PARTICIPATORY MAPPING AND THE USE OF GIS FOR SUSTAINABLE LAND USE PLANNING IN THE HARDAP REGION, NAMIBIA

by

LISHO CHRISTOH MUNDIA

submitted in accordance with the requirements for
the degree of

DOCTOR OF PHILOSOPHY

in the subject

GEOGRAPHY

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF. SIMPHIWE E MINI
CO – SUPERVISOR: MR. AC VLOK

August 2015

Declaration

I, Lisho Christoh Mundia, hereby declare that the thesis, which I hereby submit for the degree of PhD (Geography) at the University of South Africa, is my own work and has not previously been submitted by me for a degree at this or any other institution.

I declare that the thesis does not contain any written work presented by other persons whether written, pictures, graphs or data or any other information without acknowledging the source.

I declare that where words from a written source have been used the words have been paraphrased and referenced and where exact words from a source have been used the words have been placed inside quotation marks and referenced.

I declare that I have not copied and pasted any information from the Internet, without specifically acknowledging the source and have inserted appropriate references to these sources in the reference section of the thesis.

I declare that during my study I adhered to the Research Ethics Policy of the University of South Africa, received ethics approval for the duration of my study prior to the commencement of data gathering, and have not acted outside the approval conditions.

I declare that the content of my thesis has been submitted through an electronic plagiarism detection program before the final submission for examination.

SIGNED  **DATE**: *21 August 2015*

Dedications

I dedicate this work to

My son — Lisho Mundia Junior

My wife — Elma M. Tholiso-Mundia

My mother — Ms. Brenda Kahimbi Lisho

My father — Mr. Jones Mundia

Acknowledgements

I would like to thank everyone who contributed towards this research. Without their assistance it would have been difficult, if not impossible to fulfil the requirements for a PhD degree in this field:

- The Almighty God for the wisdom, strength and perseverance to complete this thesis.
- A special thank you to my wife, Elma Tholiso-Mundia, and my son, Lisho Mundia Junior, for their devoted support and encouraging attitude during my studies.
- My parents, Ms. Brenda Kahimbi Lisho and Mr. Jones Mundia.
- My promoters, Prof. Simphiwe E. Mini and Mr. Chris Vlok for showing confidence in me, their support, encouragement and guidance.
- The ministries, private owned organisations and individuals that has provided me with all different data and inputs which was used in this research.

My undivided and faithful appreciation also goes to my friend, Faniel Maanda, who has always been a supportive friend in all my studies. A big thank you also goes to those that are reading and using this thesis in any way, thank you for your time and for reviewing my work.

Abstract

Namibia, like most developing countries, lacks complete and comprehensive sustainable land use plans. This has a negative impact on a range of land use activities. Although Geographical Information System (GIS) is used as a planning tool in Namibia in an ad hoc manner, there is no broader comprehensive framework to guide applications of GIS as a planning tool specifically for land use planning (LUP). The purpose of this study is to demonstrate how integration of participatory mapping and GIS can be used to enhance land use planning in the Hardap Region, Namibia. The study seeks to point out lack of local communities' engagement in LUP process; lack of policy frameworks and guidelines for Integrated Land Use Planning (ILUP); and poor data management.

The study adapted quantitative and qualitative approaches to collect relevant data and information related to LUP. Data collected using participatory approaches such as Focus Group Discussion (FGD), Participatory Rural Appraisal (PRA) and Strengths Weaknesses Opportunities and Threats (SWOT) analysis were applied in an integrated manner in various contexts. FGDs were used to evaluate participants' knowledge of LUP in the Hardap region. Besides participating in the FGDs, PRA and SWOT analysis, the participants also expressed opinions concerning desirable and undesired land uses in the region. Sketch and photo-mapping methods were found to be suitable approaches to capture local knowledge. GIS was found to be effective in integrating participatory maps produced by the local communities and existing spatial land use data.

The results shows that local communities are eager to learn about participatory approaches and are willing to share their views and knowledge on land use in their respective areas. A user-friendly comprehensive georeferenced digital database was created for the Hardap region. This database is used for spatial data management, analyses, maintenance and production of maps. Maps of new development initiatives in the region were produced.

The frameworks and guidelines suggested in this study has the potential to guide participatory techniques aided by GIS technology involving local communities in sustainable LUP processes in Namibia. The digital database incorporates experts' knowledge on the users and implementation aspects, making it a LUP benchmark tool of Namibia.

Key recommendations include incorporation of GIS technology in the ILUP, implementation of comprehensive participatory LUP, adoption of guidelines for future LUP, skills training and capacity development, and result-based monitoring.

Key Terms

Geography, participatory mapping, Geographical Information Systems (GIS), maps, mapping, land, Integrated Land Use Planning (ILUP), cartography, Land Use Planning (LUP), Sustainable Land Use Planning (SLUP), Namibia, Hardap region.

Table of Content

List of Figures

List of Tables

List of Abbreviations and Acronyms

ALAN	Association of Local Authorities in Namibia
CBNRM	Community Based Natural Resource Management
CBS	Central Bureau of Statistics
CDCs	Constituency Development Committees
CI	Conservation International
DBMS	Database Management System
EIS-Africa	Environmental Information Systems-Africa
ESRI	Environmental Systems Research Institute
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GIS	Geographical Information System
GISci	Geographical Information Science
GIT	Geographical Information Technology
GPS	Global Positioning System
GRN	Government of the Republic of Namibia
HIRLUP	Hardap Integrated Regional Land Use Plan
HIV	Human Immunodeficiency Virus
IAPAD	Integrated Approaches to Participatory Development
IEK	Indigenous Environmental Knowledge
ILUP	Integrated Land Use Planning
ILUPs	Integrated Land Use Plans
IRDNC	Integrated Rural Development and Nature Conservation
IRLUP	Integrated Regional Land Use Plans
ISK	Indigenous Spatial knowledge
ISLM	Integrated Sustainable Land Management
ISLUP	Integrated Sustainable Land Use Planning
KISS	Keep It Short and Simple
LUP	Land Use Planning
LUPA	Land Use Planning and Allocation
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MLR	Ministry of Lands and Resettlements
MME	Ministry of Mines and Energy
MRLGHRD	Ministry of Regional, Local Government, Housing and Rural Development

NACOMA	Namibian Coast Conservation and Management
NAU	Namibian Agricultural Union
NCGIA	National Center for Geographic Information and Analysis
NDC	Namibia Development Corporation
NDP	National Development Plan
NGOs	Non-Governmental Organisations
NOAA	National Oceanic and Atmospheric Administration
NPC	National Planning Commission
NSA	Namibia Statistics Agency
NSDI	National Spatial Data Infrastructure
OOGIS	Object-oriented GIS
PGIS	Participatory GIS
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
PSP	Participatory Spatial Planning
RDCC	Regional Development Coordinating Committees
RRA	Rapid Rural Appraisal
RS	Remote Sensing
RTPI	Royal Town Planning Institute
SDI	Spatial Data Infrastructure
SEA	Strategic Environmental Assessment
SLM	Sustainable Land Management
SNAFU	Southern Namibia Farmers Union
TB	Terabytes
UN	United Nations
VDCs	Village Development Committees
VGI	Volunteered Geographical Information

Chapter 1: Background and Problem Statement

1.1 Introduction

In this research 'participatory mapping and the use of Geographical Information System (GIS) for sustainable land use planning in Namibia' are investigated. The approach used draws on concepts developed under the umbrella term of geography. Participatory mapping, as a sub-field of geography, recognises the political economy of the society and the concerns regarding data access, data representation, structural knowledge distortion, and community empowerment as legitimate and significant issues in the application of land use planning.

In Namibia, public participation is an important and required component of Integrated Land Use Planning (ILUP). Currently, GIS is used in ILUP to facilitate the handling of the extensive spatial environmental, ecological, land use, infrastructure, biological, archaeological and cultural data needs and to assist in the decision-making process. This integration of Land Use Planning (LUP) and GIS, however, is generally devoid of a community involvement component and the use of geo-visualization techniques rarely extends beyond two-dimensional mapping. The ILUP process is predominantly a top-down expert-driven, quantitative approach that seeks to draw upon public participation at certain stages of projects to define and evaluate social, economic, and environmental issues. However, this public participation is arguably limited in its ability to influence the expert driven process. It is suggested in this study that such limitations can diminish and undermine community perspectives on a range of important issues in the ILUP process and constrain the ability of the public to participate in defining, examining, and reviewing project development and decision-making.

This introductory chapter provides the research background, the research problem, the overall aim, the objectives and the research questions of the study. The chapter introduces the Hardap region as a study area with regard to socio-economic aspects, population dynamics, land use in the Hardap region, climate and rainfall, topography, landscape, soil, vegetation, geology and minerals. Because of the dynamics of water sources in Namibia, the chapter further provides context of the hydrology and geohydrology of Hardap region, and then followed by the justification of conducting the study. Lastly, the chapter closes with a layout of the organization of the thesis.

1.2 Background of the Research

In the global context, land is considered a limited and vulnerable resource. However, if used appropriately it can become renewable and be used unceasingly. The use of land has considerable impacts on the natural and human environment (Randolph, 2004:42). Conversion of natural and productive lands to human use, sprawling human settlements and inappropriate location of development, roads and building construction, and land use practices after development, all have extensive negative impacts on human environmental health and the natural environment (Randolph, 2004:42). Several environmental and social planning approaches both in urban and rural communities have been developed. The development and inclusion of ILUP through participatory mapping and GIS can cater for improved community involvement in such planning. Arendt 1996, 1999, and Yaro, Arendt, Dodson and Brabec (1988 cited in Randolph, 2004:41) stated that "popularise the conservation residential design approach to protect rural and small-town values and morals." Other geographers have focused their work on rural sustainability (Audirac, 1997; and Golley & Bellot, 1999 cited in Randolph, 2004).

The Directorate of Land Reform of the Ministry of Lands and Resettlements (MLR) under the Government of the Republic of Namibia (GRN) is responsible for developing Integrated Land Use Plans (ILUPs). It also has the mandate to provide guidelines for drafting regulations aimed at land use planning. The GRN has recognised the need for integrated efforts to coordinate the development of the country (Haub, 2009). Therefore, this research attempts to follow the approach of ILUP through a process which enables collaboration, interaction and knowledge exchange between the various stakeholders in order to help achieve land use conflict resolution, identify problems hindering ILUP as well as drawing together the sectorally focused planning effort. The results of this study will be handed over to the Directorate of Land Reform of the MLR for them to use as a tool in land use planning activities.

Participatory mapping, GIS, and remote sensing (RS) are seen as mechanisms and tools for comprehensive geographical information management about the use of land resources. It also helps provide collaborative resources management for sustainable future land use across the country. Noongo (2007:202) in the study titled "*The Implementation of Geographic Information Systems in Namibia*" concluded that "there is no strategy used by organisations in Namibia through which GIS is adopted or implemented."

GIS is able to combine data of different formats (in digital form) and type of data from all relevant sources (Wehrmann & Glavina, 2009). A number of negative issues on GIS, such as poor GIS technology deployment in land use management exist in Namibia. These include the reallocating of one portion of land to different investors, poor record keeping and management of land uses. This has contributed to land-related disputes and poor security of land. The use of participatory mapping aided by GIS can help improve land use security and solve existing land-related disputes in Namibia by identifying and applying better ways of implementing sustainable land use planning and management.

A number of issues hindering sustainable ILUP in Namibia were identified. Five main issues are addressed in this study:

- Participatory mapping has not yet been use in land use planning to determine the communities' level of participation in ILUP and participatory mapping' appropriateness in Namibia.
- Lack of land use maps from existing spatial data is hampering comparison of desired and undesired land uses in the region.
- Exploring the use of the SWOT analysis in sustainable land use management in Namibia for evaluation of the outcomes of participatory mapping aided by GIS.
- There is a lack of frameworks and guidelines for future participatory mapping aided by GIS technology for ILUP processes in Namibia.
- There is lack of a user-friendly comprehensive georeferenced digital database for sustainable land use planning in the Hardap region.

1.3 The Research Problem

The primary problems that this research seeks to address are the lack of a proper land use planning process involving local knowledge; the lack of frameworks and guidelines for integrated land use planning process; and poor data management by relevant ministries and organisations for land use planning.

De Mers (2005:20) stated that "We live in a complex world. To succeed, we must be aware of this complexity and be able to organise it around a framework that allows us to understand how such a seemingly disordered system continue to function." Longley, Goodchild, Maguire and Rhind (2001:60) in support of participatory approaches, stated that "almost all human activities at some time require knowledge about parts of the earth that are

outside direct experience, because they occur either elsewhere in space, or elsewhere in time." Participatory approaches are often presented as an alternative to the typical "top-down" land use planning methods. In Namibia, at present, there is no defined participatory mapping aided by GIS guidelines for integrated land use planning in Namibia.

All existing and approved Integrated Regional Land Use Plans (IRLUPs) were done as stand-alone exercises and not as a subset of a National Land Use Plan for Namibia. The consequences of these exercises are land conflicts and uncertain understanding of land use by the local communities. Consequently, the results of these IRLUPs are difficult to compare, difficult to access and less useful because different GIS mapping compilation procedures were applied. The maps also differ in content, layout, resolution and are paper based only, making it more difficult to be made available to others. At present, line ministries are in the process of developing specific criteria for rigorous monitoring of progress towards meeting environmental and developmental objectives. To date, irregular monitoring, missing and poorly documented data in addition to poorly defined indicators present difficulties in reviews of the impacts of policies and programmes (Noongo, 2007).

The existing integrated regional land use plans hardly contain proposals for future scenarios, such as suggested land use zoning and related projects and programmes and are more of an inventory presenting geographical data which existed at the time of publication. The absence of an overall planning system in the country results in a lack of geographical integration and harmonisation of sectoral and development plans. As existing land use plans are not properly documented, an already strained situation is compounded, thus making accessibility to such plans difficult. The reality is that poor management of land use planning data and land use disputes in Namibia are still increasing with no solution in sight. Noongo (2007:17) maintains that "spatial data are particularly valuable for planning and development efforts because they describe the spatial distribution of economic resources, population and other relevant factors that would contribute to mitigate problems of uneven development in a society like Namibia."

Various less costly mapping techniques such as sketch mapping and photo-mapping have been implemented in different programmes in different countries. So far, the potential of these processes, in terms of social inclusion in decision-making, have seldom been investigated. In addition, the implementation of GIS technology in Namibia has not been exploited and documented.

There is little information on the impacts of participatory mapping aided by GIS. Thus there is

a need for frameworks and guidelines to guide the implementation of participatory mapping aided by GIS in integrated land use planning. To close this gap the intension is to involve local communities in gathering and sharing their local spatial knowledge in Namibia.

1.4 The Aim and Objectives of the Study

The research aims to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management.

The objectives of this research are to:

- produce participatory land use maps for different units of land within the six constituencies of the Hardap region by local communities.
- produce land use maps of the Hardap region from existing land use data for comparison of desired and undesired land uses.
- produce a SWOT analysis for evaluation of outcomes of participatory mapping aided by GIS for sustainable land use management in Namibia.
- produce frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia.
- conceptualise and setting up a user-friendly comprehensive georeferenced digital database for sustainable land use management of the Hardap region to be used by the MLR.

The research objectives complement each other towards the realisation of the study aim. The techniques of participatory approaches used to produce participatory land use maps also gathered the participants' viewpoints, opinions and perceptions. Participatory approaches were used to gather the participants' knowledge of the Hardap region's land uses.

It is hoped that the development of frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management will establish and enhance the relationship between both local communities and land use planners in Namibia. The outcome of the study is expected to contribute to the improvement of the quality of incorporating local communities and experts' viewpoints, opinions and perceptions in land use planning.

1.5 The Research Questions

The research questions below is based on the objectives of the research. Thus the main research questions are:

- What land uses are found in the Hardap region and are these known to its local communities?
- What are the most effective and efficient mapping procedures for developing regional land use maps by the land use planning experts and relevant stakeholders?
- What is the role of participatory approaches, aided by GIS in land use planning and management in Namibia?
- What sustainable methods, frameworks and guidelines are required for participatory mapping aided by GIS in land use planning to ensure sustainable land management in Namibia?
- How can the methods, frameworks and guidelines which are suggested for land use planning via participatory mapping aided by GIS be implemented to support sustainable land management in Namibia?

Environmental Information Systems-Africa (EIS-Africa) (2002:02) stated that, “in Africa, GIS technologies create both opportunities and challenges for achieving wider and more effective use of Geo-information in decision-making.” The research emphasise that, for any comprehensive integrated land use planning in Namibia, there is a strong need for stakeholder participation at all levels, and this will allow a greater opportunity for integrating geo-information for decision-making.

1.6 Research Design

The nature of this study is complex as it is largely empirical exploratory research which focuses on people's knowledge, experiences and data about places. Therefore, the study relied on holistic approaches comprising of different theoretical and methodological techniques.

The key guiding methodology for the study was driven by the postmodernist perspective of geography which is regarded as one of the major turning points in the history of geography. The study was therefore subjected to the methodological guidance of a postmodern way of thinking based on the work of Knox and Marston (2004, cited in Arentsen et al. 2004) and

Thomas (1993, cited in Creswell, 2007). The research design is discussed in detail in Chapter 4 of this study.

1.7 The Study Area

1.7.1 The Shape of the Land in Namibia

Namibia's land surface covers an area of approximately 823 680 km^2. Much of Namibia's land surface consists of a wide flat plateau that reaches to the north, the south and the east into Botswana and other neighbouring countries. The height of the plateau ranges between approximately 900 – 1 300 m above sea level (Mendelsohn, Jarvis, Roberts and Robertson, 2002). However, there is great variation in altitude to the west and the south, where the escarpment rises from the coast. The incisions into the landscape made by major river systems are often spectacular, especially so in the case of the Fish River Canyon, where some of Namibia's oldest rocks are exposed.

The highest elevation (2 579 m above sea level) in Namibia is the Brandberg (indicated with a round circle in Figure 1.1) in the Erongo region, followed by Moltkeblick (2 479 m) in the Auas Mountains a few kilometres south of Windhoek in the Khomas region. Namibia is characterised by the prominent steep southern escarpment, as well as the central Khomas Hochland highlands, the hills around Otavi in the Otjozondjupa region, and many of the river valleys that lead to the coast into the central Kalahari (Mendelsohn *et al*., 2002).

The highest elevation in the Hardap region is much lower than the Brandberg in the Erongo region and the Auas Mountains in Khomas region. Mendelsohn *et al.,* (2002:18) stated that "Naukluft mountains perched on the edge of the escarpment, this highland consists largely of limestone and shale. The mountains were formed from sediments which were forced during the formation of the continent of Gondwana some 550 million years ago, but then shifted 120 km south-westwards. The highest points are just over 1 900 m above sea level. The area is deeply dissected into valleys by many small rivers. Some of these are tributaries of the Tsondab River, which flows along a valley formed by a glacier that cut through the mountain."

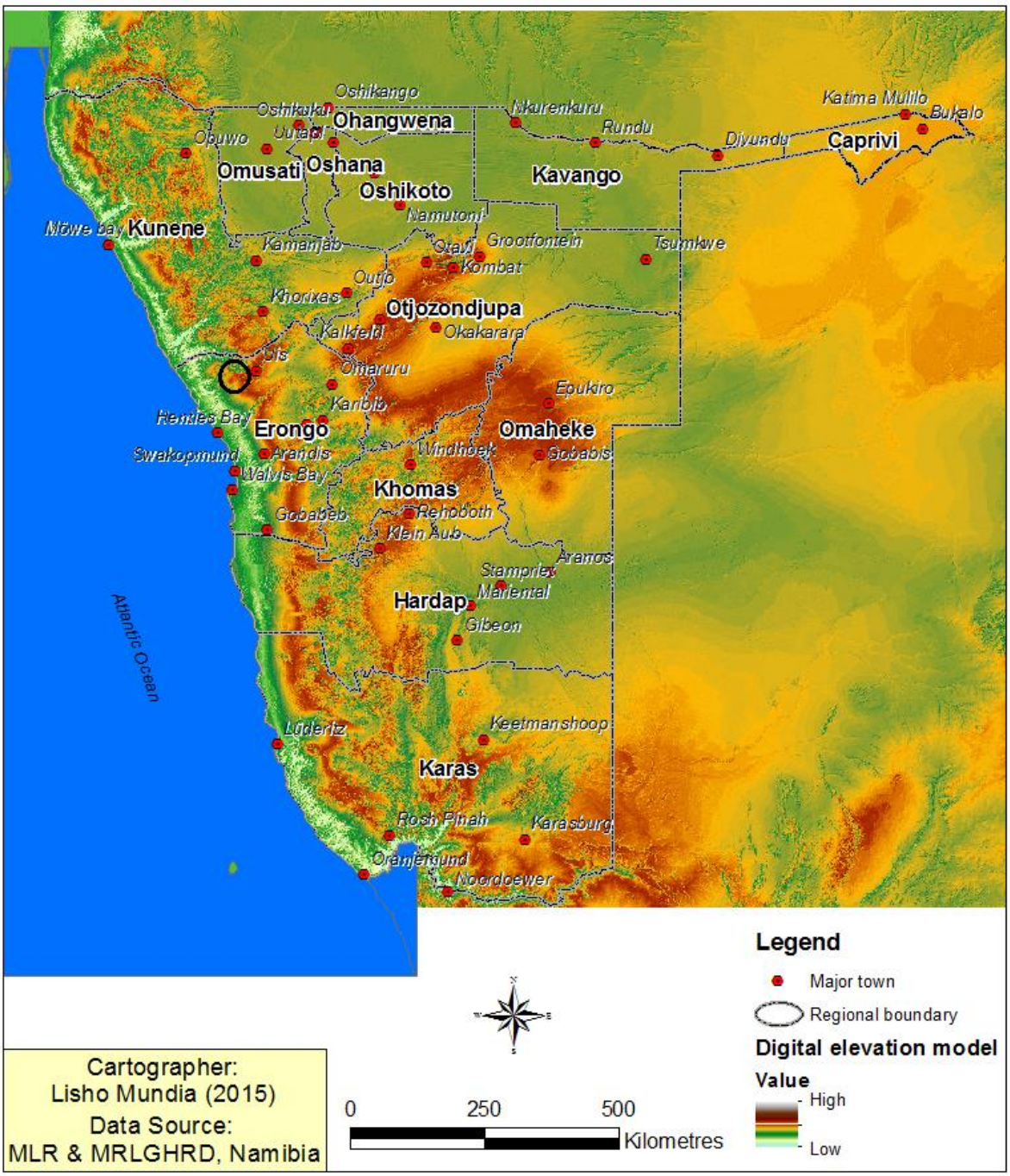


Figure 1.1: Digital elevation model of Namibia

1.7.2 General Overview of the Hardap Region

After Namibia's independence in 1990, the Hardap region was divided into six political constituencies: Gibeon, Mariental Rural, Mariental Urban, Rehoboth Rural, Rehoboth Urban East and Rehoboth Urban West (Government of Namibia, 2006b). In August 2013, the Hardap region was re-demarcated with two extra constituencies (Aranos and Daweb) by the President after the 4th Delimitation Commission's recommendation to bring about better service delivery to the community of the Hardap region. However, this study was done in the

six original Hardap political constituencies. This is because the practical components (participatory mapping, participatory rural appraisals and focus group discussions) of the study were already done before the re-demarcation was implemented and there is still lack of data in the two new constituencies.

In terms of land, approximately 75% of the surface area of the Hardap region is owned by private farmers on a freehold basis. The second largest landowner is the government that owns the extreme western part that constitutes approximately 15% of the area and is designated as part of the Namib-Naukluft Park. The central-southern part of the region is designated as communal farmland representing about 10% of the area over which traditional authorities and small-scale farmers hold control (Government of Namibia, 2006b).

Mendelsohn *et al.,* (2002:16) stressed that "other small parcels of land, scatted throughout the region, are owned by government, including about ten resettlement farms, two parcels dedicated to government agriculture and one additional protected area surrounding the Hardap Dam. Ten (10) designated local authorities are situated in different areas within Hardap Region with the largest being Rehoboth in the far north of the region and including the regional capital, Mariental located further in the south."

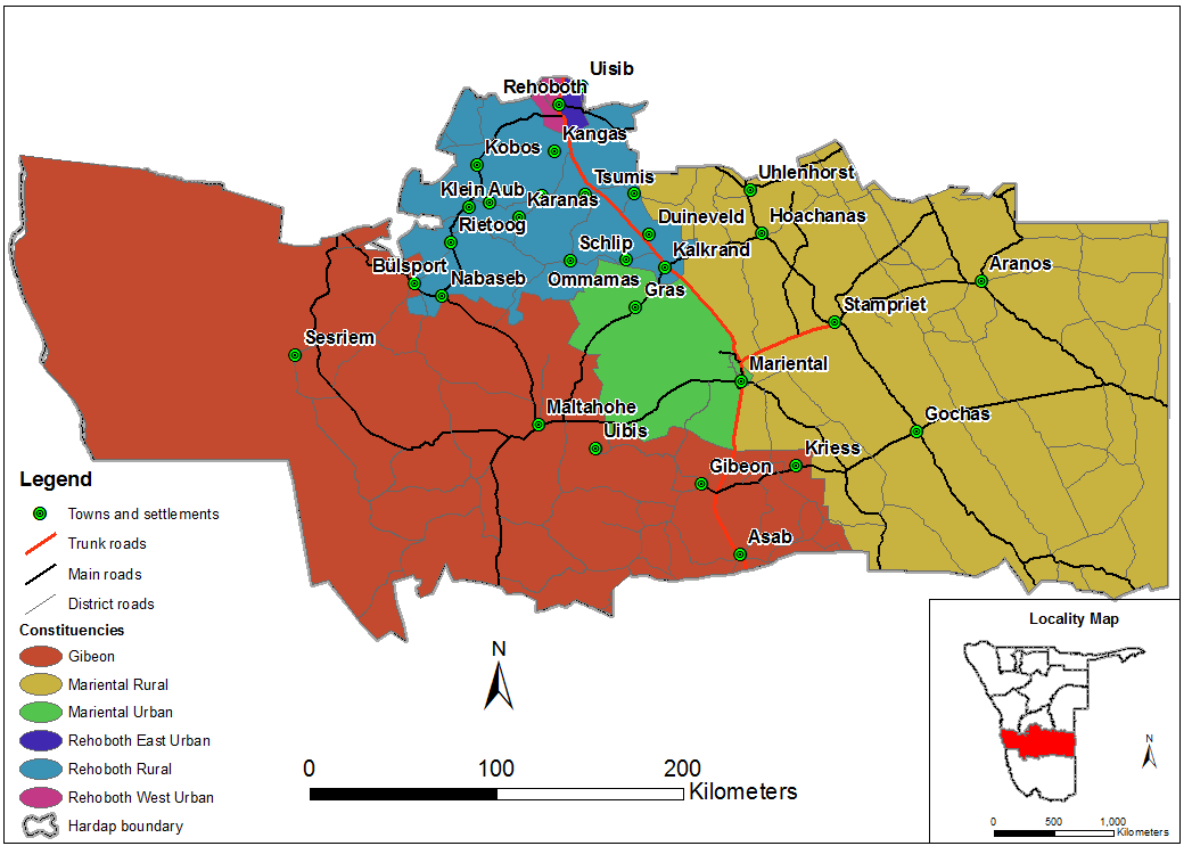


Figure 1.2: Study area

The study area is located in the south of Namibia, as seen on Figure 1.2. The Hardap region measures about 109 000 km² and the region has a population of approximately 79 000 people (Namibia Statistics Agency, 2013). The region was chosen mainly due to a presence of a combination of issues that may easily lead to land disputes. These issues include, environmental issues, competitive industries who use the land for mining, agriculture and nature conservation, and an uneven distribution of infrastructure, such as boreholes, wind pumps and water canals. Flooding of the area has occurred when the sluice gates of Hardap Dam had to be opened to control dam water level. It is mainly the town of Mariental that has been affected by such flooding..

The participatory mapping aided by GIS for sustainable land use planning was carried out in six different land portions as per constituencies of the Hardap region. The land portions where participatory mapping took place vary in land uses. Participatory mapping exercises were carried out at selected sites in each of the six constituencies of the Hardap region. These included rural, peri-urban and urban sites.

The use of the word ‘Hardap’ as the name of the region reflects the prominent role of the Hardap Dam in the agro-economic and tourism sectors of this region. The two major towns of the region are Rehoboth and Mariental.

1.7.3 Population Dynamics

In the Hardap region, just like many other regions in Namibia, rural to urban migration is very common. The main reason is to seek employment. As indicated in the 2001 census report the net migration for the Hardap region during the period 1996 - 2001 is 0.9% (Government of Namibia, 2006b). The migration net rate dropped to 0.6% during 2011 (Namibia Statistics Agency, 2013). Of the total regional urban population, 57.6% are in the age group of 15 - 59 while the figure for the rural population is 53.3%.

