recording information about lands held in urban informal settlements, and making them readily available to the local authorities through the use of computers and state-of-the-art GIS applications (Chapter 2).
- Design of a conceptual model of a land inventory system based on the *needs* analysis (Chapters 3 and 4).
- Implementation of the proposed informal settlement land database model using a ArcView GIS application (Chapter 4).
- Evaluation of the system design in terms of performance and how well it could be integrated with the existing deeds registration system (Chapter 5).

1.3 RESEARCH METHOD AND PROCEDURE

The following procedure outlines the methods used in this study:

- Visits to Surveyor-General and Deeds Registry offices in both Cape Town and Pietermaritzburg for interviews.
- A literature review of the practice and procedure underlying deeds registration system in South Africa (Chapter 2).
- A literature review of land management functions of local authorities in South Africa, and land tenure practice in urban informal settlements in South Africa (Chapter 2).
- Defining a land inventory/registration model suitable for recording and maintaining information about lands held in urban informal settlements in South Africa (Chapter 3).

- Modelling and prototyping an informal settlement land database (Chapter 4).
- Evaluating the proposed land inventory/registration model with regards to performance and how well it can be integrated with the existing deeds registration system (Chapter 5).

1.4 DATA SOURCES

The following data collection methods were used:

- A desktop study of academic journals, books and theses in the libraries of the University of Cape Town, South Africa Chief Directorate of Survey and Mapping in Mowbray (Cape Town) and University of Durban (Pietermaritzburg Campus).
- Interviews with personnel at the Surveyor-General and Deeds Registry offices in Cape Town and Pietermaritzburg, and also at Pietermaritzburg-Msunduzi Transitional Local Council (TLC).
- Internet searches on land registration, land inventory and land management systems.
- Compilation of a simulated data set for implementing the proposed informal settlement land database model.

1.5 SCOPE OF THE STUDY

This dissertation describes a land inventory model for recording and managing information about lands held in urban informal settlements in South Africa. A study of this nature would require a general knowledge of the existing land tenure practices in urban informal settlements in South Africa, and also the deeds registration system. The importance of the proposed model is to enable local land managers secure easy access to land tenure information regarding the names and addresses of occupants and/or owners of allocated

sites in urban informal settlements, date of allocation, and the geographical locations of allocated sites and other physical features that are of interest to local land managers from a land management perspective. Among other things, local land managers may require this information to monitor the growth of urban informal settlements that are within their jurisdictions effectively and also to provide them with the necessary infrastructure and social services. In this regard, this study has been limited in scope to address the question as to **who** is occupying **what site** and **where** in a particular informal settlement, and by **what de facto** vested land rights or interests in the sites (or plots) being held. This aspect has been addressed in the modelling of the proposed informal settlement land database.

Also, this study is focussed on large urban informal settlements that are made up of wards or suburb areas and with each ward having its own elected leaders. This aspect has also been incorporated in the proposed land inventory/registration model.

1.6 ASSUMPTIONS AND LIMITATIONS OF THE STUDY

Firstly, the design of the proposed land inventory model is based on the assumption that land tenure practices in urban informal settlements in South Africa are the same and also each urban informal settlement has an elected executive committee in place to deal with land allocation, dispute resolution and general discipline. The rationale behind this assumption is that the land inventory model as discussed in Chapters Three and Four demands a partnership between local authority officials and the community leaders for the recording and maintenance of land tenure information at the settlement level. It is envisaged that through this partnership, informal dwellers in South Africa will embrace the proposed land inventory/registration model and see it as a resource.

Secondly, with regards to the creation of the proposed informal settlement land database model, it was assumed that each allocated site in the urban informal settlement has at least a physical structure (or a building) built on it either for dwelling purposes or other use. Accordingly, it has been stated that some of the allocated sites in urban informal settlements in South Africa do not have their spatial dimensions explicitly defined. As a

result, allocated sites and structures built on them could not be modelled in the proposed informal settlement land database as separate entities; instead they were both represented as one entity. The same also applies to un-surveyed sites that are within a demarcated surveyed block.

The only limitation of this study is that an ideal informal settlement land database could not be modelled to address the requirements of local land managers regarding information about lands held in urban informal settlements. This is reviewed in terms of the structure and the content of the proposed informal settlement land database model. It was difficult populating the land (or spatial) database model with a simulated data set. However, it is worth noting that this is a prototype database model, which is required in this study to demonstrate the flexibility of using a GIS application to manage land tenure information.

1.7 ORGANISATION OF THE THESIS

This dissertation is categorised into six major chapters. Chapter One outlines the background and the objectives of the study, research method and procedure used, data sources used, the scope of the study, assumptions and the limitations of the study.

Chapter Two addresses the concept of land tenure and land management framework, and acknowledges the relevance of GIS technology in land management. Particularly, it reviews the existing practice and procedure of the South African deeds registration system, and also the land tenure practice in urban informal settlements in South Africa. Lastly, it outlines the forces that drive the need for a computerised land inventory/registration model.

Chapter Three describes a land inventory and registration model that could be implemented by local authorities in South Africa for managing information about lands held in urban informal settlements in South Africa. First of all, it outlines the benefits of the proposed land record, and also identifies the information or data set that needs to be recorded in the proposed informal settlement land database model. Also, a data collection

methodology suitable for capturing both spatial (community map) and non-spatial land information has been addressed. This chapter also addresses the establishment of local land office and the formation of local land allocation board to be responsible for the recording and maintenance of land tenure information at the settlement level.

Land allocation and registration models suitable for providing legally enforceable land rights in urban informal settlements in South Africa have also been discussed in this chapter. Lastly, maintenance of the land record and its implementation plan have also been discussed in this chapter.

Chapter Four reviews the concept underlying relational database design, and outlines the steps taking to construct the proposed informal settlement land database model. Lastly, it addresses how spatial and non-spatial data could be retrieved from the proposed informal settlement land database.

Chapter Five reviews the system design. Primarily, it evaluates the proposed land inventory/registration model in terms of performance (*i.e.* the strength and weakness of the model), and also examines how the proposed land inventory/registration model could be integrated with the existing South African deeds registration system.

The sixth and final Chapter summarises the conclusions that have been drawn from this study and also offers some recommendations.

CHAPTER TWO: CONCEPT OF LAND TENURE AND LAND MANAGEMENT FRAMEWORK

2.1 INTRODUCTION

In this chapter, the concept of land rights, land tenure and land management, as well as geographical information systems (GIS) and land inventory system as tools for effective land management have been addressed. Readers understanding of these concepts at this stage is essential in that they provide the framework upon which the proposed GIS-based land inventory model is developed. The existing land allocation practice in urban informal settlements in South Africa has also been addressed, and a *needs* analysis in respect of recording the underlying *de facto* vested land rights or interests in lands held in urban informal settlements, and making this information readily available to local authorities for land management purposes has been discussed.

Statutory requirements, examination and registration procedures of the existing South African deeds registration system have been reviewed. This aspect is essential to this study in that it reviews the current state of the existing deeds registration system, and thus enabling the author to identify ways of which the proposed land inventory model could be integrated with the existing deeds registration system for the purpose of upgrading the underlying *de facto* vested land rights of the informal dwellers to legally enforceable rights as and when necessary. Lastly, the land management functions of local authorities in South Africa have been discussed, and the use of a GIS-based land inventory model to enhance these tasks with regards to recording and processing of land tenure information has also been addressed.

2.2 LAND RIGHTS AND LAND TENURE

2.2.1 Land Rights

As already emphasised in Section 1.1, increase in the population of informal dwellers in and around urban cities in South Africa has resulted in a competition for vacant lands in urban areas and also evolution of bundle of rights to use the land. Primarily, land rights can be held in two different ways. It can either be held through a long-standing tradition (or custom) of the community in question or by a more formal process of the statute law. According to Cook (1994), the latter approach is popular in countries where land rights are enshrined in the law governing land tenure practice. The traditional method, on the other hand, is prevalent in countries where customary land holdings exist (Latu, 1995).

Toms (1996 quoting Crocombe (1974)) and Holzknrecht (1994) have identified six-fold classifications of land rights, and these are:

- *Rights or claims to direct use of the land:* These may include rights to plant, harvest, gather and build on the land. Direct use rights may be held or vested in one or more persons in respect of the same piece of land. Subsidiary user rights may also exist, including rights of access, and rights to the use of water.
- *Rights of indirect economic gain* (e.g. right to rental income).
- *Rights of control:* These include rights held by persons other than the user (e.g. those held by chiefs or land courts).
- *Rights of transfer:* These accord powers to transfer rights over a parcel of land by will, sale, mortgage, gift or inheritance.
- *Residual rights* such as reversal rights of the clan in the event of the death of the former rights holder without descendants or collateral heirs.
- *Symbolic rights or rights of identification* (e.g. where a rights holder has informally given land to another person).

Latu (1995) has stated that two or more of these rights can exist concurrently in the same piece of land, and could also be held by different people or organisations. Simpson (1976:7) has also compared the different rights to a bundle of sticks of different thickness and lengths. He explains that the number of sticks represents the different rights, the thickness represents the extent of each right, and the length represents the time span of each right. Based on this philosophy, land rights must be discrete or unambiguously defined, but in practice this is not always so. For example, Davies (1998) has stated that land rights in urban informal settlements in South Africa are not always discrete due to conflicting claims on the same piece of land. Thus, for local authorities in South Africa to provide a secured tenure model in urban informal settlements within their jurisdictions, they need to first identify the existing *de facto* vested land rights of the informal dwellers and record them in some form that will permit easy access and manipulation.

Holzkecht (1994) has stated that recording of land rights and the mechanism for their enforcement is essential in land management. He explains that recording of these rights will enable land managers and other potential users to distinguish between land rights that are subject to constraints of the statute law, those that are quasi-legal, and those that are outside statute law but still subject to customary constraints. The different ways of which these rights can be secured or held are discussed in Section 2.2.2.

2.2.2 Land Tenure

It can be inferred from the above discussion that, associated with each piece of land is an array of land rights. And the way in which people obtain, use and distribute these rights is commonly referred to as land tenure. Typically, land tenure is more concerned with the rights, restrictions, and responsibilities people have with respect to the land (International Federation of Surveyors (FIG), 1994), and there are three main forms of land tenure systems that can be identified in practice, namely: freehold, leasehold and customary tenures.

- *Freehold Tenure* (same as Private Ownership in South Africa law): Literally, freehold owners can do whatever they like with the land subject to the rights of the general public. For instance, they can sell, donate, mortgage and lease their properties as and when necessary. Nonetheless, since absolute ownership only exists for the State in most countries (UNEC for Europe, 1999), freehold rights are sometimes limited by restrictive measures and/or planning regulations that are imposed by statute with regards to the use of the land. In spite of this, freehold tenure system generally does not lapse with time and is freely transferable.

According to Pienaar (1996:14), until recently freehold rights were restricted mainly to the White South Africans. He explains that during the apartheid era, Black South Africans were made to occupy land under a variety of conditional tenures, which includes residential permits, site permits, deeds of grant, certificate of occupation, permission to occupy (PTO's) and quitrent, and these tenures were only for a short-term and were designed specifically to deny Black South Africans equal opportunity to own land in areas of the country reserved predominantly for the White South Africans (Pienaar, 1996:14). Apparently, even though the present democratic government has repealed the past racially based land policies, freehold tenure is still rare in most urban informal settlements in South Africa (Davies, 1998). Davies (1998) has stated that this form of land holding may soon change in some urban informal settlements in South Africa since plans are underway to open township registers in some of these settlements to effect transfer of freehold rights to the individual dwellers.

- *Leasehold Tenure* (same as Lease in South Africa law): Leasehold, on the other hand, means that the freehold owner has relinquished some of the rights in the land to another person or group of people for a certain period of time (usually up to 99 years), and subject to certain conditions. During this period, the leaseholder can have exclusive use of the land in question or part of it, but has no legal rights to subdivide or consolidate the land.

According to a work done by Davies (1998), occupants of surveyed plots in some urban informal settlements in South Africa (e.g. Mzamomhle township in East London) are under lease agreement with the local authorities concerned. He explains that although this contractual agreement is not as strong as registered real rights, it does however provide certain degree of tenure security to its holders. For instance, leaseholders are able to defend their derived real rights at an administrative structure higher than the powers of the settlement executive and ward (or area) committees.

- *Customary Tenure*: Acquaye (1984) has pointed out that customary land tenure does not lend itself easily to a precise definition due to its variation between communities. However, in the context of this study, customary land tenure is defined as the system of holding rights to land, which is derived from the operations of the traditions of the people affected (Benwell and Ezigbalike, 1994:179).

Accordingly, customary land tenure is characterised by ownership of land in common by a community, which can be a family or an extended family (clan), or a tribal group (Latu, 1995). According to Pienaar (1996:8), access to and use of land by individuals or families, under this system, are usually regulated by intricate customary traditions (or customs). These customs sometimes allow chiefs or heads of clans to act as trustees and administer the clan's land (Castro, 1984:184). In this case, chiefs have a broad discretion to allocate the land among the tribe members for residential, cultivation and grazing purposes (Pienaar, 1996:7). Granting of land rights to individuals or families by tribal leaders usually involves performing of public ceremonies (Latu, 1995). He explains that these ceremonies are carried out in order to make the grant known to other members of the tribe with regards to the nature of the rights and also the location and extent of the land being granted.

Cross (1994:177) and Davies (1998) have also stated that people in urban informal settlements in South Africa are influenced by traditional rural values (or customs) even when they are born and raised in the urban informal settlements. As a result, the existing land allocation practice and administrative structure responsible for land allocation in

urban informal settlements in South Africa are identical to that of the rural (or customary) tenure practice (Cross, 1994:177). For example, these researchers have stated that until such time that a township register is opened in these communities to effect transfer of freehold rights to individuals, informal dwellers cannot sell the sites (or lands) that have been allocated to them by the settlement executive committee. A further discussion about land allocation practice in urban informal settlements in South Africa is addressed later in this chapter. The ensuing section however discusses the development and operation of the existing deeds registration system in South Africa in terms of legal requirements, examination and registration procedure of deeds.

2.3 LAND REGISTRATION AND OVERVIEW OF SOUTH AFRICA APPROACH

Land registration system, according to FIG definition, is the official recording of rights or interests in land (International Federation of Surveyors (FIG), 1994). There are three recognised systems for recording rights in land, namely; private conveyancing, registration of title, and registration of deeds. A discussion of these systems is outside the scope of this dissertation. The following section however reviews the systems as being practised in South Africa.

2.3.1 Overview of South Africa Deeds Registration System

In South Africa, the system of deed registration, which is based on Roman-Dutch law, has been in operation since 1652 (Jones, 1964; Twomey, 1987; du Plessis, 2000). According to Henssen (1995), the South Africa deeds registration system is an improved form of deeds registration system in that it is based on a cadastral mapping and examination of the deeds or other documents. Fourie and van Gysen (1996:5) have also stated that the South African deeds registration system is bound up with an efficient cadastral system which is recognised internationally especially in African countries such as Malawi, Kenya, Zimbabwe and Botswana. According to UNCHS (Habitat) (1990:9), cadastral systems play an important role in land administration. Besides other things, they provide the base

maps upon which individual land parcels could be identified. Barnes (1990:9) has pointed out that the South African deeds registration system uses a register that reflects all registered rights to a land parcel and also carries the history of all previously registered documents to the last registered deed. In essence, the deeds register reviews at all times how a vendor acquired a certain property and the conditions under which the property was acquired.

History has it that the registration system as existed in Holland in the 12th century, was introduced to the Cape colony in 1685 (Twomey, 1987:2) by the Dutch colonists who first arrived at the Cape of Good Hope with Commander Jan van Riebeck in 1652 (Jones, 1964:10). According to Twomey (1987:2), a debt registry was first established in 1714 at the Cape colony to deal with mortgages on immovable properties, but in 1828 a Registrar of Deeds was officially appointed to take over the day-to-day administration of the deeds registration system.

Thereafter, other deeds registry offices were opened in other parts of the country (as shown in Figure 2.1) to oversee the administration of the deeds registration system. According to Jones (1964), the first deeds registry office in the Republic of South Africa was opened in Cape Town in 1839 for the province of Cape of Good Hope. Seven others were opened in the following areas in South Africa as indicated in Figure 2.1 (overleaf):

- Pietermaritzburg for the colony of Natal in 1846.
- Bloemfontein for the Republic of the Orange Free State (now Free State) in 1856.
- King Williams Town for the territory of the British Kaffraria in 1858.
- Pretoria for the Republic of South Africa in 1866.
- Kimberly for Griqualand West in 1872.
- Vryburg for the Republic of Stellaland in 1883.
- Rand Township Registration Office in Johannesburg for the mining districts in Johannesburg in 1902.

According to McLachlan (pers. com, 2000), even though the magisterial boundaries have since changed, the administrative boundaries of the existing deeds registry offices remained unchanged, however, there is now a registry office at Umtata for the former Transkei in the Eastern Cape Province and the surrounding towns. Under the current deeds registration system, the following documents and certificates can be registered at any of the above-listed deeds registry offices in South Africa: deeds of grant, deeds of transfer, certificates of consolidated title, certificates of amended title; personal and praedial servitudes (or easements), mineral rights, leases, interdicts and caveats.