Mariental and Rehoboth are the two main towns to which people move to seek work but other primary and secondary growth points have also seen increases of population over the past decades due to natural birth. The region's average number of children per woman is standing at 3.5. Approximately three quarters (74%) of the people living in Hardap were born in the region (Government of Namibia, 2006b). Based on the above statistic, it can be concluded that the region has a relatively stable population.

Namibia Statistics Agency (2013:04) stated that, the Hardap region "is composed of 19 307 households, which is equal to about 4.4% of the total households of Namibia. The total population of the Hardap region is 79 507." In percentage, the Hardap region contributes about 3.8% to Namibia's total population. The average household size of Hardap region is 4.2 persons per household. The average household size in the Hardap region is in line with the national average size, also comparing to other parts of Namibia such as the central northern regions with average household size of above 8 persons.

With regard to population by gender and region, the Hardap region has a total of 38 935 females constituting 3.6% of the total population of Namibian females. The male population is about 40 572 which represents about 3.9% of the Namibian male population. The gender ratio of women to men in the Hardap region is 100 to 104 (Namibia Statistics Agency, 2013). Nationally, the Namibian population is composed of more women than men, with a gender ratio of 94:100 (Namibia Statistics Agency, 2013).

The main languages spoken in households in the Hardap region are Nama/Damara (44.3%), Afrikaans (43.9%) and Oshiwambo (7.4%). In descending order, other spoken languages in less than 5% of all households (represents less than 1% per language) are languages of the Zambezi region (formerly Caprivi region), English, German, languages of the Kavango, Otjiherero, Khoekhoegowab, Tswana and other African and European languages (Government of Namibia, 2006b).

1.7.4 The Socio-Economic Environment

The Hardap region fares well in the provision of social services (health and education) and have a well-developed communication infrastructure. The Government of Namibia (2006b:01) stated that the "road network and the railway line offer good access to most parts of the region. The Hardap Dam is the largest in the country, provides Mariental and the nearby irrigation schemes with water all year round. Mariental has an all-weather airstrip. The region has a good educational infrastructure comprising of more than 10 basic schools and a reasonable number of tertiary training centres, including the Tsumis Agricultural College. On average, the region has a teacher pupil ratio of 1:21. As part of its well-developed social infrastructure, the region also has twenty-five early childhood centres; five hospitals, eleven clinics and one health care centre." A literate person is considered to be someone who can read and write with understanding in at least one language. As depicted in Table 1.1 there is almost no difference between the literacy levels of male and female in the region.

Table 1.1: Population 10 years and above by sex and literacy

Gender	***Literacy***	***Percentage***	***Total***		***Total for Both Sexes***			
		%	**%**	**Number**	**Literate %**	**Not Literate**	**%**	**Number**
Female	Literate	83.2	100	25 751	**82.7**	**17.3**	**100**	**50 966**
	Not Literate	16.8						
Male	Literate	82.2	100	25 215				
	Not Literate	17.8						

Source: Government of Namibia (2006a)

The Hardap region is well serviced with water infrastructure to provide for safe drinking water. The majority of households (87.8%) in the region have access to piped water (see Table 1.2). The quality of drinking water accessible by the household is a measure of the households' quality of water – Hardap region has good quality of drinking water. Table 1.2 indicates that piped water is the main source of drinking water for households in Namibia's Hardap region, accounting for 87.8% per cent of all households.

Table 1.2: Percentage of households by main source of water

Source of Water	*Percentage*
Piped water	87.8
Boreholes/protected wells	8.0
Flowing water	0.6
Stagnant water	3.1
Other source	0.5
All households	100%

Source: Government of Namibia (2006a)

The Hardap region's main sources of income are represented in Table 1.3. The table shows that salaries or wages is the main source of income (64.2%) for households in the Hardap region. The other prominent sources of income in the region are old-age pensions (13.4%) and subsistence farming (with 6.9%).

Table 1.3: Percentage of households by main source of income

Source of Income	***Percentage***
Farming	6.9
Old-age pension	13.4
Wage and salaries	64.2
Cash remittance	6.7
Business, non-farming	4.2
Orphan's grant	0.6
Disability grant	1.3
Retirement fund	1.1
Other	1.7
All households	**100%**

Source: Namibia Statistics Agency (2013)

Household wealth is measured by the number and value of assets owned by individual. Wealth is also measure by having access to services such as telephone, radio and motor vehicle. Table 1.4 shows ownership and access to selected durable goods. A high proportion of households owns or has access to a telephone/cell phone (79%), a motor vehicle (59%), a television (47%) and a refrigerator (48%).

Table 1.4: Percentage of households by ownership of/access to selected goods

No. Household	**Own/ Access to**	**Radio**	**Television**	**Telephone/cell phone**	**Donkey/ox cart**	**Motor vehicle**	**Sewing/knitting machine**	**Plough**	**Refrigerator**	**Freezer**	**Bicycle**
16326	Own	75.1	35.0	32.3	20.3	21.6	21.6	0.5	39.5	19.3	18.9
	Access to	10.3	13.1	46.7	5.6	37.3	2.3	1.3	8.6	5,1	5.4
	No Access to	14.6	51.9	21.0	74.1	41.1	76.1	98.2	51.9	75,6	75.7
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Government of Namibia (2006a)

As shown in Table 1.5 the majority of households in the Hardap region do not have domestic animals, grazing land or fields for crop cultivation. A comparison of Table 1.5 with Table 1.3 with regard to sources of income shows that the majority of households in the Hardap region depend on salaries or wages (about 62%) and pension (about 15%).

Table 1.5: Percentage of households by ownership of domestic animals and access to grazing land and fields for crop cultivation

Number of Household	Own/ Access	Cattle	Goat	Sheep	Poultry	Ostrich	Pig	Horse	Donkey/ mule	Grazing land	Field for crops
16365	Own	13.0	27.4	12.6	24.5	1.0	1.0	16.8	17.5	4.7	2.2
	Access	4.7	6.2	6.8	1.0	0.6	0.5	2.7	3,8	28,8	10.3
	No Access	82.3	66.4	80.6	74.5	98.4	98.5	80.5	78.7	66.5	87.5
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Government of Namibia (2006a)

1.7.5 Land Use and Tenure

In the year 2000, the estimated area cleared for crops in the Hardap region was 40 km². The crops are grown in the irrigation schemes using water from Hardap Dam or local boreholes. Livestock at that time totalled 151 600 goats, 3 400 donkeys, 36 900 cattle, 50 800 Karakul sheep and 56 5400 Dorper sheep (Mendelsohn *et al.* 2002). Sheep and cattle are more common in the eastern part of the Hardap region while goats are common throughout the region (excluding the Namib Desert which forms part of a national game park where animals such as Oryx and Desert Horse roam freely).

Table 1.6 shows that most housing units in the country are owned and occupied by households without mortgage (48.9%). Housing units occupied by owners with mortgages are mainly found in urban areas and less so in rural areas. This is because most dwellings in rural areas are traditional houses that do not have title deeds and cannot be mortgaged. Only in urban areas are significant numbers of dwelling units rented.

Table 1.6: Percent distribution of households by type of tenure status by area

Tenure Status	Percentage
Owner occupied with mortgage	14.6
Owner occupied without mortgage	48.9
Rented (Government)	2.0
Rented (Local authority)	2.6
Rented (Parastatal)	0.3
Rented (Private firm)	1.8
Rented (individual)	5.8
Occupied rent free	23.9
Other	0.2
Total	**100%**

Source: Namibia Statistics Agency (2013)

Long-term average livestock carrying capacity ranges from less than 10 to more than 40 kg per hectare in the Hardap region. The average livestock carrying capacity varies widely from year to year due to variability in rainfall. Recently, the stocking density was estimated to be between 0 to 20 kg per hectare with a few areas in the east having stock densities between 20 to 40 kg per hectare. It is believed that the Hardap region is generally stocked to near carrying capacity. The risk of farming is estimated to be medium to high with predicted changes in rainfall in the order of 10 to 40 millimetres (mm) annually (Mendelsohn *et al*., 2002).

Most of the farming areas in the Hardap region are found on freehold farms that range in size between 2 500 and 20 000 hectares. Most other farming areas range from 5 000 to 10 000 hectares in extent. The market values of average farms in the year 2 000 ranged from N$ 50-75 per hectare to the west of Maltahöhe to N$150-175 per hectare in areas around the east of Mariental (Mendelsohn *et al*., 2002).

The entire western portion of the Hardap region comprises of the Namib-Naukluft Park (a protected area). The other protected area surrounds the Hardap Dam and a registered conservancy is located at Oskop. Approximately 20 existing accommodation facilities in the western escarpment of the Hardap region have tourism potential.

1.7.6 Climate and Rainfall

The Hardap region, like most of the country is an arid region. Most rain falls in the late summer months. As shown on Figure 1.3 rainfall ranges between 0-50 mm in the Namib Desert to the west and 250 mm to 300 mm in the Rehoboth area to the north; the largest part of the region receives 100 mm to 200 mm of rain per annum. The rainy season lasts an average of thirty to thirty five days per year. Nevertheless, the coefficient of variation of average rainfall in the Hardap region is unreliable. February is the peak rainfall month with January and March next highest. The region experiences little to no rain during the months of May to October.

Rainfall in the Hardap region is very irregular resulting in below average rainfall amounts, but ‘normal’ by the region’s standards. As an indicator of ‘drought’, not just normal dryness, the lowest year out of fourteen is selected. In one of fourteen years, the rainfall in the entire region may be lower than 100 mm in the east and less than 25 mm in the west. Anything higher than these amounts is considered ‘normal’ even if it is below the calculated average (Mendelsohn *et al*., 2002).

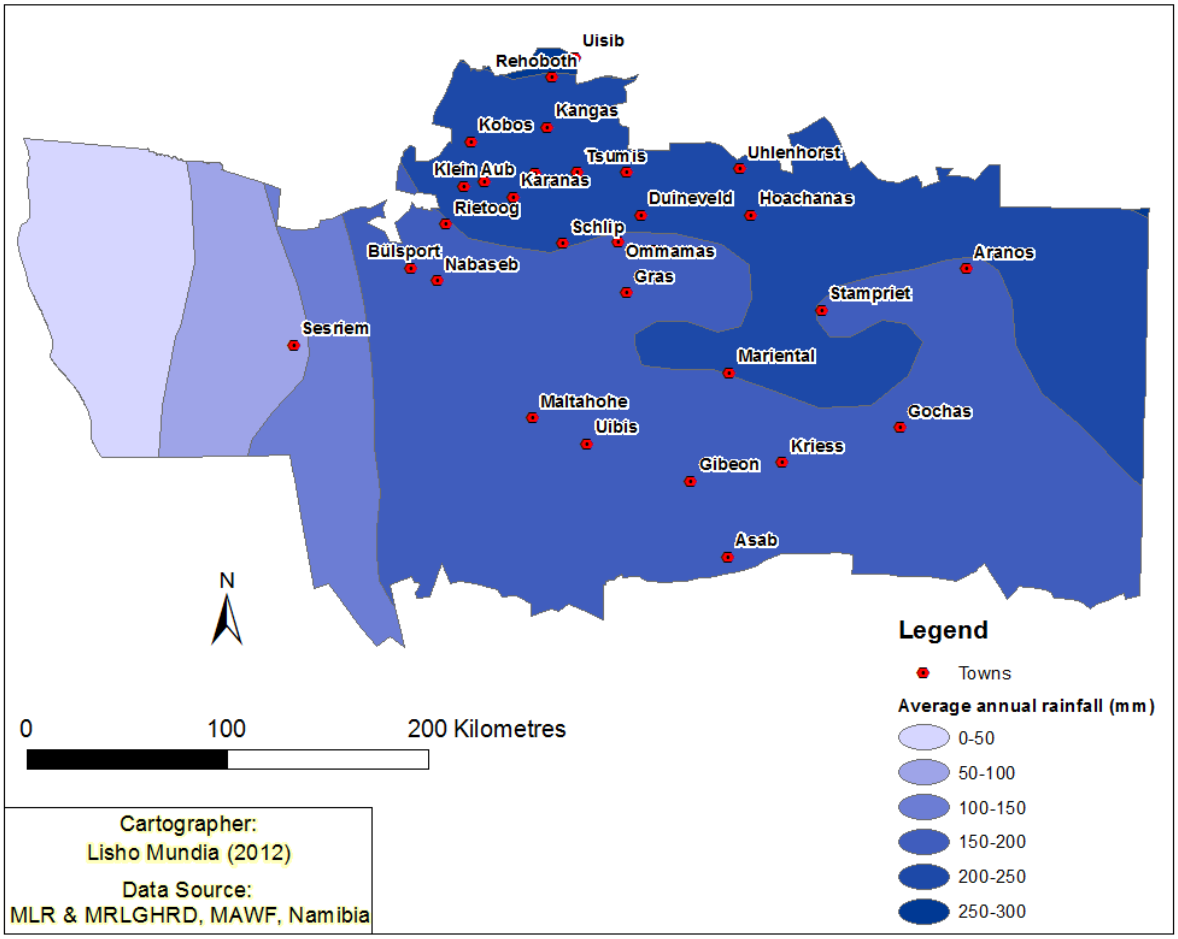


Figure 1.3: Average annual rainfall

Rainfall in the Hardap region is usually low and extremely variable, which means that those years of abundant rain is often followed by long periods of extremely dry conditions. As a result of low rainfall, vegetation is generally sparse, with few trees and a thin covering of grass (Food and Agriculture Organization (FAO), 2005).

Evapotranspiration is very high in the Hardap region. The average water deficit (average evaporation rate is less than the average annual rainfall) ranges between 1 700 and 1 900 mm, along the desert coast where fog reduces evaporation, to a high of 2 300–2 500 mm per year south west of Maltahöhe. As a result of the low cloud cover, most of the Hardap region, excluding the coast, receives 9-11 hours of sunshine per day as the annual average (Mendelsohn *et al*., 2002).

Annual average temperatures range from less than 16°C along the coast to up to 22°C in the vicinity of Mariental. Maximum temperatures during the hottest months exceed 36°C while minimum temperatures during the coldest months measure below 2°C. The north eastern part of the region can have more than thirty days of frost per year. Humidity varies between

10–20% during the dry periods (especially October) and 50-80% during the humid periods of March and April. As with rainfall, humidity varies from year to year. Wind speed at Mariental is rarely higher than 10 km per hour during day time. The wind speed is however higher in summer during the day time. Morning and evening winds occur more frequently in winter. The coast, in contrast, has strong southerly winds (>30 km/hr) during most of the year (Mendelsohn *et al*., 2002).

1.7.7 Topography, Geology and Mineralogy

Elevation in the Hardap region ranges from 2 000 m to 2 200 m above sea level along the Great Western Escarpment. The elevation is about 1 000 - 1 300 m in the Kalahari to the south and east (Namibia Development Corporation (NDC), 2000). Four major areas such as the Namib Desert, Naukluft Mountains, Tsondad and Tsauchab can be delineated. The coastline is sandy or rocky and several islands lie within Namibia's territorial waters. East of the coast, the Namib Desert rises to about 1 000 m above sea level and stretches up to the base of the escarpment. Large sand dunes are traversed by several ephemeral rivers, notably the Tsondad and Tsauchab, which transition into an underground water system (Mendelsohn *et al.,* 2002).

The Great Western Escarpment borders the desert in the east consisting of the Naukluft Mountains and the Schwarzrand. East of the escarpment and the plains of the Fish River basin, lays the Kalk Plateau. Scattered granite and other inselbergs lie west of Rehoboth. East of the Kalk Plateau lies the Kalahari basin with two major ephemeral rivers, the Oanob and the Nossob. Both the Oanob and the Nossob are fossil tributaries of the Orange River. Low, vegetated sand dunes of the Kalahari overlie solidified sandstones resulting in a flat terrain extending far into Botswana (Mendelsohn *et al.,* 2002). The Kalahari Group is almost 300 m thick in the basin where it overlies the upper reaches of the pre-Kalahari Aranos River System, just south of 24ºS. The elevation of the base of the succession as well as that of the present-day surface, which is the top of the Kalahari group, falls to the south and east (Miller, 2008).

The geology of the Hardap region is a mixture of simple and complex formations, echoing the topographic units described above. Namib and Kalahari sands occupy the majority of surface area in the west and east. Figure 1.4 show that Mariental is characterised by the Karoo Supergroup with nearby places such as Maltahohe and Uibis surrounded by Nama Group. The less noticeable geology in terms of area covered are the Namaqua Metamorphic Complex to the north and the Karoo Super Group north and south of the Hardap region

(Mendelsohn *et al.,* 2002). The Fish River rocks are characteristically red in colour and can further be subdivided on the basis of the relative abundance of sandstone and shale, into the *Stockdale, Breckhorn, Nababis and Gross Aub Formations* (Miller, 2008). The Namaqua Metamorphic Complex is formed by deeply eroded, high-graded metamorphic rocks, mainly various granitic gneiss.

Miller (2008:16-2) stated that "the main Karoo basins in Namibia are the Owambo Basin in the north, Aranos Basin (also referred to as the Stampriet Artesian Basin) and the Karasburg Basin in the Southeast and South." Rocks of the Karoo Supergroup are distributed throughout Namibia either in several sub-basins or in scattered deposits of limited lateral extent (Miller, 2008). The Karoo Supergroup is visibly dominant in the Hardap region (Figure 1.4).

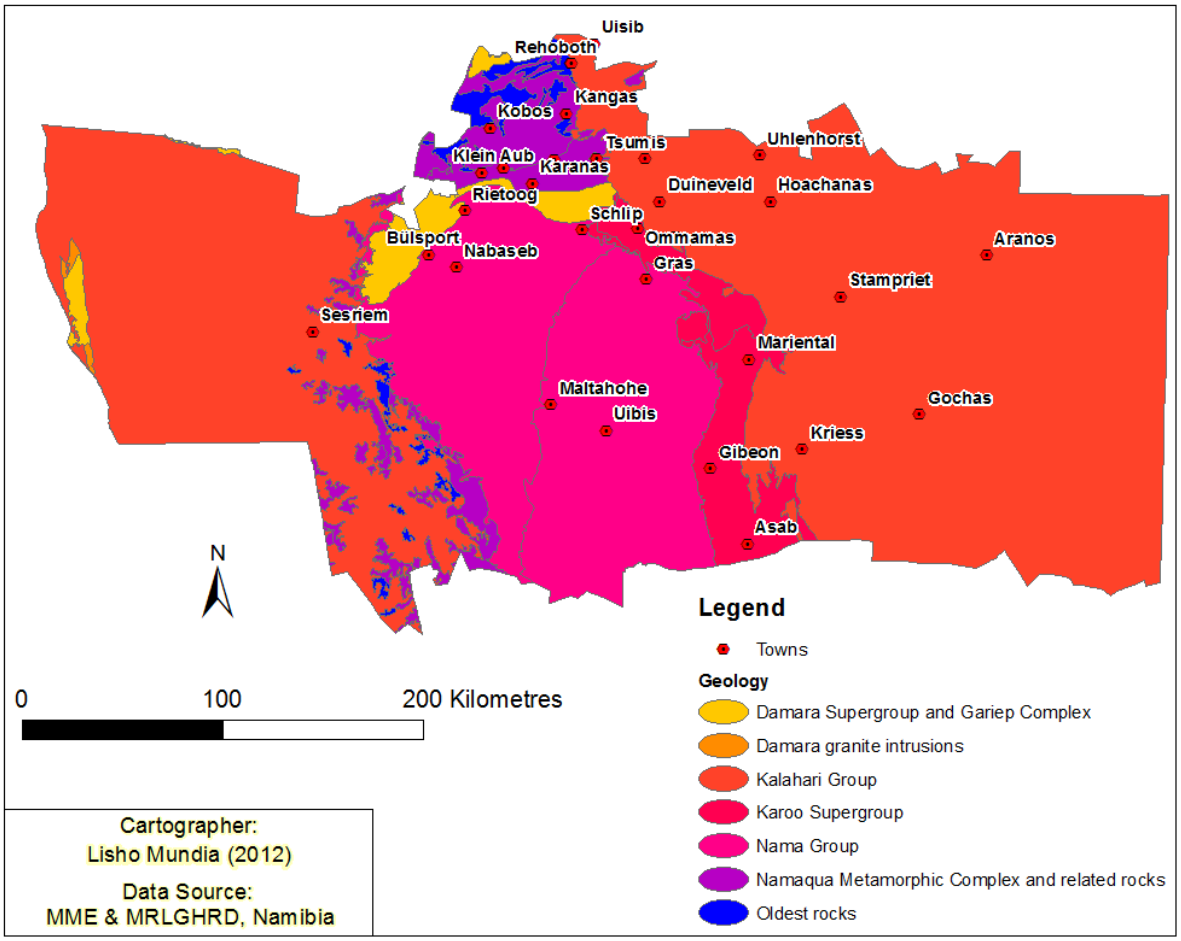


Figure 1.4: Geology of the study area

Known mineral resources, of commercial value in the Hardap region are limited. Several dormant, worked-out mines in the vicinity of Klein Aub have been mined for copper, zinc, gold and silver in the past. Similarly, the limited diamond deposits on the coast are the result

of total exhaustion of the resource. A clay deposit near Mariental has potential for pottery production (NDC, 2000).

1.7.8 Landscapes, Soils and Vegetation

The landscapes, soil and vegetation of the Hardap region vary from the west to the east. Figure 1.5 shows the Namib dunes to the west. Mendelsohn *et al.,* 2002 stated that the "Namib dunes comprises of dune sands formed by the wind into a variety of shapes. The dunes sands formed by the wind include some of the highest dunes in the area of Sossus Vlei" in the Hardap region. The dunes support sparse vegetation such as perennial grasses and a few types of succulents (Mendelsohn *et al.,* 2002).

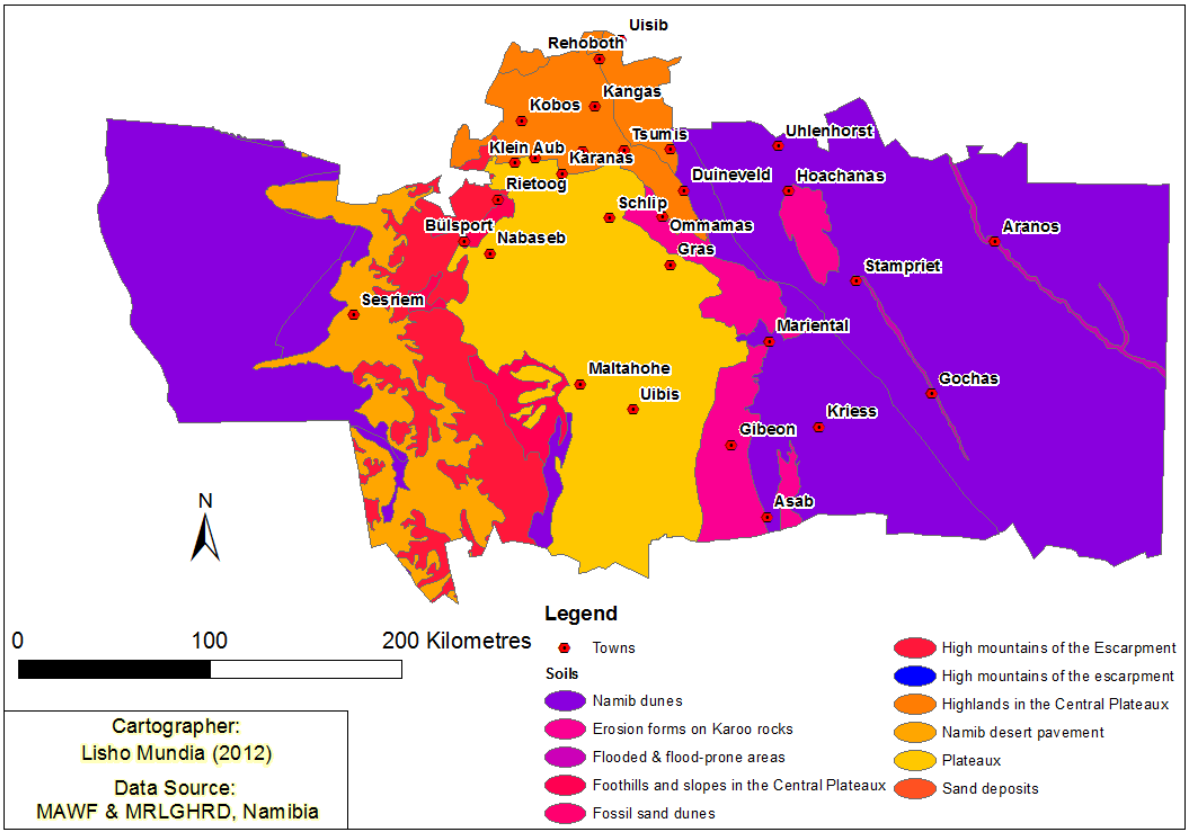


Figure 1.5: Soil types of the study area

The western escarpment provides the headwaters of several small ephemeral rivers flowing westward into the Namib. While trees grow along the water courses, the rugged, calcareous escarpment supports mainly dwarf shrub vegetation. East of the western escarpment, shallow stony soils support a dwarf shrub savannah with the Karas dwarf shrub land intruding from the south. The shrubs are considered part of Nama Karoo biome. Open acacia woodlands predominate the sandy soils further east in the Kalahari Sandveld landscape (Mendelsohn *et al.*, 2002).

Figure 1.5 shows the sandy deposits within the central part of the region. The sandy deposits soils of the Namib and the Kalahari are very permeable with low water retaining capacity. The effect of these different landscapes, soil types and vegetation communities, combined with the prevailing dry climate, means that the Hardap region is mainly suitable for use as extensive rangeland rather than for crop cultivation (Mendelsohn *et al.,* 2002).

1.7.9 Hydrology and Geohydrology

The Hardap region shares the Fish River basin with Karas region to the south and the Khomas region to the north, where a small portion of its northern headwaters lies. To the east lie the ephemeral Oanob, Auob, Olifants and Nossob Rivers, as shown in Figure 1.6. They are either active or fossil tributaries flowing southwards towards the Orange River, some terminating in the sands of the Kalahari.

A few small, ephemeral rivers arise along the western escarpment and flow westward into the Namib (Mendelsohn *et al.,* 2002). A number of ephemeral rivers, such as the Auob and Nossob cross into Botswana and South Africa, but their flows are so irregular that their importance as shared surface water sources is not significant. Groundwater flow in eastern Namibia is generally in an eastern direction, but no attempt has been made to quantify this flow and it has not been raised as an issue of shared resources (Food and Agriculture Organization, 2005).

Two areas in the Hardap region lend themselves to irrigated agriculture. Based on the natural artesian Stampriet Aquifer, irrigated agriculture is practiced in the vicinity of Stampriet and the upper Auob River. The Hardap Irrigation Scheme was developed around the Hardap Dam along the Fish River near Mariental. With the exception of water provided from the Hardap Dam and the Oanob Dam, all water used for domestic and agricultural consumption comes from groundwater. A productive fractured aquifer lies in the western escarpment and a productive porous aquifer lies east of Mariental surrounding the Stampriet area as shown in Figure 1.6.

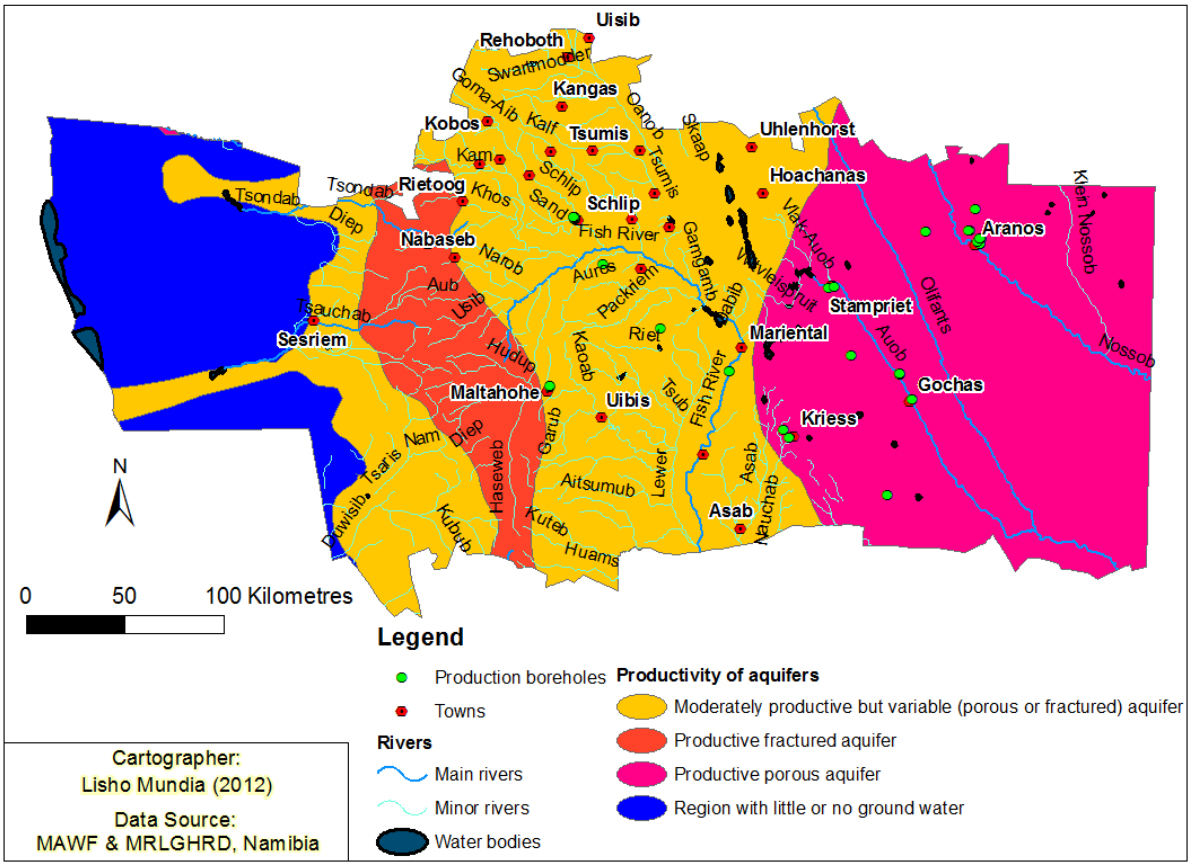


Figure 1.6: Hydrology of and boreholes in the study area

The central part of the Hardap region is water-supplied from a moderately productive aquifer while there is little or no groundwater under the Namib as presented in Figure 1.6. The Hardap region has several areas where the total dissolved solids, indicating saltiness of the water, implies that the water can only be used for livestock or is totally unusable. Appropriate management of the limited groundwater of the region should be a focus in the near future (Mendelsohn *et al*., 2002).

1.8 Justification of the Study Area

The focus area of the research is the Hardap region in Namibia, where participatory mapping and the use of GIS for sustainable land use planning are explored and applied. Namibia, like any other developing country in Africa faces a situation where proper national land use plans, policies, capacity building, community involvement and proper usage of participatory mapping aided by GIS are still uncertain. The use of participatory mapping in land use planning is still relatively unknown in Namibia. Bansouleh (2009:7) stressed that “in most developing countries, methodologies that are capable of simultaneously addressing the various dimensions of land use are lacking, thus seriously hampering informed decision-

making" and creating land use conflicts. Participatory mapping and the use of GIS are becoming the data management tools for land use planning and natural resources management in other countries such as South Africa and Ghana. Goodchild, Steyaert and Parks (1996:01) stated that "as we face monumental problems in coping with an anticipated population growth and natural resource use, GIS will be essential in our effort to understand what is happening to planet earth and in developing appropriate policy."

Accurate spatial information is an essential ingredient in nearly every aspect of government planning and policy making. Although no proper GIS strategies are in place, most Namibian government directorates collect and/or use some form of geographical data to conduct their daily business practices, such as:

1. managing natural resources and protecting the environment;
2. providing a foundation for homeland security, public health and safety, emergency preparedness and response;
3. improving transportation, housing, education and community services;
4. addressing economic development and social and demographic issues;
5. enabling executive strategic planning and more efficient government operations;
6. providing more effective communication between the state and citizens.

Land use changes are altering human and natural systems globally and regionally. The high population growth and the impact thereof on the environment warrants in-depth studies on proper integrated land use planning, land management and monitoring. Worldwide, geography, GIS, remote sensing and participatory mapping have been widely applied in land use demarcation, analysing land uses and land cover changes. Davis (2009:11) stresses that Geographical Information Science (GISci) and the associated GIS technologies have been able to firmly develop the spatial aspects of the study of landscapes and are thus invaluable to the field. Environmental Information Systems – Africa, (2002:02) states that "sustainable development in Africa requires access to data, information and knowledge about the environment and natural resources including socio-economic development opportunities such as existing and planned local infrastructure."

Recently, it became possible to combine wide ranges of different spatial data through the utilisation of GIS technologies. These tools could enable proper gathering and processing of different themes of spatial data and provide the information required for land use planning. Proper introduction and implementation of these GIS technologies can now help in capacity building by involving local communities and leads to better decision-making in Namibia. As

indicated by Cloete, Wissink and De Coning (2006:172), “decision-making is based on what the community considers to be right and wrong, as well as on the interaction between various subcultures and their values.” The context of deciding on new frameworks and guidelines for integrated land use planning through participatory mapping and GIS should therefore have both factual and ethical elements.

The rationale behind this research into participatory mapping aided by GIS for land use planning in Namibia is to develop frameworks and guidelines for participatory mapping aided by GIS for effective integrated land use planning and management. The proposed research further intends to enhance the implementation of sustainable land management by involving the local community through participatory mapping techniques in the Hardap region. This research therefore, will contribute to an understanding of the local spatial knowledge of the Hardap region with regard to its land uses and the statutes of how participatory mapping aided by GIS can help in integrated sustainable land use management in Namibia.

The study of geography has evolved over the years to primarily cater aspects of human-environment relations and physical geography as in this study. This research is pitched in geography as the body of knowledge presenting alternative participatory techniques and the use of GIS in Namibia and to empower and educate local communities about the human and physical environment surrounding them and in which they live. The significance of this study within the context of geography, is to promote local participation in decision-making processes towards sustainable land use planning, and to make use of local knowledge in collecting land use data as presented in chapter 4 of this study.

1.9 Organisation of the Study

This thesis is divided into seven (7) chapters. **Chapter 1** provides the background and problem statement of the study, as it is depicted in Figure 1.7. The background of the study is provided and the problem statement within the context of participatory mapping, land use planning, GIS and geography are provided in this chapter. The research aim and objectives are also outlined. Justification for the choice of the study is outlined in this chapter. Chapter 1 guides the research results to be presented, as shown in Figure 1.7.

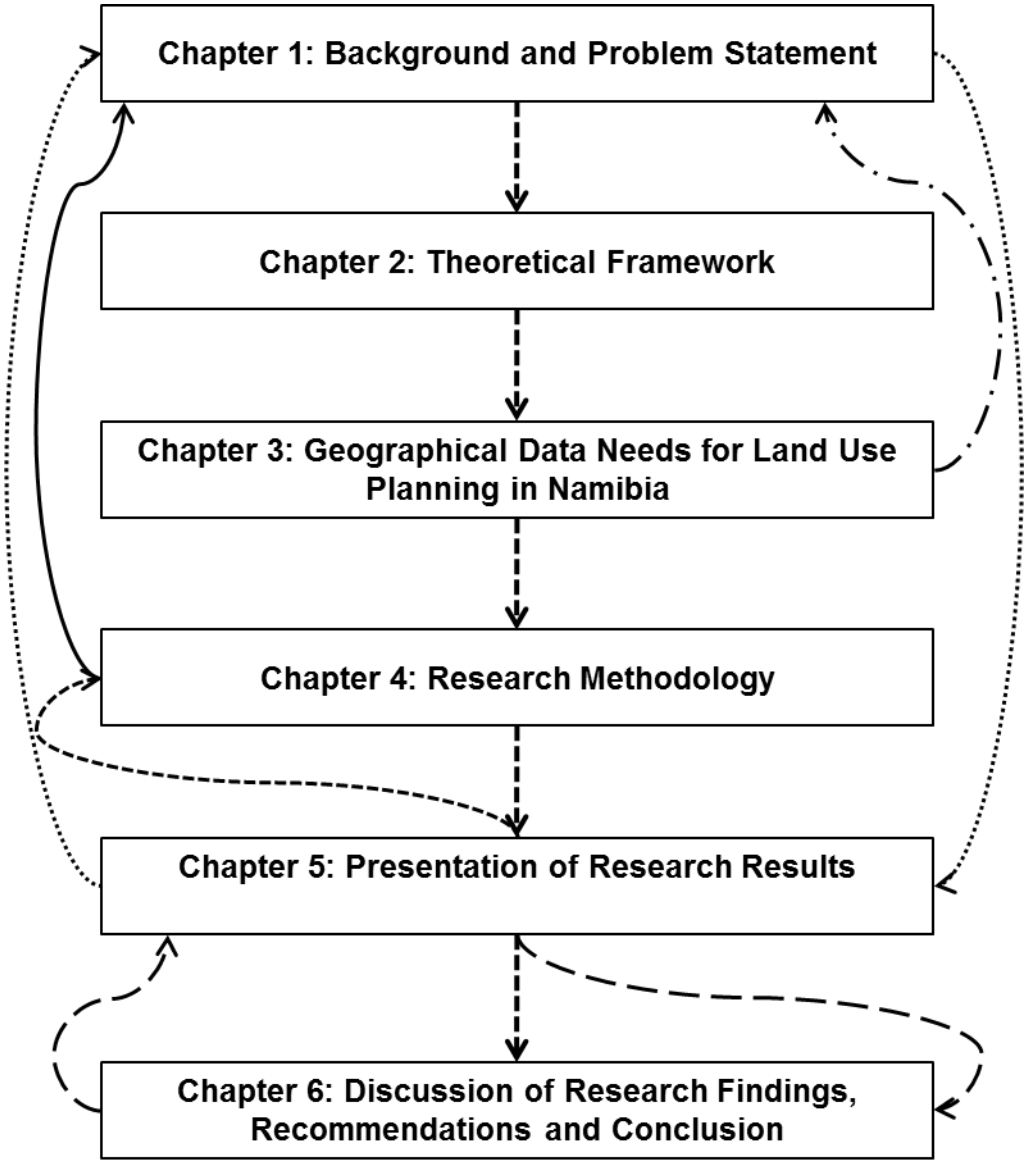


Figure 1.7: Chapter outline

Chapter 2 provides a broad theoretical framework on participatory mapping, geography, GIS and integrated land use planning. This chapter sets the stage for evaluating the significance of participatory mapping in sustainable land use planning through GIS. An overview of the evolution of participatory mapping theories, and the role of participatory mapping aided by GIS in land use planning is provided. This chapter also reviews the role of ILUP, LUP, participatory mapping, GIS and local spatial knowledge within the context of the existing theories and approaches in Namibia and other parts of the world. In this chapter key concepts are explained and detailed definitions and explanations of key terminologies used in the study are provided.

In **Chapter 3** the literature on the geographical data needs for land use planning in Namibia, in relation to international standard is reviewed. The basic principles of data collection, the nature and scale of the data and information, including geographical data models and data types are provided on this chapter. The importance of spatial data needs for land use planning is reviewed within the context of existing theories and approaches and substantiated with relevant evidence selected from various case studies. As shown on Figure 1.7, chapter 3 gives feedback into chapter 1 to respond to the geographical data needs as outlined in the objectives.

Chapter 4 provides an account of the research methodology. The chapter begins with a description of the research philosophy, followed by the methodology. The postmodernism research philosophy provides insight into the nature of the research and how it fits into the postmodernist perspectives. The research methodologies were used within the framework of the available methods and theories. Specific focus is placed on the explanation of how the data collection instruments were developed, including the description of the respondents, outline of the process followed to obtain permission to gather different types of data and how the data was collected, sampled and analysed. As shown on Figure 1.7, chapter 4 responds to the set research objectives in chapter 1.

Chapter 5 deals with the presentation of the research results obtained in this study. The chapter presents results of participatory mapping, focus group discussions on expert and local level and participatory rural appraisal on local level. The results of a SWOT analysis, framework and guidelines are presented as well. Lastly the land use planning data and the process of integrating the data into a conceptualised digital georeferenced database are all provided in this chapter. Chapter 5 responds and gives feedback to the set objectives in chapter 1. The research results responds to the methods set in chapter 4 and guides the recommendations and conclusion chapter, as depicted in Figure 1.7.

Chapter 6 provides the discussion of the research findings, recommendations and conclusion. These include the evaluation of research methodology used, interpretation of research findings and unanticipated findings. It also presents the implications for future action, research contributions and suggestions for further study. As shown on Figure 1.7, chapter 6 gives feed back into chapter 5 of the research results.

1.10 Chapter Conclusion

This chapter has introduced the topic of participatory mapping aided by GIS for land use planning to the reader and it also provided the rationale for choosing the topic. The background issues concerning land use planning of the Hardap region was briefly presented in relation to GIS concepts. The aims and objectives of the study were outlined. The different research questions were posed and approaches were imparted and reference was made as to the organisation of the research process in section 1.8. The study area was introduced and an overview of the Hardap region in terms of its geographical characteristics was given.

The next chapter will focus on the theoretical context relevant to the study. This will entail presenting different relevant theoretical and conceptual frameworks regarding geography, participatory mapping, GIS and ILUP. These theoretical contexts will further assist in analysing the topic and creating a greater understanding of participatory mapping, GIS and land use planning. The various relevant theories are going to be discussed in relation to geography as a field of study in an attempt to explain the research aim and objectives. This will assist in crystallising and substantiating the arguments on the use of participatory mapping and GIS in ILUP relating to the study area. Chapter 2 will also look at the existing theories of local knowledge, and refer to experiences of other countries regarding participatory mapping, GIS and ILUP.

Chapter 2: Theoretical Framework

2.1 Introduction

In this chapter, relevant theories in geography, participatory mapping, GIS and integrated land use planning are reviewed and linked to the current practice in Namibia. In particular, the chapter focuses on highlighting recent initiatives in applications using technology in the decision-making processes of ILUP. These initiatives have spawned a number of debates in geography concerning the nature of the technologies and their ability to deal with complex socio-economic and environmental issues.

This chapter starts with explanations of geography as a field of study and is followed by a review of participatory mapping where general participatory mapping, sketch mapping, photo-mapping and cartography is discussed. It is followed by the context of GIS definitions, components of a GIS and GIS application areas. The key aspects of this study are the context of participatory mapping, GIS and geography for ILUP. Based on the existing theoretically contexts, subsections such as participatory mapping in ILUP, GIS in LUP, participatory mapping context in Namibia and the general GIS context in Namibia were produced.

Other context of LUP which are subdivided into the ILUP context and land use planning context in Namibia are also dealt with in this chapter. The theories of global and local spatial knowledge and an overview of land use planning in Namibia conclude this chapter.

2.2 Geography as a Field of Study

Geography as a field of study connects many cultures and societies. Hartshorne (1959, cited in Norman, 2005) define geography as ‘‘concerned to provide accurate, orderly, and rational description and interpretation of the variable characters of the Earth’s surface.”

Rosenberg (2011:1) stated that “many famous geographers and non-geographers have attempted to define the discipline of geography in a few short words. The concept of geography has also changed throughout the ages, making a definition for such a dynamic and all-encompassing subject difficult.” Table 2.1 provides some of the ideas about and definitions of geography throughout the ages.

Table 2.1: Definitions of geography

Authors	Definition
Ptolemy (150 CE)	The purpose of geography is to provide 'a view of the whole' earth by mapping the location of places.
Immanuel Kant (c. 1780)	Geography is the synoptic discipline synthesising findings of other sciences through the concept of Raum (area or space).
Alexander von Humboldt (1845)	....synthesising discipline to connect the general with the special through measurement, mapping, and a regional emphasis.
Halford Mackinder (1887)	Man in society and local variations in environment.
Ellen Semple, (c. 1911)	How environment apparently controls human behaviour.
Harland Barrows (1923)	Geography is the study of human ecology; adjustment of man to natural surroundings.
Fred Schaefer (1953)	The science concerned with the formulation of the laws governing the spatial distribution of certain features on the surface of the earth.
Richard Hartshorne (1959)	To provide accurate, orderly, and rational description and interpretation of the variable character of the earth surface.
H.C. Darby (1962)	Geography is both science and art.
J.O.M. Broek (1965)	To understand the earth as the world of man.
Robert E. Dickinson (1969)	Geography is fundamentally the regional or chronological science of the surface of the earth.
Holt-Jensen (1980)	Study of variations in phenomena from place to place.
Martin Kenzer (1989)	...concerned with the locational or spatial variation in both physical and human phenomena at the earth's surface.
Yi-Fu Tuan (1991)	Geography is the study of earth as the home of people.
Gregg Wassmansdorf (1995)	Geography is the study of the patterns and processes of human (built) and environmental (natural) landscapes, where landscapes comprise real (objective) and perceived (subjective) space.
National Geographic (2001)	The world of geography is much more than place names and state capitals.
Royal Geographical Society (2005)	Geography is the study of the earth’s landscapes, peoples, places and environments. In simple terms, it is the study about the world in which we live.
Bonnett (2008)	Geography is an all-encompassing discipline that foremost

Authors	Definition
	seeks to understand the earth and all of its human and natural complexities - not merely where objects are, but how they have changed and come to be.
International Geographical Union (2012)	Geography is the discipline that attempts to explore how environments emerge by natural processes, how societies produce, organise, use and misuse environments, and how societies themselves are influenced by the environments in which they are located.

Source: Rosenberg (2011); National Geographic (2001); Royal Geographical Society (2005); Bonnett (2008) and International Geographical Union (2012)

The ideas and definitions in Table 2.1 make it clear that the trend of defining geography has been changing from broader definition in the earlier ages to more specific applications of geography as a field of study in the more recent years. Geography is one of the oldest sciences of significance to society. Geography provides answers to the question that the earliest humans asked, “What's over there?” Exploration and the discovery of new places, new cultures, and new ideas have always been basic components of geographical science.

According to Kennedy (2002:2) “geography[1] and GIS particularly, depend on the concept of location which we use in our everyday life through formal and informal observations.” Formally, geographers usually delineate geographical space in two dimensions on the Earth’s surface by means of the graticule of latitude and longitude, or with some other system based on that graticule. Informally and, in the vast majority of instances, geographers organise space in terms of features in that space. This applies when geographers use location in their daily lives as a frame of reference to make decisions. Moreover, an individual can only manage, locate and monitor a place, area or feature if he/she has interest in and knowledge of such place, area or feature.

Observations that are undertaken in places are mostly location-based information. The major goal of the geographical observations made is to generate knowledge about the processes influencing spatial patterns. The goal is to add to the understanding of spatial processes (Fotheringham, Brunsdon & Charlton, 2000:4).

[1] Geography is an attempt to both understand and meet the world. In this sense we may say that geographers are explorers. This ambition makes geography a distinctive contribution to increasing bureaucratic and institutionalised systems of education (Bonnett, 2008:122).

Geography is a dynamic subject and this is why its definitions, philosophies and methodologies are constantly changing. The core concerns in geography are places, spaces, landscapes, locations and especially the interrelationships between people and their environment. Despite different definitions, it is a fact that geographers tend to approach problems related to the human-environment system from a space-in-time perspective and that space is the fundamental concern in geography.

Geography attempts to describe and explain the world and its people. There are many pitfalls in such attempts. One of the most fundamental aspects in geography is how geographers can know about people (and their environment) from other parts of the world. The increased mobility of people and information means that the issue of 'knowing others' has become a defining dilemma of the modern era. Bonnett (2008:24) maintains that "prejudice, ignorance and stereotype are concerns within all intellectual fields of enquiry. But because of the nature of geography, because of its claim to produce information about other societies and other landscape, it is forever shacked to this set of problems."

Sets of problems such as land degradation, poor land use planning and overpopulation are becoming matters of concern in Namibia. Participatory approaches attempts to address these sets of problems concerning land by involving the local communities in the research. Bergman and Renwick (2005:4) define Geography as follows: Geography "is the study of the interaction of all physical and human phenomena at individual places and how interactions among places form patterns and organise space."

Geography itself is a broad field of study with subfields of study such as physical geography and human geography. Bergman and Renwick (2005:04) stated that "physical and human geographers share both their approach and a great deal of information, and their analyses of landscape always weave their understanding together." Thus, geography bridges the physical sciences and social sciences. In this regard, the geographical perspective is of value to this type of research because issues of land features and human (land occupants) knowledge are dealt with in this study.

Physical geography studies the characteristics of the physical environment. When geography concentrates on topics such as climate, soil and vegetation, it is a natural science. Human geography studies people groups and their activities such as the language they speak, their industry and the architecture to buildings they live and work in. Cultural geography is a subfield of human geography which focuses specifically on the role of human cultures. More specific definitions were formulated by Bergman and Renwick (2005:04) who

state that “cartography (map making) and its computerised extension to GIS provide tools that help both physical and human geographers store, maintain, analyse and display geographical data.”

2.3 The Context of Maps and Participatory Mapping

2.3.1 Cartography and Maps

Maps have been used for centuries to visualise spatial data. It helps their users to visualise and better understand spatial relationships. From maps, information such as distances, directions and the sizes of areas can be retrieved. On maps, patterns are revealed and the relationships to different phenomenon can be understood. According to Nyerges, Janowski and Drew (2002:2) “basic GIS capabilities such as data management, spatial analysis and map display have been used to generate various types of geospatial information structures for group interaction, since maps are commonly conversation generators.”

Traditionally maps are divided into two main groups, namely topographic and thematic maps. Topographic maps give a general image of the earth’s surface: roads, rivers, buildings and often the nature of the vegetation, the relief (shape of the land) and the names of various mapped objects. In topographic maps attention is paid to accuracy in terms of positional relationships among the specific features mapped. Thematic maps represent the spatial distribution of particular phenomena. The maps emphasise spatial variation of one or a small number of geographical phenomena. These phenomena are, for example, climate, soil types or phenomena from the human environment such as population density and health issues.

A map is usually recognised as being a simplified, generalised and reduced representation of a part of the curved earth on a flat sheet of paper. Wade and Sommer (2006:130) defined a map as a “graphic representation of the spatial relationships of entities within an area.” According to Robinson, Morrison, Muehrcke, Kimerling and Guptill (1995:4-5) “a map has two important functions:

1. It serves as a storage medium for information which humanity needs.
2. It provides a picture of the world to help us understand the spatial patterns, relationships, and complexity of the environment in which we live.”

Robinson *et al*. (1995:09) also defines a map as a graphic representation of the geographical setting. Cartography is more than a map. It is the making and study of maps in all aspects (Robinson *et al*., 1995:09). Wade and Sommer (2006:27) in agreement with Robinson *et al*. (1995) defined cartography as "the art and science of expressing graphically, usually through maps, the natural and social features of the earth." Natural and cultural phenomena are represented on the map by unique symbols so that they are easily identifiable. Clarke (1997:8) stressed that understanding the way maps are encoded to be used in GIS requires knowledge of cartography.

Over the past few years geography experts have come to expect the world to be mapable at numerous scales and in numerous ways. Cartographic visualisation offers the possibility of providing any data set such as number of sports field, shops, hospitals, houses and schools, and presents information as a map (Bonnett, 2008). Maps are important tools in land use planning and are essential to geographers. In this study, maps help the researcher, land use planner and decision-makers to understand different types of land use in the Hardap region.

2.3.2 Participatory Mapping

The participatory creation of maps started in the late 1980s. At that time development practitioners were inclined to adopt Participatory Rural Appraisal (PRA) methods such as sketch mapping, photo-mapping and transect walks (Rambaldi, Chambers, McCall & Fox, 2006a). Preference was given to eliciting local knowledge and building on local dynamics to facilitate communication between insiders (villagers) and outsiders, such as researchers and government officials. Minang and McCall (2006:11) stated that "using Participatory GIS [2] (PGIS) with communities can add value to local knowledge in support of development mechanism." In their study *"Participatory Spatial Information Management and Communication in Developing Countries"* Rambaldi, Kyem, McCall and Weiner (2006b:1) stated that "participatory creation of maps, above and beyond their interpretation, started in the early 1980s. The state of affairs in mapping changed in the '90s, with the diffusion of modern spatial information technologies including GIS, global positioning systems (GPS), RS image analysis software and open access to spatial data and imagery via the internet."

Different participatory mapping strategies[3] including participatory photo-mapping and sketch mapping as well as participatory GIS (PGIS) have traditionally been involved in the collection

[2] Participatory GIS is an emergent practice in its own right; developing out of participatory approaches to planning and spatial information and communication management (Rambaldi & Weiner, 2004).

[3] Participatory mapping is a map-making process that attempts to make visible the association between land and local communities by using the commonly understood and recognized language of cartography (International Fund for Agricultural Development, 2009:06).

of data. These mapping strategies have specifically been used for monitoring purposes in land use development, urban development, land degradation or deforestation and urban settlement.

According to Rambaldi *et al*. (2006a:106) “practitioners, researchers and activists in different parts of the world have tested and developed a range of integrated approaches and methodologies, which led to many innovations within what is now referred to as Participatory GIS (PGIS) practice.” Nethengwe (2007:153) also realised the importance of PGIS in the study ‘*Integrating Participatory GIS and Political Ecology to study Flood Vulnerability in the Limpopo Province of South Africa’* and stressed that there is “the need for some form of advocacy to help communities understand and map processes that make them vulnerable and to integrate their coping strategies within a wider socio-economic and political context.”

In a recent study done in South Africa, titled ‘*Community Asset Mapping*’ by Kramer and Amos (2010:7), an asset mapping approach was used by means of “appreciative interviewing, asset mapping and skills inventories methods.” The specific participatory measures used in their study were participatory mapping, diagramming and indexing. The results of the Community Asset Mapping study showed the ranking of health infrastructure in both urban (Rustenburg) and rural (Mapothostat) areas in South Africa (Kramer and Amos, 2010). In the Kramer and Amos (2010) study, recommendations were made that the tools used be carefully examined to ensure that the assets mapped were built on the strengths of existing instruments. The specific use of the tools in promoting safety and peace needed to be highlighted. It was recommended that the most beneficial aspects of each of the tools are combined into an appropriate and novel model that is specific to the South African context. In this study, participatory approaches were important because there were tools perceived to bring about a bottom-top decision-making process in Namibia. The phase of engaging both local communities and experts brings about advantages of participatory mapping in ILUP.

Chirowodza, van Rooyen, Joseph, Sikotoyi, Richter, and Coates (2009:42) in their study ‘*Using Participatory Methods and Geographic Information Systems (GIS) to Prepare for an Human Immunodeficiency Virus (HIV) Community-Based Trial In Vulindlela, South Africa*’ stated that “the aim of the participatory mapping and transect walks is to provide a space for communities themselves, to describe and to define their communities.” Understanding both physical and social environments is a prerequisite to planning and implementation of community-based research. The visualization capacity of information management tools such as GIS can assist researchers in capturing the broader spatial and social contexts of communities (Chirowodza *et al.,* 2009:46). Participation is promoted in order to encourage

and reinforce local decision-making and local responsibilities to lead towards eventual empowerment of local peoples, as moves towards more equitable social redistribution, to empower weak groups in access to, and control over, resources, and to promote people's initiative, local control, and 'ownership' (McCall, 2004).

2.3.3 Crowd Source Mapping

Various developments have created an environment that has allowed the collection of geodata to move from national mapping agencies and major commercial data providers to what are now sometimes called crowd sourced data collectors (Chilton, 2009). Crowd sourcing is an emerging approach where members of the public are asked to contribute to the way in which we share information and knowledge. One area of crowd sourcing is Volunteered Geographical Information (VGI), in which people share information in order to quantify and visualise built and natural geographical environments (Clouston, 2012).

Crowd source mapping is an interdisciplinary field bridging many areas of expertise, including the need to access different levels of experts and use of GIS technologies. In order to ensure that these cutting-edge technologies do contribute to sustainable land use planning, there is a need to better define how the various areas of expertise and local communities come together. Clouston (2012:2) stated that "crowd sourced mapping approach requires greater collaboration and understanding - as well as a willingness for volunteers, regulators and professionals to work together."

The development of OpenStreetMap and a variety of other web-based mapping services such as Google Maps allow volunteers to assist in spatial planning via mapping and other spatial analyses. The use of these type of web-based mapping services tool is significantly increasing in both developed and developing countries. Given the immediate need for reliable maps in volatile disaster response situations, the model of peer produced mapping provides a number of new avenues for producing and accessing spatial data, apart from the traditional models of top-down GIS provision (Zook, Graham, Shelton and Gorman, 2010). Zook *et al*. (2010:11) stated that "cloud sourcing refers to the ability of people from around the world to collaborate on projects that are often highly ambitious in both their scale and scope." It also marks the "increased ability for individual users and loosely affiliated networks to construct and shape cyberspace and their daily lives" (Crutcher and Zook, 2009:524). The crowd sourcing of information has reshaped a variety of practices, but arguably none as profoundly as the production of geographical information where many users have moved from being passive recipients of geographical information to being producers themselves

(Budhathoki, Bertram, and Nedovic-Budic, 2008). A core motivation behind the production of VGI is the inaccessibility and cost of accurate sources of geographical information (Haklay and Weber 2008).