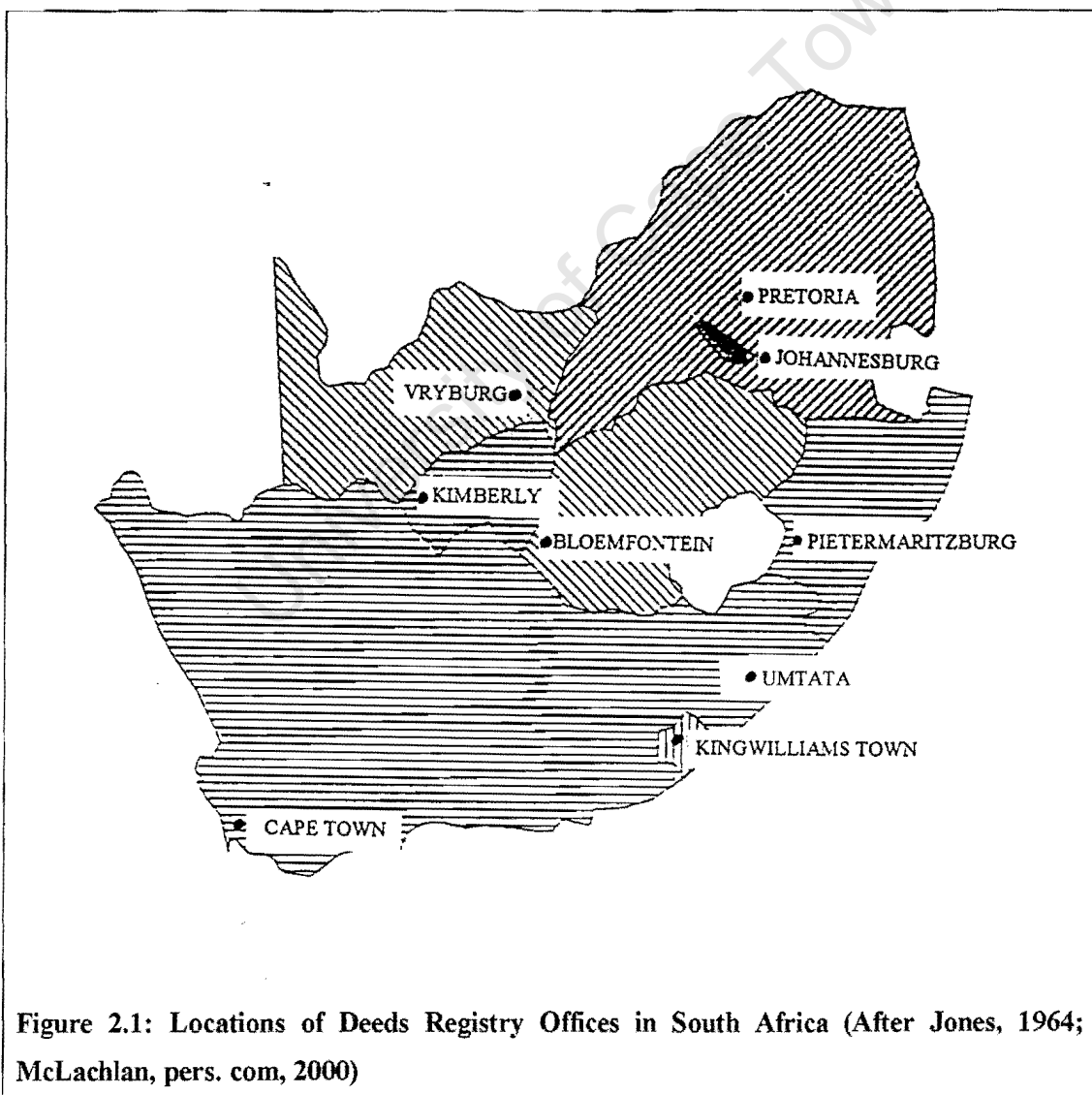


Figure 2.1: Locations of Deeds Registry Offices in South Africa (After Jones, 1964; McLachlan, pers. com, 2000)

Functionally, the Deeds Registries Act (Act No. 47 of 1937) requires that each transfer deed or document be prepared by a conveyancer, and lodged at a deeds registry office for examination. The transfer documents must be submitted together with approved survey diagrams or plans of the properties concerned. These diagrams or plans, which show the exact positions, dimensions and description of the properties under consideration, must first be examined and endorsed by a Surveyor-General based on the requirements of the Land Survey Act (Act No. 8 of 1997). Under no circumstances would a deed be registered in South Africa without the attachment of an approved survey diagram or plan of the land in question. Figure 2.2 (overleaf) shows the flow of the examination procedure of deeds as being carried out at deeds registry offices throughout South Africa.

As indicated in Figure 2.2 (overleaf), the greater part of the registration process is devoted to the scrutiny of deeds and other documents. And during this time, the examiners at the registry critically check on interdicts and caveats that have been endorsed on the deeds or documents against the registration of previous transactions. This is carried out through extensive cross-references. The examiners also ensure that the legal requirements of the Deeds Registries Act (Act No. 47 of 1937) with regards to preparation and correctness of deeds are met. The examiners, in this case, have the power to reject deeds that do not meet the specified requirements. As indicated in Figure 2.2, the examination cycle officially ends when the registrar or his designate appends his or her signature on the deeds or other documents (*i.e.* at the execution stage). So far, the individual real rights have been well supported by the existing deeds registration system but at a high cost. Accordingly, the South African deeds registration system is said to be very costly (Fourie, 1994:16; Buckley, 1995:2).

In relation to this study, a review of the existing deeds registration system explains categorically the reason why land transactions have been taking place outside the deeds register in urban informal settlements in South Africa. This is argued on the basis of the cost and the legal requirements for executing deeds and other documents at the deeds

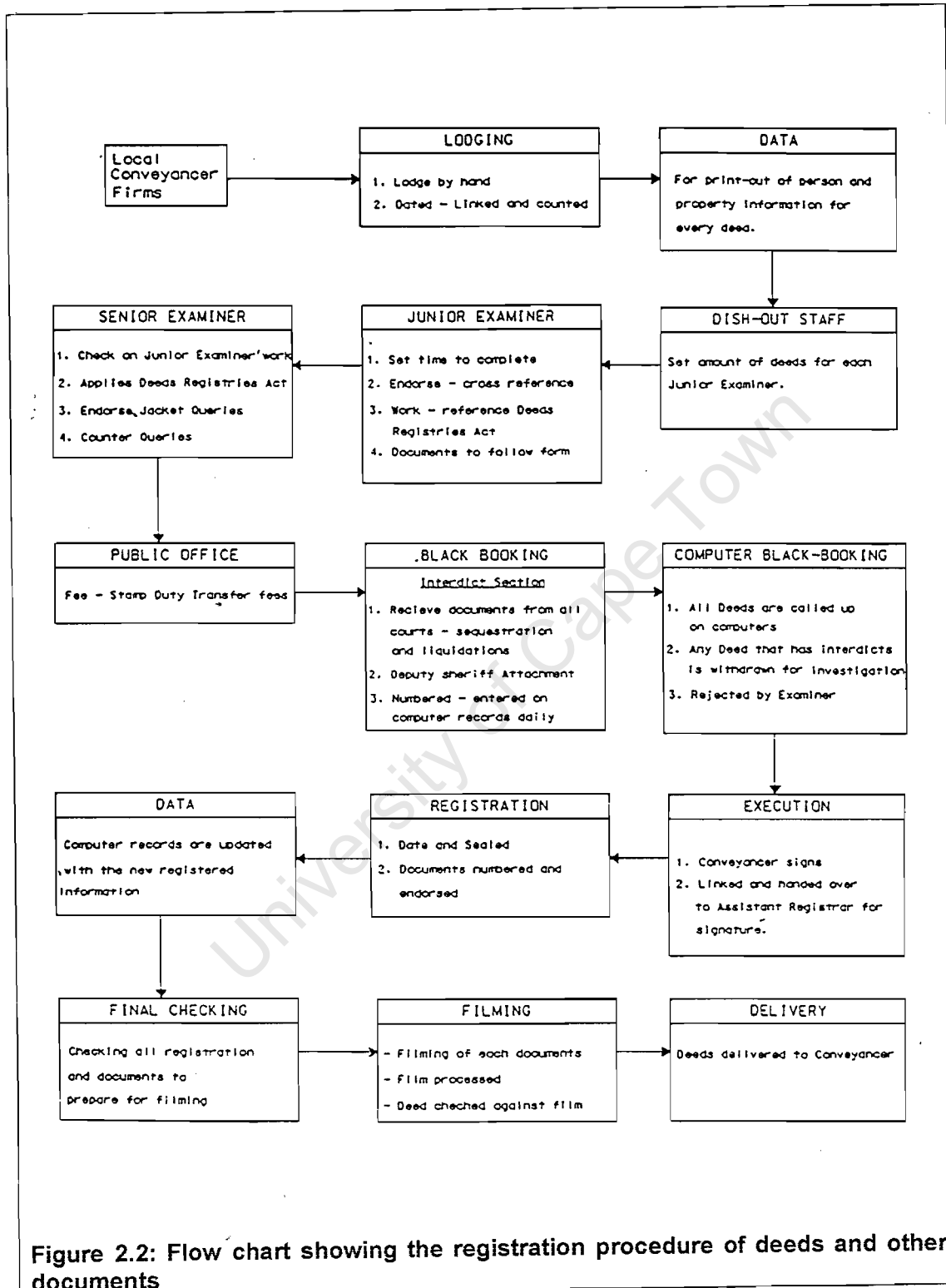


Figure 2.2: Flow chart showing the registration procedure of deeds and other documents

registry offices. The following section outlines the land allocation procedure as carried out in urban informal settlements in South Africa.

2.3.2 Land tenure practice in urban informal settlements in South Africa

As stated in Section 2.2.2, land tenure practice in some urban informal settlements in South Africa is similar to the traditional tenure pattern in the sense that although individual dwellers have a piece of land to build a house or dwelling, the land remains the property of the community in question (Davies, 1998). Davies (1998) has pointed out that in some urban informal settlements if a person wishes to leave the settlement, he or she is required to seek permission from the settlement executive committee to sell the house or any physical structure on the land but not the land itself. This role of the settlement executive committee is comparable to that of the local chiefs in that they all have control over who lives in the settlement. Also, identical to the rural (or communal) tenure practice, informal dwellers can live on the lands that have been allocated to them as long as they behave according to the rules of the community (Davies, 1998). Any resident member who commits serious moral offence such as murder, theft, etc. can have their *de facto* vested land rights terminated. In effect, the land allocation practice in urban informal settlements in South Africa is governed by these rules.

With regards to power structures in some urban informal settlements in South Africa, Davies (1998) has again identified a similarity with the communal tenure system whereby chiefs and sub-headmen of the *induna* wards are responsible for land allocation. In the case of urban informal settlements, settlement executive and ward (or area) committees are usually elected by the dwellers of the settlement to deal with land allocation, dispute resolution and general discipline. The settlement executive committee, which is the highest power structure in most urban informal settlements (David, 1998), is made up of chairs of all the ward committees in the settlement and other appointed members. The ward committees in this case are responsible for the people in the various wards in the settlement. According to Davies (1998), informal dwellers respect the authority of the elected executive and the ward committees to deal with land allocation, dispute resolution

and general discipline. The ensuing sections outline the requirements and the procedure of allocating sites to newcomers in urban informal settlements in South Africa.

2.3.2.1 Probation

Accordingly, newcomers are required to have a sponsor or a relative already residing in the settlement, and also to undergo a period of probation before being allocated a piece of land in the settlements (Davies, 1998). Cross (1994:179) has stated that communal practice of sponsorship and probation has been modified in urban informal settlements in South Africa to speed up the land allocation process. In some informal settlements in South Africa, strangers or newcomers are required to submit a letter of conduct from their previous place of residence before being allocated a place to build houses of their own in the settlement. Davies (1998) explains that whenever a permission is granted to a newcomer to live in a settlement, a member of the executive committee marks out a site (or a plot) to the person concerned, and also gives the person a number to be painted on the door of his or her house for identification purposes. Thereafter, details of the person are recorded in an exercise book, which is kept by the executive committee. One thing that cannot be guaranteed in this case is whether these records are kept up-to-date with regards to occupancy and land usage. For instance, in large settlements, the currency of this record cannot be ascertained since people leave their houses or shacks without notifying the settlement executive or ward committees concerned (Barry, 1999).

2.3.2.2 Allegiance and Affiliations

It has also been established that in some informal settlements in South Africa, newcomers are required to join or affiliate with a local group such as a political party in the settlement before being recognised (Byerley and McIntosh, 1994:172). Davies (1998) has confirmed this by stating that the residents of Mzamomhle township (or settlement) in East London are also required to be members of a particular political party before being granted a piece of land for dwelling. According to Davies (1998), this aspect of land allocation in urban informal settlements is identical to the rural (or communal) tenure practice whereby people

in the rural community shows allegiance to the chiefs or heads of clans in return for the privilege of belonging to the tribe.

In comparison, land allocation practice in urban informal settlements in South Africa, although not well structured in some cases, gives *de facto* land rights to the residents as long as they remain in the settlement. In this case, the executive committee ensures that *de facto* land rights of these residents are protected within the community involved, as long as they behave well according to the set rules. The allocated sites in most cases are not surveyed as required by the existing deeds registration system, and informal dwellers do not have to pay exorbitant fees to have their details recorded by the executive committee. However, for land management purposes, availability of land information in its current form is essential, and since one cannot guarantee the currency of these records as compiled by the executive committee, it is essential that a land inventory model of some kind be put in place to facilitate easy recording and maintenance of this information. The purpose of this study is therefore to identify a methodology, which will expedite recording and dissemination of land information between local authorities and the local communities for land management purposes. The next section addresses the concept of land management in respect of managing the use and development of land.

2.4 LAND MANAGEMENT

Land management, according to International Federation of Surveyors (FIG) (1994) and Okpala (1992:262), involves a process of recording and managing the use and development of land resources. This definition seems to be central to the study in that it expresses the importance of recording and managing land tenure information including lands held in urban informal settlements. Accordingly, land management embraces all activities that are concerned with the management of land as a resource from both environmental and economic perspectives (UNEC for Europe, 1999). It covers such matters as:

- Property conveyancing, including decisions on mortgages and investment;

- Property assessment and valuation;
- The development and management of utilities and services;
- The formation and implementation of land-use policies;
- Environmental impact assessment;
- The monitoring of all activities on land that affect the best use of the land.

Williamson (1991:47 quoting Ljung and Farvaque of the World Bank, 1988), has listed the following as essential components of effective land management:

- A legal framework for easy land transactions;
- Procedures and regulations that ensure that land is made available at affordable cost;
- Taxation measures to stimulate efficient land use and equitable land distribution;
- Registration systems that can identify land ownership, facilitate transfer of ownership and assure taxes to be assessed and collected.

According to Davies (1998), the above land management functions are already in place in South Africa except that it does not extend to informal settlements. In other words, the existing deeds registration system has no information about lands held in urban informal settlements that are not in the process of being formalised. Okpala (1992:262-3) and Latu (1995:18) have pointed out that without adequate identification and inventory of land, effective land management is hardly possible. According to Nicols (1994), land tenure information such as conditions of title, ownership descriptions, survey information, land use, and zoning is essential to land managers in that it serves as a basis for implementing and enforcing land management decisions. UNCHS (Habitat)(1990) has also reported that land managers require land tenure information to address the following land management queries:

- Indicate availability of land for development;
- Determine existing use of land;
- Identify potential for other forms of land use;
- Identify areas of dereliction of the land.

Davies (1998) has proposed a land management approach based on a partnership between local authorities and the informal settlements within their jurisdictions. He explains that this partnership will enable local authorities to develop a viable solution for upgrading and developing urban informal settlements within their jurisdictions. The proposed computerised land inventory model has been designed in the line of Davies' land management approach (*i.e.* participatory approach), but also utilises the power of GIS applications and computer systems to store, query, analyse and display spatial and descriptive information about lands held in urban informal settlements. The next section outlines the relevance of GIS technology in land management.

2.5 GIS AND ITS RELEVANCE IN LAND MANAGEMENT

Geographical Information Systems (GIS) is simply referred to as an information system that is designed to work with data referenced by spatial or geographic co-ordinates (Star and Estes, 1990). In other words, it is classified as both a database system with specific capabilities for spatially-reference data, and also a set of operations for working with spatial data. The strength of GIS therefore lies in its ability to deal with data that are related to location and real world space, and more importantly, it allows users to record adjacency information about spatial entities (ESRI ARC/INFO Data Management, 1994). This is its inherent advantage over other systems such as Computer Assisted Drafting (CAD) or automated mapping.

A GIS application is a powerful tool for addressing geographical and environmental issues. It allows users to arrange information about a given region as a set of maps with each map (or layer as it is commonly known) displaying information about a specific feature of the region. These layers can be overlaid using a common reference system (*e.g.* latitude and longitude) so that every location on one layer (or map) is precisely matched to its corresponding locations on all the other layers. Once the referencing is established, information displayed on the different layers can be compared and analysed in combination (ESRI ARC/INFO Data Management, 1994).

In relation to land management, GIS provides both point-and-click query capabilities and sophisticated analysis tools to provide timely information to land managers and other potential users. With this tool, land managers can handle analytical questions such as the following:

- Who owns a particular land parcel or site?
- How far is it between two places?
- Where are lands or sites zoned for residential use?
- Where are lands or sites suitable for building new houses?

Using a GIS application, the results of these queries can be presented succinctly and clearly in the form of a map and accompanying report, allowing land managers and other users to focus more on the problem at stake instead of trying to understand the data set. Moreover, because GIS products can be produced quickly, multiple scenarios can be evaluated efficiently and effectively.

According to van Rensburg and Dickinson (1991), the greater part of information or data used by local authorities relates to discrete land parcels and services within a region and therefore has a geographic reference. Riley (1991) has pointed out that local authorities are involved with land management tasks, which one way or the other require data set that has a spatial component (*i.e.* locational information) and thus need GIS application to process them more efficiently. It includes the following:

- (a) Long-term services planning and development relating to:
 - ✓ stormwater and sewerage
 - ✓ water supply and distribution
 - ✓ electricity supply and distribution
 - ✓ roads
 - ✓ waste disposal sites
- (b) Land and property related planning and operations, covering:

- ✓ land planning database, town planning scheme, etc.
 - ✓ land, property and services database
 - ✓ property valuations
 - ✓ capture and maintenance of services and installations data
 - ✓ environmental and ecological monitoring
 - ✓ emergency services planning
 - ✓ refuse collection planning
- (c) Community and amenity related operations, including:
- ✓ voter's roll
 - ✓ fire inspection scheduling
 - ✓ register of buildings requiring environmental health support.

According to Becker *et al* (1999), local authorities need for, and use of GIS can fall into several categories including maintaining public records, responding to public enquiries for information, conducting studies and making recommendations to decision-makers, and managing public facilities and services (*i.e.* utilities, garbage removal, transportation, etc.). The GIS functions that meet these needs are:

- Providing regular maps;
- Conducting spatial queries and displaying the results either on a computer or in a report form;
- Conducting complex spatial analyses.

Becker *et al* (1999) has pointed out that local authorities undertake many of these tasks, albeit by manual means, but concludes that GIS would be able to handling these tasks much more efficiently and effectively. In relation to this study, local authorities in South Africa can utilise the power of GIS technology to manage land tenure information by setting up a spatial land database. A prototype model of an informal settlement land database (*i.e.* a spatial land database) has been modelled and constructed in Chapter Four of this document. The next section discusses land inventory (or community register) as a

suitable model for recording information about lands held in the urban informal settlements in South Africa.

2.6 LAND INVENTORY (OR COMMUNITY REGISTER)

It has been stated that the first step towards land registration is the introduction of a land inventory or community registers (The Central Board for Real Estate, Botswana). According to these researchers, a land inventory system generally provides a less formal record of land holding or ownership. It consists of inventory (or community) maps of low accuracy showing vacant and occupied lands, arable lands and other allocated plots (or sites) within the community, and also contains details of landholders or occupants of these properties. Functionally, a land inventory system is not another kind of land registration system in that it does not provide or maintain a register, which is recognized at law as the final authority on land holding or ownership. Nevertheless, according to a report by The Central Board for Real Estate (Botswana)(1988:5), a land inventory or record system may be required for two purposes. First of all, it could serve as an administrative tool to local land officials for their land record keeping and land use planning, and secondly, as a source of reliable and easy accessible land information.

In light of what has been discussed above, it is certain that the proposed land inventory model would be suitable for recording and managing information about lands held in the urban informal settlements. It is envisaged that this system would bring together all forms of spatial and descriptive data using modern computer technology and a GIS application. The proposed land inventory model could also be extended to recording of information about other land-related features in urban informal settlements that are of interest to local authorities from a land management perspective.

2.6.1 The Need for a Computerised Land Inventory Model

This section describes the forces that drive the need for a computerised land inventory model. As already indicated in Section 1.1, information about lands held in informal

settlements in South Africa has not been included in the existing cadastral record, and as a result, local authorities have not been able to administer these communities effectively due to lack of land tenure information. To address this situation, local authorities in South Africa would require a land inventory model that will facilitate easy access to this information and also to improve its distribution by utilising the power of computer technology. According to UNEC for Europe (1999), computer technology today offers excellent opportunities for the automation of cadastre and the creation of cost-effective land management system. Thus, by utilising this technology local authorities in South Africa would be able to accomplish the following:

- speed up the processes of land management functions at the local authority;
- decrease the cost and space required for storing land records at the local authority;
- prevent unnecessary duplication in the processing and storage of land records;
- facilitate the compilation of land information and reports that are impossible or cumbersome to produce manually;
- facilitate access to land-related data and improve their distribution;
- force standardisation in the collection and processing of land information.

In relation to land management, local authorities would require this model to:

- monitor the influx of newcomers to the settlement through the compilation of the land record;
- managing disasters, e.g. flooding and fire;
- control expansion and development of the settlement, including monitoring informal property market;
- provide security of occupation and regularisation of tenure by issuing PTO certificates and other subsidiary titles to residents;
- empower informal community to participate in providing and using information held in a local land record;
- indicate availability of land for development;

- determine existing land use and zoning;
- document, query, analyse and display spatial and descriptive information about lands held in urban informal settlements using a GIS application;
- link the proposed spatial land database to other land related information systems when the need arise.

2.7 DISCUSSION

This chapter has reviewed the concept of land tenure, land management, geographical information system, and land inventory system, and has established that land is so vital to human existence and development, and thus needs to be managed effectively in terms of usage and control. It has been mentioned that different rights can exist concurrently in the same piece of land, and these rights may differ in terms of nature, extent and duration. To distinguish between these rights for various reasons, it has been stated that some form of recording system should be put in place. One such recording system is the existing cadastral record, which is maintained at the deeds registry offices throughout the country. The cadastral record generally describes the extent of each land parcel and links them to the record describing the nature of the interest affecting them, ownership of those interests, and often the value of the parcels and their improvements. The quality of the existing cadastral record can be validated by the quality of the existing deeds registration system in South Africa, which is esteemed in some African countries. The only problem with the existing system in relation to this study is that it does not extend to informal settlements.

From a land management perspective, it has been argued that local land managers require adequate information about each land parcel in order to make an informed decision regarding its use and development. In this regard, it is essential that local authorities in South Africa secure readily access to information about lands held in urban informal settlements that are within their areas of jurisdiction. It has been said that even though the existing land allocation practice in urban informal settlements in South Africa keeps details of informal dwellers in an exercise book, the currency of these records in terms of

occupation and usage cannot be guaranteed. This is argued on the basis that certain individuals in urban informal settlements vacate their plots without notifying the executive or the ward committee concerned. Thus, addressing the research objectives, it has been mentioned that by utilising the power of computer technology and GIS software application, local land managers would be able to speed up the processes of land management functions, produce regular maps and handle complex spatial queries. The next chapter outlines the components of the proposed GIS-based land inventory model.

CHAPTER THREE: COMPUTERISED LAND INVENTORY SYSTEM

3.1 INTRODUCTION

Van Rensburg and Dickinson (1991) have stated that one of the greatest assets of local authorities in South Africa is the information that they have gathered over the years. According to their report, local authorities use this information to manage facilities that are within their jurisdiction, and also to address the numerous queries from the general public. As already indicated in Chapter Two, some of the local authorities in South Africa have very little or no information about lands held in urban informal settlements that are within their jurisdiction with regards to details of occupants and the underlying *de facto* vested land rights (Davies, 1998). Davies (1998) has also stated that since there is no mechanism in place at the moment to record this vital information, some of the local authorities have not been able to render and maintain high quality services to urban informal settlements that are within their jurisdiction.

In this regard, this chapter describes a land inventory model, which could be implemented by local authorities in South Africa to record and maintain information about lands held in urban informal settlements. According to The Central Board of Real Estate (Botswana)(1988), land inventory systems generally produce a less formal record of land holding, and are intended primarily as administrative tools for land record keeping and land use planning. Thus, the proposed land inventory model as described in this chapter has specifically been modelled to serve as an administrative tool for urban informal settlement land management. The proposed land inventory model is termed a GIS-based model in the sense that it utilises the power of computer technology and the state-of-the-art GIS application to store and process both spatial and non-spatial land information about lands held in urban informal settlement.

The chapter begins by addressing some of the anticipated benefits of the proposed land inventory model and also the data sets that could be stored in the proposed informal

settlement land database. The chapter continues with a data collection methodology that could be implemented by local authorities in South Africa for the capturing of both spatial and non-spatial land information. The establishment of the proposed local land offices and local land allocation boards to enforce legally enforceable land rights in urban informal settlements in South Africa; land allocation and registration models suitable for upgrading the existing land tenure practice in urban informal settlements in South Africa have also been discussed. Lastly, maintenance of the proposed local land record and its implementation plan have also been addressed.

3.2 BENEFITS OF THE PROPOSED LAND INVENTORY MODEL

With reference to a research work done by Davies (1998), the proposed land inventory model has the tendency of improving the land management functions of local authorities in South Africa with regards to providing tenure security in urban informal settlements. Some of the anticipated benefits are as follows:

- It increases community participation in developing local communities. Davies (1998) has stated that community participation is considered a major benefit in that it emphasises on training and capacity building. He explains that it gives the local residents a tool to articulate and motivate needs based on the interpretation of the local land record. Josayma (1996) has also acknowledged the importance of community participation in land management and development. He explains that it gives local residents more confidence during discussions;
- It gives access to demography information. In this case, local authorities will have readily access to a reliable information on how urban informal settlements are growing and developing (Davies, 1998);
- It enables local land managers to monitor the rate of influx and growth of urban informal settlements; and
- It improves the efficiency of land management functions locally.

3.3 INFORMATION/DATA TO BE RECORDED

Generally, in database modelling, the data set that is stored in a database is more or less related to the intended use of the database. Thus, addressing the question as to **who** (i.e. owner/occupant) is occupying **what site** and **where** in the settlement and by **what *de facto*** vested land rights are the lands being held in urban informal settlements in South Africa and other land-related information, the proposed informal settlement land database model as described in Chapter Four has been designed specifically to address the data set as indicated below. The choice of these items for this study is based predominantly on the requirements of the existing land tenure practice in urban informal settlements in South Africa as described in section 2.3.2, the *needs* analysis as discussed in section 2.6.1, local authorities land management data requirements as listed in section 2.5, and lastly the proposed land inventory and registration models as described in this chapter. Readers must note that this is a prototype land database model and thus does not intend to address data requirements that are outside the scope of this dissertation.

- Information about urban informal settlements that are within the jurisdictions of a local authority with regards to name, population distribution, area extent and number of wards.
- Information about wards (or areas) of urban informal settlements with regards to name, population distribution, area extent and number of wards.
- Information about demarcated blocks in urban informal settlements with regards to block number, number of sites within the block, area extent, population distribution and associated general plan number.
- Information about surveyed and un-surveyed sites (or plots) in urban informal settlements with regards to identification code, ward name, geographical location (x,y co-ordinate), occupation status (i.e. vacant or occupied), land use/zoning (i.e. residential, shop, park, farm, playground, etc.) and ownership type (i.e. freehold, leasehold, inheritance, group, 'permission to occupy', etc.).

- Information about landholders or occupants of allocated sites in urban informal settlements with regards to name, sex, marital status, name of spouse, number of children, date of arrival in the settlement, date of site allocation and names of next of kin.
- Information about newcomers in urban informal settlements with regards to name, sex, marital status, name of spouse, number of children, date of arrival in the settlement, probation period, sponsor's name, permission to occupy (PTO) certificate number, site number and name of next of kin.
- Information about sponsors or relatives of newcomers with regards to name, sex, marital status, name of spouse, number of children, date of arrival in the settlement, date of site allocation and name of next of kin.
- Information about buildings or physical structures that have been erected on allocated sites in urban informal settlements with regards to identification code, physical description (*i.e.* block, wood, stone, etc), date built, owner's name, occupation status (*i.e.* vacant or occupied), number of rooms, etc.
- Information about streets in urban informal settlements with regards to name, surface type, width and number of lanes.
- Information about schools with regards to identification code, date built, building type (*i.e.* bricks, blocks, or wood), number of students, geographical locations, school type (*i.e.* pre, primary or high school), ward's name, number of teachers and Principal's name.
- Information about public toilets with regards to toilet code, date built, building type (*i.e.* bricks, blocks, or wood), geographical locations and ward's name.

- Information about community halls with regards to hall's name, date built, building type (*i.e.* bricks, blocks, or wood), geographical locations, ward's name and caretaker's name.
- Information about clinics with regards to name, date built, building type (*i.e.* bricks, blocks, or wood), number of rooms, number of beds, geographical locations, ward's name and doctor in-charge.
- Information about settlement executive and ward committees, general plans showing the block of sites in urban informal settlements, *starter* titles, deed of transfer, *landhold* titles, local land office and local land allocation board will also be recorded.

Besides recording and storing the above data set in the proposed informal settlement land database, digital maps showing the geographical locations of all the allocated sites in urban informal settlements and other physical features that are of importance to local land managers would also be captured and queried using ArcView GIS application. Also, registers and hard copies of the community maps would be kept at the local land offices to serve as reference documents.

3.4 DATA COLLECTION METHODOLOGY

The following sections describe a data collection methodology that could be instituted at the settlement level for the capturing of both spatial and non-spatial information about lands held in urban informal settlements in South Africa.

3.4.1 Inventory (or Community) Map

An inventory or community map, according to The Central Board for Real Estate (Botswana)(1988:24), shows boundaries of sites (or plots) in a given locality, their descriptions and geographical locations. However, since sites (or plots) in some urban informal settlements in South Africa do not have their spatial dimensions explicitly

defined (Davies, 1998), the geographical locations of buildings or other physical structures built on such plots could be captured as point features using a differential GPS device. Here, the geographical co-ordinates (*i.e.* latitude and longitude) of at least one of the building corners would be captured and stored in the proposed informal settlement land database.

According to Hartley (*pers. com.*, 1999), in later part of 1998, Durban Metropolitan Council embarked on a similar project by capturing the geographical locations of informal dwellings that are within its area of jurisdiction with a hand-held GPS device (*i.e.* GeoExplorer II). Here, the informal dwellings were captured as point features and exported to ArcView *shapefile* format for further processing with ArcView GIS application. A digital aerial photograph of the informal settlement was geo-referenced and used as a backdrop image in ArcView GIS to provide a better view of the settlements (see a sample data set in Figure 3.1 overleaf). In relation to this study, the proposed local land allocation board will be required to record the geographical co-ordinates of at least one of the corners of all un-surveyed allocated sites in the settlement using either a hand-held GPS device or other simple survey method. With regards to surveyed sites or block of sites, the boundary co-ordinates of the outside figure would be stored in the proposed informal settlement land database. In both cases, the geographical co-ordinates are required for site identification.

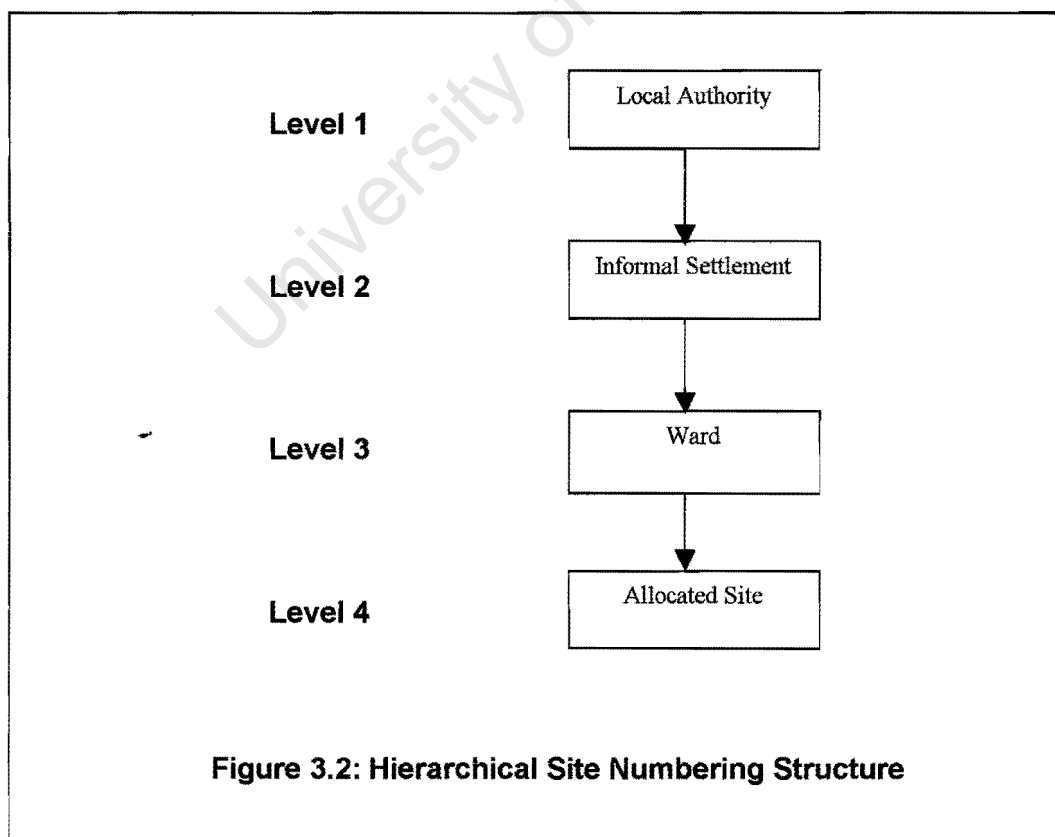
However, prior to the capturing of these coordinates, the author reckons that each allocated site in the settlement should be given a special identification code. Accordingly, local authorities and other service providers operating within urban informal settlements are able to locate sites in informal communities with relative ease by using their unique identification codes (KwaZulu/Natal Numbering System Task Team, 1999). In this regard, the following section describes a site-numbering scheme, which could be utilised by local land allocation board to uniquely identify (or locate) allocated plots or sites in their respective jurisdiction.



Figure 3.1: A sample of a Differential GPS data of an Informal Settlement with an aerial photograph as a backdrop image.

3.4.1.1 Proposed Site Numbering System

As already stated in Section 2.3.2.1, the executive committee of some urban informal settlements in South Africa assigns numbers to allocated sites. However, based on a work done by The Central Board for Real Estate (Botswana) (1988), numbers that are assigned to allocated sites in informal communities generally do not depict their geographical locations. Thus, in an attempt to address this scenario, the KwaZulu/Natal Numbering System Task Team (1999) has reported that identification numbers of sites in urban informal settlements should be related to the local authority, the settlement and the ward in which they are situated. In this regard, the author recommends that allocated sites in urban informal settlements in South Africa with or without identification numbers should all be given special codes, which must reflect the local authority, the settlement and the ward in which they are situated. Figure 3.2 (below) illustrates how the proposed site numbering system could be structured.



Level 1 – means that local authorities must be coded within the confines of the province they fall. The number of digits will depend on the total number of local authorities in the province concerned. In this example, it is assumed that within each of the nine provinces in South Africa, the total number of local authorities will not exceed 999. Thus, in this example a code of 3 digits can be applied.

Level 2 – means that urban informal settlements within the jurisdiction of each local authority will also be coded. Again, the code limit will depend on the total number of urban informal settlements that are within the confines of each local authority. In this example, a code of 3 digits shall be applied.

Level 3 – means that each of the wards within the confines of each recognised urban informal settlement shall be coded. The code limit will also depend on the total number of wards in each settlement. Also, a code of 3 digits shall be applied.

Level 4 – Finally, the individual site numbers (if available).