Clouston (2012:4) states that "this new constellation of social and technological forces provides a number of benefits, yet also faces shortcomings." Zook *et al*. (2010:12) state that "perhaps the greatest benefit to this form of distributed mapping is that a greater number of maps can be produced in a shorter period of time, allowing scarce technical resources to be diverted elsewhere. This is especially the case for labor, as volunteer, crowdsourced mapping allows aid agencies to focus their limited resources on other needs that cannot be so easily met via distributed, volunteer workers." Crowd sourced maps can be updated quickly where there is at least one willing and capable volunteer.

However, just like the participatory mapping approach, crowd sourced maps also often suffers from variable accuracy, completeness and consistency in comparison to GIS maps that are created by qualified personnel (Clouston, 2012). It was also confirmed in the studies done by Brandel (2002) and Burgener (2004, cited in Zook *et al*., 2010) that reliance on crowd sourced labour has led, however, to a return to concerns regarding the accuracy and validity of data that is not being centrally managed.

2.3.4 Sketch Mapping

Sketch mapping or “resource mapping” helps people in picturing resources and features on a given base and in graphically manifesting the significance they attach to them. It is a method for collating and plotting information on the occurrence, distribution, access and use of resources within the economic and cultural domain of a specific community (Integrated Approaches to Participatory Development (IAPAD), 2010). Corbett, Rambaldi, Kyem, Weiner, Olson, Muchemi, McCall and Chambers (2006:14) stated that “sketch mapping is a slightly more elaborate method. A map is drawn from observation or memory. It does not rely on exact measurements, such as having a consistent scale, or georeferencing. It usually involves drawing symbols on large pieces of paper to represent features in the landscape.” The sketch mapping method is detailed and requires more time to compile than the photo-mapping method, since maps are drawn from the participants' memory, whereas photo-maps are drawn from georeferenced remotely sensed images.

The International Fund for Agricultural Development (IFAD), (2009:13) describes sketch mapping as a “hands-on mapping that includes basic mapping methods in which community

members draw maps from memory on the ground (ground mapping) and paper (sketch mapping).” These maps represent key community-identified features on the land from a bird’s eye view. They do not rely on exact measurements, a consistent scale or georeferencing, yet they do show the relative size and position of features. These maps have been commonly used in Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA) initiatives.

Integrated Approaches to Participatory Development (IAPAD), (2010) stated that the sketch mapping “outputs may differ according to the specific purpose the exercise is conducted for, and to the characteristics of participants. It is best associated with other tools and in particular with transects walks, which contribute to a more critical analysis of the individual resource. Sketch mapping should be conducted at the onset of a community based activity, but only after rapport has been established with the community. Knowledge on the social structure of the participating community is a prerequisite for the facilitator as the community may consider resource distribution, use and access as sensitive issues.” The International Fund for Agricultural Development, 2009:13) maintains that “sketch mapping techniques are a good starting point for framing important land-based issues. They can help provide a broad picture of issues and events covering a large area and can be useful to introduce and acquaint a community with maps and build confidence in using the cartographic medium. They can help plan subsequent mapping activities and engage non-expert users. This approach to mapping is especially useful when engaging non-literate communities and those from marginal livelihood systems including indigenous peoples, forest dwellers and pastoralists.”

Sketch mapping has strengths and weakness in the application of land use planning. The strengths and weaknesses of this approach are outlined below.

Strengths

1. Low-cost and not dependent on technology (International Fund for Agricultural Development, 2009).
2. Repeatable at given intervals, sketch mapping can become an integral part of participatory monitoring and evaluation (IAPAD, 2010).
3. In depth resource mapping for a particular resource can be done at any time of the project cycle. It can help generating qualitative and quantitative information (IAPAD, 2010).
4. Sketch maps can be delivered within a short time frame and provide tangible short-term outcomes (International Fund for Agricultural Development, 2009).

5. Sketch mapping can apply to all ecosystems known to the community and it can be elaborated up to different levels of definition (IAPAD, 2010).

Weaknesses

1. In a general assessment of this approach, it was observed that the participatory sketch map is spatially confined to the social, cultural and economic domains of those who produce it. Thus, in the case of larger areas, like protected areas and their buffer zones, covering hundreds of square kilometres and tenth of different administrations, the production of a sufficient number of community-specific sketch maps becomes unrealistic from both practical and financial points of view (IAPAD, 2010).
2. Provided good community mobilization, transect diagramming and plotting natural and other resources onto sketch maps are readily adopted methods. Nonetheless reservations remain about how to 'translate' these sketch maps into more precisely scaled authoritative information that could be used officially for management purposes. Experience has shown that bureaucracies tend to pay little attention to informal documents, including sketch maps (IAPAD, 2010).

Some of the drawbacks of sketch mapping, pointed out by the International Fund for Agricultural Development (2009:13) are that "the final map outputs are not georeferenced and can only be transposed onto a scale map with difficulty. This makes them less useful when locational accuracy is important, such as when there is a need to determine the size of an area or make other quantitative measurements. This lack of cartographic accuracy undermines their credibility with government officials and thus diminishes their potential for advocacy. Although the final map can be photographed, the long-term usefulness of ground maps is further undermined by their impermanence and fragility."

Despite the weaknesses mentioned above, the International Fund for Agricultural Development (2009:14) stated that the implications of the "low-cost, low training requirements and ease of delivery of sketch mapping makes this a useful tool for initially engaging communities - particularly non-literate groups." It is a useful process for determining and extracting community views and information. This type of mapping is already commonly used in various parts of the world and is often a component of broader PLA initiatives. The overall impacts of the mapping process are minimal in relation to long-term change and empowerment of communities engaged in the process.

2.3.5 Photo-Mapping

Photo-mapping exercise is usually carried out on the printouts of georeferenced or ortho-rectified remotely sensed images (Rambaldi *et al*., 2006b). Ortho-photo maps are one of the sources of accurate remotely sensed data that may be used for large scale community mapping. The International Fund for Agricultural Development (2009:14) stated that "local knowledge is identified through conversation and then drawn directly onto a photocopied map or remotely sensed image or onto clear plastic sheets placed on top of the map. The position of features is determined by looking at their position relative to natural landmarks, such as rivers, mountains, lakes." This method is commonly used where accurate and affordable scale maps are available. This method also works well with aerial and satellite images, which can be particularly helpful when working with people who cannot read a topographic map and with non-literate communities, including those from marginal livelihood systems, such as indigenous peoples, forest dwellers and pastoralists. Additional information can be collected in the field using GPSs and later be transferred to the map (International Fund for Agricultural Development, 2009).

According to Müller and Wode (2003, cited in IAPAD, 2010:16), photo-mapping is one of the "conventional approaches used to obtain land use maps usually conducted by outsiders who interpret remote sensing data without profound knowledge of local resource conditions. Limited field experience possibly results in inaccurate delineation and misinterpretation of land use classes."

Müller and Wode, (2003, cited in IAPAD, 2010:17) stated that "the objective of participatory photo-mapping is to enable villagers to carry out the interpretation of aspects of their land resources, which are of significant importance to them. In this process villagers delineate their land use on transparencies laid over an ortho-photo. The information on the transparencies will later be scanned or digitized and georeferenced. Involving local stakeholders with their extensive field experience is expected to improve the accuracy and precision of obtained data."

Müller and Wode (2003, cited in IAPAD, 2010:26) further maintain that "Ortho-photo-maps are an effective participatory communication tool on village level to:

- visualize resource use to facilitate discussions without communication barriers and to motivate participants to reflect and discuss about land issues;
- allow a rapid identification of social, economic, and environmental problems of the

village by determining and debating issues related to natural resource use with active participation of the community;

- create a common understanding among local land users and administrative authorities on spatial distribution and status of resources and resource use;
- provide a basis for joint and demand-driven decision-making between different villages and between villages and state entities;
- acquire accurate spatial data on large scale on the basis of local knowledge;
- provide options for participatory impact monitoring for rural development investments from government and other donors;
- mediate and solve prevailing boundary conflicts;
- generate accurately scaled information on land use that can be officially approved for management purposes."

Photo-mapping techniques are a good format for communicating community information to decision-makers because they use formal cartographic protocols, such as coordinate systems and projections. Information can be incorporated into other mapping tools, including GIS and GPS data can be easily transposed onto these scale maps. When accuracy is required where scale maps are not available, scale maps can be made using survey equipment including compasses and GPS tools. This approach to participatory mapping is important in regions where accurate topographic maps are not available, such as in remote and marginal areas which often tend to be inhabited by indigenous peoples, forest dwellers and pastoralists. The time and energy required to create scale maps from scratch are considerable (International Fund for Agricultural Development, 2009). Like sketch mapping, the International Fund for Agricultural Development (2009:15) maintains that the photo-mapping approach "is relatively cheap and fast and still provides an accurate spatial representation of local knowledge, particularly if the information drawn on the map is 'ground-truthed' using a GPS. The resulting map can be used to determine quantitative information such as distance and direction."

Some of the drawbacks of photo-mapping are that in some countries, access to accurate scale maps is regulated and difficult. Furthermore, maps in some areas might not be accurate or up-to-date. A further drawback is that using scale maps requires understanding formal cartographic protocols such as scale, orientation and coordinate systems which can be challenging for non-literate people (International Fund for Agricultural Development, 2009). According to the International Fund for Agricultural Development (2009:15) "scale maps and images have particular potential for adoption of delineated geographical features.

The field application is straightforward, engaging and relatively cheap, although there are photocopying and pen costs. This process also permits the collection of georeferenced spatial information that can be imported directly into GIS systems." Like sketch mapping, the impacts of photo-mapping process are minimal in relation to long-term change and empowerment of communities engaged in the process.

2.4 Context of Geographical Information Systems (GIS)

2.4.1 GIS Definitions

There have been several attempts to provide a definition for GIS. Table 2.2 shows that there are different types of GIS definitions provided from different viewpoints. As the person's experience changes, their perception of GIS and as a result the definition of GIS also changes. Looking at dozens of definitions for GIS it becomes clear that each definition is developed from different perspectives. Some definitions regard GIS in terms of a list of its elements, such as system components, hardware and software aspects, others see GIS in a narrower sense as a marriage of computer assisted cartography and database technology, and still others view GIS as any computer graphics and drafting software package capable of displaying a map to be labelled as GIS.

Maguire (1991, cited in Noongo, 2007:22) points to "three perspectives of describing GIS, namely, *identification*, *technological* and *organisational* perspectives. The *identification perspective* describes the unique features of GIS that distinguish GIS from other types of information systems, giving GIS its special identity to justify separate attention needed during its implementation."

The technological perspective tends to gravitate towards four different approaches. The first of these is a process or function oriented approach. This approach emphasises the information handling capabilities of GIS. A second approach is an application approach, with a focus on the applications of GIS and the problems they attempt to solve. The third approach, which is probably the most widely used is, the toolbox approach. This approach emphasises the generic aspects of GIS as a toolbox to manipulate spatial data (Burrough, 1986). The fourth approach is the database-oriented approach, which regards GIS as a database system, reflecting the influence of database theory and practice on GIS. Other authors such as Goodchild (1997, cited in Heywood, Cornelius and Carver, 2002:13) also offers a useful summary of key concepts that help with defining GIS:

1. Geographical information is information about places on the Earth's surface.
2. Geographical information technologies include global positioning systems (GPS), remote sensing and geographical information systems.
3. Geographical information systems are both computer systems and software.
4. GIS can have many different manifestations.
5. GIS is used for a great variety of applications.
6. Geographical information science is the science behind GIS technology."

Table 2.2: Selected definitions of GIS

Authors	***Definitions***
Department of Environment (1987)	A system for capturing, storing, checking, manipulating, analysing and displaying data which are spatially referenced to the Earth.
Aronoff (1989)	Any manual or computer based set of procedures used to store and manipulate geographically referenced data.
Carter (1989)	An institutional entity, reflecting an organisational structure that integrates technology with a database, expertise and continuing financial support over time.
Parker (1988)	An information technology which stores, analyses, and displays both spatial and non-spatial data.
Dueker (1979)	A special case of information systems where the database consists of observations on spatially distributed features, activities, or events, which are definable in space as points, line, or areas. A GIS manipulates data about these points, lives, and areas to retrieve data for ad hoc queries and analyses.
Smith *et al.* (1987)	A database system in which most of the data are spatially indexed and upon which a set of procedures are executed in order to answer queries about spatial entities in the database.
Ozemoy, Smith and Sicherman (1981)	An automated set of functions that provides professionals with advanced capabilities for the storage, retrieval, manipulations, and display of geographically located data.
Burrough (1986)	A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world.
Cowen (1988)	A decision support system involving the integration of spatial referenced data in a problem-solving environment.
Koshkariov, Tikunov and Trofimov (1989)	A system with advanced geo-modelling capabilities.
Devine and Field (1986)	A form of MIS [Management Information System] that allows map display of general information.

Source: Maguire (1991)

The United States of America Department of Environment (1987, cited in Heywood, Cornelius and Carver, 2002:12) defined "GIS as a system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the

Earth." Information systems and technologies, including GIS have been advocated as mediums through which many of the objectives of the new development mechanisms could be achieved (Tötemeyer *et al.,* 1993, Mendelsohn 1996, Klintenberg *et al*., 2001, Nakanuku *et al*., 2001, cited in Noongo, 2007). A GIS provides a framework for gathering and organising spatial data and related information for it to be displayed and analysed.

The term 'Geographical Information System' describes an information system. In this study, GIS was used as a computer system with emphasis on spatial data and functions to be able to generate information that can lead to efficient decision-making in spatial planning. The definitions of GIS are important in this study to provide an understanding as to how GIS was involved. Clarke (1997:8) defines GIS as "a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes." Chrisman (1997, cited in Clarke, 1997:17) however, defined GIS as "organised activity by which people measure and represent geographical phenomena, and then transform these representations into other forms while interacting with social structures."

Society and numerous social structures influence the nature of spatial representations. Likewise, certain characteristics of spatial information can influence a society. Chrisman (1997) noticed that research in GIS rarely takes account of this two-directional flow of influence. This again relates to the argument that GIS research has been conceived without clear consideration of social factors.

According to Noongo (2007:30), "the debate on GIS and society was extended at a workshop held in November 1993 entitled '*Geographical Information and Society*'. A special edition of *Cartography and GIS* documenting the workshop entitled "GIS and Society" was published in 1995." In this collection of essays, a number of authors made important claims for addressing the broader implications of GIS research." Sheppard (1995, cited in Noongo, 2007:30) for example, called the "GIS community to recognition of GIS's applicability to pressing social issues, in addition to acknowledging that social structures construct and represent information in a variety of ways."

Chrisman (1996, cited in Noongo, 2007:30) in his contribution to the National Centre for Geographic Information and Analysis (NCGIA)'s Initiative 19 (GIS and Society: The Social Implications of How People, Space, and Environment are Represented in GIS) argued correctly "that in order to understand the linkages between GIS and society the GIS community must accept the following three principles:

- Social context influences GIS and GIS influences society.
- Multiple social structures interact in the linkages between GIS and the society.
- GIS technology cannot be reduced to some mechanistically determined parts."

Arguments concerning GIS and society often slip into a discourse of technological determinacy. GIS proponents and critics alike assert, consciously or unconsciously, that technology is inherently independent from the social world. This, according to Chrisman (1993, cited in Noongo, 2007:30) "perpetuates the two major tenets of technological determinism:

1) Technology engages unilinear progress from less to more advanced systems;
2) Technology is an imperative to which social institutions and people must adapt."

Many GIS-technologists have been well aware of the wider political aspects of GIS implementation, and that many GIS applications are being performed in a socially naive manner by users who are largely oblivious to the potentially broader implications of what their technology is being or may be used for (Openshaw 1991, cited in Noongo, 2007).

2.4.2 Components of Geographical Information Systems

An operational GIS has a series of components that combine to make the system work. These components are critical to a successful GIS (Buckley, 2000). A working GIS integrates five key components, which are hardware, software, data, people and methods and procedures which are described briefly below. According to Heywood, Cornelius and Carver (2002:13) "there is almost as much debate over the components of a GIS as there is about its definition." The GIS components are also viewed in relation to what they have been applied for and their purpose in the research.

Hardware

Hardware is the computer system with which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations (Buckley, 2000). Heywood, Cornelius and Carver (2002:13) maintain that "systems are available that use dedicated and expensive workstations, with monitors and digitising tables built in; others will run on bottom-of-the-range computers. In all cases, there are a number of elements that are essential for effective GIS operation. Burrough (1986, cited in Heywood *et al.,* 2002:13) stated that, "these include:

- The presence of a processor with sufficient power to run the software;
- Sufficient memory for the storage of large volumes of data;
- A good quality, high-resolution colour graphics screen;
- Data input and output devices (for example, digitizers, scanners, keyboard, printers and plotters)."

Software

GIS software provides the functions and tools needed to store, analyze, and display geographical information (Buckley, 2000). According to Heywood *et al.* (2002:13) "there are a number of essential software elements that must allow the users to capture data, store the data, manage the data, transform the data into results, analyse the data, and produce output from the data."

Although GIS generally fit all these requirements, their on-screen appearance may vary from one to the next. Some GIS software use command line interfaces while others use point-and-click menus. Therefore, as Heywood *et al*. (2002:14) points out "the type of interface individual finds easier to operate is largely a matter of personal preference and experience."

Data (Spatial and Non-spatial)

Perhaps the most important component of a GIS is the data. In this study, data were important because the research could not have been possible. Geographical data and related tabular data can be collected in-house, compiled to custom specifications and requirements, or occasionally purchased from a commercial data provider (Buckley, 2000). A GIS can integrate spatial data with other existing data resources, usually stored in a corporate Database Management System (DBMS). A DBMS is a set of computer programs for organising information, at the core of which will be a database.

The integration of spatial data (often proprietary to the GIS software), and tabular data stored in a DBMS is a key functionality of GIS (Buckley, 2000). Heywood *et al.* (2002:14) maintain that "the data management functions necessary in any GIS facilitate the storage, organisation and retrieval of data using a data DBMS."

The functions that a GIS should be able to perform include data input, storage, management, transformation, analysis and output. Data input is the process of converting data from its existing form to one that can be used by the GIS (Aronoff, 1989, cited in Heywood *et al*., 2002).

According to Burrough and the Department of the Environment as cited in Heywood *et al*. (2002:14) “all GIS software has been designed to handle spatial data (also referred to as geographical data). Spatial data are characterised by information about position, connections with other features and details of non-spatial characteristics.” Non spatial data describe what the features represent. Data input and updating are frequently the most expensive and time-consuming part of any GIS project and their importance and complexity should never be underestimated.

People and GIS

GIS technology is of limited value without the people who manage the system and develop plans for applying it to real world problems (Buckley, 2000). GIS projects often fail because of lack of buy-in of strong management and drivers of the GIS vision. GIS users vary from technical specialists, who design, maintain the system and research, to those that use it to perform their everyday tasks. The identification of GIS specialists versus end-users is often critical to the proper implementation of GIS (Buckley, 2000).

Heywood *et al.* (2002:14) stated that “most definitions of GIS focus on the hardware, software, data and analysis components. However, no GIS exist in isolation from the organisational context, and there must always be people to plan, implement and operate the system as well as make decisions based on output.” In most organizations the introduction of GIS is an important event, a major change bringing with it the need for internal restructuring, retraining of staff and improved information flows. It is therefore important to carefully examine the issues surrounding the introduction and implementation of GIS in an organisation.

Methods and Procedures

A successful GIS operates according to a well-designed implementation plan and business rules, which are the models and operating practices unique to each organisation (Buckley, 2000). As in all organisations dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation. To do this properly requires not only the necessary investments in hardware and software, but also in the re-training and hiring of personnel to utilise the new technology in the proper organisational context. Failure to implement GIS without regard for a proper organisational commitment will result in an unsuccessful system result.

2.4.3 Some Application Areas of GIS

GIS is a vital decision-support tool used in specialised areas such as environmental management, governance and planning to mention only a few. Table 2.3 summarises some application areas in which GIS is used. According to Heywood *et al.* (2002:213) "GIS applications tend to fall into one of three categories: pioneering, opportunistic or routine applications. Pioneering applications are found in organisations that are either at the cutting age of their field, or have sufficient financial reserves to allow them to explore new opportunities. Opportunist applications are found in organisations that keep a careful eye on the pioneers and quickly adopt the technology once they see the benefits. Routine users adopt a tried, tested and refined product with lower risk and cost."

Recently, GIS has been applied to diverse fields to assist experts in analysing various types of spatial data and dealing with complex situations. Either in business, government, education, tourism, transportation, utilities or natural resources management, GIS plays an essential role to help people collect data, analyse the related spatial data and display data in different formats. Increasingly, GIS capabilities are being extended to include more applications, in specific market sectors.

GIS is a very useful and important tool in land use planning. It uses aerial photography and orthophotograph to show land parcels, topography, street names and other pertinent information. Aerial photography and orthophotograph can be used in GIS to identify different current land uses and plan for different future land uses in Namibia.

Virtually every country in the world has areas of natural beauty and conservation value that area managed and protected for public interest. Those managing these areas face the problem of balancing human activities, such as farming, industry and tourism with the natural elements of the landscape, such as climate, flora and fauna in order to maintain the character of the particular landscape without exploitation or stagnation (Heywood *et al.*, 2002).

Table 2.3: Application areas for GIS

Activity	***Application***
Socio-economic/government	Health Local government Transport planning Service planning Urban management
Defence agencies	Target site identification

Activity	*Application*
	Tactical support planning Mobile command modelling Intelligence data integration
Commerce and business	Market share analysis Insurance Fleet management Direct marketing Target marketing Retail site location
Utilities	Network management Service provision Telecommunications Emergency repairs
Environmental management	Landfill site selection and mineral resources Mapping Pollution monitoring Natural hazard assessment Resource management Environmental impact assessment.

Source: Heywood *et al* (2002:12)

The fact that GIS is able to integrate large datasets effectively makes it an indispensable aid in environmental management. This is critical for integration of historical and current environmental data. The current spatial information, planning and management of urban land use can be carried out efficiently to help prevent flood, fires, as well and human made environmental disasters.

2.5 The Context of Participatory Mapping and GIS for Land Use Planning (LUP)

2.5.1 Participatory Mapping in LUP

Participatory mapping has emerged as a contemporary spatial planning paradigm at national, regional and local levels (Corbett *et al.*, 2006). Land use planning frameworks require effective stakeholder participation especially in developing countries like Namibia which are overwhelmed with random land developments and lack of institutional arrangements for enforcing local laws. Participatory mapping has been identified as one of the methods by which LUP can be used to achieve development goals such as creating a healthy, convenient, economically functional and pleasing living environment (IFAD, 2009). It is a powerful tool that increases stakeholder involvement and provides a means for participants to express their ideas in an easily understandable visual format. In general,

participatory mapping can help provide:

- a way to engage stakeholders near and far;
- objective local information on resources;
- traditional knowledge and practices of the community;
- information on how communities perceive, value, and use resources;
- a focal point for discussions on land use issues;
- a valuable tool to support decision-making; and
- graphical and easily understandable communication tools.

Participatory maps often differ considerably from GIS maps in content, appearance and methodology. IFAD (2009:07) mentioned that "*criteria used to recognise and denote community maps include the following:*

- *Participatory mapping is defined by the process of production. Participatory maps are planned around a common goal and strategy for use and are often made with input from an entire community in an open and inclusive process.*
- *Participatory mapping is defined by a product that represents the agenda of the community. It is map production undertaken by communities to show information that is relevant and important to their needs and for their use.*
- *Participatory mapping is defined by the content of the maps which depicts local knowledge and information. The maps contain a community's place names, symbols and other important features.*
- *Participatory mapping is not defined by the level of compliance with formal cartographic conventions. Participatory maps are not confined by formal media; a community map may be a drawing in the sand or may be incorporated into a sophisticated computer-based GIS. Whereas GIS maps seek conformity, community maps embrace diversity in presentation and content."*

According to Müller and Wode (2003) conventional approaches such as GIS and remote sensing are often used by consultants to collect and manipulate data used in the preparation of land use maps. The said consultants sometimes lack in-depth knowledge of the local resources locations which, depending on the mapping approach may lead to inaccurate delineation and misinterpretation of land use classes. Müller and Wode (2003:01) emphasised that "the objective of participatory mapping is to enable villagers to carry out the interpretation of aspects of their land resources that are of significant importance to the

community, in this process villagers delineate their land use on transparencies laid over an ortho-photograph." Involving local stakeholders with their extensive field experiences is expected to improve the accuracy and precision of obtained data.

Participatory mapping has two decades of applications in participatory spatial planning, whether manifested as rural-located 'community-based natural resources' or as 'participatory neighbourhood planning' in urban settings. Participatory mapping has been commonly used in claiming land, management of customary land and resources, mapping social and environmental inequalities and strengthening community awareness and cultural identity (McCall and Minang (2005).

The IFAD (2009) states that there are six possible purposes for initiating a participatory mapping project that support sustainable land use planning. These purposes are outlined below:

1. To help communities articulate and communicate spatial knowledge to external *agencies*

   Participatory maps have proved to be an effective, legitimate and convincing approach to demonstrate to external agencies how a community values, understands and interacts with its traditional lands and immediate space. Maps present complex information in a well understood and easily accessible format (IFAD, 2009).
2. To allow communities to record and archive local knowledge

   Local communities and indigenous groups in particular, are increasingly using participatory maps to record and store important local knowledge and cultural information (IFAD, 2009).
3. *To assist communities in land-use planning and resource management*

   Participatory maps can be a medium to help plan the management of traditional land and make community knowledge about land and resources visible to outsiders. They have helped communities communicate their long, but often invisible, history of managing resources. This might include identifying and locating specific natural resources such as forest, medicinal plants, grazing lands, water sources, hunting and fishing grounds, fuel sources and building materials (McCall, 2003).
4. To enable communities to advocate for change

   Within the broad participatory mapping toolbox, counter-mapping is the map-making process whereby local communities appropriate the state's techniques of formal mapping and make their own maps to bolster the legitimacy of customary claims to land and resources (Peluso, 1995, cited in IFAD, 2009:09). These maps are viewed

as alternatives to those used by government, industry and other competing outside groups. The maps become tools in a broader strategy for advocacy (IFAD, 2009).

5. To increase the capacity within communities

   Often the benefits of participatory mapping initiatives are far wider and more intangible than those that result simply from map production and use. One of the greatest strengths of these initiatives is the ability of the mapping process to bring community members together to share their ideas and visions, which can contribute to building community cohesion (Alcorn, 2000, cited in IFAD, 2009:09).

6. To address resource-related conflict

   Participatory mapping can be used to manage, in particular, avoid and reduce conflicts between a community and outsiders and to address internal conflicts. Maps can represent a conflict graphically, placing the parties in relation to the problem and in relation to each other. Through delineating boundaries of competing groups that represent overlapping land claims (especially where rights and responsibilities over land and resources are unclear), the areas of tension are made visible. This process can help identify key areas of conflict and help reduce those conflicts (IFAD, 2009).

Since participatory mapping requires significant time and resources, it may not be feasible or effective for all situations. Participatory mapping may be used when the process will benefit the overall purpose in LUP. Participation is a key element among the criteria of good governance for effective participatory spatial planning. Governance is a set of measures of the relationships between the ‘governed’, which is the civil society and the public, and the ‘governing’, the government, its institutions, and private sector interests (McCall & Minang, 2005).

2.5.2 GIS in Land Use Planning

Cooper (2009:01) stated that “GIS are essential for innovation and economic growth, for effective policy formulation and for planning, implementing and monitoring development projects.” The key benefit of GIS in land use planning is the ability to provide the integration of different datasets to gain new insights. Many of the datasets used in a GIS are obtained from outside an organisation, such as remotely sensed images from satellites and aircraft, and fundamental base data from national mapping and statistical agencies.

GIS can assist community organisations regardless of the rung they are placed on, and assist them to climb the ladder further (Weiner, Harris, and Craig, 2001). More detailed spatial information will help develop appropriate responses regarding spatial planning. In

addition, GIS technology supports the creation of map products and analyses. Weiner *et al*. (2001:3) maintained that “GIS can also help a community organisation climb the participation ladder, and the state may be willing to share more power with a credible partner. Other similar community organisations see an organisation's status grow, and are more likely to enter into collaborative efforts with them. However, even the most homogeneous community organisations contain individuals whose goals differ from those of the group, and who may be marginalised by this process.” Participatory approaches in the development of frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management helps to develop local knowledge processes. This knowledge process creates a channel of coordination between local communities and the experts. In the study ‘*GIS for Participatory Land Use Planning in the Mekong Delta, Vietnam*’, Trung, Tri, van Mensvoort and Bregt (2004) concluded that “GIS was used for analysing the land use change, the realisation of the farmers’ preference, the preference change and the preference conflicts between groups of aquaculture and agriculture farmers. GIS was found to be a very useful tool to support the data analysis and results presentation”.

The societal impacts of spatial data in the new information age have been pursued in recent years under the umbrella title of GIS and Society (Harris and Weiner, 1998). More recently, attention has also focused on the potential of GIS to empower communities, such as ‘public participation GIS’. Obermeyer (1998:2) stated that “the use of GIS can make it increasingly difficult for average citizens to participate in ongoing policy debates. This difficulty arises because using GIS simplifies the performance of spatial analysis and the preparation of excellent graphics (maps being the most obvious example), which lend an impression of persuasiveness to the reports on policy that public and private institutions prepare.” Harris and Weiner (1998:03) stated that “GIS contributes to the social and spatial marginalisation of communities in four ways:

1. differential access to data and information;
2. the geo-demographic and surveillant capabilities of GIS;
3. the digital representation, epistemology; and
4. the multiple realities of landscape represented in GIS.

Harris and Weiner (1998:3) state that "recent case studies represent an important shift in scale and purpose from a critique of GIS to endeavours that operationalises GIS for community empowerment. The advocacy of popular causes, a more complete understanding of local issues, and greater community access to advanced technologies and digital information, are successes that have already been demonstrated." The integration of local

knowledge and the representation of territory space and different environments are complex and potentially contradictory aspects of alternative GIS production and use.

According to Nedovic-Budic (2000:82) "*ultimately, a GIS as applied in the field of urban and regional planning should advance the following goals of urban and regional planning:*

- *better quality (liveable, safe, and aesthetically pleasing) of urban environments;*
- *environmentally and socially sustainable communities;*
- *effective spatial organisation of urban activities (work, residence, commerce, and recreation);*
- *"smart growth" of urban areas;*
- *efficient communication between various urban functions;*
- *revitalization of deteriorated areas;*
- *variety of housing options;*
- *employment opportunities and economic development; and*
- *democratisation of the planning and policy-making process".*

The ability of GIS to collate many sources of data and offer analysis capabilities for that data are profoundly useful in terms of any study related to land use. Chrisman (1987, Edney, 1991, cited in Harris and Weiner, 1998) recognised that institutional and organisational responses to the implementation of GIS had a marked influence on the success or failure of a project. While it was acknowledged that these nontechnical issues were important corollary to the adoption of GIS, it was Chrisman (1987) who provided some of the earliest insights into the social and ethical implications of use of GIS and the responsibilities associated with software development.

As GIS finds its way into practical use, it must be economically, politically, socially, and even ethically accountable (Chrisman 1987, cited in Harris and Weiner, 1998). The earlier advances made in GIS, he argued, had been achieved by exploiting the easy parts of the problem and "the tough issues, temporarily swept under the rug, will emerge, perhaps to discredit the whole process" (Harris and Weiner 1998). Chrisman (1987, as cited in Harris and Weiner, 1998) suggested that the design of equitable GIS should be based on social and cultural goals. As such, GIS is both an expression and a part of a political process and not solely a technical or computational problem (Harris and Weiner, 1998).

2.5.3 Participatory Mapping Context in Namibia

In a study carried out in the northern regions of Namibia, Tagg and Taylor (2006) state that participatory mapping was used for conservation, and land and natural resource mapping by the San communities in collaboration with NGOs. They discovered that the lack of understanding regarding the use of participatory mapping in integrated land use planning can, to some extent, be attributed to the lack of comprehension of the use of GIS in integrated land use planning especially by the Ministry of Land and Resettlement (MLR).

On '*Participatory GIS and mapping for conservation in Namibia*', Tagg and Taylor (2006:79) stated that the "emergence of mapping and GIS as a central community-based natural resource management (CBNRM) tool in Namibia's community conservation programme. Here, the use of GIS in CBNRM has evolved in response to the needs of communities, NGOs, and government. In this process, competing land use activities take place within conservancies, for example, farming, wildlife, settlement, and mining. Consequently, land use planning is a key necessity. The purpose of creating different land use zones (zonation or zoning) is to plan the use of land. Using a participatory process, conservancies establish the best locations for different activities which are selected according to existing land use practices, and the nature and potential of the natural resources. Importantly, this activity seeks to reduce conflict between land uses and optimise benefits."

The Namibian CBNRM GIS approach has been to optimise and pool local indigenous knowledge. It also uses the knowledge and skills of those supporting and assisting the community to build a GIS. The GIS must be accessible and appropriate for all parties and ultimately, beneficial for a wide range of natural resource management efforts. From the early stages of development, the collaborating group adopted an approach of sharing public domain datasets, as well as approaches and resources (Tagg & Taylor, 2006).

Tagg and Taylor (2006:81) specifically outlined that "GIS and maps are essential tools for conservancies to communicate their plans to other parties. They need to communicate internally with members and externally to neighbours, government, partners, donors, and investors. Using GIS and maps leads to greater shared understanding of important issues about natural resource management and land use planning."

With regards to the study on '*land and natural resource mapping by San communities and NGOs: experiences from Namibia.*' Taylor, Murphy, Mayes, Mwilima, Nuulimba, and Slater-Jones (2006:79) stated that "in Caprivi, a region in north-eastern Namibia, which borders in

the south with Botswana, a partnership between the Namibian NGO, Integrated Rural Development and Nature Conservation (IRDNC), the international NGO Conservation International (CI), and local communities has been developed. This has resulted in the evolution of a PGIS mapping method, termed as participatory ortho-photo mapping. This method is being used to promote CBNRM on communal land. It uses information obtained from village mapping workshops to produce computer-generated maps."

The methodology for western Caprivi builds on village mapping workshops and field data collection to collate and visualise indigenous spatial knowledge (ISK), including local names, natural resources that residents depend on for their livelihoods, such as grazing, farmlands and useful wild plants; distribution of wildlife, and migration routes. To ensure that information contained in maps is inclusive and comprehensive, a fair representation of age and gender has been encouraged. However, the equal participation of women remains a challenge due to cultural norms whereby meetings and workshops tend to be seen as a male domain (Taylor *et al.,* 2006).

Verlinden and Dayot (2005:144) in their study titled '*A comparison between indigenous environmental knowledge and a conventional vegetation analysis in north central Namibia*' emphasised that "studies of indigenous environmental knowledge (IEK) have been increasing since late 1990s and during recent decades." Studies on local land classifications were undertaken in northern Namibia (Dayot and Verlinden, 1999; Rigourd and Sappe, 1999; Shitundeni and Marsh, 1999; Verlinden and Dayot, 2000; Hillyer, 2004, cited in Verlinden & Dayot, 2005). These studies all aim to understand the ways that local people view and classify the land with the ultimate aim of understanding and improving indigenous resource management.

The study on data collection of local knowledge by Verlinden & Dayot (2005) focused on individuals who have a comprehensive knowledge of the environment. These key informants held specific knowledge on the indigenous classification of the local environment and on the various uses of resources (rangeland, forest, cropping, soil and water). They were solicited to join the team either during field observations of land units or during interviews on the use and management of land resources (Verlinden & Dayot, 2005).

2.5.4 GIS Context in Namibia

Since 1995 significant steady progress has been made regarding management of spatial data in Namibia. However, there is room for improvement to enable GIS users in remote

areas to access complete, secure and updated spatial data. As indicated by Noongo (2003:30), “GIS have facilitated the production and generation of digital data in various government agencies tasked with planning, managing and monitoring of natural resources. In most cases data that are collected for a particular project are useful for other projects.”

Noongo (2003:18) stated that “much of the data in Namibia takes the form of maps and paper records. There has, nevertheless, been a realisation that the use of computers in data management necessitates availability of such data in digital formats. Consequently, efforts are underway to create digital databases in many agencies through the conversion of existing maps and paper records into digital format. The current progress in database development shows that various agencies are implementing components of data infrastructure to better manage and utilise their datasets.”

The government of Namibia formulated an ambitious vision which stipulates that, by 2030; Namibia should join the ranks of high-income countries and afford citizens an improved quality of life, comparable to that of the developed world (National Planning Commission (NPC), 2008). In Vision 2030, it is envisaged that rapid economic growth, accompanied by equitable social development, would result. The tools which serve to drive national implementation programmes are five-year National Development Plans (NDPs).

According to the NPC (2008) “the main development objective of deploying GIS and statistics was to contribute to the development of a knowledge-based economy and technology-driven nation.” This entails the enhancement of GIS and statistics managed by the Office of the President, under the NPC Secretariat. The specific objective was to improve production, accessibility and distribution of geospatial and statistical information. During the 2001 Census, GIS was used to create digital maps to facilitate the data-collection process (Mwazi, 2007:3). The project - titled *“GIS and Statistics Development in Namibia”* was realised in August 2007 through a funding agreement between the Central Bureau of Statistics (CBS) in the NPC and the Development Cooperation of the Grand Duchy of Luxembourg.

A number of sub-projects were realised, including a Bachelor of Geo-Information Technology Degree offered at Namibia’s University of Science and Technology, formally known as the Polytechnic of Namibia (PoN). The said course has already been implemented.

The development of GIS in Namibia together with the promotion of the use of official statistics at regional level is in line with the Vision 2030 goal, which is to create a knowledge-

based economy. A commitment was undertaken by GRN to improve access to spatial information and statistics by the year 2011. The spatial information and statistics sub-sector of the NDPs is comprised of the two broad inter-related areas namely, spatial information and official statistics. Production of statistics and management are common to both spatial information and official statistics. Spatial, statistical and other attribute data are seen as providing the bedrock for e-government[4].

The NPC together with the MLR in Namibia has cooperated in formulating the National Spatial Data Infrastructure (NSDI) Policy. The Spatial Data Infrastructure (SDI) is a set of policies, standards and procedures under which organisations and technologies interact to foster more efficient use, management and production of spatial data. According to the Government of Namibia (2009:7) "the purpose of this NSDI Policy for the Republic of Namibia is to set out a policy for the collection, processing, integrating, storing, distribution, and improved access and utilisation of spatial data and services. The policy guides spatial data activities of public, private and civil society organisations in Namibia."

The Government of Namibia (2009:8) maintains that the "*NSDI provides the basis or structure of practices and relationships among data producers and users that facilitate data sharing and use. The goal of this infrastructure is to:*

- *develop and mainstream common understanding of SDI in Namibia;*
- *address the need for policies that promote NSDI;*
- *promote the use of available spatial data in Namibia;*
- *promote free access to spatial data within Government, free viewing of unrestricted public sector spatial data and free access to metadata;*
- *promote transparency of user conditions and restrictions;*
- *create a single point of access to available spatial data;*
- *reduce the duplication of effort among stakeholders;*
- *improve quality and reduce costs related to the production and usage of data;*
- *provide easy, efficient and equitable access to spatial data where technology, data formats, institutional arrangements, location, costs and conditions do not inhibit its use;*
- *promote the development of private value added services;*
- *preserve confidentiality, privacy, security and intellectual property rights which will protect the rights of data custodians and all sectors of the community;*

[4] E-Government is the use of information and communication technologies (ICTs) to improve the activities of public sector organisations.

- *establish partnerships between the Government, the private sector and academia to increase data availability and accessibility; and*
- *facilitate capacity building at individual, institutional and systemic levels (and through public and private partnerships).”*

The institutional home of the NSDI is the Namibia Statistics Agency (NSA) — previously known as the Central Bureau of Statistics (CBS) — which is envisaged to be developed into a more autonomous State funded agency (Government of Namibia, 2011). The NSA functions under the new Statistics Act of 2011 which provides for its functioning. It will also include the functions of the NSDI into this act. The Government of Namibia (2011:6) maintains that “NSA will be tasked to coordinate NSDI within the Government.” The NSDI coordination structure is depicted in Figure 2.1.

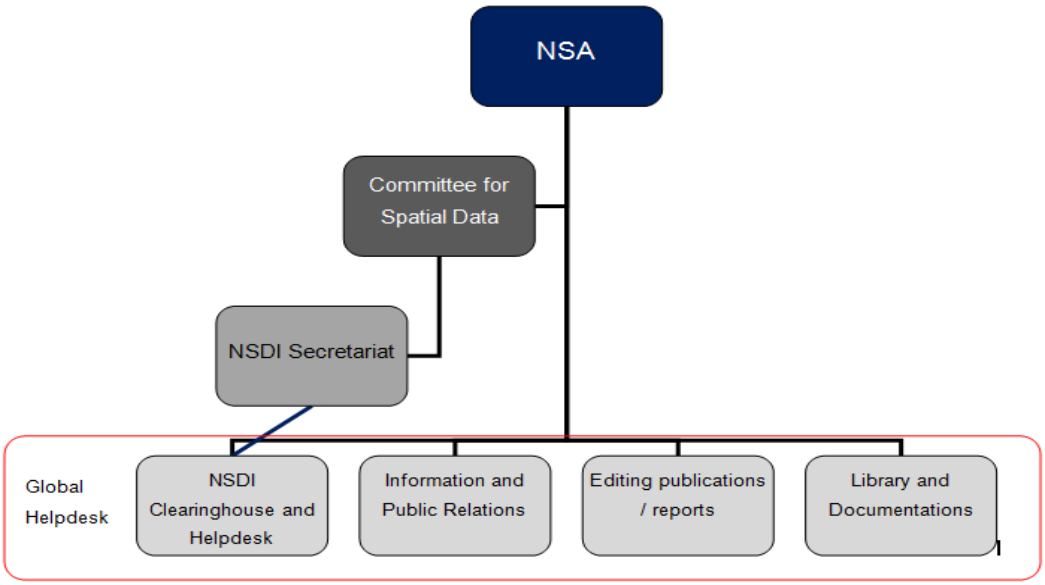


Figure 2.1: NSDI coordination structure.
Source: Government of Namibia (2011:07)

The Government of Namibia (2011:7) pointed out that *“the Committee for Spatial Data will be established as the advisory body for the Agency and is therefore an important coordinating mechanism for all NSDI activities in Namibia. Besides an advisory role, it must:*

- *facilitate, promote and safeguard an environment for the efficient collection, management, distribution and utilization of spatial data;*
- *promote awareness of its activities, including dissemination of information on the importance of spatial data for effective governance, planning and decision-making;*

- *be consulted before any spatial data are captured unless a national emergency makes such prior consultation impossible or impractical; and*
- *before the Agency makes any standard relating to the NSDI or formulate the NSDI policy the Agency must consult the committee for Spatial Data."*

The committee for spatial data shall comprise of members from the government, academia, the public and private sectors and NGOs. At the same time, the NSDI Secretariat, including the NSDI Clearinghouse and Helpdesk will be established by the NSA to support the committee and implement approved recommendations (Government of Namibia, 2011).

2.6 Contexts of Land Use Planning

2.6.1 Introduction

There is not much available scientific literature about land use in the Hardap region. However, this subchapter explains and describes the integrated land use planning in general and then land use planning in Namibia.

2.6.2 Integrated Land Use Planning Context

The European Commission in the study edited by Christou, Struckl and Biermann (2006:8) stated that "Land Use Planning" can be defined as "a systematic assessment of land and water potential, alternative patterns of land use and other physical, social and economic conditions, for the purpose of selecting and adopting land-use options which are most beneficial to land users without degrading resources or environment, together with the selection and implementation of measures most likely to encourage such land uses."

They further maintain that a "*plan"* is an intellectual anticipation of a desirable situation in the future, or in other words, a plan describes a situation in the future. The term "*Planning*" therefore is the procedure to elaborate a plan. Actually this term covers a range of activities, from procedures of a purely technical type to administrative or government arrangements."

"Land use planning has to be understood as an aspect of 'spatial planning', that refers to the space as a multidimensional concept that describes and reflects the synthesis of the physical environment and its use by humans, whereas traditional land use planning deals only with the efficient use of land ['land' as a synonym for the surface of the earth]" (Christou, Struckl and Biermann 2006:8).

Land use planning is the systematic assessment of land, water potential, alternatives for land use, economic and social conditions in order to select and adopt the best land use options (Food and Agriculture Organisation, 1996). Davis (2009:7) defined sustainable land use as "the use of land that meets the needs of the present without compromising the ability of future generations to meet their own needs. Another definition relating to land use is sustainable land use is the use of land without impairing ecosystem services. The purpose of land use planning is to select and put into practice land uses that will best meet the needs of the people while safeguarding resources for the future. Salimi, Soleimani, Roshan and Sabetraftar (2008:15) defined land use planning as "a science that determines the type of land use through studying the ecological character of the land as well as its socio-ecological structure." An ILUP approach requires coordination of planning and management of land and other resources.

Wade and Sommer (2006:120) defined "land use as the classification of land according to what activities take place on it or how humans occupy it; for example, agricultural, industrial, residential, urban, rural or commercial." Land use should not be confused with the term land cover, which concerns the natural and artificial features covering the earth's surface like forest, roads, grassland, bare soil, and lakes. According to Wade and Sommer (2006:119) land cover entails "the classification of land according to the vegetation or material that covers most of its surface; for example, pine forest, grassland, ice, water or sand."

The Canadian Council of Forest Ministers, (2009:1), in its integrated forest land use planning projects emphasised that "integrated land use planning seeks to balance the economic, social and cultural opportunities in a specific area of forest with the need to maintain and enhance the health of the area's forest. It is a process whereby all interested parties, large and small, come together to make decisions about how the land and its resources should be used and managed and to coordinate their activities in a sustainable fashion." Amler, Betke, Eger, Ehrich, Kohler, Kutter, Lossau, Müller, Seidemann, Steurer, Zimmermann (1999:24) state that "in many countries there are traditional, non-codified forms of agreements on land use which work well at local level. However, they often fail when social relationships become more complex, such as spontaneous migration, pressure of use on areas which had previously been reserved for pastoralists. Nevertheless they provide important connecting links for LUP at local level." The focus of integrated land use planning, include maintaining the integrity of the ecosystem and sustainable land use as the primary consideration which plays an important role in land use planning.

Amler *et al.*, (1999:24) further maintains that "LUP is a partially integrating and sector

overlapping process. The planning objects are the land resources. Therefore, LUP is not suitable for solving all local problems, nor can it replace the overall planning for an area." The basic technical strategy in LUP is to plan land use according to the suitability and the various needs in the area to be considered. Table 2.4 shows the aspects which distinguish LUP from other sector-overlapping processes.

Table 2.4: What distinguishes LUP from other sector-overlapping planning processes?

Planning process	Key question	Objective
Land use planning	What is the land currently used for and how suitable is the current land-use?	Optimisation of land use in an area in terms of: • sustainability which is adapted to the area, • meeting needs for long term conservation of land resources, and • the settlement of conflicts between interest groups.
Regional planning	What is the region's comparative advantage and how can it be enhanced to boast the development of the region?	Best possible supply to a specific (administrative) unit with productive, social and infrastructural facilities and their most efficient possible use of available means.
Regionally orientated programme planning.	What activities must be carried out in order to achieve a certain developmental objective?	Identification of core problems and appropriate packages of responsive measures.

Source: Amler *et al.,* (1999:24)

Land use is characterised by the arrangements, activities and inputs of people to produce food, change and maintain certain land cover types (Di Gregorio and Jansen, 1998). This definition of land use establishes a direct link between land cover and the actions of people in their environment. For a sustainable land use plan, nowadays, land use planning requires more data integration, multidisciplinary and complex analysis and quick data retrieval. Not only does this facilitate the improved accuracy and scope for creating maps for use in land transactions, but also land administration processes. Longley, Goodchild, Maguire & Rhind (2005:345) believe that "land administration can assist enormously in the process of data integration and the creation of a truly national GIS." According to Cloke (1989:9), "the role of planning is important because of one fundamental premise; namely that planning and policy-making are undeniably an integral aspect of state activity and as such are subject to the context and constraints of all activities."

Wade and Sommer (2006:120) defined land use as the classification of land according to

what activities take place on it or how humans occupy it; for example, agricultural, industrial, residential, urban, rural or commercial. Land use should not be confused with the term land cover, which concerns the natural and artificial features covering the earth's surface like forest, roads, grassland, bare soil, lakes. According to Wade and Sommer (2006:119) land cover entails "the classification of land according to the vegetation or material that covers most of its surface; for example, pine forest, grassland, ice, water or sand." Land use planning should be understood as the systematic assessment of physical, social and economic factors that encourage and assist land users in selecting options that increase their productivity, sustainability and meet the needs of society.

Land use planning is generally applied at three interactive levels; national, regional and local level (FAO, 1993, cited in Nabwire, 2002), where different priorities, planning strategies and kinds of decisions are made. At the national level general land use planning policies, priorities and legislation are set. However, at the lower levels the plans become more detailed, for example, putting in place water sources and infrastructure (Nabwire, 2002). Interaction, information flow and data sharing between the different planning levels are important.

The realisation of comprehensive Integrated Sustainable Land Management (ISLM) can be made possible with applied participatory mapping and GIS technologies. Salimi *et al*. (2008) stated that it is feasible to plan for the appropriate use of land and to enhance the present management of land use by utilising GIS. Sustainable Land Management (SLM) refers to approaches to land and renewable natural resources management that bring together government line ministries and other sectoral service providers to jointly plan and coordinate support to local communities under the direction of these communities (Government of Namibia, 2005). SLM also refers to approaches that promote the holistic management by local residents of all renewable natural resources including water, soil, grazing, forests and wildlife within one land management area.

2.6.3 The Land Use Planning Context in Namibia

Positive and negative land use changes are taking place naturally. In Namibia, which is the most arid country in Sub-Saharan Africa, land use is generally adapted to highly variable and arid climatic conditions. However, certain policies and cultural barriers may have contributed to the entrenchment of inappropriate land use systems.

The Namibian constitution makes provision for central, regional and local levels of

government. The central government consists of the Legislature or parliament which is the National Assembly and the National Council, the Judiciary, the Supreme, the High and the lower courts and the Executive (the President, the Cabinet and the Ministers). At regional level, there are 13 political regions as depicted in Figure 2.2, comprising of 107 constituencies. According to Mendelsohn *et al* (2002:139) “these were first demarcated in 1993 for the purposes of regional representation.” Local governments or authorities are provided for by proclamation of settled areas as municipalities, town and villages. This means that each region is responsible for its land management activities within its area of jurisdiction.

Each region is headed by a regional governor, who chairs a Regional Council comprising the region’s councillors. There are also long-established systems of traditional leadership or administration in communal areas. Although systems vary among the communities, most operate within some kind of hierarchical order (Mendelsohn *et al.,* 2002).

Land tenure in Namibia is based on three major categories of land ownership: private individuals and companies (freehold land); central government (communal or protected parks); and local authorities (urban land). The state manages its state land directly through its line ministries. Approximately 43% of Namibia’s land is used for commercial farming and 56% of land is owned by the Government (state land-communal land, protected areas, and parks). The remaining land is owned by local authorities and parastatals. In Namibia, most land use planning functions are carried out in terms of the relevant legislations and regulations. Some of the common legislations and regulations are presented in Table 2.5. The table presents some of the general legislations and regulations used to govern the land use planning activities in Namibia.

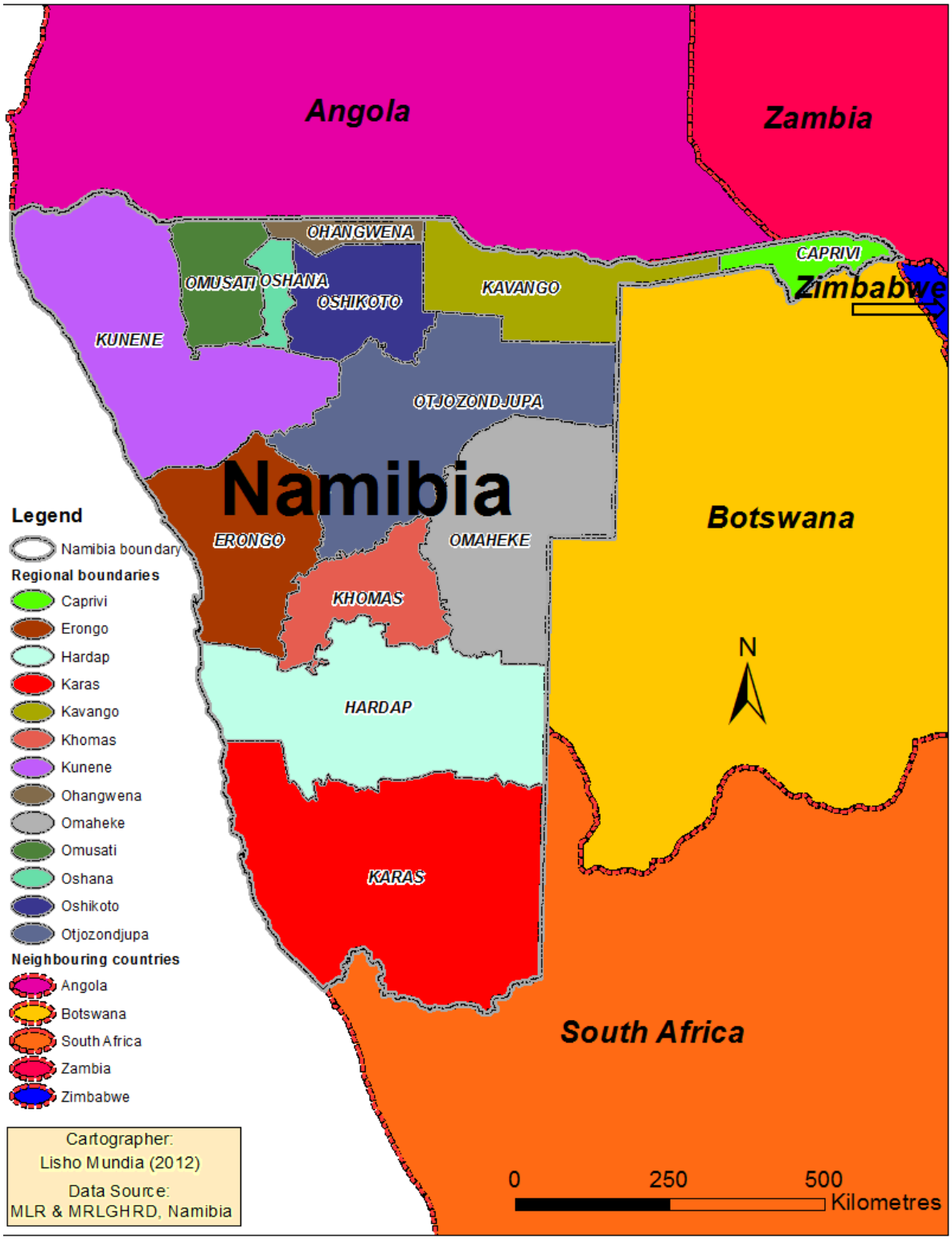


Figure 2.2: Regional map of Namibia

There is no legislation in Namibia that requires the preparation of a coherent, national and regional land use framework but it is envisaged that this will be introduced when the Draft Urban and Regional Planning Bill is enacted (NACOMA, 2008).

Table 2.5: Land use planning legislations and regulations

Legislations and regulations	**Brief explanation**
The Town Planning Ordinance, No. 18 of 1954	The Town Planning Ordinance makes provision for the preparation and carrying out of town planning schemes. The Ordinance aims to ensure that every town planning scheme shall have for its purpose, the coordinated and harmonious development of the area to which it relates "in such a way as will most effectively tend to promote health, safety, order, amenity, convenience and general welfare, as well as efficiency and economy in the process of development and the improvement of communications."
The Townships and Division of Land Ordinance, No. 11 of 1963	Relates to the establishment of townships and for the regulation and control of development and the subdivision and consolidation of land.
The Local Authorities Act No. 23 of 1992	The Local Authorities Act establishes the system of local government in Namibia and defines the powers, duties and functions of local authority councils. The Act is administered by the Minister responsible for regional, local government, housing and rural development. The area over which a local authority has jurisdiction is declared by the Minister by notice in the *Gazette*. The Minister is given the power by notice in the *Gazette* to alter the boundaries of any local authority area by excluding any proportion from the area or adding any area to it. Local authorities are given wide-ranging powers including powers: to supply water to residents; to provide and maintain sewerage and drainage systems; to provide waste removal services; to supply electricity or gas to residents; to establish and operate sand, clay, stone or gravel quarries; and to promote tourism. A local authority council may also enter into agreements with other local authority councils, the Government of Namibia or Regional Councils in relation to the exercise or performance of powers, duties and functions which allows them to act co-operatively or on behalf of one another.
The Regional Authorities Act No. 22 of 1992	This Act provides for the establishment of a Regional Council for each of the regions determined in accordance with Article 103 of the Namibian Constitution. In addition to the powers conferred upon a Regional Council by article 108 of the Namibian Constitution and under other legislation, this Act grants a range of powers to Regional Councils including the power: (a) to undertake, with due regard to the powers, duties and functions of the National Planning Commission … the planning of the development of the region for which it has been established with a view to; (iii) the natural and other resources and the economic potential of such regions; (v) the general land utilisation pattern; (vi) the sensitivity of the natural environment; (b) to exercise in connection with its region such powers, and to perform the duties and functions connected with such powers, as may be delegated by the president to the Regional Council in terms of section 29;

Legislations and regulations	Brief explanation
	(c) to exercise any power assigned to Regional Council by the law governing land which vests in the government of Namibia by virtue on the provisions of Schedule 5 to the Namibian Constitution, or any other power so assigned by or in terms of any other law;" A Regional Council may also enter into an agreement with the government of Namibia, with other Regional Councils or with any local authority in terms of which it agreed to exercise powers as their agent or in co-operation with them. The Regional Council may also declare areas that fall outside of the local authority area to be settlement areas and to manage and control settlements within those areas using powers which would otherwise have been exercised by a local authority under the Local Authorities Act, 23 of 1992 (had the area fallen within jurisdiction of a local authority). A Regional Council may, after consultation with the Minister, make regulations relating to the prohibition, restriction, regulation and control of the conducting of any trade, business or occupation or other activity for gain in areas outside local authority areas.
Sectional Titles Act No. 66 of 1971	Governs the division of ownership of buildings.
Decentralisation Enabling Act No.33 of 2000	This act establishes procedures for decentralising powers functions vested in various ministries (referred to in the act as "line ministries" to regional councils and local authority councils. The act empowers the minister responsible for regional and local government matters by notice in the Gazette, to decentralise any function to any regional council or local authority council.