Thus, as indicated in Table 3.1 below, the proposed numbering code for a site in a particular urban informal settlement would be read as 111/015/043/14567.

Table 3.1: Example of a proposed numbering code

	Local Authority No.	Settlement No.	Ward No.	Site No.
Code	111	015	043	14567
Code	103	020	050	12345

3.4.2 Non-Spatial Data Collection

With reference to work done by Davies (1998), a questionnaire could be drawn up by the local land allocation board for the collection of social data in the settlement. According to Davies (1998), the format of, and the questions on the questionnaire should be work-

shopped extensively with the local residents. He explains that local residents must have the freedom to amend or reject any part or details of the proposed questionnaire. In his opinion, this freedom may create a space and opportunity for community participation in the recording of tenure information at the settlement level. He stated further that the intentions of the local land office must also be spelt out clearly to the local residents in order to win their uttermost support.

In relation to this study, the above methodology can also be implemented locally. In this case, a constituted body comprising of the local executive committee and local authority officials can be formed at the settlement level to deal with the design and the distribution of questionnaires to the local residents. The following sections outline the administrative set-up that could be put in place for the recording and maintenance of the proposed local land record.

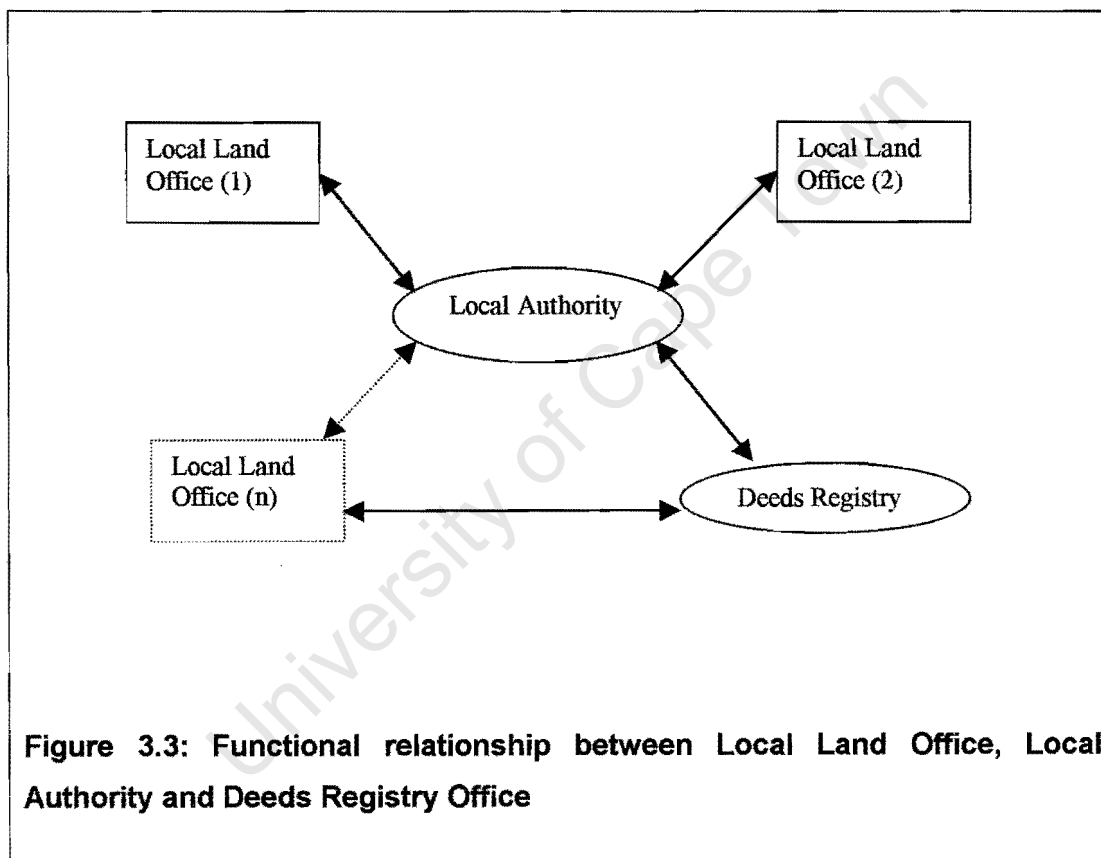
3.5 ESTABLISHMENT OF LOCAL LAND OFFICE AND LOCAL LAND ALLOCATION BOARD

3.5.1 Local Land Office

According to Fourie (1996:10), the establishment of local land offices in informal communities could make land tenure information readily accessible to the local communities, and the following could also be accomplished:

- Build a local knowledge about property rights, thereby improving the legitimacy and sustainability of the inventory system;
- Undertake adjudication over time using local officials;
- Improve currency in the land inventory or record;
- Get people to feel that the local land office is a resource;
- Get poor people to register their land;
- Solve boundary, inheritance and group and individual disputes locally and cheaply using local officials.

In relation to this study, the establishment of local land offices in urban informal settlements is mainly to decentralise the land management functions of local authorities in South Africa for the purpose of recording and managing information about lands held in urban informal settlements. Administratively, the proposed local land offices would be linked to local authorities and deeds registry offices (see schematic illustration in Figure 3.3 overleaf).



Accordingly, the proposed local land office could have the following functions (Christensen *et al*, 1999):

- Processing and entering data in relation to transactions in respect of starter title and landhold title;
- Archiving source documentation in relation to the above-mentioned transactions;

- Ensuring the accuracy and reliability of the records through interviewing parties to the transaction; obtaining independent verification of details presented by the parties, and taking responsibility for the accuracy of such details;
- Assisting members of the public in the drawing up of standard agreements of sale and offering information and advice in relation to property related transactions;
- Maintaining the 'permission to occupy, PTO' register for the areas within their jurisdiction;
- Ensuring that registration of *starter* title and *landhold* title takes place in accordance with the prescribed procedures;
- Liaison with the Deeds Registry offices on matters pertaining to the registration of the outside figures of the block of sites in the deeds register and the endorsement of the title deed in respect of the block;
- Liaison with the local land manager on matters pertaining to land policy implementation and maintenance of the local land record;
- Facilitating resolution of property related disputes through using local knowledge and custom; and
- Ensuring that information about lands held in urban informal settlements is accessible to the public.

(Christensen *et al*, 1999)

3.5.2 Local Land Allocation Board

From what has been discussed above, a governing body such as the proposed local land allocation board, comprising of the local executive committee and local authority officials, could be formed at the settlement level to administer land allocation and registration functions. It is envisaged that by adopting a participatory approach to informal settlement land management, local authorities in South Africa would be able to develop a mechanism that would empower informal community leaders to be actively involved in the adjudication of property-related disputes at the local government level, particularly in solving disputes related to inheritance. For the partnership between local authority officials and the informal community leaders to be strong and effective, it has

been said that the partnership should be formally constituted (Davies, 1998). In other words, certain obligations and expectations should be spelt out clearly between these two parties. For instance, according to Davies (1998), local authorities could finance and provide the necessary technology and training required for the recording of both spatial and non-spatial land information at the settlements, while community leaders ensure that informal settlers provide the necessary information to keep the local land record current and reliable. In this regard, community leaders would be required to assist with the adjudication, demarcation and collection of land tenure information locally. Certainly, informal community leaders would not be able to function effectively without any financial gain. In this regard, local authorities would be required to negotiate some financial benefits with the informal community leaders during their term of office.

In order for a local land allocation board to fulfil its functions effectively, the author reckons that the local authority official seconded to the local land allocation board should be a person with a professional qualification either in town and regional planning or land surveying, and also has the appropriate professional experience and drive to administer land allocation/registration functions at the local land offices. More so, the person needs to have good communication skills to be able to carry out work in cooperation with the informal community, and also to liaison between local authorities and the informal communities. In this respect, further training could be provided when necessary.

3.5.3 Data Transfer and Access

With regards to data transfer and access between local land offices and local authorities, it is assumed that the necessary hardware and software applications will be made available at the local land offices. In this case, using a customised interface, data entry can be carried out at the local land offices, and could be accessed by local land managers via a local area network (LAN) system. The proposed informal settlement land database could be protected against illegal use and misuse of information by incorporating password protection and read/write permissions into the system. It is envisaged that through the use of computer systems, state-of-the-art software applications and local area networking system, data transfer and access between local land offices and the local

authorities or other organisations could be improved. This information would also be available to the general public via the local land offices.

3.6 LAND ALLOCATION MODEL

As stated in Chapter Two, except where a township register is opened at informal settlements, the executive committee controls or manages the land they occupy. The following steps outline a methodology that could be implemented at the local land offices to standardise land allocation functions in urban informal settlements.

Step 1: Applicant or a newcomer must first find a vacant piece of land suitable for his/her purposes. The site could either be standalone or within a demarcated block of sites in the settlement.

Step 2: Applicant will check with the ward committee concerned to be certain that the land in question is really vacant. This is to avoid double allocation.

Step 3: If the chair of the ward committee gives his/her consent, then the applicant can submit a completed application form to the chair of the ward committee concerned for onward submission to the local land allocation board for approval.

Step 4: The local land allocation board will interview the applicant to ascertain the use of the land, and relevant information that needs to be recorded in the database can be obtained.

Step 5: If the application is successful, then a site within a demarcated block will be allotted to the said applicant. At this stage, the local authority official and other members of the local land allocation board will be required to set out the corners of the allocated site. For identification purposes, geographic co-ordinates of one of the corners of the site would be recorded with a hand-held differential GPS device. The digital community map will then be updated with the new information or data set. The local land allocation

board will also be required to assign identification numbers to the allocated site based on the proposed site numbering scheme.

Step 6: 'Permission to occupy, PTO' certificates (not a deed of transfer certificate) would be issued to the applicant. This is required to provide some degree of security to landholders at the settlement and also to entice them to co-operate in the recording of land tenure information at the settlement level. This is not a proof of ownership at this stage as it only indicates that a site in the settlement has been allocated to the said applicant.

3.7 LAND REGISTRATION MODEL

As already stated in section 1.1, local authorities in South Africa are required by the current constitution to upgrade the existing land tenure practice in urban informal settlements to a formalised one such as a freehold or leasehold tenure. According to Davies (1998), this conversion can only take place after a township register has been opened in an informal settlement. However, based on research reports by Christensen *et al* (1999) concerning the development of a flexible land registration system in Namibia, the author reckons that the proposed forms of tenure, namely; *starter* title and *landhold* title, could also provide tenure security in urban informal settlements in South Africa. The following sections describe aspects of the *starter* title and *landhold* title.

3.7.1 Starter Title

According to Christensen *et al* (1999), a *starter* title is a basic form of tenure for informal communities and can be registered in respect of a block of sites consisting of 40 to 100 family units. The block of sites, in this case, could be owned by a local authority, a private developer or an NGO. The purpose of the *starter* title is:

- to create an inexpensive and simple form of land registration which provides a degree of security of tenure to urban dwellers in the context of an upgrading project

or to new occupants in an area earmarked for development in a 'green fields' context;

- to provide a tool for land management at the local government level;
- to provide a record of families and individuals occupying land in a defined area;
- to establish a rational basis for planning the layout of an area and the installation of engineering services; and
- to establish a basis for further upgrading of tenure over time.

(Christensen *et al*, 1999)

Starter title could provide holders with the following rights (Christensen *et al*, 1999):

- The right to perpetual occupation of a site within a block of sites;
- The right to transfer or otherwise dispose of the right subject to local custom or a constitution of the group occupying the site to restrict transfer;
- One can build a permanent structure without the fear of being moved once a layout plan for the area has been approved;
- Group cohesiveness within the outside figure would be important because the outside boundary is designed to protect occupants' rights against the state and outside groups, but it will not protect people from encroachment by their immediate neighbours within the block;
- While the block would be registered in freehold ownership in the main registry, the *starter* title would be recorded at the local land offices;
- A conveyancer need not prepare registration documents. Local land office officials would be required to assist people with the preparation of transfer agreements and other simple land transactions;
- There will be no survey of the internal boundaries within a block. Hedges and fences could be encouraged to provide a measure of certainty as to the location or extent of sites within a block. A community map could be used to indicate these boundaries.

3.7.2 Landhold Title

Landhold title, on the other hand, has certain aspects of ownership but without the complications of full ownership. According to Christensen *et al* (1999), this title could provide holders with the right to occupy a particular site in perpetuity. In this case, the site could be sold, transferred and otherwise disposed of, or mortgaged.

Accordingly, the *landhold* title would:

- be recorded in the local land offices;
- not necessarily register landhold rights using conveyancers as the range of transactions would be limited, and the local land staff could be trained to recognise each of these transactions; and
- allow boundaries of sites to be mapped at a lower accuracy by a technician and not a professional surveyor.

(Christensen *et al*, 1999)

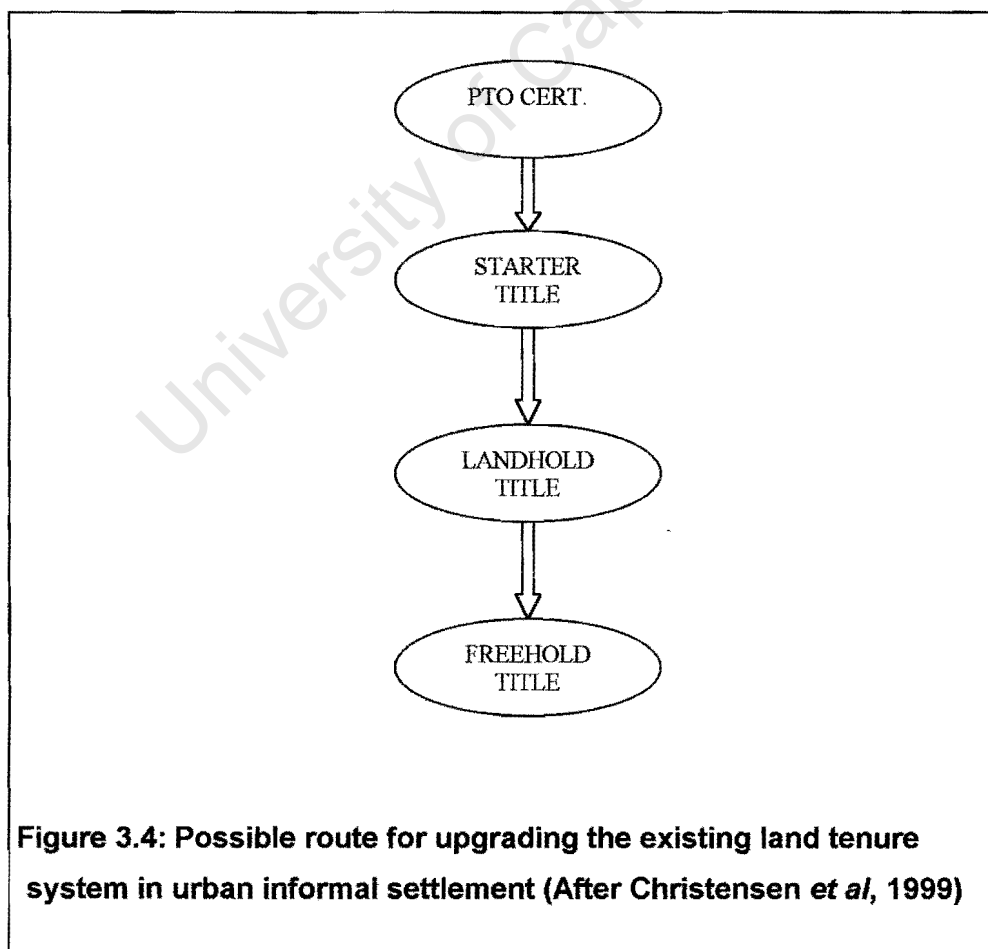
According to Christensen *et al* (1999), upgrading from *starter* title to *landhold* title will only be possible when the whole group within a block of sites agrees to do so. In practice, *starter* title would not require adjudication as the title will be a form of family title and internal boundaries would not be surveyed. *Landhold* title, on the other hand, is more individualised than the *starter* title, and so an adjudication process must take place so as to ensure that the right parties become owners upon upgrading (Christensen *et al*, 1999). The ensuing section describes how these titles could be applied in this study.

3.7.3 Application to the proposed Land Inventory Model

From the foregoing discussion, it can be inferred that *starter* title and *landhold* title could both provide some degree of tenure security to landholders in urban informal settlements in South Africa. Thus, in relation to this study, the author recommends that allocated sites in urban informal settlements without *deeds of transfer* should be regrouped into

block of sites. In this case, depending on the size of a settlement, a block of sites could contain between 20 and 50 sites or plots.

Furthermore, since the majority of the informal settlers cannot afford to survey the outer boundaries of the block(s), local authorities would be required to undertake the initial survey of the outside figures and the registration of the block of sites in accordance with the Land Survey Act (Act No. 8 of 1997) and the Deeds Registries Act (Act No, 47 of 1937) respectively. In this case, local authorities will be entitled to keep the original copies of the group titles or certificates, but would be required to provide copies to landholders within the block of sites. The group titles, in this case, must bear the names and signatures (or thumb prints) of all the landholders within the block of sites. This endorsement may be useful during adjudication process.



Moreover, besides issuing landholders with copies of the group title, the local land allocation board will be required to replace the existing 'permission to occupy (PTO)' certificates with the *starter* title certificates, which must be endorsed by the local land managers. Upgrading of the 'permission to occupy (PTO)' certificates to *starter* titles would be based on the details as recorded in the local land record. Also, as illustrated in Figure 3.4 overleaf, the *starter* titles could be upgraded to *landhold* titles when the landholders within the block decide to do so. Likewise, the *landhold* titles could finally be upgraded to freehold titles once a township register is opened in a settlement. The ensuing section describes how *starter* title and *landhold* title rights can be registered at the local land office.