Source: Namibian Coast Conservation and Management Project (NACOMA), 2008

Currently the establishment of towns and the subdivision of land are regulated by the Townships and Division of Land Ordinance of 1963 while the development and application of town planning schemes is regulated by the Town Planning Ordinance 18 of 1954 (NACOMA, 2008). Both these ordinances must be read together with the Local Authorities Act 23 of 1992.

ILUPs consider the full range of resources and values present on public lands and aims to blend or coordinate management strategies and implementation requirements across jurisdictions. Integrated land use planning is a tool which provides a means for stakeholders, communities, individuals and civil society to engage in collaborative decision-making about land use and resource management within a defined area.

According to the Association of Local Authorities in Namibia (ALAN), (1995:05) “plans provide a future framework within which human activities can take place and serve two main purposes namely to provide:

a. spatial structure for future activities and land uses which, in some way, will create a pattern of development which is better than patterns that would exist without planning; and
b. authorities responsible for development with a tool for development control. Examples include zoning plans which provide authorities with the means to assess whether proposed uses of land and buildings conform with, or are opposed to, the long-term development objectives of that authority.”

The key words here are:

- future - all plans are future oriented;
- activities - the primary purpose of planning is to facilitate the harmonious activities of people. People’s participation is therefore essential;
- land use - ultimate control of activities is through control of land use;
- better than - unless planning results in improvement, it is worthless.

According to the Royal Town Planning Institute (RTPI), (2001:02) “planning goals remain valid today as was in the past, and require to be championed just as vigorously. However, the pace of change - social, technological, economic, environmental and political - has never been so fast, or on such a large scale.” Managing the spatial dimension of this change depends on working with a growing variety of organisations and individuals, many of them

with a global perspective. These relationships are becoming increasingly complex. Effective planning however cannot be delivered through governmental activity alone - all sectors of society share this responsibility (RTPI, 2001). The Royal Town Planning Institute (2001) maintains that "a new vision for planning is required which seeks to build the capacity within society and its institutions to take effective and relevant decisions. This challenges us to think beyond the scope of statutory systems and take a broader view of what society needs through planning. It also challenges us to see planning as an activity, which professional planners facilitate, but do not own or monopolise." The new vision for land use planning sees planning as being about people and places, the natural and the built environment, immediate requirements and long-term stewardship.

The RTPI (2001:2) states that "the new vision for planning is built around the core ideas of planning. These core ideas are:

- spatial - dealing with the unique needs and characteristics of planning;
- sustainability - looking at the short, medium and long-term issues;
- integrative - in terms of knowledge, objectives and actions involved; and
- inclusive - recognising the wide range of people involved in planning."

The RTPI (2001:2) further concludes that, "in all these matters planning is:

- value-driven - concerned with identifying, understanding and mediating conflicting sets of values; and
- action-oriented - driven by the twin activities of mediating space and making place."

Thus, planning is a multifaceted process dealing with people, places, and nature making it difficult to capture in one definition. In order to have a better understanding of planning, an understanding of the theory and practice of planning is necessary. This should include the ability to comprehend the nature of planning theory.

The government of the Republic of Namibia has recognised the need for integrated efforts to coordinate the development of the country (Haub, 2009). Like in many developing countries, the concept of LUP is generally still new in the country and to the people especially at constituency level (Nabwire, 2002). Despite the efforts of the Namibian government to achieve and implement the goals set out by the decentralisation policy, sectoral and top-down planning on regional and local levels is still common practice. This commonly leads to

situations where regional development initiatives are not harmonised amongst the national, regional and local administrative levels. This also results in the failure of the National Development Plans (NDP) to appreciate the initiatives and the needs of communities at grass root level in planning and budget allocation. The need to develop integrated regional land use plans for Namibia's thirteen political regions is recognized by the Ministry of Lands and Resettlement (MLR), Vision 2030, and NDP3. This research provides details on the best approaches to be embedded into the process of IRLUP in Namibia.

The Ministry of Lands and Resettlement (MLR) within its mandate to facilitate utilisation of land as custodian of Namibian land is the main actor and coordinator in the planning and administration of land falling within the rural areas of Namibia. As stated earlier, the Division of Land Use Planning and Allocation (LUPA) under the Directorate of Land Reform of the MLR are responsible for developing plans for commercial and communal land use. Its mandate is to provide guidelines for drafting regulations on land use planning. This Integrated Land Use Plan is a direct outcome of the MLR mandate.

The Hardap Regional Council is instrumental in successfully implementing and monitoring the recommendations made by the Hardap IRLUP as it holds in trust the Hardap region's natural and cultural resources for present and future generations, and has a responsibility to the public to ensure that resource management represents a balance of community, economic and environmental needs. The Hardap Integrated Land Use Plan (HIRLUP) provides the mechanism for making comprehensive decisions about the use of land and resources within the Hardap region, setting out coordinated management directions for future uses of land and resources while allowing for the evaluation of the success of management activities over time (Government of Namibia, 2007). The plan is future orientated and interactive, allowing plans to be adjusted in response to changing social and economic demands and circumstances.

The overall development planning (including planning of land and other natural resources) is vested in a number of different Namibian government institutions. Amongst other key responsibilities, the Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD) through the Directorate of Decentralisation Coordination is responsible for the effective and efficient implementation of a decentralised system of governance through providing management direction, co-ordination, consultation, trading and research to all stakeholders (line ministries, regional and local authorities, non-governmental organisations, community-based organisations and the public at large). The Ministry of Lands and Resettlement through the Directorate of Land Reform and

Resettlement (Division of Land Use Planning and Allocation - LUPA) is responsible for land use planning in the country — more specifically the communal areas and commercial farms.

The ministries with strong and established institutional setups for extension work in different regions are the Ministry of Agriculture, Water and Forestry (MAWF) and the Ministry of Environment and Tourism (MET) as shown in Figure 2.3. These ministries plays major roles in land use planning, specifically from the sector planning point of view, primarily through project based interventions often carried out in collaboration with NGOs and development partners. Community forestry and communal nature conservancies which fall under the MET are examples of projects where natural resource management is placed firmly in the hands of the local communities for their collective benefit.

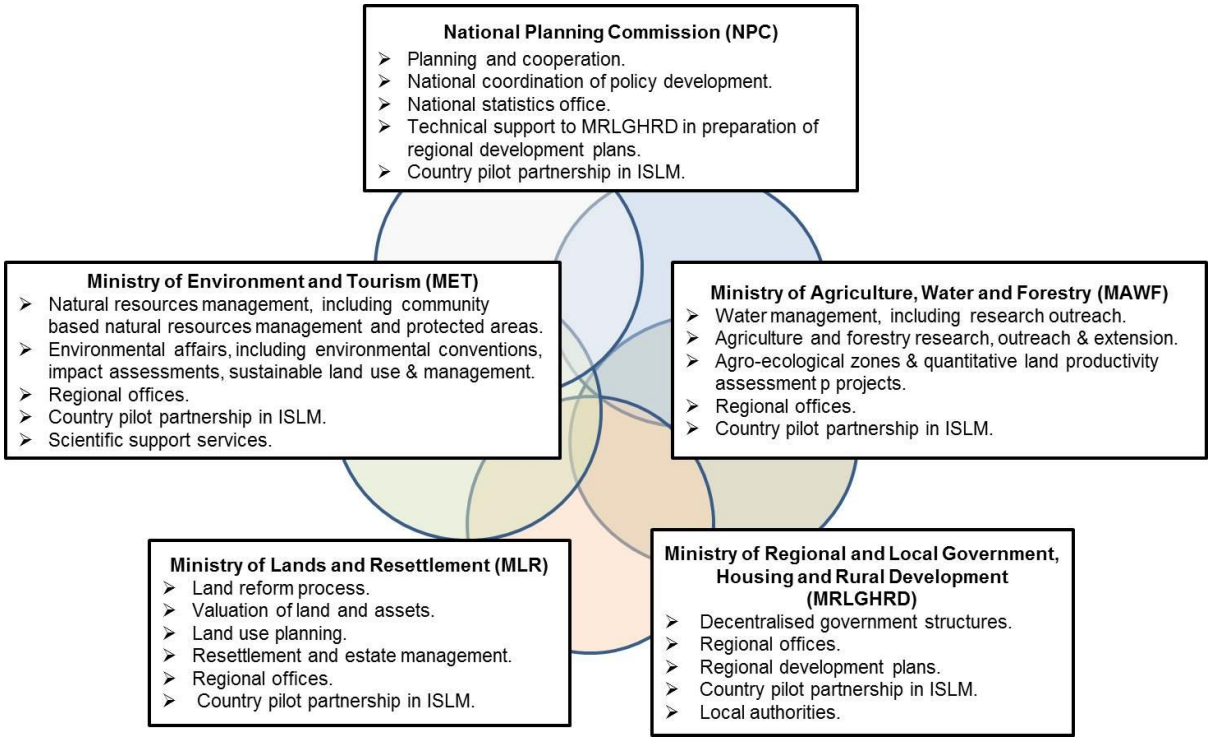


Figure 2.3: Key line ministries responsible for planning aspects relevant to SLM, LUP and land reform in Namibia

Source: Adapted from Government of Namibia (2007:09)

Conflicting mandates are apparent amongst the different ministries as epitomised by the various organisations established through sectoral policies at local level such as conservancy committees under the MET, water point committees under the MAWF, community forestry committees under the MAWF) and village development committees under the authority of the MLRGHRD tasked with local level planning. There is a wide variety of land use planning stakeholders to be involved in the Hardap region with land use

management and planning. The most important stakeholders are:

- The Hardap Regional Council
- The Ministry of Lands and Resettlement (MLR)
- Traditional authorities
- Local authorities
- Line ministries such as MET, MAWF, MRLGHRD, MME and MFMR
- Conservancies
- NAU and SNAFU
- NGO's and private individuals
- Land users in general

The conflicting mandates paired with a general lack of coordination among the different stakeholders make it difficult to implement integrated land use development plans that cut across different sectors.These plans are rarely implemented as there is no input from the different stakeholders into these plans and many are not aware of their proposed role in these plans.

2.7 Tapping into Local Spatial Knowledge on a Global Scale

Over the past decade, 'local communities' and PGIS have been applied to participatory spatial planning (PSP). This include mapping community space, either urban neighbourhoods or ancestral domains, analysing and ameliorating land and resource conflicts, participatory land use planning, awareness raising, and efforts to build people's empowerment. The geo-information tools used in these applications include collaborative spatial data collection using Rapid Rural Appraisal (RRA) or PRA methods, participatory maps, remotely sensed photographs and images; and PGIS analyses and representations.

There is an implicit, sometimes explicit, assumption that using GIS at the local level is both efficient and effective, in that it is believed to:

- simultaneously deal with the planning content;
- answer the questions asked about the geo-information; and
- address and satisfy the local stakeholders' underlying interests.

Globally, participatory mapping is expected to be implemented in a participative manner and

make use of local information, of which ISK is a special category. As such there is an assumption that the use of GIS is a tool for better governance (McCall, 2003). ISK is a measure of local community capability. It has the potential to put the community on equal status with outsider 'experts', and may be the only resource that local groups, especially the 'resource poor', who have ownership of their resources (McCall, 2004).

Much indigenous spatial knowledge has spatial connotations (McCall, 2003:560). Consider for instance the locations of indigenous resources and local resource management activities, environmental hazards, ecosystems relationships, spatial correlations between local groups and resource units (McCall, 2003:560). Indigenous spatial knowledge describes home and action space, it is innate and sustain knowledge about the land, it identifies issues of immediate significance and encodes the information about the environment in a language the inhabitants understand (Duerden & Kuhn, 1996).

However, beyond these easily identifiable, material items within ISK, there is a more slippery concept of spiritual or mystical knowledge associated with space, and particularly with specific areas of land (or certain land resources). According to McCall (2003:560) *"there are propositions about basic spatial cognition, or 'naive geography[5]', which may be valid as generalisations about ISK, and therefore relevant to applying Geographical Information Technology (GIT). These propositions include the following statements:*

- *Real space is 'tightly coupled' with time in people's conceptualisations. Urban landscape perception are example of Egenhofer and Mark (1995) where they name old European land units in which each farming areas are related to time of farming production.*
- *Reasoning about geographical space deals with incomplete information, i.e. people have to interpolate much missing information using 'common sense' rules.*
- *Multiple levels of detail correspond to different conceptualisations of space, some cognitive spaces are continuous and some discrete.*
- *Boundaries are not necessarily discrete entities and not necessarily seen by neighbours as symmetric. Consider the boundaries in natural resource conflicts or in the perceptions of urban 'neighbourhoods'.*
- *Distances are more likely than not asymmetric depending on the means of overcoming 'friction of distance' or movement hindrances.*

[5]Naive geography is the body of knowledge that people have about the surrounding geographical world" (Egenhofer & Mark, 1995, cited in McCall (2003:560).

- *'Community' maps are distorted when they are only simplistic agglomerations of individual mental maps. Group representations of space are needed, using PRA methods."*

Land has strong spiritual and cultural values for many people — especially for indigenous people who have settled in a unique location for a very long time. Harmsworth (1997:3) in New Zealand stated that "land units have specific characteristics of respect for resources, authority, and life force and energy." Therefore, 'land' cannot be simply defined as an economic commodity, and placed in narrow categories of 'high value', 'marginal', or 'wastelands'. The ISK of land resources therefore incorporates customary laws and ancestor-directed objectives in spatial decision-making processes. 'Naming' of sacred places and symbology in spatial representations are elements of this. Such values are identifiable in the concepts of probably all people who retain a spiritual feeling for land (Bartolo & Hill, 2001). In the modern urban context, some PGIS practitioners are emphasising similarly a 'sense of urban place' as a form of ISK (Casey & Pederson, 2000).

Local knowledge and different land use stakeholders' views can be managed and well analysed by using GIS technologies. The concept of combining local knowledge and GIS technologies in land use planning processes is appropriate for better decision-making. Schwedes and Werner (2010:16) state that "*over the last decade's approaches on how to join local knowledge using participatory mapping and GIS technology have been successfully developed and tested in different contexts. Examples of such combinations include the following:*

- *Information derived from stakeholders can be complemented with information from statistics and technical field surveys (for example regarding soil qualities, carrying capacities or utilisation potentials of forests), which can confirm existing potentials or other critical areas of planning.*
- *If participatory maps were developed or site visits undertaken, the spatial information derived can be transferred into georeferenced digital maps prepared by GIS professionals.*
- *Participatory mapping data can be transferred into ortho-photos, topographic maps.*
- *GPS surveys can be conducted in order to locate precise areas of relevance or key structures that the local communities points out. By entering this information into the GIS system, the information can also be considered for regional integrated land use planning.*

- *Different development initiatives land use maps can be discussed with local, public and private stakeholders during planning meetings."*

Data in many different forms can be entered into a GIS. Data that are already in participatory sketch or photo-maps forms can be included in a GIS. Whenever local stakeholders have mapped their natural resources, land uses, infrastructure, settlement areas and other features of relevance in participatory mapping exercises, such as sketch and photo-maps), the information can be transferred into a GIS (Schwedes and Werner, 2010). Digital, or computerised, data can also be entered into GIS. An example of this kind of information is data collected by satellites that show land use – crop fields and forests. It has been proven in the study carried out by Schwedes and Werner (2010) that it is easier for local communities to work with satellite images or aerial photographs, which were, whenever possible, already corrected ortho-photos. The stakeholders transfer their own information regarding resources, land uses and infrastructure, onto those images by using their preferred symbology. Specialists then enter this spatial information into the GIS and develop land use maps.

Wu and Isaksson (2008:23) have different views on the integration of participatory mapping into GIS. They state that "there are certain gaps to be bridged between the GIS maps and participatory maps. If participatory maps are to be integrated with scientific maps, there might be a need of conforming to certain attributes of scientific mapping such as categorisation and generalisation." This is a relevant statement, because in the process of planning of future development projects and in the development of future land use maps, normally best procedures are repeated. Whenever accuracy of data for the exact location of future boundaries or points is needed, technical surveys with the help of GPS will become necessary. These surveys will be conducted by land survey specialists.

2.8 Guidelines and Framework for Participatory Mapping in Namibia

Literature can illustrate the value of information, show where to find data, and teach how to do research. However, there is little written to provide any guidelines for actually using information to achieve success. Most of the existing literature on participatory mapping and GIS for integrated land use planning can be grouped into three clusters: individual, community and action success stories (Craig & Elwood, 1998).

In Namibia presently, due to the socio-political situation of the country, land resources are

mostly used and managed by individual land users, without much consideration for the welfare and future of the wider population. To date, no legal framework, guidelines or policy has been developed for participatory mapping in the process of integrated regional land use planning in Namibia. As there is no national framework for integrated land use planning, land use planning takes place in an uncoordinated and isolated manner. The National Land Policy provides for the mandate of coordinated land use planning to be done by MLR, but no decisive measures or guidance are given by the policy on these plans. The NDP1, NDP2 and NDP3 encourage the integrated regional land use plans to be produced, monitored and updated for the regions in Namibia.

There are is a wide variety of stakeholders and institutions involved in land use planning and land management in Namibia. These include line ministries, the respective regional councils, the Constituency Development Committees (CDCs), the Village Development Committees (VDCs), the traditional authorities, the land and farming committees, the conservancies and the community forests (Government of Namibia, 2010). Combined with the lack of a national land use planning policy and participatory land use planning guidelines, the result is that land use planning and management is not coordinated and sectorally driven.

According to Amler *et al.,* (1999:106) “the implementation of the plan is the real and original task of the target population. External support should only consist of friendly advice and the provision of materials as well as specialised know-how, which would otherwise not be accessible or affordable to the target group.” To this end, the guidelines and framework are of a technical nature and are meant to guide relevant institutions and authorities in land use planning activities at village, district and national level (Venema, Alim, Vargas, Oduori and Ismail, 2009). The Government of Namibia (2010:38) emphasised that the following are “the main gaps in the policy and legal framework affecting integrated land use planning and management in Namibia:

- the lack of an existing approved national Land Use Planning Policy, and the implementation of land use plans;
- the lack of community control and authority over common grazing lands;
- the lack of clarity on group tenure over communal land;
- the lack of a common national policy on community-based natural resource management (CBNRM).”

Participatory mapping and GIS are some of the major technologies to be incorporated into

the processes of ILUP in Namibia. Globally, emphasis on land conflict identification, land conflict management, as well as land development potential has been identified and monitored using appropriate tools and technologies such as participatory mapping and GIS. One other important key element for proper sustainable land use planning is to take into consideration the involvement of all stakeholders such as local communities, government experts, researchers and officials of non-governmental organisations in order to help increase the representation of appropriate views in the implementation of future ILUP projects in the Namibian context. A good representation of all stakeholders in LUP will integrate the broad views, perceptions and opinions of the society on future land uses that would directly have an effect on their livelihoods. In this study a bottom-up approach to sustainable land use planning was applied through the use of participatory mapping, participatory rural appraisal and focus group discussions with local participants as stakeholders. Because such a holistic approach is the first of its kind in Namibia, there is a need to document the conceptualised frameworks and guidelines during the whole process for future reference.

The final product of participatory mapping aided by GIS can serve as a benchmark for future land use planning in different regions in Namibia. Some flexibility will be required in order to capture new dynamics and characteristics within and among different areas of the country.

2.9 Chapter Conclusion

The use of GIS technology has rapidly diffused over the past two decades and is now widely applied in many domains. The map remains a dominant form of spatial representation in GIS although GIS technology is more than just a map. GIS has evolved to socially constructed technology, whereas participatory mapping has raised several concerns about the implications of top-down planning approaches. Understanding the limitations and strengths of participatory mapping and traditional GIS is important in order to appropriately apply participatory mapping aided by GIS across a range of application areas.

In recent years, participatory mapping has been widely adopted in environmental decision-making. In this respect, public participation has been identified as an important component of planning and as a prerequisite to identifying environmental and social impacts in the early stages of planning projects. Many ministries in Namibia responsible for planning, for example MLR, MET, MRLGHRD and MAWF certainly require public participation to be incorporated with integrated land use planning projects. ILUP methods, however, requires a

holistic qualitative approach to expert knowledge acquisition and gathering of local communities' viewpoints, opinions, and perceptions. In most cases, these ILUP methods are spatially oriented. Participatory mapping has shifted the focus in GIS from purely technical or application driven concerns toward more theoretical discussions of GIS and how people, space, and environment can benefit from GIS.

A number of participatory mapping studies have provided a foundation for local stakeholder engagement in most planning aspects. In emphasising issues of local knowledge, ethics, representation, and community empowerment, participatory mapping has much to offer mainstream GIS applications and integrated land use planning. Participatory mapping provides additional powerful visualisation tools to the Geographers' toolbox. The emphasis on graphical and visual approaches to complex data display and analysis would appear to be valuable to non-expert communities seeking to understand complex spatial information. The intersection of participatory mapping, GIS and integrated land use planning is potentially significant and this research seeks to explore that intersection.

Chapter 3 presents the data needs for land use planning in Namibia. The chapter provides the conceptual needs of the spatial data and in the arena of spatial planning. The data needs results as per the concepts is presented in chapter 5 of the research results.

Chapter 3: Geographical Data Needs for Land Use Planning in Namibia

3.1 Introduction

The need for geographical data for integrated land use planning in Namibia is rationalised in this chapter. Aspects of data collection such as the nature, scale and measurements of data for land use planning are presented as well as characteristics of spatial data models and data types. The following aspects will be dealt with:

- geographical datasets and non-geographical information
- organisation of GIS data and database functionality
- participatory mapping aided by GIS in the process of LUP
- spatial data models and types
- the need for local spatial knowledge
- frameworks and guidelines for participatory mapping by means of GIS in LUP

Furthermore the chapter provides context on the data needs for sustainable land use planning in Namibia. The context of the data needs respond to the main research aim for this study, which was to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management. The research aim and objectives were realised by addressing the research objectives using the data gathered and collected for this research.

3.2 Geographical Data and Information for Land Use Planning

3.2.1 The Nature and Scale of Geographical Data and Information

If geography is concerned with the description and explanation of things occurring on or near the earth's surface, then geographical data are facts relating to features which are spatially referenced to this surface (Walford, 2002). The systematic evaluation and planning of land resources requires data and information about the land, the people and the organisation of administration and service (Verheye, 1998). This is essential at any level of research for this project. However, the range and the amount of information, as well as its accuracy and precision, vary greatly according to the scale and objectives of the land use plan. Five basic

principles apply to the collection of data for land use planning:

a) Data and information collection should be objective-oriented and meet users' demands.
b) Data and information collection should be geared to gaining an understanding of how the land or land use ecosystem functions. What are the processes involved, how do land properties affect land use, and what is the impact of changes in land use on the land resources?
c) Data and information collection should be efficient, focusing on minimum datasets, and flexible to allow collection of any additional data which may be relevant.
d) Physical data are needed in a spatial format as maps or georeferenced observations. Differences in land resources is the main requirement for sustainable land use planning.
e) Data and information collection should be part of a continuous process. Rather than being seen as a one-time exercise needed to produce a rigid land use plan, the initial data set should be used to formulate a flexible, rolling land use plan, which can later be modified in light of future information, or according to changing circumstances.

The most important component of GIS is the data. Geographical data and related land use planning information can be incorporated into a GIS. Most GIS software employs a DBMS to create and maintain a database to help organise and manage the data. There is a high need for greater integration of spatial data in the process of LUP to be able to better plan for the current land uses and future land uses. The combining of different types (categories) of land uses will also be of value for the comparison of existing and proposed land uses. The common advantage of GIS in combining different types (categories) of land uses is to help address conflicts and possible synergies between land users.

Data structures provide the information that the computer requires to reconstruct the spatial data model in digital form. There are many different data structures in use in GIS. Different data structures and formats are the some of the contributing factors for exchanging spatial data between different GIS software. However, despite the existing diverse data structures, reality can be modelled in a GIS as raster or vector models (Heywood *et al*., 2002). Vector and raster data models are the two basic data models for storing and manipulating GIS data in a computer. The GIS, including the object-oriented GIS[6] (OOGIS) and Computer Aided

[6] An object is a self-contained package of information describing the characteristics and capabilities of an entity under study. In a geographical object data model the real world is modeled as a collection of objects. Each entity in the real world to be included in the GIS is an object (Longley et al., 2005:191).

Design (CAD) software packages available today are primarily based on one of the two data models, while they have some extended functions to support data structures such as aerial photographs, images, points, lines and polygons. Most GIS software are vector-based systems with simple programming interfaces. In an object-oriented GIS (OOGIS), each object instance would contain its graphical characteristics, its geographical location and all of the attributes data. Kantabutra, Owens, Ames, Burns and Stephenson (2010:44) stated that "in an object-oriented database system, on the contrary, the objects are identified by their storage location rather than by the values of their attributes."

The terminologies may differ between different GIS software packages, but the approach to spatial data are usually the same. A range of terms are used to refer to data layers in GIS software. These include themes, coverages, layers, levels, objects, and feature classes. Data layer and theme are the two most commonly used terms and the dominating terms in most GIS software packages. The identification of different data layers prior to data sources is critical for appropriate data collection methods. The identification of spatial data sources is often achieved through a "user needs analysis" (Buckley, 2000). The user needs analysis was critical for producing land use maps of the Hardap region from existing land use data for comparison of desired and undesired land uses. The user needs analysis performs several functions, which are outlined below:

- identifying the users;
- educating users with respect to GIS needs;
- identifying information required;
- identifying data requirements for information products;
- prioritising data requirements and products; and
- determining GIS functional requirements (Buckley, 2000).

The functions of user needs analysis contributed to the development of frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management. The contributions were made by identifying users, data sources, spatial data, non-spatial data and many others as stated above. Often a user needs analysis will include a review of existing GIS operations in order to assess the required GIS resources. This is sometimes called a *situational assessment* or *cost-benefit analysis*. The cost-benefit process is well established in conventional data processing and serves as the mechanism to justify acquisition of hardware and software. It defines and compares costs against potential benefits of the project (Buckley, 2000). Most institutions will require this step before a GIS acquisition can be undertaken.

GIS has become indispensable for resource management, conservation, eradication of poverty and sustainable development in the country. It is important to know that "geographical analysis is only as good as the geographical database on which it is based and a geographical database is only as good as the geographical data model from which it is derived" (Longley *et al.,* 2005:195). It is therefore very important preparatory process before starting to gather and creating GIS data. The data gathered and created in this study were stored and managed in a developed georeferenced digital database for sustainable land use management of the Hardap region to be used by the MLR. Before the data were gathered, collected, stored and managed, the following issues were considered when setting up data for a GIS project:

- *Data detail:* a measure of how much information is stored for each feature. Which type of geometry should be used to represent the geographical features, for example, points, lines or polygons? The question remains whether it will provide the desired detail later when mapping the features. What needs to be done with this data once it is created?
- *Accuracy:* is about how closely are the geographical features represented on the map to the real world? Accuracy is dependent on how data are collected and is usually judged by comparing several precise measurements from the same or different sources.
- *Coordinate system:* this is the standard coordinate system required by the organisation or other agencies that are commonly used in the country. It is a good idea to use the commonly recognised coordinate system so that the data will align correctly when displayed together on a map.
- *Data storage format:* different formats such as shapefile, geodatabase, or database file are commonly used. It is important to ask questions, such as 'Can the data be added to an existing database? Can the data be shared with the private sector or government ministry?
- *Scale:* this is about size of the spatial data, either relative or absolute, and involves a fundamental set of issues in geography. Scale primarily concerns space in geography. Scale is the level of detail for spatial data and is about the physical extent of the study area.
- *Map scale:* the ratio of a distance on the map to the corresponding distance on the ground. It refers to the display scale of a map at which the map is compiled.
- *Resolution:* the degree to which closely related geographical features can be discriminated. It refers to the smallest distinguishable ground feature that can be

detected in the image. Usually, the larger the area represented by the cell, the lower the resolution and vice versa. As a result, the higher the resolution, the more accurately features are represented.