3.7.3.1 Registration procedures in respect of Starter title and Landhold title rights at the Local Land Office

As already stated, the entire block must first be registered in accordance with the existing legislation as applicable to freehold title. Here, a professional land surveyor is required to survey the outside figure of the block(s) in accordance with the existing Land Survey Act, and lodge the corresponding diagram or general plan for approval at the Surveyor-Generals office. When approved, the outside figure of the block(s) could then be registered at the deeds registry office by a conveyancer. In this particular instance, an application could be made for the freehold title deed of the property to be endorsed to the effect that *starter* title rights would be registered against the said property and that the records in this regard will be held at the local authority. The effect of such an endorsement will be that the block(s) would not be dealt with in any manner save as may be required in terms of the applicable legislation to upgrade *starter* title into *landhold* title or freehold title. According to Christensen *et al* (1999), the owner of the property (*e.g.* local authority or NGO) should be allowed to register servitudes over the property without the permission of the *starter* title holders.

Once the demarcation and registration of the block(s) is completed, details of existing occupiers within the block(s) would be recorded and entered into the proposed land database. In the case of the *starter* title, applicants (in this case, heads of the household)

will be required to complete an application form at the local land office. In addition, applicants would be required to appear in person at the local land office to verify the information as provided. Once the board is satisfied with the information provided and the details have been entered into the land database, holder's copy of the *starter* title certificate will then be issued to the beneficiaries. With regards to transfers, both the transferor and transferee would be required to appear at the local land office to register the said transfer. This approach is required to counteract fraud and coerced transfers.

Landholder title rights, on the other hand, could be registered either as the outcome of the upgrading of *starter* title rights or may be registered as the first form of tenure (Christensen *et al*, 1999). According to Christensen *et al* (1999), the following steps should precede registration of *landhold* title rights:

- outside boundaries of the underlying land on which *landhold* title is to be established have been surveyed by a professional land surveyor;
- erf or plot has been registered as a single plot in the name of a single owner. In other words, any subdivisions or consolidations to create a single plot may have been completed; and
- any title deed conditions or underlying rights inconsistent with the envisaged use of the property have been removed, cancelled or the holder's consent obtained.

Once these steps have been addressed, the owner of the underlying title can submit application to the local land office for the opening of a *landhold* title register. Accordingly, the approval of a *landhold* title register would not have the effect of subdividing the block. In other words, the owner of the block would continue to be the owner until such time that the *landhold* title right is upgraded to a freehold title. At this stage, the block would be subdivided and professional land surveyors would be required to survey the individual sites within the block(s). For security purposes, the deeds registry office and Surveyor Generals' office will be notified of the registration of *starter* title rights, *landhold* title rights, as well as land transfers at the local land office.

3.8 MAINTENANCE OF THE LOCAL LAND RECORD

According to Okpala (1992), data maintenance is often more important than the initial system creation and installation. Therefore once the land data has been collected and input into the proposed informal settlement land database, it is essential that local land managers ensure that new dwellings and changes in land use or allocation are recorded and incorporated into the system. In this regard, the ward committees would be required to monitor and record erection of new dwellings within their jurisdiction.

On the other hand, Davies (1998) has stated that the land record system could be designed in such a way that local residents would be encouraged to inform the local land allocation board through their ward representatives of land sales, transfers, subdivisions or out-migration. According to him, participants could be given priority over non-participants when allocating serviced erven in the settlements. In relation to this study, such benefits could also be instituted to encourage informal settlers to provide the necessary land information with regards to land sales, transfers, subdivisions and out-migration.

3.9 IMPLEMENTATION PLAN

From the foregoing discussion, a need for a simple and fairly accurate method of recording and maintaining land record in urban informal settlement is evident. The first step of instituting such a system is to put in place a policy decision plan to manage this system. Such a policy decision plan would give the necessary official status to the first phases of the implementation programme, and also provide the programme with an overall time-schedule and action plan.

The following implementation plan has been proposed for the land inventory model:

- (i) Policy decision to be put in place by the local authorities to manage the proposed system;

- (ii) Selection of a pilot project area (*i.e.* an informal settlement) to adjust and refine the proposed method under real conditions;
- (iii) Meeting with the local residents of the pilot project area to discuss aspects of the proposed land record in terms of what it does, why it is desirable and how the entire community would benefit from the information that is held in the land record. These meetings are needed to create awareness about the system and also to encourage participation.
- (iv) Appointment of a local land manager to oversee the day-to-day running of the proposed local land office;
- (v) Identifying and purchasing of suitable hardware and software applications for the storage, processing and dissemination of the land data;
- (vi) Identifying a suitable location for the local land office in the project area;
- (vii) Formation of the proposed local land allocation board to deal with land allocation and related issues locally;
- (viii) Preparation of questionnaires for data capturing;
- (ix) Selection of an appropriate mapping technique for the capturing of the geographical locations of sites and other features of interest;
- (x) Demarcation of the outer boundaries of the block of sites;
- (xi) Numbering of the sites and recording of landholders details into the land database;
- (xii) Processing and dissemination of land information across the local area network;
- (xiii) Evaluation of the pilot project outcome and identification of training needs;
- (xiv) Launching of a full-scale programme of the land inventory model.

3.10 CONCLUSION

This chapter has discussed a land inventory model in the context of recording and maintaining information about lands held in urban informal settlements in South Africa. It was established that the land inventory model could serve as an administrative tool for effective record keeping and land use planning, and also as a source data for upgrading the existing tenure situation in urban informal settlement into freehold tenure. The information that needs to be inventoried into the proposed informal settlement land database, and a data collection methodology that needs to be put in place for the

capturing of both spatial (map) and non-spatial land information have also been addressed. It is evident from this discussion that GIS and GPS applications can play an important role in the recording and manipulation of land information. For instance, sites in urban informal settlements that do not have spatial dimensions defined, can first be captured as point features using either a GPS survey or other simple survey method, and then linked to their attribute information using a vector-based GIS software application.

It is evident that the use of aerial photographs as backdrop images in GIS application could give users a better view of undeveloped urban informal settlements. The importance of having an identification code that relates to the geographical locations of sites in urban informal settlement has also been emphasised. It is stated that service providers such as the local authorities require these codes to locate sites in urban informal settlements with relative ease. Furthermore, it is established that the recording and maintenance of land information in urban informal settlements would not be an easy process without the establishment of local land offices and the formation of local land allocation board. Primarily, this is required to create a partnership between local authorities and the community at large for the recording and maintenance of information about lands held in urban informal settlements.

Land allocation and registration models that are suitable for managing lands held in urban informal settlements have also been discussed. It was emphasised that the *starter* title and *landhold* title could be implemented as intermediary titles, but could later be upgraded to freehold title. In other words, upgrading of the existing tenure practice in urban informal settlements in South Africa could be carried out in three phases. That is, from 'permission to occupy' certificate to *starter* title, then to *landhold* title and finally to a freehold title.

The benefits of the proposed land inventory model have been outlined, and it includes such things as improving the efficiency of land administration. It has been stated that prior to a full implementation of this model, policy decision plan should be put in place to manage this system. Also, a pilot project should be carried out to assess the strength and

weaknesses of the model in real condition, and based on the outcome of the pilot project, training needs could be identified and addressed.

The next chapter addresses the construction of the informal settlement land database. Particularly, it explores the flexibility of using a vector-based GIS software application to store, display and manipulate records from the informal settlement land database.

CHAPTER FOUR: CONCEPTUAL DESIGN OF INFORMAL SETTLEMENT LAND DATABASE

4.1 INTRODUCTION

Geographic Information Systems (GIS) belongs to a class of computer systems that require the building of databases before they become useful. One of the goals of database development is to eliminate redundant data collection and storage. In other words, data is collected once and accessed by all those who need it. This chapter addresses the design and construction of the proposed informal settlement land database. As already indicated, this chapter explores the flexibility of using a vector-based GIS application to store, retrieve, display and manipulate records from the informal settlement land database. It is important to note at this stage that the proposed informal settlement land database is a spatial database model and thus will be addressed as such.

The chapter begins with an overview of a relational database design as proposed by Elmasri and Navathe (1989), and also discusses Chen's Entity-Relationship model in the context of modelling the proposed land database. The proposed land database was implemented using ArcView GIS software application.

4.2 DESIGN PHASES OF THE INFORMAL SETTLEMENT LAND DATABASE MODEL

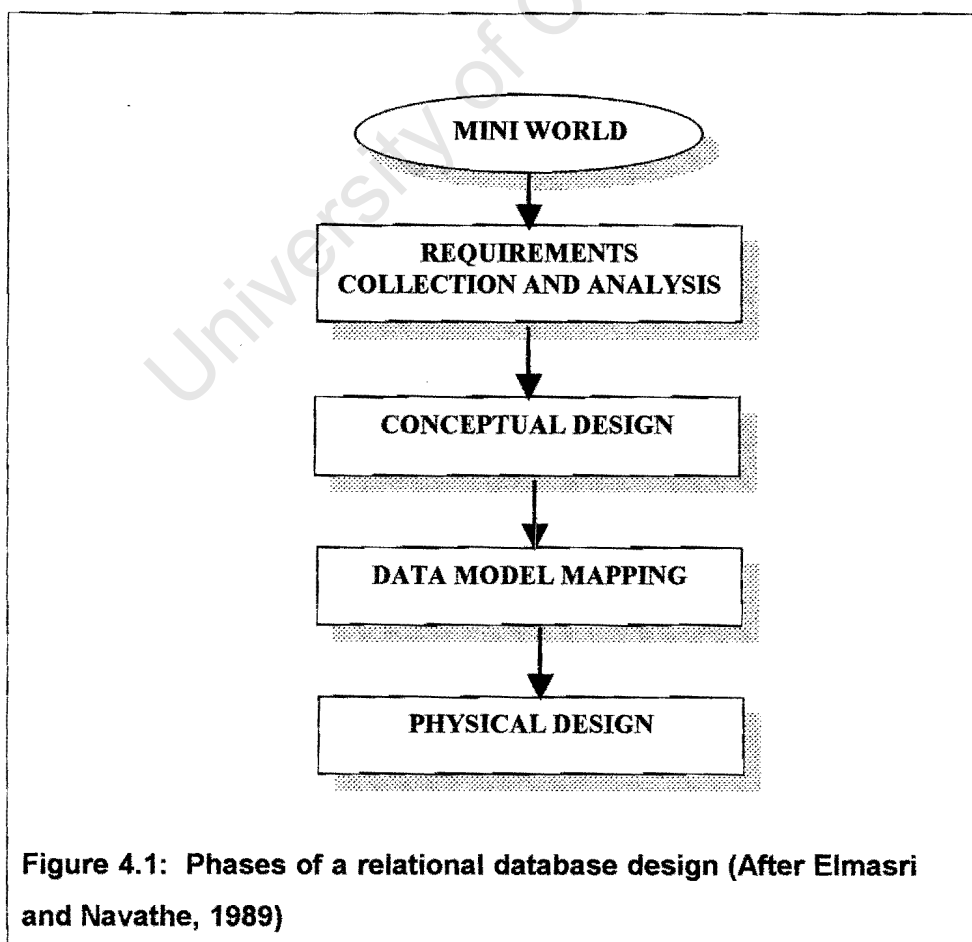
According to Marble (1988), database design is generally the development of the database structure as well as definition of its contents. Elmasri and Navathe (1989) have defined the goals of database design as follows:

- To insure that all data needed to satisfy user's requirements are stored in the database;
- To eliminate redundant data;
- To provide a way to understand the organisation of the data; and

- To support the specified processing requirements and performance objectives.

Typically, database design process involves the following phases as schematised in Figure 4.1 below:

- a) Collection of data related to the intended uses of the database (*i.e.* requirements collection and analysis);
- b) Interpretation of users' needs and the development of a conceptual schema (*i.e.* conceptual modelling);
- c) Mapping of conceptual schema into the data model of the database management system (DBMS) (*i.e.* logical modelling);
- d) Specification of storage structures and paths (*i.e.* physical modelling);
- e) Implementation of the database.



In modelling the proposed informal settlement land database model, the following design methodology as proposed by Environmental Systems Research Institute, Inc (ESRI, Inc, 1994: ARC/INFO Data Management) for spatial database modelling was considered together with the design methodology as indicated in Figure 4.1:

- i) Modelling users' view concerning land tenure information;
- ii) Defining entities and their relationships;
- iii) Identifying spatial representation of entities; and
- iv) Matching conceptual models to GIS geographic data sets.

(ESRI, Inc, 1994: ARC/INFO Data Management)

The first three steps (as indicated above) basically develop the conceptual model of the proposed informal settlement land database, classifying spatial features based on understanding of the data required to support land management functions of the local authorities, and also deciding on their spatial representation (*i.e.* either as points, lines or polygons). The last step develops the logical model of the proposed land database.

4.2.1 External Modelling: Requirements Collection and Analysis

This phase involves strategic planning, implementation plan and data flow modelling. Here, the designer identifies main users and determines users' data requirements and also establishes query types. The designer does so by interviewing prospective users of the database to understand and document their data requirements. In this study, however, the external modelling of the proposed informal settlement land database model was carried out based on the information as gathered from the interviews conducted by the author at Cape Town and Pietermaritzburg deeds registry offices, and also at Pietermaritzburg-Msunduzi Transitional Local Council, and also a desktop study of the existing land tenure practices in South Africa.

4.2.2 Conceptual Modelling: Entity-Relationship Approach

The next phase of the design process is to identify entities and their relationships. Elmasri and

Navathe (1989) have stated that the Entity-Relational model is close to users' perception of the data and application, and it is independent of database management systems (DBMS), and also provides flexibility for modifications during the design process. In relation to this study, the conceptual design of the informal settlement land database model was carried out using Chen's Entity-Relationship model. According to Maciaszek (1990), Chen's Entity-Relational model uses the concept of entity, relationship and attribute to represent data in a database. He defines entities as things or objects of the real world, about which a set of data is collected, correlated and stored in a database. Relationship, on the other hand, is defined as the direct association between entities with common attributes or characteristics, and attributes as the properties that describe the entities and relationships.

On the Entity-Relationship diagram, these items are graphically represented using the three basic symbols (*i.e.* rectangle, diamond and ellipses). Entities are represented as rectangles, relationships as diamonds and attributes as ellipses (Elmasri and Navathe, 1989) (see Appendix B). With regards to the design of the informal settlements land database model, the following entities were identified, and their key attributes and spatial representation in GIS have been defined in Table 4.1 (overleaf). Details of these entities have been listed in Appendix A.

4.2.3 Mapping of Conceptual model into Relational model

The next phase of the design process after conceptual modelling is the logical modelling. This phase involves the transformation of the conceptual model (or Entity-Relationship diagram) into relational data model. The relational data model, which was introduced by Codd in 1970, stores data in a database as a collection of *relations* (or tables). Here, each column in a table represents an attribute, and each row is a collection of related data values for each attribute. There are two aspects of integrity in relational data model that need to be emphasised in this study, namely; entity integrity and referential integrity (Codd, 1970). The entity integrity ensures that each *relation* (or table) has at least one primary key. The primary key, in this case, can be a combination of one or more attributes and whose value can uniquely identify each row in a database.

Table 4.1: Entities and their spatial representation

Entities	Attributes (PK-Primary Key, FK-Foreign Key) – see Appendix A	Spatial Representation
Building	Build_Code (PK), Location, Build_Use, Date_Built, P_Descrip, Occu_Sta, No_of_Room, Site_No (FK), Own_Per_ID (FK)	Point
Block	Block_No (PK), Plan_No (FK), Area, Perimeter, Population, Sur_Name (FK)	Polygon
Clinic	Cli_Name (PK), Location, No_of_Room, Ward_Name (FK), Build_Type, Date_Built, Per_In_Char, No_of_Bed	Point
Community Hall	Hall_Name (PK), Date_Built, Build_Type, Location, Caretaker, Ward_Name (FK)	Point
Deed of Transfer	DoT_No (PK), L_Title_No (FK), Date_Iss, Pla_Iss	None
Executive Committee	EC_Name (PK), Inf_Name (FK), Chair_Name, Term_Off, Start_Date, End_Date	None
General Plan	Plan_No (PK), Date_Prep, Date_App	None
Informal Settlement	Inf_Name (PK), Population, Area, Perimeter, No_of_ward	Polygon
Landhold Title	L_Title_No (PK), Starter_Title (FK), L_Date_Iss, L_Date_Con	None
Local Land Board	LLAB_Name (PK), ChairPer_ID, Term_Off, Start_Date, End_Date	None
Local Land Office	LLO_Name (PK), LLAB_Name (FK), Inf_Name (FK), Location, Off_Char	None
Newcomer	New_Per_ID (PK), Start_Prob, End_Prob, WC_Name (FK), Spon_Per_ID (FK), PTO_Cert (FK), Site_No (FK)	None
Occupant	Occ_Per_ID (PK), Build_Code (FK)	None
Owner	Own_Per_ID (PK)	None
Person	Per_ID (PK), Name, Per_St, Sex, Marital_Status, No_of_Chil, Name_of_Sp, Date_of_Arr, Next_of_Kin	None
PTO Certificate	PTO_Cert (PK), LLO_Name (FK), Date_Iss, Date_Conv, Pl_Iss	None
Public Toilet	Toilet_Code (PK), Date_Built, Build_Type, Location, Ward_Name (FK)	Point
School	Sch_Name (PK), No_of_Stu, Location, Sch_Type, Date_Built, Ward_Name (FK), Prin_Name, No_of_Tea	Point
Site	Site_No (PK), Location, Area, Perimeter, PTO_Cert (FK), S_Title_No (FK), L_Title_No (FK), Ward_Name (FK), Block_No (FK), DoT_Title (FK), Land_Use, L_Tenure, Date_Allo	Point
Sponsor	Spon_Per_ID (PK), Ward_Name (FK)	None
Starter Title	S_Title_No (PK), S_Date_Iss, S_Date_Conv, Pl_Iss, PTO_Cert (FK)	None
Street	Str_Name (PK), Sur_Type, Width, No_of_lane, Ward_Name (FK)	Line
Surveyor	Sur_Per_ID (PK), PLS_No, Com_Name, Com_Tel	None
Ward	Ward_Name (PK), Inf_Name (FK), Population, Area, Perimeter	Polygon
Ward Committee Chair	WC_Per_ID (PK), Ward_Name (FK), EC_Name (FK)	None

Referential integrity, on the other hand, requires a relational database management system (RDBMS) to keep each foreign key consistent with its corresponding primary key. A foreign key is a primary key of one table that is embedded in another table. Both primary and foreign keys play a unique role in database application. Whilst primary keys provide quick access to specific records in a database due to their uniqueness, foreign keys enable the linking of two

or more tables. As a rule of thumb, both primary and foreign keys must be underlined on Entity-Relationship diagram to distinguish them from the other non-key attributes (Maciaszek, 1990)(see Appendix C). The diagram in Appendix C represents the mapping of the conceptual schema in Appendix B into relational model, but for the sake of clarity some of the attributes as listed in Appendix A have been omitted from the diagram.