- *Level of generalisation:* in a GIS, each map within a certain scale range requires its level of detail to depend mainly on the purpose of the map. The amount of details can be reduced in a meaningful way. The process of generalisation is normally executed when the map scale has to be reduced.
- *Precision:* the smallest difference between adjacent positions of geographical features that was measured to the original stored feature. It is the degree to which repeated measurements under unchanged conditions show the same results.
- *Metadata:* data about data that provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographical data.

During data collecting, data processing and the data visualisation process, it is essential that the nature of the attribute information be established. These attributes can refer to visible characteristics, such as deciduous trees, and non-visible characteristics on the map, such the temperature. When attempting to define the attribute values of objects, one usually tries to measure, categorise or characterise the attributes either as qualitative or quantitative. Kraak and Ormeling (2003:05) stated that one may distinguish a number of measurement scales on which the values for attributes characteristics can be accessed:

- *nominal scale:* attributes are different from each other, without one aspect being more important than another. An example of this is different languages (English, Afrikaans, Oshiwambo and Silozi) spoken in Namibia.
- *ordinal scale:* attribute values are different from each other, but there is one single way to order them, as some are more important or intense than others. For example, the weather, where some parts of the country can be warm, others mild or cold.
- *interval scale:* attribute values are different, can be ordered and the distance between individual measurements can be determined. Temperature lends itself to demonstrate interval scaling. As the respective zero-points of their measurement scales have been selected at random, it is impossible to say that, for instance, a temperature of 64ºF is twice 32ºF. This is better understood when the values are converted into Celsius and become 18ºC and 0ºC respectively.
- *ratio scale:* attribute values are also different and can be ordered. Distances between individual measurements can be determined, and these individual measurements

can be related to each other. If, for instance, the per capita income in South Africa is S.A.R 300.00 per annum and in Namibia N$150.00, then one can say that the amount in the former is twice the value of that in the latter.

Spatial data and attribute information of an object will be subject to changes over time; such as the size or composition of the population of an area, and even the location of an object may change, for instance, the wet land surrounding Hardap Dam may change over time. The data time stamp is seen as one of the major components of geometry types and attributes values. The recently interest in the data temporal component increases because of the expanded number of time series in GIS databases and the wish to analyse processes over time instead of during a single time slice (Kraak and Ormeling, 2003).

As the study of land use planning and sustainable land management emphasises, the integration of various disciplines (geography, development studies, environmental studies and land management), the nature of data and information to be collected reflects such fields of specialisations as well. The nature, types and information of data and information needed for this study are presented in Table 3.1.

Table 3.1: Nature of Data and Information

Data	Information
Data about land resources	• climate • landforms and soils • land cover • water resources
Land use related data	• present land use and characteristics • selected physiological characteristics of crops such as sorghum, maize and beans. • land utilisation types and production systems (current and potential) • ecological requirements of land use types and production systems.
Socio-economic data	• population (information such as age and gender distribution) • living conditions • household size • access to piped water • access to fire wood • access to land • access to electricity. • food security • access to markets • costs of production and product prices
	• relevant government policy documents, laws and regulations related to land

Data	Information
Legal data and information	• present system of land allocation • land tenure information • traditional ownership and user rights
Institutional information	• institutions and their mandates, resources and infrastructure • links between institutions • support services extension
General data and information	• infrastructure, accessibility

Source: Food and Agriculture Organization (1999)

Land use planning is a form of spatial planning and therefore a base map at an appropriate scale is a requirement for a land use plan (Verheye, 1998). In spatial planning, most types of data and information are scale-related and scale-dependent. The spatial distribution of different geographical features can be represented on a map with certain mapping units, (such as countries, regions of Namibia or neighbourhoods in a town or city) and scales. A scale is very significant with regard to the information base and the level at which land use planning takes place (Verheye, 1998). As shown in Table 3.2, there should be a proper balance between scale and level of application. Scales in geography have effects on the spatial extent. Scale effects, due to changes in the amount of geographical detail, fall into four categories:

1. Changes in the number of features;
2. Difference in measured lengths and areas;
3. Displacement in the position of features; and
4. Failure to find relationships that matter.

Table 3.2: Recommended map scales for use at different application levels

Data Level	Administrative Unit	Map scale
National	Country	Large: 1: 250 000 Medium: 1: 1 000 000 Small: 1: 5 000 000
Regional	Region and constituency	Large: 1: 100 000 Medium: 1: 250 000 Small: 1: 1 000 000
Local	Town, community	Large: 1: 10 000 Medium: 1: 25 000 Small: 1: 1: 50 000
Village/farm	Village, farm or ranch	Large: 1: 1 000 Medium: 1: 5 000 Small: 1: 10 000

Map scale has an impact on GIS projects due to changes in spatial extent of the mapped

area. The impact of scale can be measured using locations with the same detail but different spatial extent. If for example, only a small spatial extent is considered, and a particular resource is widely available within that small extent, then it would be assumed that losing part of that locally-abundant resource is not very important. If however, a wider area is studied and it is found that the resource is rare at a national level, then the same amount of resource loss would have a relatively greater importance and the impact significance is deemed to be high. The planning level normally relates to administrative boundaries of the study area. Because administrative boundaries differ from country to country, there is sometimes a natural overlap of map scales from national to regional level because the data were sometimes captured on the same scale. Large countries may have more than two intermediate levels, such as region - province - constituency, or town - community - village.

3.2.2 Geographical Data and Information for LUP

Walford (2002:4) maintains that "regardless of whether geographical data are obtained from primary or secondary sources, the method by which the data are collected and presented provides another basis for classification." Spatial data classification decisions are influenced by the purpose of the map, characteristics of the data to be used, the scale of the map, the size of the symbols to be used in representing the data and the visual variable (s) applied for the representation. There is a need for both vector and raster based spatial data models in the process of LUP. Accurate and up-to-date data are essential for land use planning purposes because land-related planning issues are very crucial in the process of regional development of the rural areas of most countries.

Datasets may appear relatively error-free when examined individually in terms of their internal validity but they can produce and demonstrate errors when overlaid on each other and when compared in terms of cartographic elements such as scale, north arrow, legends and cartographer's name (Walford, 2002). It should be noted that inaccurate data can cause problems in the planning process. Inaccurate farm boundary data for example, can cause land disputes to farmers. Furthermore, land use planning development initiatives could be implemented in the wrong areas.

During the process of data needs assessment, certain standard datasets were identified that are applicable to land use planning. These datasets form the basis for all the Integrated Regional Land Use Plans that will eventually be combined so as to create the "National Land Use Plans for Namibia." This means that the structure of the land use plans should be similar for them to be integrated into one plan. For this reason, there are certain datasets

which should be compulsory for all plans. The data presented in Table 3.3 are the identified sets of base data required for the process of integrated land use planning in the Hardap region.

Table 3.3: The identified datasets for the ILUP

Vector data	***Raster data***
Namibia boundary Political regions Magisterial districts Constituencies Town land boundaries Agro-ecological zones Growing period zones Vegetation units Schools Health facilities Biomes Towns National and other roads Police stations Conservancies Airports Airstrips Border posts Boreholes Livelihoods Carrying capacity Water features Electricity features Environmentally sensitive areas	Topographic map sheets Ortho-photos Aerial photographs Satellite images

The collection of data and information on the socio-economics of land use planning should focus on gaining an understanding of local communities and their natural, human and capital resources (Food and Agriculture Organization, 1999). Socio-economic data includes data about:

- community housing
- population (such as age group, population density, births & deaths and life expectancy).
- gender-related issues
- ethnicity
- income
- labour availability

- agricultural or other land use practices
- access to land
- land tenure
- access to infrastructure such as roads and water.

The required socio-economic data and information for land use planning are outlined in Table 3.4. One of the purposes of socio-economic data collection is to identify and characterise specific groups that are targeted for inclusion in the land use planning process.

Table 3.4: Socio-economic data and information requirements

Data	**Detailed breakdown of data requirements**
Farm and household data	Gender and income
Legal and tenure aspects	Land rights and size
Infrastructure	Roads, railway, telecommunication towers and boreholes infrastructure and their quality
Access to markets and price development	Market place
Supporting services	Extension service
Intervening agencies	NGOs, institutions and government ministries
Population	Age, growth rate, language, employment, literacy and ethnic composition
Gender distribution	Gender based information

In addition to information on factors such as population, labour availability, infrastructure, markets and support services, information such as agricultural extension and veterinary facilities, should be collected and verified by relevant organisations. Wehrmann (2011:117) stated that "specific information and data needed for land use planning depends on the characteristics of the planning area as well as on the planning objectives. As a golden rule, the amount of data collected should be kept as small as possible. Hence, it is important to first define the land use planning objectives (for example, identifying potential land uses and proposing new land use planning) and identify the data needed before starting data collection." Information should also be assembled on legal rights and restrictions on land use and related issues, and on any particular government policies or development plans pertaining to land use planning (Verheye, 1998).

3.2.3 Data Sources and Methods for Data Collection

Data collection is one of the most important aspects of setting up a GIS project. In the 19th

century in Namibia, spatial data collection was the main project tasks (Noongo, 2003). Data collection typically consumes the majority of the available resources such as financial resources. The process of collecting detailed, suitable and reliable spatial data can be a time-consuming and expensive process.

The generation and gathering of information from different data sources is an ongoing development. GIS specialists continue to research and implement new or existing data collection and gathering methods into their work. Most of these new data sources are based on scientific technological developments (Buckley, 2000). Recently, there is development in generating land use planning related data using participatory mapping and crowd sourcing methods. Although the specific information and data needed for land use planning depends on the characteristics of the planning area as well as on the planning objectives, certain aspects of land use planning such as the purpose and expected outcomes should always be thoroughly considered (Wehrmann, 2011).

There are many methods of data collection for integrated land use planning. A recent study undertaken by Wehrmann (2011) concluded that different data collection methods exist for land use planning. The identified common methods for data collection in land use planning are as follow:

- acquisition and digitising of aerial photographs;
- acquisition and digitising of satellite images;
- acquisition of land uses through delineating from an aerial photograph;
- acquisition of land uses through delineating from satellite image;
- gathering opinions and perceptions of stakeholders using questionnaire technique;
- literature review and assessment of legislations, plans, programs and reports;
- using a SWOT analysis to gather opinions and perceptions of stakeholders about land use planning in the Namibia;
- using FGD and PRA to gather opinions and perceptions of stakeholders regarding land use planning;

Wehrmann (2011:120) states that "generally, local land users - no matter how poor they might be or how limited their formal education is - do have a perfect understanding of their immediate environment - having lived and worked there a lifetime and benefited from their forefathers' experience and wisdom. Hence, the knowledge of local land users is an important potential source of information for land use planning. However, it is not easy to

collect and document such local knowledge."

There is a lack of common terminologies in land use planning and related sciences in Namibia, especially concerning the environment. A major problem is the different interpretations of the land use planning context by the Namibian experts and experts educated abroad. The evaluation by the population of a forest based on its use contrasts with a scientific and ecological evaluation in which conservation such as soil erosion and biodiversity has priority. In addition, indigenous or traditional classification includes religious and cultural aspects as viewed by experts educated abroad. Experts that tend to provide conclusions based on one-sided view when interpreting and analysing the situation in participatory data collection and planning processes should be avoided. Participatory methods make it possible for outsiders to get to know and to understand seemingly irrational decisions on land use by getting familiar with the background as well as cultural values and norms (Wehrmann, 2011).

3.3 Spatial Data Models for Representing Land Use Planning Data

This section provides a discussion of the spatial data models available for land use planning. The need for land use planning data is growing because of the complex socio-economic problems related to demand for land, re-distribution of land, land development and land management. Spatial data is one of important components that drive a GIS. The functionality that makes a GIS separate from another analytical environment is rooted in the spatially explicit nature of the data.

The two fundamental ways of representing geographical features of land use planning are discrete (vector) objects and continuous (raster) data structures. Longley *et al*. (2005:76) states that “the discrete object view represents the geographic world as objects with well-defined boundaries in otherwise empty space. The continuous field view represents the real world as a finite number of variables, each one defined at every possible position.” Two methods are used to reduce geographical features to forms that can be coded in computer databases — these are called raster and vector data models. In principle, both can be used to code both continuous and discrete objects, but in practice there is a strong association between raster and fields, and between vector and discrete objects. Raster data model representations divide the geographical features into arrays of cells and assign attributes to the cells. In the case of vector data models the geographical features are represented as points, lines and/or polygons.

In this study it is important to understand the advantages and disadvantages of both raster and vector data models in terms of data sources, volume of data, type of applications, functionality and representation to help make an informed decision about which model to use. This is required in most GIS projects because the choice of data model influence data collection methods. Based on the type of maps intended to be produced and the spatial data sources used to gather and collect spatial data, a combination of both raster and vector data model are used in this study.

To effectively use GIS, it is critical to understand different GIS applications as well as the advantages and disadvantages of each spatial data model. The difference in the two models helps the researcher to make a tangible decision in choosing the best data model for different applications. There are several advantages for using either the vector or raster data model. These advantages, adopted from Longley *et al*. (2005), are summarised in Table 3.5.

Table 3.5: Relative advantages of raster and vector representation

Issue	Raster	Vector
Volume of data	Depends on cell size	Depends on density of vertices
Sources of data	Remote sensing, Imagery	Social and environmental data
Applications	Resources, environmental	Social, economic, administrative
Software	Raster GIS, Image processing	Vector GIS, automated cartography
Resolution	Fixed	Variable

Adopted from: Longley *et al*. (2005:76)

Given the nature of this study which incorporates aspects of the physical and human environments, both raster and vector data models are used. The data of the two data models are stored and managed in a conceptualised and developed user-friendly georeferenced digital database for sustainable land use management of the Hardap region to be used by the MLR. The raster data model is often used for physical and biological subsystems of the geosphere such as elevation, temperature, water flow, or vegetation (Longley *et al*., 2005). However, it can also be used for data usually represented by lines and polygons such as roads or soil properties, especially for scanned maps (Neteler and Mitasova, 2008). Besides being used for representing physical phenomena (especially continuous variables), the raster data model was used for participatory photo-mapping in this study as a base map on which the participants delineated different land uses and infrastructure such as roads.

Vector data are most efficient for discrete features which can be described by lines with simple geometry, such as roads, utility networks, property boundaries and building footprints. Although continuous spatial data can be represented by vector data models using isolines, point clouds or various types of irregular meshes, such representations usually lead to more complex algorithms for analysis and modelling than the raster data model (Neteler and Mitasova, 2008).

The land use maps produced from existing land use data in Namibia are mainly based on vector data model. Various land use maps such as mining, agriculture, urban land use are produced from vector data model in this study.

Most GIS software utilising vector data structure also has the capability to convert to raster data structure for further analysis. Other more comprehensive GIS software provides both integrated raster and vector analysis techniques. They allow users to select the data structure appropriate for the analysis requirements. Integrated vector and raster processing capabilities are more desirable and provide the greatest flexibility for data manipulation and analysis.

Data can be collected once users' tasks and needs have been analysed and identified. Different data collection and analyses are among the most important stages in implementing GIS in LUP as they largely dictate the costs and benefits of a GIS project. The benefit derived from a system depends on access to the proper data at the right time, and on the efficiency with which the system processes the data accessed. It follows therefore that the choice of GIS data in LUP should relate directly to user needs. In any event, it should be based on a cost-benefit analysis.

3.4 Organisation of GIS Data and the Digital Database

A large volume of spatial data are nowadays distributed through *Internet based GIS* and *Web Services* (Longley *et al*., 2005). The data sets are stored on central server(s) and users access the data as well as the display and analysis tools through the Internet. Examples are the browser-based interactive maps and virtual globes, such as Google Earth, National Aeronautics and Space Administration (NASA), WorldWind, and others. Internet technology is important in this study because it is a source of spatial data and as a spatial data disseminating tool to different land users in Namibia and around the world.

Most multipurpose GIS software includes tools supporting development of Web-based

applications (Neteler and Mitasova, 2008). Geopublisher can be used for developing Web-based GIS applications which supports a variety of spatial requests like making maps, scale-bars, and point, area and feature queries. The availability of public programming interfaces by many Web mapping providers inspires implementation of “mashups” that aggregate different web based services into new value-added applications.

3.5 The Need for Local Spatial Knowledge in LUP

Local knowledge was required to produce frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia. Local knowledge is unique to a culture or society. It is the basis for decision-making at a local level regarding aspects such as agriculture, health care, food security, education, natural resource management and a host of other socio-economic issues in communities (World Bank, 1998; Tripathi and Blattarya, 2004). There is a general agreement that the concepts “indigenous knowledge, traditional knowledge, local knowledge, community knowledge and rural people’s knowledge” are accepted terms for knowledge belonging to local people (Tripathi and Blattarya, 2004).

Integrated land use planning is a sector-overlapping and integrative decision-making process that facilitates the allocation of land to the uses that provide the greatest sustainable benefits. Land use planning should include a constructive dialogue between all stakeholders to reach decisions based on consensus. Overall, planning and management of land use requires interdisciplinary cooperation, sectoral integration, and local engagement. Therefore stakeholder participation should promote active involvement of all levels of government, local institutions, non-governmental organisations (NGOs) and civil society.

The complex nature of sustainable land use management demands research that uses a systems approach; such as research that is interdisciplinary - combining bio-physical and socio-economic dimensions, and attempts to understand the interrelatedness of system components (Barr and Dixon, 1998 as cited by Tripathi and Blattarya, 2004). Participatory approaches such as sketch and photo-mapping are being adopted widely as possible solutions to address land use planning problems. Natural resources at community level are planned through the use of participatory approaches such as participatory mapping to enhance natural resource management, decision-making and policy processes.

It is generally recognised that indigenous knowledge plays an important role in the

sustainable management of land use and can also have an impact on issues of global concern. This recognition is directly related to the growing realisation that scientific knowledge has contributed very little to the development of communities and societies without indigenous knowledge (Murdoch and Clark, 1994; Norgaard, 1992; FAO, 1990; Ulluwishewa, 1993, cited in Tripathi and Blattarya, 2004).

The potential disappearance of indigenous practices could have a negative effect primarily on those who have developed them and who make a living through them. A greater awareness of the important role that indigenous knowledge can play in the development process is likely to help preserve valuable skills, technologies, artifacts and problem solving strategies among local communities. In this study, indigenous knowledge is measured in producing participatory land use maps from different units of land within the six constituencies of the Hardap region by local communities. Methods such as participatory mapping, FGD and PRA are used to gather indigenous knowledge in the Hardap region. The World Bank (1998:03) stated that "learning from indigenous knowledge, by investigating first what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help the communities. Understanding indigenous knowledge can increase responsiveness to clients. Adapting international practices to the local setting can help improve the impact and sustainability of development assistance. Sharing indigenous knowledge within and across communities can help enhance cross-cultural understanding and promote the cultural dimension of development." It is a belief that indigenous knowledge and scientific technical knowledge can complement the local communities' strengths and weaknesses in their planning activities (Tripathi and Blattarya, 2004).

3.6 The Need for Guidelines and a Framework for Participatory Mapping aided by GIS in LUP

It is important to have a clear structure in place before initiating or engaging in a participatory mapping and GIS project for land use planning. Clear frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia is critical to enhance a land use planning project. The benefits of the structured process are that it is transferable and straightforward to follow. In addition, a knowledge base already exist that development intermediaries and future community members can draw on for guidance. A highly structured approach may, however, sacrifice flexibility. A successful participatory mapping aided by GIS

process ideally should be developed or tailored directly with community members to suit the needs and requirements of each community. Other participatory approaches can be significantly less structured. However, a disorganised and unfocused process is likely to undermine a mapping initiative and alienate community members. People like to have in mind an achievable road map and set of understandable long-term objectives.

Land use planning aims for sustainability by balancing social, economic and environmental needs both currently and in the future. In order for an integrated land use plan to be sustainable, it must incorporate the aspects and planning of infrastructure, natural resources availability, socio-economic issues, and views and opinions of local communities, government and private institutions.

According to Haub (2009:19) "*Namibia has carried out four Integrated Regional Land Use Planning (IRLUP) projects. These were conducted in:*

- *the Kunene region (1999);*
- *the Caprivi region (2001);*
- *the north-central regions of Omusati, Oshana, Ohangwena and Oshikoto (2002); and*
- *the Otjozondjupa and Omaheke regions (2005).*

The only two land use plans to be approved were that of Kunene and Caprivi. All four IRLUP projects were hampered by the following shortcomings:

- *poor incorporation of future scenarios, such as zoning options or potential activities, projects or programmes which could be implemented are not considered. The "plans" are more like resource inventories, without implementation options.*
- *there is an absence of appropriate stakeholder involvement and consideration of inter-sectoral integration during the planning phases. Other sectoral plans or lower level plans were also not integrated in the land use plan.*
- *numerous planning instruments are used, including various policies, acts and development plans but they are not sufficiently integrated and in some cases even contradict each other.*
- *no digital maps or data were produced to enable a constant update and monitoring of plans and their implementation.*
- *different methodologies were applied in the course of the compilation of plans, i.e. they were carried out as "stand-alone" projects, and so the plans differ in content,*

scale and layout of maps, structure, etc, *and cannot be compared with each other."*

Namibia has committed to sustainable land management through ILUP in the National Development Plan (NDP) 1, NDP 2 and NDP 3. ILUP has thus far not been used as an instrument for managing land-related resources and developments (Haub, 2009). The above mentioned shortcomings justify the need for proper documented guidelines and a framework for community involvement in ILUP through participatory mapping and the need for a proper model of a comprehensive georeferenced database to store and manage ILUPs data. Inadequate land use management causes land conflict and unforeseen environmental impacts. Sustainable land use planning may be regarded as the progressive and balanced achievement of sustained economic development, improved social equity and environmental sustainability (Luxem and Bryld, 1997).

3.7 Chapter Conclusion

In any GIS project a variety of spatial and non-spatial data layers are required. These must be identified before the project is started to give priority for data requirement processes. This is mandatory, as one data layer often contains features that are coincident with another. Data layers are commonly identified based on the needs of the users in relation to the area of study, such as land use planning. The data needs and requirements are completely user identifiable. The identification of data layers is fully dependent on the area of interest and the priority needs of the GIS project.

When considering the physical requirements of the GIS, it is important to understand that two data types are required — the spatial and the non-spatial (attribute) data. It is also important to understand the data models to be used, as this also influences the type of data, data sources, data analyses and data maintenance. These data analyses and maintenance processes are important for consideration in the physical requirement of the GIS as they also influence the speed of spatial analyses.

A number of issues such as data accuracy, precision, scale, resolution and generalisation are taken into consideration before the data are gathered, collected, stored and managed. The aspects of a conceptualised and developed user-friendly georeferenced digital database for sustainable land use management to be used by the MLR were covered in the chapter. The aspects of georeferenced digital database unfolded issues of data management, data analysis and data dissemination. The current state of ILUP in Namibia was dealt with and it

was revealed that there is poor data management system and lack of stakeholders' involvement in the process.

In recent years, the use of GIS software has emerged worldwide as a powerful tool used in many application areas such as land use planning, land administration, geology and environmental impact assessments. It is regarded as a system for managing and analysing large amounts of spatial data. Besides performing analytical functions, GIS can also be used to generate maps in a flexible, versatile and integrated manner. GIS can further be used to extract tables and textual reports that are needed to support the land use planning process.

The applied research methodology will be explained in chapter 4. The chapter provides the detailed contexts, explanations and descriptions of how the methods used in this study were applied. The aspects of postmodernist geography philosophy, participatory and sampling techniques are also explained in chapter 4.

Chapter 4: Research Methodology

4.1 Introduction

This chapter is divided into seven (7) sections. The first section commences with the *introduction* and the views of *postmodernist perspectives* and is followed by an elaboration of the applied research methodology. The fourth section of the chapter is dedicated to the *undertaken steps for participatory methods*. The fifth section explains how the specific research methods were adapted to the research including subsections such as *fieldwork planning, consultative meetings, focus group discussions (FGD), participatory rural appraisal (PRA), participatory mapping aided by GIS, field and participant observations and SWOT analysis*. It closes with the discussion of the *sampling methodology* used in this study and the *conclusion*.

The chapter provides the research methods used in this study in order to respond to the main research aim and objectives. The main research aim for this study is to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management. The research aim is realised by addressing the research objectives using the methods discussed in this chapter. This research used the qualitative approach for research questions requiring qualitative information. The research specifically used a number of research methods such as participatory mapping, FGD and PRA, for research questions requiring textural or descriptive information.

Methodology refers to the applied practises, procedures and rules appropriate to a field of study (Alagan, 2007). Participatory approaches outlined and used in this study promote the use of a variety of methods to address issues of community representation and empowerment. Participatory mapping methods seek to facilitate decision-making from the bottom-up rather than from the top-down and to do so using GIS technology that traditionally have been top-down ‘expert’ oriented (Harris and Weiner, 1998). This recent approach seeks to adapt and merge traditional and modern research methods in order to yield improved results.

The methodologies employed in this research enhance existing participatory methodological approaches in social science research. The specific methodology employed here involves the integration of participatory mapping aided by GIS into the process of integrated land use planning. Various datasets were gathered and collected to be used to establish the status

quo in terms of regional planning data of the Hardap region to assist with the regional planning process. Geographical data or information is important because regional land use planners need to visualise the reality of geographical features of the area before they are able to start with the regional planning process.

4.2 Postmodernism Perspective

This section provides insight into the nature of the research and how it fits into postmodernist perspectives. The postmodernist perspective is a philosophical school of thought about geography according to which this research was carried out.

At the end of the 20th century a philosophical school of thought, postmodernism, began to put its stamp on the discipline of geography. This new philosophy introduced new ways of how geography is theorised and how the world is represented. Arentsen, Stam and Thuijs (2004:1) state that the term "*post* at the beginning of the word postmodernism means that there was a modern way of thinking that proceeds the postmodern way of thinking." Knox and Marston (2004, cited in Arentsen *et al*. 2004:1) defined *modernity* as "a forward-looking view of the world that emphasises reason, scientific rationality, creativity, novelty, and progresses." This means that a scientist should not be able to withhold the truth and must, at all times, strive to discover new things.

Thomas (1993, cited in Creswell 2007:25) "calls postmodernists 'armchair radicals' who focus their critique on changing ways of thinking rather than on calling for action based on these changes." Postmodernism can be considered a family of theories and perspectives that have something in common such as land and people (Slife & Williams, 1995, cited in Creswell, 2007). The basic concept explains that knowledge claims must be set within the conditions of the world today and in the multiple perspectives of class, race, gender and other group affiliations. There are negative conditions which are revealed in the presence of hierarchies, power and control by individuals in these hierarchies and the different meaning of language. These conditions include the importance of different discourses, the importance of marginalised people and groups (the "other") and the presence of "meta-narratives" or universals that hold true regardless of the social conditions (Creswell, 2007).

Given the nature of this research, which involves humans and follows physical geography, a postmodern approach to geography was adopted for this study to allow for a more holistic approach. According to Kitchen and Tate (2000:17) ''this approach is based upon the notion

that there is no one answer, that no one discourse is superior or dominant to another, and that no-one's voice should be excluded from dialogue''. Answers Corporation (2010:1) also maintains that postmodernism is a ''philosophical stance which claims that it is impossible to make grand statements—meta-narratives—about the structures of society or about historic causation, because everything we perceive, express, and interpret is influenced by our gender, class, and culture; knowledge is partial and situated, and no one interpretation is superior to another." This philosophy was applicable to this study due to the nature of the research which involves a qualitative approach based on human and physical geography.

There are no postmodern methods as such, but the engagement with postmodernism and deconstructionist ideas in geography are likely to generate more linguistic and interpretative accounts and a greater concern with the multiplicity of experiences, all as partial and evolving ''truth'' (Rigby, 1997). The postmodern philosophy produced a new branch of political geography, referred to as critical geo-politics, and contributed to the revival of cultural geography through studies of places. "Postmodernism has confirmed in geographers the recognition that space, place and scale are social constructs, not external givens" (Answers Corporation, 2010).

4.3 The Research Methodology Used in This Study

4.3.1 Introduction

The research process involved a variety of methods applied to the data collection. As it followed qualitative and quantitative approaches, a number of empirical research tools such as FGD questionnaire surveys, PRA, sketch mapping, photo-mapping and scientific literature review were used to unravel different viewpoints, perceptions and opinions of local people and different experts on land use planning. Fotheringham *et al*., (2000:04) state that, ''qualitative methods are concerned with meaning, rather than with measurement. The emphasis is on subjective understanding, communication, and empathy, rather than on prediction and control, and it is a tenet that there is no separate, unique, 'real' world.'' On quantitative methods, Fotheringham et al. (2000:4) stated that ''quantitative geography consists of one or more of the following activities: the analysis of numerical spatial data; the development of spatial theory; and the construction and testing of mathematical models of spatial processes''. Therefore, only high-quality data was considered for final analysis during this study. "High-quality data analysed in considerable depth and methodological precision are often far better than vast amounts of data superficially analysed" (Bak, 2004:58).