Also, depending on the participation constraints, relationships between entities can be presented in different ways in a relational data model. For instance, a binary one-to-many (1:M) relationship can be presented by including the primary key of the (one-) entity type into the table of (many-) entity type. For example, as indicated in Appendix C, the key attribute *inf_name* of the INFORMAL SETTLEMENT table (*i.e.* one- entity type) has been represented in the WARD table (*i.e.* many- entity type). In this example, the key attribute *inf_name* of the INFORMAL SETTLEMENT table has become a foreign key in the WARD table. With regards to one-to-one (1:1) and many-to-many (M:M) relationships, it does not matter which of the two key attributes is represented elsewhere.

4.2.4 Physical (or Internal) Modelling

Physical (or Internal) modelling is the process of choosing a specific storage structure and access requirements for the database files in order to achieve good performance for the various database applications such as update, delete, insert and display of records. In view of this, the physical modelling depends largely on the database management system (DBMS) used (*i.e.* the software) and also the capacity of the hardware system. At this stage of the design process, the database designer would take into account the various options available in the database management system (DBMS) for file organisation and access requirements (Elmasri and Navathe, 1989).

Commenting on the software component of the physical modelling of the proposed informal settlement land database, ArcView GIS as a vector-based GIS application has an index function, which speeds access to data by ordering the values in the fields or columns. There are two indexes available in ArcView GIS for accessing data, namely: attribute index and

spatial index. The attribute index helps ArcView GIS to find records in the database more rapidly. This function improves the performance of data retrieval operations based on values that are indexed (*e.g.* join, link and simple queries operations).

Spatial index, on the other hand, improves Arcview's performance of such operations as identifying spatial features, spatial joins, and theme-on-theme selection. A spatial index is created automatically whenever a spatial join or theme-on-theme selection is performed, or when a theme's *Shape* field in the attribute table is indexed.

4.3 CONSTRUCTION OF THE INFORMAL SETTLEMENT LAND DATABASE WITH ARCVIEW GIS

The first step in developing a database is to acquire the data set, which can be in variety of forms (*e.g.* ascii text, digital maps or layout, images, photographs, scanned documents, etc.). Thus, constructing the proposed informal settlement land database, two sets of data were captured and processed with ArcView 3.1, namely, *shapefiles* (or themes) and their descriptive information in tabular form. In all, eleven *shapefiles* (or themes) were created from a simulated data set, namely, WARD, LOCAL LAND OFFICE, INFORMAL SETTLEMENT, BUILDING, COMMUNITY HALL, STREET, PUBLIC TOILET, CLINIC, BLOCK, SITE and SCHOOL.

The WARD theme contains polygon features that represent the physical boundaries of wards in an urban informal settlement. INFORMAL SETTLEMENT, BLOCK and SITE themes are also represented as polygon features. In this case, the INFORMAL SETTLEMENT theme represents the area extent of recognised urban informal settlements that are within the jurisdiction of a local authority. The BLOCK theme represents the area extents of block of sites in each ward. The SITE theme represents allocated sites within a block of sites.

BUILDING theme, on the other hand, contains point features that define the geographical locations of buildings (or structures) in an urban informal settlement. COMMUNITY HALL,

PUBLIC TOILET, CLINIC, LOCAL LAND OFFICE and SCHOOL themes also contain point features, which as well define their geographical locations in the settlements. The STREET theme however contains line features, which represent the street centre lines. In this study, the attribute tables of the above-mentioned themes and also the following Dbase tables: LOCAL LAND ALLOCATION BOARD, NEWCOMER, WARD COMMITTEE CHAIR, EXECUTIVE COMMITTEE, SPONSOR, PTO CERTIFICATE, STARTER TITLE, LANDHOLD TITLE, DEED OF TRANSFER, SURVEYOR, GENERAL PLAN, and PERSON were all created with ArcView GIS. ArcView GIS automatically defines a *Shape* field in the corresponding table whenever a new theme is created. Additional fields or columns can then be added to the new table by defining the following parameters:

- The item (or column) name;
- The item (or column) width (*i.e.* number of spaces required to store the item values); and
- The item type (*i.e.* integer, or character, or numeric and or date).

Generally, GIS applications use a geo-relational model to establish and maintain connection between spatial features and their attribute information (Environmental Systems Research Institute, Inc., 1994: Introducing ArcView). They represent spatial features as an interrelated set of spatial and descriptive data. This is so because spatial features and their corresponding attribute data are both labelled with a common feature identifier or code. Thus, in a GIS environment, users can display attribute information about spatial features by selecting the features, or creating dynamic (or derived) maps based on their attribute information. In this regard, ArcView GIS has the functionality of linking spatial features to their attribute information, and thus useful for addressing the queries as listed in Appendix D.

One other functionality of ArcView GIS that can be useful for manipulating land information at the local authorities is its *hot link* facility. This facility basically allows ArcView GIS users to associate and display additional data about spatial features from a *view* by clicking on the feature with the *hot link* tool. The data set, in this case, can be an image, a photograph, a text file or a document containing additional textual information about spatial features. For images, ArcView GIS supports the following image data (Environmental Systems Research

Institute, Inc., 1994 – *Introducing ArcView*): photographs, remotely sensed data, scanned data, satellite data and graphics. The image data could also be in one of the following image format: TIFF (Tag Image File Format), X-Bitmap, MacPaint, Microsoft DIB (Device Independent Bitmap), SunRaster File, GIF (Graphics Interchange Format).

To use the *hot link* facility, it must first be defined in the feature attribute table, and to do so an additional field must be added to the feature attribute table for the storage of the full path name of the image data or document. Also, a predefined action (*e.g.* link to text file, link to image file, or link to document) and the field that contains the path name of the image data or document must be specified in the *hot link* window panel of the Theme Properties dialog. Seemingly, each theme in a *view* can have its own *hot link* definition.

In relation to this study, photographs of the buildings or other features of interest in urban informal settlements can be captured in a digital form and linked to their corresponding spatial features using ArcView GIS *hot link* facility. Once the *hot link* is defined, users would then be able to display photographs of the buildings by clicking on the corresponding features with the *hot link* tool. In this exercise, a sample photograph named *aerial.bmp* has been associated to the point feature (named A8) in the BUILDING theme. Here, the 'Hotlink' field which has been added to the BUILDING attribute table contains the path name of the image data *aerial.bmp*. Readers must note that the existing path name of the image data *aerial.bmp* must be edited in the BUILDING attribute table whenever the image data or file is moved to another directory or location. The stify disk, which has been provided with this document, contains an ArcView project called *informal.apr*. This file contains all the themes that have been listed in Section 4.3.

4.4 RETRIEVING DATA FROM THE INFORMAL SETTLEMENT LAND DATABASE

One of the key functions of local authorities is to respond to queries for data sets of some kind (*i.e.* either spatial or non-spatial data set). Accessing or retrieving a data from a table in

ArcView GIS is a simple process. Depending on the nature of the query (*i.e.* spatial or non-spatial query), a user can work on either a single table or a combination of two or more tables. ArcView GIS allows users to join a table to the *active table* based on the values of a common field found in both tables. The name of the field does not necessarily have to be the same in both tables, but the data type must be the same (Environmental Systems Research Institute, Inc., 1994 - *Introducing ArcView*). The *join* function in ArcView GIS establishes a one-to-one or many-to-one relationship between the destination table (the active table) and the source table. Typically, the source table contains additional descriptive information of features in the *active theme* that are not available in the theme's attribute table. The source table could also be obtained from an external database server such as Oracle or Sybase by using ArcView's SQL connection feature. Here, records from the external database server can be retrieved into ArcView GIS as tables.

To select a record from a theme's attribute table and/or a feature from the *active theme* in a *view*, a query builder interface in ArcView GIS is used to build up a condition or criteria for the selection. To do this, the user must select the desired item (or attribute) from a list of attributes on the left side of the *Query Builder dialog* box, followed by identifying an operator (*i.e.* AND, OR, NOT, =, >, <, >=) and lastly specifying the attribute value of the required feature (see the example below).

Example:

([L_Tenure] = "Freehold" AND ([Ward_Name] = "A"))

In the above example, freehold sites in Ward A will be selected (or highlighted) in a *view* if the SITE theme is the *active theme*. The same procedure was followed in Appendix E to address the sample queries as listed in Appendix D. By customising ArcView with Avenue programming language, selection of records from the informal settlement land database could be automated by a mere pressing of a button. Nonetheless, this is outside the scope of this study. In an ideal condition, local authorities can address this situation by incorporating other compatible database applications that could speed up this process.

It has been established that the land management functions of local authorities include maintaining public records, identifying items of interest and subsequent retrieval and manipulation, simple display of maps or diagrams, responding to public queries for information and maintaining public facilities. These tasks by their nature may require one of two types of data set (*i.e.* spatial or non-spatial data). However, from the above discussion, one can conclude that GIS applications have the functionality to address the above tasks much more efficiently and effectively.

Thus in relation to the proposed land inventory model as discussed in Chapter Three, a spatial database of this nature can be implemented on a mainframe (or central server) at the local authorities and also be monitored by respective local land managers. In this case, updating and inputting of land records in the spatial land database or modification of the database structure can be carried out at the local land office. As already indicated, a local area network (LAN) system can be put in place to allow readily access to this information, and also to link up with the external users. This system can also be integrated with other non-GIS databases that contain spatial data set.

4.5 CONCLUSION

The purpose of this chapter is to design a prototype model of an informal settlement land database, which could be utilised by local authorities in South Africa to manage land tenure information about lands held in the informal settlements. In this regard, the application of Entity-Relationship model in the conceptual design of the informal settlement land database has been discussed. This phase entails data requirement collection and analysis. The data requirement, in this case, is more or less related to the intended uses of the informal settlement land database model. The conceptual design of the informal settlement land database was based on the Chen's Entity-Relationship model, which uses the concepts of entity, relationship and attribute to represent data in the database. In all, eleven entities were identified for the construction of the informal settlement land database, and their spatial representation in GIS has been discussed. The conceptual schema was mapped into relational model for the implementation of the informal settlement land database.

The physical schema, which depends on both the database management systems (DMBS) used (*i.e.* software) and the capacity of the hardware system to achieve a good performance for the various database applications such as update, insert, display of records, etc. has been discussed. Commenting on the software component of the physical schema of the informal settlement land database, it was identified that ArcView GIS has an index function that facilitates rapid access to records in a database. This includes attribute and spatial indexes.

It is established that ArcView GIS represent spatial features as an interrelated set of spatial and descriptive data, and thus by selecting a feature in a *view*, the corresponding attribute information is also selected (or highlighted) simultaneously in the feature attribute table, and *vis-a-vis*. This aspect of ArcView GIS was utilised greatly in the processing of the sample queries as listed in Appendix D. In a nutshell, ArcView GIS provides a greater flexibility to manipulate records in spatial databases and thus could be useful for managing land tenure information about lands held in urban informal settlements in South Africa. The next chapter examines the strengths and weaknesses of the proposed system design.

CHAPTER FIVE: SYSTEM DESIGN ANALYSIS

5.1 INTRODUCTION

This chapter evaluates the strengths and weaknesses of the system design, and also discusses the advantages and disadvantages of implementing the proposed system. This evaluation is based on the *needs* analysis as outlined in Section 2.6.1. The chapter further addresses how the proposed land inventory model could be integrated with the existing deeds registration system in the context of upgrading the existing *de facto* vested land rights to a legally enforceable one.

5.2 STRENGTHS AND PROBLEMS OF THE SYSTEM DESIGN

As already indicated in Chapter Three, the proposed land inventory model is required to record and maintain information about lands held in urban informal settlements in South Africa. This information is required by local land managers to monitor the growth of urban informal settlements that are within their areas of jurisdiction. To accomplish this task, local land managers need to know the names and addresses of the occupants and/or landholders in each urban informal settlement, the geographical locations of all the allocated sites and other physical features of interest, and also the underlying *de facto* vested land rights. This aspect has been dealt with in the design of the proposed informal settlement land database.

However, as indicated in Section 3.4.1, some of the sites in urban informal settlements in South Africa do not have their spatial dimensions explicitly defined. As a result, these sites were represented in the proposed informal settlement land database as point features. On the other hand, sites that are within a demarcated block of sites were represented as polygon features due to their fairly defined boundaries. It is worth noting that the proposed land inventory model has been modelled such that local land managers will be able to identify the existing land use pattern in urban informal settlements. This information is essential for identifying sites in urban informal settlements that are available for development, and those that have been abandoned. In essence,

local land managers will be able to monitor the activities in urban informal settlements that affect the best utilisation of the land.

Certainly, not every aspect of the local land managers' data requirements could be modelled and incorporated into the proposed informal settlement land database. For instance, land management tasks such as environmental impact assessments; development and management of utilities and services, which one way or the other require data sets that have a spatial component (*i.e.* locational information) were not considered in this study. In addition, the system design did not take into account the other informal dealings in land with regards to inheritance, donations and sales. Instead, it focused on personal and site details and also the underlying *de facto* vested land rights. In this respect, the system design has proved to be an effective tool for managing informal settlement land tenure information.

The use of computer technology and GIS software applications in this model offer an excellent opportunity for creating a cost-effective land information system at the local government level. For instance, these systems together have the tendency of decreasing the space required for storing land records, and also facilitating the compilation of land information and reports that are too cumbersome to produce manually. Secondly, the ability of GIS software applications to integrate and analyze a variety of themes or layers of spatial data sets provides an effective way of documenting, displaying and analyzing informal settlement land tenure information.

It has been emphasized that for any land tenure system to function effectively in urban informal settlements in South Africa, it needs an accessible system of land administration where informal settlers will be able to identify those who have the authority to make binding decisions. Moreover, individuals need to know about the steps to take if their underlying *de facto* vested land rights or interests in the land are undermined or threatened. In this regard, the proposed land inventory/registration model will not be practicable unless it is transparent and easily accessible. It is envisaged that the involvement of local authority officials in land allocation and administration at the settlement level will create transparency in the entire allocation and registration processes.

It is important to note that the proposed land inventory model is only a tool to be used by local land managers for land management purposes, as such, it will not by itself improve or reform the existing land tenure practice in urban informal settlements in the country. Nevertheless, it is anticipated that once the system is implemented, it could provide local land managers with reliable information that will enable them to identify ways and means of upgrading the existing land tenure situation in urban informal settlements in South Africa.

5.3 ADVANTAGES AND DISADVANTAGES OF IMPLEMENTING THE PROPOSED LAND INVENTORY MODEL

The advantages and disadvantages of implementing the proposed land inventory model are outlined in the following sections:

5.3.1 Advantages

- i) The proposed system will enable local land managers to monitor the influx of newcomers to informal settlements that are within their areas of jurisdiction;
- ii) This system will build a local knowledge or create awareness about the benefits of the formalised property rights through the formation of the Local Land Allocation Board. Accordingly, the Local Land Allocation Board will be required to educate informal settlers about the purpose and importance of keeping the local land record.
- iii) Locally held land tenure information will be readily available to the informal settlers. This is because the proposed local land offices will be located much closer to the people than the existing deeds registry offices as shown in Figure 2.1.
- iv) Local land managers will be able to identify allocated sites in urban informal settlements.
- v) There is a greater likelihood that the currency of the land record would be improved.

This is based on the assumption that informal settlers will respect the authority of the local executive committee members on the board, and will provide the necessary land information regarding the underlying *de facto* vested land rights, occupation and land use.

- vi) With this system in place, boundary disputes, group or individual land disputes will be solved locally and cheaply. This is because, the local land allocation board will ensure that disputes are resolved based on the records as endorsed in the local land register.
- vii) The proposed land inventory model will provide a much stronger security of tenure to the informal settlers than the existing tenure system. This is because, the underlying *de facto* vested land rights and the intermediary titles (*i.e.* *starter* title and *landhold* title) will be protected by an institution much higher than the existing executive and ward committees.

5.3.3 Disadvantages

- i) The proposed system may lack administrative capacity at the settlement level on the grounds that some of the local leaders seconded to the local land allocation board may lack administrative skills.
- ii) The proposed system is likely to create instability on the part of some of the executive and ward committee members whose power over the people lies in the control of the land. Hence, the formation of the local land allocation board may seem to deprive local leaders from controlling land allocation in the informal communities.

5.4 INTEGRATING THE PROPOSED SYSTEM WITH SOUTH AFRICA DEEDS SYSTEM

As discussed in Section 2.2.2, the existing land tenure practice in the urban informal settlements in South Africa is similar to the customary tenure system in terms of concept and control of the

land. Accordingly, Section 152(b) of the present South African Constitution requires local authorities in South Africa to upgrade the existing land tenure practice in urban informal settlement to a freehold tenure where informal settlers will eventually own the sites they occupy or have the right to occupy the sites in perpetuity. It has been mentioned that the only way by which the existing land tenure practice in informal settlements could be integrated with the existing deeds registration system is by merging the informal system of land transfers, subdivisions, land use and land delivery with that of the formal system. This will mean introducing local land record offices, re-engineering professionals and training up local land administrators (Fourie, 1996). Some of these aspects have been considered in the proposed land inventory model in Chapter Three. For example, the establishment of the local land offices in the urban informal settlements, and also the formation of local land allocation board to administer land allocation and registration functions at the settlement level.

It has been mentioned that the conversion from the existing land tenure practice in urban informal settlements to a freehold tenure should not be a sudden process since the majority of the informal settlers will not be able to afford the cost of engaging the services of conveyancers to prepare deeds or transfer documents on their behalf, and also have their sites surveyed by professional land surveyors. Thus, in the event of integrating the proposed system with the existing deeds registration system, it has been recommended that the proposed intermediary titles (*i.e.* *starter* title and *landhold* title) should be implemented in urban informal settlements in South Africa. As indicated in Figure 3.4, the proposed land record could be used as a data source for upgrading the existing 'permission to occupy (PTO)' certificate to a *starter* title, and then to a *landhold* title, and finally to a freehold title.

According to Christensen *et al* (1999), the *starter* title can be registered in respect of a block consisting of 40 to 100 families units, and this block could be owned by a local authority, a private developer or an NGO. Seemingly, it is only the outside figure of the block of sites that needs to be surveyed by professional surveyors and registered at the deeds registry office by conveyancers. With regards to the internal boundaries of the block, it has been mentioned that hedges or fences could be constructed to provide a measure of certainty as to the extent of the sites within the block.

As stated in Chapter Three, *starter* titles could be upgraded to a *landhold* titles once the group agrees to do so. In this case, land survey technicians would be required to map the internal boundaries at a minimal fee. The *landhold* titles can also be upgraded to freehold titles. Here, the internal boundaries are required to be surveyed and registered in accordance with the existing legislation. As pointed out in Section 3.7.3.1, both *starter* title and *landhod* title would be registered locally at the local land offices, and local land officials will be required to notify the Surveyor-Generals' office and deeds registry offices to endorse the registration of *starter* and *landhold* titles against the corresponding general plans and title deeds respectively. Administratively, the local land allocation board would be responsible for the accuracy and reliability of the local land record. This aspect is essential in the sense that in the event of settling land disputes, the information as recorded in the register kept at the deeds registry office in respect of the outside figures, and the local land record will be consulted.

5.5 CONCLUSION

This chapter has discussed the strengths and problems of the proposed land inventory system, and has established that even though not every aspect of the local land managers' data requirements could be modelled and incorporated in the proposed informal settlement land database model, the system is able to address the question as to *who* is occupying *what* site and *where* in urban informal settlements and by *what* rights or interests are the lands held. The database implementation has also revealed that computer technology can play a major role in the execution of the proposed land inventory model with regards to data manipulation and access. In other words, certain operations would not have been possible without the use of computers.

It has been established further that even though the proposed informal settlement land database contains a less formal record of land holding, it could be used as a data source for upgrading the existing land tenure practice in urban informal settlements to a legally enforceable one. In this regard, it has been mentioned that in the process of upgrading the existing *de facto* vested land rights to a freehold title, the intermediary titles as discussed in Chapter Three (*i.e. starter* and *landhold* titles), must first be enforced in urban informal

settlements. This is required to avoid the high cost commonly associated with the freehold tenure practice in South Africa. In a nutshell, it can be concluded that if the proposed land inventory model is well structured in terms of scope and content, then it could be a valuable tool for managing information about lands held in the urban informal settlements in South Africa.

University of Cape Town

CHAPTER SIX: SUMMARY CONCLUSION AND RECOMMENDATION

6.1 INTRODUCTION

The primary objective of this study is to design a conceptual model of a land inventory system, which could be implemented by local authorities in South Africa for land management purposes, and also to upgrade the existing land tenure system in urban informal communities to a legally enforceable one. In particular, this study has explored the use of GIS application and computer technology to design a prototype model of an informal settlement land database, which in essence is required to facilitate land data storage, processing and retrieval; and also to expedite the flow of land information between local authorities and informal communities. In order to achieve the overall objective, the following tasks were targeted:

- A literature review of the statutory requirement and examination procedure of the existing deeds registration system in South Africa (Chapter 2).
- A literature review of the land tenure practice in urban informal settlements in South Africa (Chapter 2).
- Development of a *needs* analysis in respect of recording information about lands held in urban informal settlements and making them readily available to the local authorities through the use of computers and state-of-the-art GIS applications (Chapter 2).
- Design of a conceptual model of a land inventory system based on the *needs* analysis (Chapters 3 and 4).
- Implementation of the proposed informal settlement land database model using ArcView GIS application (Chapter 4).
- Evaluation of the proposed land inventory model in terms of performance and how feasible it could be integrated with the existing deeds registration system (Chapter 5).

This chapter summarises the findings of this study, forms conclusions based on the findings, and makes the necessary recommendations.

6.2 SUMMARY AND CONCLUSIONS OF THE STUDY

Chapter One has dealt with the introduction of the study, and has also addressed the background of the study, the research objectives, methods and procedures, the data sources used, the scope of the study, assumptions and the limitations of the study. Here, it was discovered that, not until the 1990s, black South Africans did not have equal access to the land in the country for urban housing. Subsequently, informal settlements were developed in most urban cities in South Africa to provide housing for the urban poor. The current South Africa Constitution has indicated that local authorities in South Africa should provide basic services to the informal settlements that are within their areas of jurisdiction. In this context, it was also identified that local authorities in South Africa depend largely on the existing cadastral record to carry out their land management functions. Apparently, the existing cadastral record does not contain information about lands held in urban informal settlements in South Africa, as a result, some of the local authorities in South Africa have not been able to manage informal communities effectively due to lack of land information. Addressing the research question, a number of data sources were utilised. This includes UCT library facilities, personal interviews with personnel involved with South Africa deeds registration system and land administration and Internet searches.

Chapter Two has addressed the concept of land tenure, land management and land inventory and geographical information systems. It was acknowledged that since land is so vital to human existence and development, the land and its rich resources should be administered efficiently. Presently, in South Africa, the land administration practice in most urban informal settlements is inefficient. This problem is further compounded by the existence of diverse land tenure practices and land rights that are conflicting with each other. In order to address this scenario and also to monitor the growth of urban informal settlements in the country, it has been mentioned that some form of recording and registration models should be put in place at the local government level. Furthermore, to expedite access to land information locally, the use of computer systems and GIS software

applications have been recommended. The benefits of using GIS applications in land management have been discussed, and it includes provision of maps and conducting of spatial queries.

Chapter Three has discussed the proposed land inventory model. It was established that the proposed land inventory model could serve as an administrative tool for effective land record keeping and land-use planning, and also as a data source for upgrading the existing *de facto* vested land rights to a legally enforceable one. The information that needs to be stored in the proposed informal settlement land database, and a data collection methodology that needs to be put in place for the capturing of both spatial (map) and non-spatial land information have been addressed in this chapter. In addition, the importance of having special codes that relate to the geographical locations of the sites in urban informal settlement has been discussed. Accordingly, service providers such as local authorities require these codes to locate sites in urban informal settlements with relative ease.

Furthermore, it is established that the recording and maintenance of land information in urban informal settlement will not be an easy process without the establishment of local land record offices and the formation of local land allocation board to administer land allocation and registration functions at the settlement level. It is envisaged that by adopting a participatory approach to informal settlement land management, local authorities will be able to develop a mechanism that will empower local leaders to be actively involved in the recording of land tenure information at the settlement level. A land allocation and registration models suitable for handling information about lands held in urban informal settlement has been discussed in this chapter. From this discussion it was stressed that the proposed *starter* title and *landhold* title could be implemented in urban informal settlements as intermediary titles, and which may eventually be upgraded to freehold titles.

The benefits of the proposed land inventory model have been outlined, and it includes such things as improving the efficiency of land management functions locally. It has been stressed that prior to full implementation of this system, local authorities must first establish a land policy to deal with the management of this system. In addition, a pilot

project should be carried out to assess the strengths and weaknesses of the system in an ideal condition, and based on the outcome of the pilot project, training needs could be identified and addressed.

Chapter Four has dealt with the design and construction of the prototype model of the informal settlement land database. Here, the chapter outlines the steps employed to construct the prototype database model. The main steps of the database design process entail acquisition of the data set and to present it in the database. With regards to data processing and manipulation, it was identified that ArcView GIS stores spatial features as an interrelated set of spatial and descriptive data, and thus by selecting a feature in a *view* the corresponding attribute information is also selected (or highlighted) simultaneously in the feature attribute table, and *vis-a-vis*. This function of ArcView GIS was utilized in the processing of the sample queries as listed in Appendix D. It is concluded that ArcView GIS provides a greater flexibility to manipulate records in a spatial database and thus could be useful for managing information about lands held in the informal settlements in South Africa.

Chapter Five has discussed the strengths and problems of the proposed land inventory model, and has established that even though not every aspect of the local land managers' data requirements could be modelled and incorporated into the land inventory model, the system is able to address the question as to *who* is occupying *what* site and *where* in urban informal settlement and by *what* rights or interests are the lands held. The informal settlement land database was implemented and analysed using a simulated data set compiled by the author.

Furthermore, it was emphasised that although the proposed land database contains a less formal record of land holding, it can be used as a data source in the event of upgrading the existing *de facto* vested land rights to a legally enforceable one. It was stressed that in the event of upgrading to a freehold title, the intermediary titles as discussed in Chapter Three, must first be enforced in the urban informal settlements. It has also been suggested that if the intermediary titles are to be enforced at the urban informal settlement for land management purposes, then local authorities must be responsible for the initial survey of the outside figure of the group's property.

Finally, from the foregoing discussions, it can be concluded that if the proposed land inventory model is well structured in terms of scope and content, then it could be a valuable tool for managing information about lands held in the urban informal settlements in South Africa, and also for upgrading the existing land tenure practices to a legally enforceable one.

6.3 RECOMMENDATION

This study has addressed a land inventory model, which could be implemented by local authorities in South Africa to record and maintain information about lands held in urban informal settlements. Certain aspects of the proposed land inventory model have been discussed in this document but there are other areas that could be investigated further.

For instance, the proposed informal settlement land database has been modelled to address the question as to *who* is occupying *what* site in urban informal settlements and by *what rights* are the lands held. As a result, land tenure information concerning inheritance, gifts, donation, marriage, etc, have not been considered in the system design. However, if the proposed system is to be integrated with the existing deeds registration system, then features that are essential to the existing deeds registration system must be identified and incorporated into the proposed land inventory model.

Lastly, as indicated in Chapter Five, the formation of local land allocation board and local land offices may create instability on the part of the settlement executive and ward committee members whose power over the people lies in the control of the land. In this regard, a further investigation should be conducted to ascertain the strengths, weaknesses, opportunities and treats of implementing the proposed land inventory model.

REFERENCES

- Acquaye, E. and Crocombe, R.G., 1984: *Land Tenure and Rural productivity in the Pacific Island*, University of the South Pacific, Suva.
- Barnes, G., 1990: *The Evolution of the Modern Cadastre concept: From Domesday Book to LIS Network*. *Surveying and Land Information Systems* 50(1) p5-9.
- Benwell, G.L. and Ezigbalike, I.C., 1994: *Epistemology and an Environmental Cadastre*. Paper presented at Geomatics Atlantic 10th Annual Conference and FIG Land Records Conference, Fredericton, Canada. 12-13 October.
- Buckley, R., 1995: *Low Level Registries*. A paper presented at the Commonwealth Association of Surveying and Land Economy (CASLE) and the International Federation of Surveyors (FIG) conference on Sustainable Development, Harare.
- Byerly, M. and McIntosh, A., 1994: *Administration of Urban Informal Settlements, in Here to Stay: Informal Settlements in KwaZulu-Natal*, Hindson, D and McCarthy J (eds) Indicator Press, CSDS, University of Natal, p167-176.
- Becker, P. *et al*, 1999: *Local Government GIS Demonstration Grant*
- Castro, F., 1984: *Ponape: Land Tenure and Registration* in Acquaye, E. and Crocombe, R.G., 1984: *Land Tenure and Rural productivity in the Pacific Island*, University of the South Pacific, Suva.
- Central Board for Real Estate Data, 1988: *Feasibility Study on land Registration/Inventory in Botswana*. A report to support District Physical Planning in Botswana.

Chen, P.P., 1976: *The Entity-Relationship Model: Towards a unified view of the data.*

ACM, Transitions on databases systems, p9-36.

Christensen, S.F., Werner, W. and Højgaard, P.D., 1999: *Innovative Land Surveying and Land Registration in Namibia. Working Paper No. 93.* Development Planning Unit, University College London.

Codd, D.F., 1970: *A Relational Model of data for a large shared data banks.*

Communications of the ACM, 3. p377-387.

Cook, J.S., 1994: *Private Communication.* Brisbane, Australia.

Crocombe, R.G., 1974: *An approach for the analysis of land tenure systems in Lundsgaarde.* University of Hawaii Press, Honolulu.

Cross, C., 1994: *Shack Tenure in Durban, 'Here to Stay: Informal Settlements in KwaZulu Natal'*, Hudson D and McCarthy J (eds) Indicator Press, CSDS, University of Natal, Durban.

Davies, C.J., 1998: *Land Management of an Informal Settlement in East London.* Unpublished Master's Thesis, Department of Surveying and Mapping, University of Natal, Durban.

Durban Metro Housing Department, 2000: 1999 Annual Report

<<http://www.durban.co.za/housing/policysupport/landinfo.htm>>

du Plessis, W., 2000: *Historical Overview: Evolution of Land Tenure System in South Africa.* <<http://www.spatial.maine.edu/landtenureabstracts/duplessis.htm>>

Deeds Registries Act (Act No. 47 of 1937)

Elmasri and Navathe, 1989: *Fundamentals of database systems*. The Benjamin/Cunning Publishing Company, Inc., California. USA.

Eekhout, L., 1989: *Land Information Management and Informal Settlements*. Paper presented at the First International Conference in GIS in Southern Africa, University of Natal-Pietermaritzburg, 3 – 6 July.

Environmental Systems Research Institute, Inc, 1994: *ARC/INFO Data Management*.

Environmental Systems Research Institute, Inc, 1994: *Introducing ArcView*.

Fourie, C., 1994: *Options for the cadastre in the New South Africa*: A report to the South Africa Council for Professional and Technical Surveyors. Department of Surveying and Mapping, University of Natal, Durban.

Fourie, C., and van Gysen, H., 1996: *Land Management and Local Level Registries*. South African Journal of Surveying and Mapping 23(6) p 353-359.

Fourie, C., 1996: *Tenure and Land Management for Developing Countries*. Paper presented at the 1996 Property Law and Land Rights Conference: Gauteng.

Fourie, C., 1998a: *Property in Post Apartheid South Africa*. Proceedings of the International Conference on Land Tenure in the Developing world with a focus on Southern Africa: University of Cape Town, 27 – 29 January 1998. p160 -174.

Hensen, J., 1995: *Basic principles of the main cadastral systems in the world*. Extract from the workshop “From Research to Application through Cooperation” of the Joint European Conference and Exhibition on Geographical Information, The Hague, Netherlands, March 26-31, 1995.

Holzknrecht, H., 1994: *Papua New Guinea's Land Tenure, Land Use and Biodiversity Conservation*. Papua New Guinea.

International Federation of Surveyors (FIG), 1994: *Statement on the Cadastre*. A report adopted by Commission 7 on Cadastre and Land Management at its meeting in Fredericton, Canada in October 1994.

Jones, B.M., 1964: *Land Tenure in South Africa-Past, Present and Future*. PhD thesis, University of Natal, Durban.

Josayma, C., 1996: *Comments on conflict resolution in community forestry issues in Asia*: Asia Forest Network, E-conference on conflict resolution over natural resources, January – April 1996.

KwaZulu/Natal Numbering System, 1999: A report by the Numbering System Task Team to the Numbering Committee on the 15 February 1999. Department of Land Affairs, Pretoria. <<http://www.nsif.org.za>>

Latu, T.S., 1995: *Modelling a Land Information System for Freehold and Customary Land Tenure Systems*. Department of Land Information, Royal Melbourne, Institute of Technology, Australia.

Land Survey Act (Act No. 8 of 1997).

Maciaszek, L.A., 1990: *Database Design and Implementation*. Prentice Hall of Australia (Pty) Ltd.

- Marble, D.F., 1988: *Approaches to the efficient design of spatial databases at a global scale*. In building database for global science edited by H. Mounsey and R. F. Tomlinson, (London: Taylor & Francis), p 49-65
- Nicols, S.E., 1994: *Managing Land Tenure Information for Sustainable Development*. FIG International Congress, Melbourne, Australia.
- Okpala, D., 1992: *Land Management and Aid Programs*. South African Journal of Surveying and Mapping 21(5) p 262-272.
- Pienaar, M., 1996: *Land Rights and Usage: Current Land Options*. Department of Land Affairs, Pretoria.
- Riley, N.M., 1991: *GIS and the Management of Change*. Proceedings of the EDIS/SAGIS '91 Conference: Pretoria, 16-18 July 1991.
- Simpson, S.R., 1976: *Land, Law and Registration*. Cambridge University Press, Cambridge.
- South Africa Government, 1997: *White paper on South Africa Land Policy*. Department of Land Affairs, Pretoria.
- Star, J. and Estes, J., 1990: *Geographical Information Systems: An Introduction*. Englewood Cliffs, Prentice Hall.
- The Constitution of the Republic of South Africa, Act 108 of 1996.
- Thomas, G., Sibanda, S. and Claassens, A., 1998: *Current Developments in South Africa's Land Tenure Policy*. Proceedings of the International Conference on

Land Tenure in the Developing world with a focus on Southern Africa: University of Cape Town, 27 – 29 January 1998. p526 –535.

< <http://www.gtz.de/orboden/capetown/cape56.htm> >

Toms, K.N., 1996: *Land Titling in Developing Countries: What Surveyors ought to know about it*. The Australian Surveyor, March 1996, p131-142.

Twomey, J.B., 1987: *Alternative Registration Systems*. Geographic Information Conference proceedings, Sun City, 19-21 October.

UNCHS (Habitat), 1990: *Guidelines for the improvement of Land Registration and Land Information Systems in developing countries*. Nairobi.

UNEC for Europe, 1999: A report by the Committee on Human Settlements.

< http://www.sigov.si:90/mola/preview/html/land_administration.html >

van Rensburg, J. and Dickinson, S., 1991: *Integration of Technical Information System within Local Authorities*. Proceedings of the EDIS/SAGIS '91 Conference: Pretoria, 16-18 July 1991.

Williamson, I., 1991: *Land Information Management at the World Bank*. The Australian Surveyor, March 30(1) p 41-51.

Personal Interviews

Mrs. Blister, 1995: Cape Town Deeds Registry Office.

Mrs. Wiseman, 1995: Pietermaritzburg Deeds Registry Office.

Mr. Cowie, 1995: Pietermaritzburg – Msunduzi Transitional Local Council.

Mr. Therarj, 1995: Pietermaritzburg – Msunduzi Transitional Local Council.

Dr. Barry, 1999: Thesis Supervisor (UCT).

Mr. Hartley, 1999: MHP Geomatics, Westville.

Mr. McLachlan, 2000: Pietermaritzburg Deeds Registry Office.

University of Cape Town

APPENDIX A

ENTITY DATA DESCRIPTION

Index:

C	Character (or character string)
Date	Date field in the form YYYYMMDD
I	Integer
PK	Primary Key (or key attribute)
FK	Foreign Key

1. **Entity Name: BUILDING** (*Attributes of Building.shp*)

Attribute	Attribute Description	Item Type	Width
Build_Code (PK)	Building Code	C	30
P_Descrip	Physical Description	C	30
Date_Built	Date Built	Date	8
Build_Use	Building Use (dwelling or business)	C	30
Location	Location (x,y co-ordinates)	C	30
Occu_Sta	Occupation Status (occupied or vacant)	C	30
No_of_room	Number of rooms	C	30
Site_No (FK)	Site Number	C	30
Own_Per_ID(FK)	Same as Per_ID in PERSON's table	C	30

2. **Entity Name: BLOCK** (*Attributes of MrgBlock.shp*)

Block_No (PK)	Block Number	C	30
Sur_Name (FK)	Surveyor's Name	C	30
Plan_No (FK)	General Plan Number	C	30
Area_sq_m	Total Area of the block (in sq. meters)	I	30
Peri_m	Perimeter of the block (in meters)	I	30
Population	Population within a block	C	30

3. **Entity Name: CLINIC** (*Attributes of Clinic.shp*)

Cli_Name (PK)	Name of Clinic	C	30
Ward_Name (FK)	Ward Name	C	30
Build_Type	Building Type (bricks, blocks or wood)	C	30
Date_Built	Date Built	C	30
Per_in_Char	Doctor in-charge	C	30

Location	Location (x,y coordinates)	C	30
No_of_Room	Number of rooms	C	30
No_of_Bed	Number of beds	C	30
No_of_Doc	Number of Doctors	N	30

4. **Entity Name: COMMUNITY HALL** (*Attributes of Building.shp*)

Hall_Name (PK)	Community Hall Name	C	30
Date_Built	Date Built	Date	8
Build_Type	Building Type (bricks, blocks or wood)	C	30
Location	Location (x,y co-ordinates)	C	30
Caretaker	Caretaker's Name	C	30
Ward_Name (FK)	Ward Name	C	30

5. **Entity Name: DEED OF TRANSFER (DoT)** (*Dottransfer.dbf*)

DoT_Title (PK)	Deed of Transfer Number	C	30
L_Title_No (FK)	Landhold Title Number	C	30
Date_Iss	Date Issued to owner	Date	8
Pla_Iss	Place Issued	C	30

6. **Entity Name: EXECUTIVE COMMITTEE** (*Execcom.dbf*)

EC_Name (PK)	Name of Settlement Executive Committee	C	30
Inf_Name (FK)	Name of Informal Settlement	C	30
Chair_Name	Chairman's Name	C	30
Chair_Per_ID	Same as Per_ID in PERSON's table	C	30
Term_Off	Term of office	C	30
Start_Date	Date of Assumption of office	C	30
End_Date	Date of Termination of office	C	30

7. **Entity Name: GENERAL PLAN** (*Genplan.dbf*)

Plan_No (PK)	General Plan Number	C	30
Date_Prep	Date Plan Prepared	Date	8
Date_App	Date Plan Approved	Date	8

8. **Entity Name: INFORMAL SETTLEMENT** (*Attributes of Informal.shp*)

Inf_Name (PK)	Name of Informal Settlement	C	30
Population	Population	C	30
Area_sq_m	Total Area of the block (in sq. metres)	I	30
Peri_m	Perimeter of the block (in metres)	I	30
No_of_ward	Number of wards	I	30

9. Entity Name: LANDHOLD TITLE (*Landhold.dbf*)

L_Title_No (PK)	Landhold Title Number	C	30
S_Title_No (FK)	Starter Title Number	C	30
L_Date_Iss	Date Issued to applicant	Date	30
L_Date_Con	Date converted to DoT Title	Date	30

10. Entity Name: LOCAL LAND ALLOCATION BOARD (*Llaboard.dbf*)

LLAB_Name (PK)	Local Land Allocation Board's Name	C	30
Chair	Chairman's Name	C	30
Chair_Per_ID	Same as Per_ID in PERSON's table	C	30
Term_Off	Term of office	C	30
Start_Date	Date of Assumption of office	C	30
End_Date	Date of Termination of office	C	30

11. Entity Name: LOCAL LAND OFFICE (*Attributes of LOffice.shp*)

LLO_Name (PK)	Local Land Office's Name	C	30
LLAB_Name (FK)	Local Land Allocation Board's Name	C	30
Inf_Name (FK)	Name of Informal Settlement	C	30
Location	Location (x,y co-ordinates)	C	30
Off_Char	Officer in-charge	C	30

12. Entity Name: NEWCOMER (*Newcomer.dbf*)

New_Per_ID	Same as Per_ID in PERSON's table	C	30
Start_Pro	Start of Probation	Date	8
End_Pro	End of Probation	Date	8
Spon_Per_ID (FK)	Sponsor's Personal ID	C	30
WC_Name (FK)	Ward Committee's Name	C	30
PTO_Cert (FK)	PTO Certificate Number	C	30
Site_No (FK)	Site Number	I	30

13. Entity Name: OCCUPANT (*Occupant.dbf*)

Occ_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30
Build_Code (FK)	Building Code	C	30

14. Entity Name: OWNER (*Owner.dbf*)

Own_Per_ID (PK)	Same as Per_ID in PERSON'S table	C	30
-----------------	----------------------------------	---	----

15. Entity Name: PERSON (*Person.dbf*)

Per_ID	Personal ID	C	30
Name	Name of the person	C	30
Per_St	Status of the person	C	30
Sex	Sex	C	30
Marital_St	Marital Status	C	30
No_of_Chil	Number of Children	I	30
Name_of_Sp	Name of Spouse	C	30
Date_of_arr	Date of Arrival at the Settlement Date		8
Next_of_Kin	Name of Next of Kin	C	30

16. Entity Name: PTO CERTIFICATE (*Ptocert.dbf*)

PTO_Cert (PK)	PTO Certificate Number	C	30
LLO_Name (FK)	Local Land Office's Name	C	30
Date_Iss	Date Issued to Applicant	Date	8
Date_Conv	Date Converted to Starter Title Date		8
Pl_Iss	Place Issued	C	30

17. Entity Name: PUBLIC TOILET (*Attributes of Public Toilets.shp*)

Toilet_Code (PK)	Toilet Code Number	C	30
Date_Built	Date Built	Date	8
Build_Type	Building Type (bricks, blocks or wood)	C	30
Location	Location (x,y coordinate)	C	30
Ward_Name(FK)	Ward's Name	C	30

18. Entity Name: SCHOOL (*Attributes of Schools.shp*)

Sch_Name(PK)	School Name	C	30
No_of_Stu	Number of Students	I	30
Location	Location (x,y coordinate)	C	30
Sch_Type	Type of school (Pre, Primary High)	C	30
Date_Built	Date Built	Date	8
Ward_Name(FK)	Ward's Name	C	30
Prin_Name	Principal's Name	C	30
No_of_Tea	Number of Teachers	I	30

19. Entity Name: SITE (*Attributes of Site.shp*)

Site_No (PK)	Site Number	C	30
Location	Location (x,y co-ordinates)	C	30
Area_sq_m	Total Area of the block (in sq. metres)	I	30

Peri_m	Perimeter of the block (in metres) I		30
PTO_Cert (FK)	PTO Certificate Number	C	30
S_Title_No (FK)	Starter Title Number	C	30
L_Title_No (FK)	Landhold Title Number	C	30
Ward_Name (FK)	Ward's Name	C	30
Block_No (FK)	Block Number	C	30
DoT_Title (FK)	Deed of Transfer Title Number	C	30
Land_Use	Land Use (residential, farm or business)	C	30
L_Tenure	Land Tenure (freehold, leasehold or PTO)	C	30
Date_Allo	Date Allocated	Date	8

20. Entity Name: SPONSOR (*Sponsor.dbf*)

Spon_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30
Ward_Name (FK)	Ward's Name	C	30

21. Entity Name: STARTER TITLE (*Starter.dbf*)

S_Title_No (PK)	Starter Title Number	C	30
S_Date_Iss	Date Issued	Date	8
S_Date_Conv	Date Converted to Landhold Title	Date	8
Pl_Iss	Place Issued	C	30
PTO_Cert (FK)	PTO Certificate Number	C	30

22. Entity Name: STREET (*Attributes of Streets.shp*)

Str_Name(PK)	Street Name	C	30
Sur_Type	Surface Type	C	30
Width	Width	C	30
No_of_lane	Number of lanes	I	30
Ward_Name (FK)	Ward's Name	C	30

23. Entity Name: SURVEYOR (*Surveyor.dbf*)

Sur_Per_ID(PK)	Same as Per_ID in PERSON's table	C	30
PLS_No	Professional Number	C	30
Com_Name	Company's Name	C	30
Com_Tel	Company's Telephone Number	C	30

24. Entity Name: WARD (*Attributes of Ward Boundary.shp*)

Ward_Name(PK)	Ward's Name	C	30
Inf_Name (FK)	Name of Informal Settlement	C	30
Population	Population	I	30
Area_sq_m	Total Area of the block (in sq. metres)	I	30
Peri_m	Perimeter of the block (in metres)	I	30

25. Entity Name: WARD COMMITTEE CHAIR (*Wardcomchair.dbf*)

WC_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30
Ward_Name (FK)	Ward's Name	C	30
EC_Name (FK)	Name of Settlement Executive Committee	C30	

Many-to-Many Relationships

26. Site / Owner

Site_No (PK)	Site Number	C	30
Own_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30

27. Building / Owner

Build_Code (PK)	Building Code	C	30
Own_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30

28. Owner / Occupant

Own_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30
Occ_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30

29. Owner / Deed of Transfer

Own_Per_ID (PK)	Same as Per_ID in PERSON's table	C	30
DoT_Title (PK)	Deed of Transfer Number	C	30

30. Surveyor / General Plan

Sur_Per_ID(PK)	Same as Per_ID in PERSON's table	C	30
Plan_No (PK)	General Plan Number	C	30

APPENDIX D

Sample Queries

1. To select all leasehold sites in an urban informal settlement.
2. To select all leasehold sites in a particular ward in an urban informal settlement.
3. To select all PTO sites in an urban informal settlement.
4. To select all PTO sites in a particular ward in an urban informal settlement.
5. To select all PTO sites allocated after 1998/06/03.
6. To select all PTO sites allocated after 1998/06/03 in a particular ward in an urban informal settlement.
7. To select all residential dwellings in an urban informal settlement.
8. To select all residential dwellings in a particular ward in an urban informal settlement.
9. To select high schools in an urban informal settlement.
10. Identifying occupants of buildings (or structures) in an urban informal settlement
11. Identifying owners of buildings (or structures) in an urban informal settlement.
12. To select sites with starter titles issued after 1996/04/15.
13. To select sites with landhold titles issued after 1996/04/25.

APPENDIX E

Solutions to the Sample Queries

Query 1: To select all leasehold sites in an urban informal settlement.

To address this query in ArcView GIS, the ALLOCATED SITES theme in the *informal.apr* file must be selected, and the ALLOCATED SITES theme's attribute table must also be opened and resized to a reasonable size. Users must ensure that no record is selected or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

([L_Tenure] = "Leasehold")

Comment

In this example, four features and their associated records will be selected (or highlighted) in the *view* document and the theme's attribute table respectively. To provide tenure security in urban informal settlements, local land managers will be interested to know or identify the number of sites in an urban informal settlement that are held under lease agreement with the local authorities.

Query 2: To select all leasehold sites in a particular ward in an urban informal settlement

To address this query in ArcView GIS, the ALLOCATED SITES theme in the *informal.apr* must be selected, and its attribute table must be opened and resized. Again, deselect all previously selected features in the *view*. Open the Query Builder dialog box and enter the following syntax:

([L_Tenure] = "Leasehold") AND ([Ward_Name] = "100")

Comment

In this example, three features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. The selected features, in this case, are the allocated sites in Ward "100" that are held under lease agreement. Also, local land managers at the local authorities may be interested to know the number of sites in each ward in urban informal settlement that are held under lease agreement.

Query 3: To select all 'Permission to occupy (PTO)' sites in an urban informal settlement.

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must also be opened and resized. Users must ensure that no record is selected or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

([L_Tenure] = "PTO")

Comment

In this example, sixteen features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. This example selects all allocated sites in urban informal settlements that are held under PTO. The PTO under this context simply means that individuals have been granted permissions to occupy sites in urban informal settlement.

Query 4: To select all 'permission to occupy' (PTO) sites in a particular ward in an urban informal settlement.

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must be opened. Users must ensure that no record is selected

or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
([L_Tenure] = "PTO") AND ([Ward_Name] = "100")
```

Comment

In this example, five features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. The selected features, in this case, are all the PTO sites in Ward "100".

Query 5: To select all Permission to occupy (PTO) sites allocated after 1998/06/03

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must be opened. Users must ensure that no record is selected or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
([L_Tenure] = "PTO") AND ([Date_of_all] > 19980603.AsDate)
```

Comment

In this example, twelve features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. This query can be defined to identify sites in urban informal settlements that were allocated after a certain date. Land managers at the local authorities will need this information to monitor the influx of people into an urban informal settlement.

Query 6: To select PTO sites allocated after 1998/06/03 in any particular ward in an urban informal settlement.

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must be opened. Ensure that no record is selected or

highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
((L_Tenure] = "PTO") AND ([Date_of_all] > 19980603.AsDate) AND ([Ward_Name] = "200")
```

Comment

In this example, four features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. Also, this query can be defined to identify sites in any particular ward in an urban informal settlement that were allocated after a certain date or period.

Query 7: To select all residential dwellings in an urban informal settlement.

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must be opened. Users must ensure that no record is selected or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
([Land_Use] = "Residential")
```

Comment

In this example, fifteen features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. Local land managers will be interested to know or identify residential houses (or structures) in an urban informal settlement.

Query 8: To select all residential dwellings in a particular ward in an urban informal settlement

To address this query, the ALLOCATED SITES theme in the *view* must be selected, and the theme's attribute table must be opened. Ensure that no record is selected or

highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
([Land_Use] = "Residential") AND ([Ward_Name] = "300")
```

Comment

In this example, four features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. Land managers will be interested to know or identify residential houses (or structures) in each ward in an urban informal settlement.

Query 9: To select high schools in an urban informal settlement

To address this query, the SCHOOL theme in the *view* must be selected, and the theme's attribute table must be opened. Users must ensure that no record is selected or highlighted at this stage. Open the Query Builder dialog box and enter the following syntax:

```
([Sch_Type] = "High School")
```

Comment

In this example, three features and their associated records will be highlighted in the *view* and the theme's attribute table respectively. Land managers will be interested to know or identify schools in an urban informal settlement in terms of location, student population, date built, etc.

Query 10: Identifying occupants of buildings (or structures) in an urban informal settlement

To address this query, *occupant.dbf* table must be joined to *building.dbf* table via *build_code*, which is a common field in both tables. In this case the attributes of

occupant.dbf table will be added to the *building.dbf* table. Open the Query Builder dialog box and enter the following syntax:

```
([Build_code] = "A3")
```

Comment

In this example, John G will be highlighted in the join table as the occupant of the building named A3 (*i.e.* the value under Occ_Name field). To remove the join, make *Building.dbf* table active and select "Remove All joins" from the Table Menu.

Query 11: Identifying owners of buildings (or structures) in an urban informal settlement.

To address this query, *owner.dbf* table must be joined to *building.dbf* table via *owner_name*, which is a common field in both tables. In this case the attributes of *owner.dbf* table will be added to the *building.dbf* table. Open the Query Builder dialog box and enter the following syntax:

```
([Build_code] = "A6")
```

Comment

In this example, John G will be highlighted in the join table as the occupant of the building named A3 (*i.e.* the value under Occ_Name field). To remove the join, make *Building.dbf* table active and select "Remove All joins" from the Table Menu.

Query 12: To select sites with starter titles issued after 1996/04/15.

To address this query, *starter.dbf* table must be joined to *sites.dbf* table via *S_Title_No*, which is a common field in both tables. In this case the attributes of *starter.dbf* table will be added to the *sites.dbf* table. Open the Query Builder dialog box and enter the following syntax:

```
([S_Date_Iss] > 19960415.AsDate)
```

Comment

In this example, one feature and its associated records will be selected or highlighted in the view and the join table respectively. To remove the join, make *sites.dbf* table active and select “Remove All joins” from the Table Menu.

Query 13: To select sites with landhold titles issued after 1996/04/25.

To address this query, *landhold.dbf* table must be joined to *sites.dbf* table via *L_Title_No*, which is a common field in both tables. In this case, the attributes of *landhold.dbf* table will be added to the *sites.dbf* table. Open the Query Builder dialog box and enter the following syntax:

```
([L_Date_Iss] > 19960425.AsDate)
```

Comment

In this example, one feature and its associated records will be selected or highlighted in the view and the join table respectively. To remove the join, make *sites.dbf* table active and select “Remove All joins” from the Table Menu.