4.3.2 The Research Data Sources and Process

The primary purpose of data selection is the determination of appropriate data sources, data types and instruments that allow the researcher to adequately answer research questions. This determination of appropriate data sources, types and instruments often depends on the field of study and is driven by the nature of the investigation, existing literature and accessibility to required data sources.

In Namibia, frameworks and guidelines on participatory mapping aided by GIS for integrated land use planning is a new concept. There is no legislation for and existing literature on frameworks and guidelines on participatory mapping aided by GIS for integrated land use planning to date. Therefore, relevant bills, acts and policies such as the Namibian Constitution, the National Land Policy and the National Land Tenure Policy, both in theoretical and technical contexts, were considered. The participatory mapping component of the integrated land use planning was realised with sketch mapping and photo-mapping methods as depicted in Figure 4.1.

The research methodology required a strong participation and stakeholder involvement at different stages, such as during data collection and verification of different scenarios. Therefore, an analysis of stakeholders was important prior to the participatory steps in order to know the responsibilities of different stakeholders and their involvement in land use planning. The analyses of stakeholders lead to the involvement of actual land users such as farmers and local communities. Other participatory methods such as the participatory rural appraisal (PRA) and focus group discussion (FGD) were also used during the research in order to gather different views, opinions and perceptions from different stakeholders with regard to land use planning. The process of involving different stakeholders and local communities through participatory approaches in this study is also summarised in Figure 4.1. More details are provided in section 4.6 about the stakeholder selection and sampling methodology for the study.

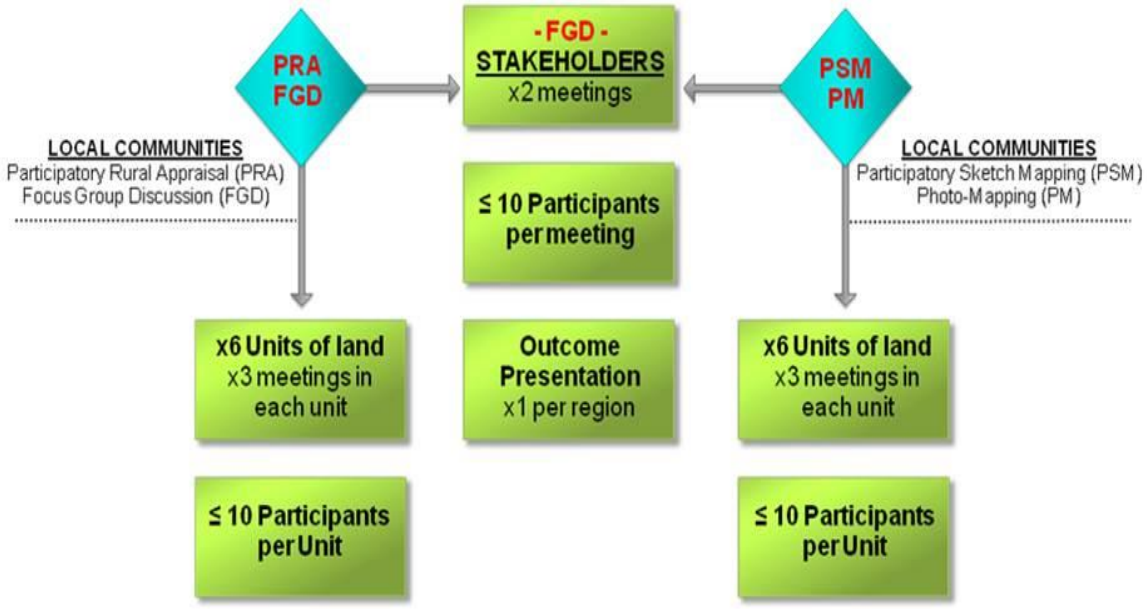


Figure 4.1: Chart depicting stakeholders' involvement

In the following sections qualitative and quantitative research methodologies as applied in this research are described. Research methodology are explained in order to provide clear understanding and to clarify their contributions in this study.

The conceptualised and developed user-friendly georeferenced digital database for sustainable land use management can be is performed using Geopublisher software. Geopublisher software is useful to store, manage, process, manipulate and display the data gathered and collected. GIS can be implemented as a comprehensive, multipurpose database (such as Geopublisher, GRASS, ArcGIS, as a specialised application oriented tool, such as GeoServer or MapQuest, or as a subsystem of a larger software package supporting handling of spatial data needed in applications, such as hydrologic modelling system, geo-statistical analysis, or real estate services Website) - (Neteler and Mitasova, 2008). The georeferenced database is developed using Geopublisher, which is open source software. Geopublisher is an atlas authoring database which allows easy publication of maps, spatial data, documents, images, videos, and statistics in the form of digital multimedia atlases. Multimedia atlases are understood as significant spatial data management tool, pre-configured end-user products of GIS which offer selected functionality only where it is meaningful. Atlases can be directly published on compact disc (CD), digital versatile disc (DVD), memory stick, external hard-drive or the Internet.

Multipurpose databases are often built from smaller components or modules which can be used independently in application-oriented systems (Neteler and Mitasova, 2008).

Multipurpose database is important to allow single users to manage the database independently. The georeferenced database is critical in responding to the development of frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management and to cater for data management of all the data collected. The multipurpose GIS usually store the georeferenced data as thematic maps. Each geographical feature or theme, such as streams, roads, vegetation, or cities is stored in a separate map using the vector or raster data model (Longley *et al*., 2005). This is important in order to create a sustainable land use management plan. The maps can then be combined to create different types of new maps as well as to perform analyses of spatial relations. Geopublisher and most of the proprietary GIS products are based on this data organisation.

4.3.3 Qualitative Research Methodology

Qualitative research explores attitudes, behaviours and experiences through such methods as focus group discussions and participatory mapping. This research methodology is employed in this study because it provides results which are descriptive in nature. The research methodology attempts to get opinions and experiences from participants. McMillan and Schumacher (1997:391) define qualitative research as a "naturalistic inquiry, the use of non-interfering data collection strategies to discover the natural flow of events and processes and how participants interpret them." This definition is supported by Bogdan and Taylor (1975:29) who explain it as "qualitative research has the natural setting as the direct source of data and the researcher is the key instrument."

The qualitative methodology aims at responding to the main study objectives in the context of participatory mapping aided by GIS in ILUP which involved local people and decision-makers' perceptions. Furthermore, the methodology was employed as some data were collected by means of structured questionnaire surveys. This implies further that time was spent in the field with local people and decision-makers to collect data using the qualitative method to substantiate the existing contexts. The research aimed to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management, which was established to be attainable through qualitative methods such as participatory mapping (sketch and photo-mapping), FGD and PRA. This is because the development of frameworks and guidelines for participatory mapping required local communities and experts' views, opinions and perceptions.

The qualitative research methodology implies the real world of programmes, organisations, neighbourhoods, street corners and getting close enough to the people and circumstances to capture what is happening (Patton, 2002). This brings closeness to the subjects which is essential as action can best be understood when it is observed in the setting in which it occurs. The setting has to be understood in the context of the history of the institutions of which they are part. In addition, Patton (2002:48) maintains that "in the context of qualitative research methods everything has the potential of being a clue which is likely to give a more comprehensive understanding of what is being studied." One significant feature of qualitative research is that it is descriptive in the sense that the data collected is in the form of words or pictures rather than numbers. Bogdan and Taylor (1975) argue that qualitative researchers in their search for understanding are confronted with the issue to not reduce the pages upon pages of narration and other data to numerical symbols. They analyse it in its original form in which it was recorded or transcribed. The written word, spoken word and drawn maps are critically important when recording data and disseminating the findings.

Bogdan & Taylor (1975) stated that qualitative researchers in most cases do not search for data or evidence to approve or reject research questions. Abstractions are built as the particulars that have been gathered are grouped together. This implies that the qualitative researcher first collects the data and gets the direction thereafter. This type of deductive reasoning is usually applied when studying geography. Bogdan & Taylor (1975) compared the process of qualitative data analysis to a funnel: aspects are open at the beginning (or top) and more directed and specific at the bottom. Similarly, the qualitative researcher plans to use part of the study to learn the important questions. A qualitative researcher does not assume that enough is known to recognise important concerns before undertaking the research. Miles and Huberman (1994) identify three types of qualitative research techniques to collect data: observation, interviews and document analysis. These three techniques are all used in order to cross-check the information.

Like all other research methodologies the qualitative methodology has both advantages and disadvantages. Some of the advantages are as follow:

- There is actual presence of the researcher in the field because he or she can validate the finding as he or she understands the context.
- The researcher can also get detailed information because he can probe and make follow-ups if the responses are vague or insufficient. In addition, the data analysis is straightforward because the data are descriptive.

- One major feature of the method, according to Miles and Huberman (1994) is that it focuses on naturally occurring, ordinary events in natural settings. Going in the field affords the opportunity to interact with the participants and enables the researcher to get valuable information compared to sending the questionnaires via mail, email or using the telephone to collect the data. The closer to the environment the greater the in-depth understanding on the subject matter.
- Qualitative research methods enable the researcher to obtain a more practical feel of the world that cannot be experienced in the numerical data and statistical analysis used in quantitative research (Bogdan & Taylor, 1975; Patton, 2002).
- The method offers flexible ways to perform data collection, subsequent analysis, and interpretation of collected information.
- Miles and Huberman (1994) testify that another feature of qualitative data is the quality of data that provides valuable information. This information is usually relevant as it reflects the environment in which it was collected. This enables a researcher to gain insight into people's behaviour and perceptions, and explore their opinions on a particular topic in more depth.

The qualitative methods are an essential part of fulfilling the goals of the research because they are concerned with the understanding of the social phenomena such as land and development from the participants' perspective. Applying these methods generates new ideas where it is not clear how the target perceives an issue or where options for addressing an issue are undefined or not well understood. Furthermore, one gains descriptive capability based on primary and unstructured data in qualitative methods. Unstructured data is a collection of records with a number of different criteria in each record. Because they are flexible the moderator can follow up on participants' initial reactions with probing questions. One may conclude that a major strength of the qualitative approach is the depth to which explorations are conducted and descriptions are written, usually resulting in sufficient details for the reader to understand the complexity of the situation.

The disadvantages of the qualitative methodology are as follow:

- It can be time consuming and expensive because the researcher has to spend time in the field (Bogdan & Taylor, 1975).
- Occasionally the participants' behaviour can change due to the presence of the researcher in their environment especially when they realise the researcher's intention and needs. In qualitative research it is easier for the researcher' prejudice

and attitude to influence the data documentation as biased (Bogdan and Taylor, 1975). This implies that it is largely impossible to escape the subjective experience, even for the most seasoned researcher. If research is conducted in a particular area, it is difficult for the researcher not to be subjective.

- It sometimes lacks consistency and reliability because the researcher can employ different probing techniques and the respondents can choose to tell some particular stories and ignore others. The major dilemma of qualitative research is to ensure the validity of the information received from the participants. In solving this problem Cohen and Manion (1994) remark that one way to validate interview information is to compare the information compiled from interviews with questionnaires — this is exactly what the researcher has applied in this study.
- Qualitative research is usually used when studying a small population. The findings of such studies, however, can be generalised to a large population. A small sample size also affects the reliability of the results because it leads to a higher variability, which may lead to distortion of results.

Consequently the advantages and disadvantages of qualitative research methodology do not encourage the growing and continuous investigation of research towards sustainable land use planning. The advantages and disadvantages of qualitative research methodology are not to be argued or compared with quantitative research methodology, as what is applicable to qualitative methods can be applicable to quantitative methods. In this study, the researcher was required to validate multiple data types that were collected from various sources as multiple research methods (FGD, PRA and participatory mapping) were used to respond to the research objectives.

4.3.4 Quantitative Research Methodology

McMillan and Schumacher (1997:616) define quantitative research method as “research that presents results with numbers. The approach uses tables and graphs to explain trends of the findings.” Quantitative researchers rely mainly on questionnaires as the main instrument to collect data. This study used questionnaires which were distributed to decision makers and local communities to complete. Furthermore, structured interviews and observations may be used in this approach and data are analysed statistically (McMillan and Schumacher, 1997). This methodology was also used in this study to find out how land use aspects in the Hardap region is managed, and whether participatory approaches were used and understood by the local people for integration in participatory mapping and GIS and implementation into ILUP.

The advantages and disadvantages of this method are critical and to be taken note of. The advantages of the quantitative methodology are as follow:

- it saves time because it can be distributed to a large number of people simultaneously and the analysis is much quicker than in the case of qualitative research;
- Patton (2002:14) states that the advantage of this method is that it is possible to measure the reactions of a great number of people to a limited set of questions, thus facilitating comparison and statistical aggregation of data. This gives a broad generalisable set of findings. This can be done for instance by using self-administered questionnaires, computers, measurements and test scores;
- that numbers are exact. “Ten” means exactly the same thing to every human-being who knows the concept, and will mean exactly the same thing in different social, cultural and linguistic contexts;
- quantitative research methods are generally easy to replicate and hence have a good prospect of reliability; and
- validity in quantitative research depends on careful instrument construction to ensure that the instrument measures what it is supposed to measure.

Like the qualitative methodology this approach also have disadvantages:

- the quantitative research method has a limitation in providing the information on the context of the situation where the studied phenomenon occurs (Bogdan & Taylor 1975).
- it is unable to control the environment where the respondents provide the answers to the questions in the survey. In fact, questionnaires without face-to-face interviews do not yield detailed information because there is no flexibility.
- the method relies heavily on questionnaires and the drawback is that the outcome of a questionnaire survey is limited to only those outlined in the original research proposal due to closed-type questions and the structured format. It does not offer a chance for probing.
- according to Bless and Higson-Smith (2000b:38) quantitative research relies upon measurement and uses various scales, thus making the data complex to work with.

Consequently, the disadvantages of quantitative approach does not encourage the evolving

and continuous investigation of a research. Because both instruments have advantages and disadvantages the researcher triangulated the data that was collected from other sources to validate it.

4.4 Steps and Procedures of Participatory Methods

4.4.1 Introduction

Fieldwork are used in this study for the purpose of gathering and collecting research data using methods such as participatory mapping, FGD and PRA. This section provides an explanation on how the fieldwork was planned and carried out in the different land units within the six constituencies of the Hardap region. The section further provides explanations of how the steps and procedures of participatory methods and GIS were applied in this study.

4.4.2 Site Selection and Fieldwork Planning

The selection of different sites for participatory approaches was done in consideration of the existing different types land use within the Hardap region. The land use in the Hardap region were considered in order to allow different types land use and users to be represented in the study as per the main research objectives and the methods to be used. Many different types of land use exist in the Hardap region. These are general residential, residential, commercial, educational, cemetery and public open spaces. Six fieldwork sites within the five major towns of each constituency were identified as fieldwork sites in the Hardap region (figure 4.2):

- Rehoboth
- Kalkrand
- Mariental
- Stampriet
- Gibeon

Six participatory studies, one in each constituency were conducted in the five major towns in order to gather different viewpoints, opinions and perceptions of the participants about land use planning in the Hardap region. Prior to conducting fieldwork within the study areas in the Hardap region, it was necessary and imperative to establish the conceptual framework for the study objectives as a whole. It was also required to socially construct the field of study.

The conceptual framework of the study was also required to determine the specific research objectives the fieldwork outcomes will address.

Pre-preparations were carried out to identify and arrange the necessary tools required to carry out data collection. The participants in the participatory mapping exercises were selected within their fieldwork towns and constituencies of the Hardap region. Different cultural backgrounds, age, gender and knowledge of their land were considered in selecting the participants, as explained in section 4.6. Cultural and beliefs played a role in gathering different viewpoints, opinions and perceptions. The various land use, different urban areas in the Hardap region influenced the selection of the fieldwork participants in all the six constituencies. Figure 4.2 depicts the locality map for the fieldwork sessions.

A number of tools and remotely sensed images were identified for fieldwork. Ortho-photos, topographic image and accessories required for the fieldwork sessions such as transparent papers, flipchart board, flip chart papers, folding table, maker pens, pens, pencils and rulers were some of the tools which were used during fieldwork in this study.

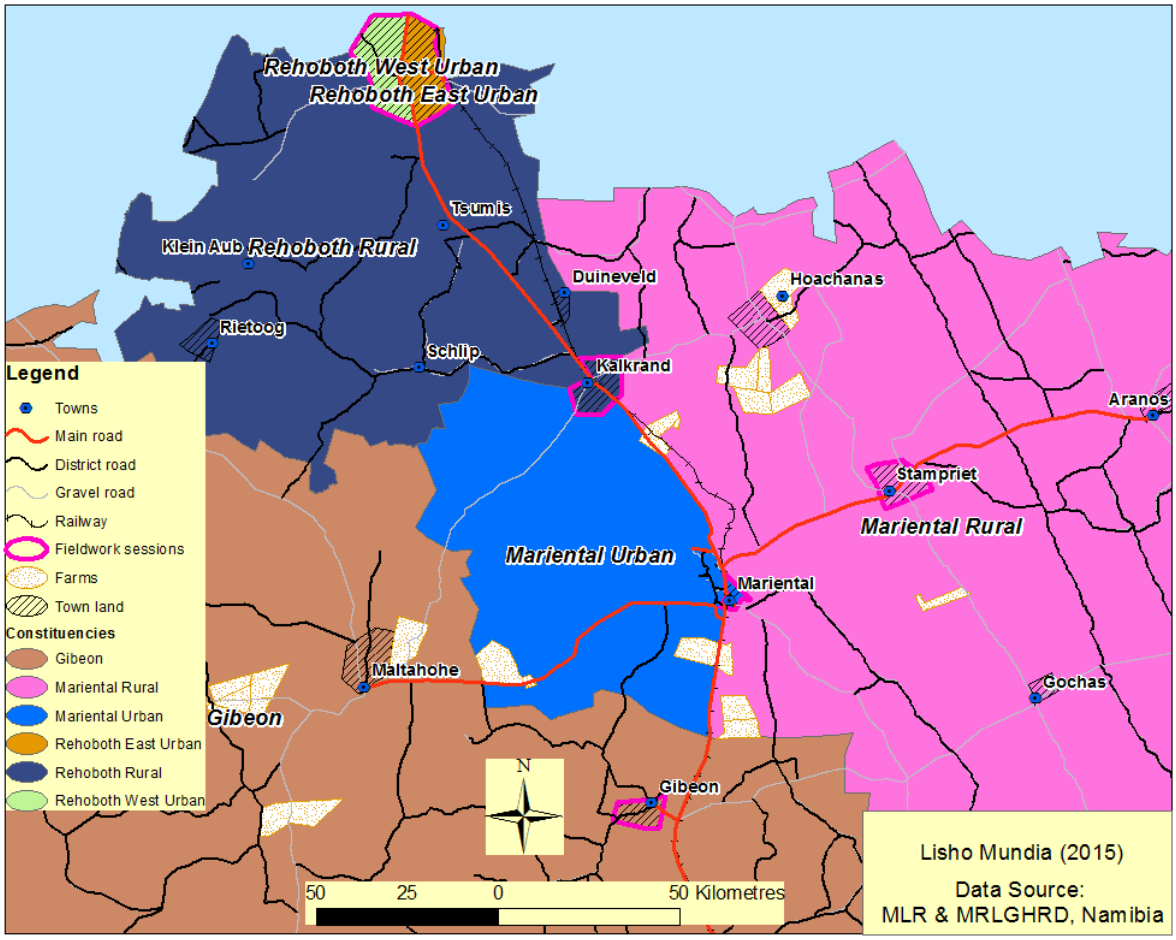


Figure 4.2: Locality map of fieldwork sessions

The participants of the participatory mapping exercises were identified via probability sampling using a stratified random sampling method which is explained and discussed in section 4.6. The communities with whom participatory mapping, FGD and PRA questionnaire surveys were carried out were called for an Information-sharing meeting. The first meetings took place in May 2011 in the areas of the participants as depicted in Figure 4.2 to explain the purpose of the research, and to agree on the dates of the FGD, PRA and participatory mapping activities. The communities agreed to participate in the FGD questionnaire surveys, PRA and participatory mapping. Georeferenced ortho-photo maps and topographic maps were used for mapping activities.

Stakeholder groups were identified as essential to be involved in the process of land use planning. The stakeholder groups were identified during consultation meetings. They were interviewed through the face-to-face consultation meetings method. The following stakeholders were identified and involved in the face-to-face consultation meetings:

- Constituency development committees (CDCs)
- The Gibeon Village Council
- Local community members from Helena Pieters' section in Gibeon
- The Kalkrand Village Council
- Local community members of Kalkrand village
- The Mariental Municipality
- Oshiwana Penduka local communities in Mariental
- Planners and consultants within the study area
- Regional Development Coordinating Committees (RDCC);
- Regional office in Mariental
- Local communities of Extension 1, Rehoboth Block E
- The Rehoboth Town Council
- The Stampriet Village Council
- Local community members of Stampriet village
- Village Development Committees (VDCs)

These stakeholders were critical in this study as they are directly involved in land use planning related tasks in their area. The stakeholder meetings generated a substantial amount of data pertaining to integrated sustainable land use planning. The views, opinions and perceptions gathered from these stakeholders contributed to the development of

frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management.

4.4.3 Steps of Participatory Methods

Participatory mapping was first conducted in July 2011 and re-conducted in November 2012 in the local communities areas as depicted in Figure 4.2 and evaluated after the entire mapping process. The participatory mapping was used in gathering local knowledge and providing participatory mapping techniques to local communities within each constituency of the Hardap region. Participatory mapping was used because the extent, use and value of participatory mapping aided by GIS implementation in land use planning were still unclear and therefore needed to be investigated in the Hardap region. Participatory methods were used for the following reasons: to study the land use planning in the Hardap region because of land disputes, conflicting land use categories in the region and poor land use planning programmes.

It was expected that focus group discussion (FGD) meetings with line ministries and partner organisations be run separately and in some cases held in conjunction with other meetings related to the research in order to have decision-makers present in those meetings. Although the FGD is appropriate in gathering experts' knowledge in land use planning, it was difficult to meet experts (decision-makers) on management level, such as managers and executive officers as they were out of office most of the time for management meetings, workshops and conferences. It was for this reason that FGD, which was undertaken with the decision-makers, was conducted in conjunction with other relevant land use planning meetings and workshops organised by the respective ministries, organisations and the researcher.

As stated earlier, Namibian laws require public participation in all national planning activities. This research incorporated a number of participatory approaches, including participatory mapping, such as sketch and photo-mapping, FGD and PRA. The participatory approaches in this study included a number of interactive sessions with the stakeholders, as depicted in Figure 4.3. Some of the techniques and procedures involved during the participants' involvement in the participatory land use planning included a combination of presentations and FGD questionnaire surveys.

The introductory presentations for the participants were used to establish a clear understanding of objectives of the participatory approaches and to provide participants with

the understanding of the analytical tools to be used in the data collection process. The objectives of the participatory approaches shared with participants were:

- to gather background data about integrated land use planning in Namibia;
- to gather knowledge about land use categories such as institutional land, residential, general residential, business, cemetery and other land use related information;
- to gather information and data about infrastructure such as roads, boreholes, telecommunication towers, railways and electricity power stations; and
- to gather data and knowledge about the use of participatory mapping in Namibia.

The FGD technique involved experts from different respective ministries, line ministries and organisations. The focus group discussions were facilitated and guided by the researcher to clarify the objectives and description of activities. This was then followed and supported by small group discussions in a FGD questionnaire survey, where participants discussed and identified other existing land use categories used for comparison of desired and undesired land uses and compromises for land conflicts in the Hardap region.

The role of the FGD questionnaire survey (see Appendix A on page 259) was to provide the line ministries and local communities with a platform to:

- declare the sectoral objectives and activities;
- identify and determine the land use types with disputes and conflicting issues;
- establish the activities that could be in conflict with other sectors' goals; and
- produce the specific compromises that would have to be accepted by each sector to prevent land use conflicts.

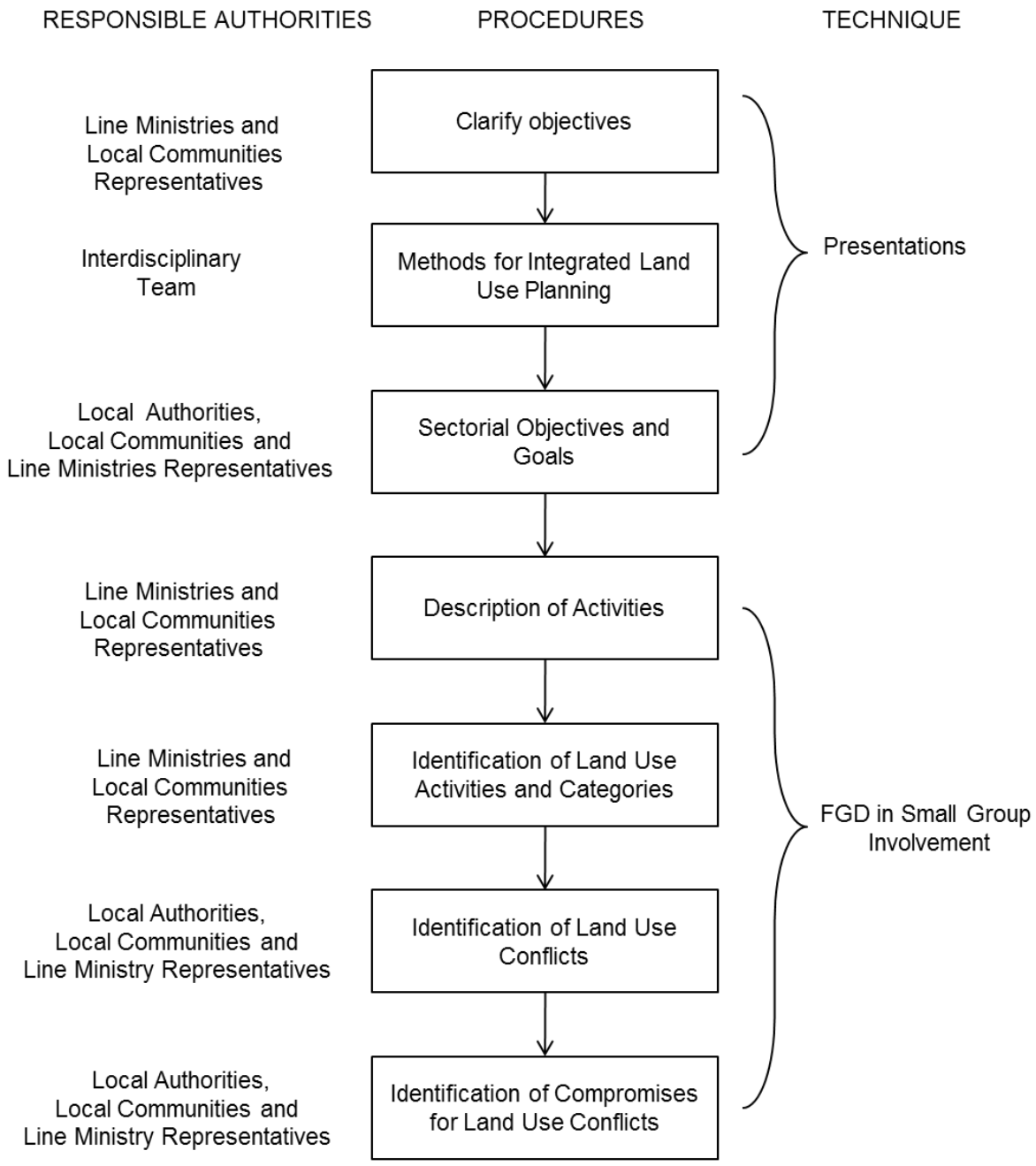


Figure 4.3: Flow chart of the participatory involvement in land use planning

Participatory approaches such as PRA, FGD, sketch mapping and photo-mapping were the approaches used in this research to obtain a variety of data and knowledge from different participants in the Hardap region and Namibia at large. The concept of participatory mapping in integrated land use planning in the Hardap region was critical in this study. This was because it involved inputs (at local, regional and national level) regarding the planning and data gathering stages of this research. Inclusivity was taken into consideration to involve community members from each constituency. The two methods, sketch mapping and photo-

mapping are compared and evaluated with the GIS produced base maps. The two methods are used in gathering data through local spatial knowledge about infrastructure such as boreholes, telecommunications, roads, wind pumps and kraals in the Hardap region.

It has to be pointed out that sketch and photo-mapping are not the same. The two methods produce different results. The significance that the two methods have in terms of the participatory mapping results is also different. The results of these two different approaches are presented in chapter 5.

The role of GIS was vital in the entire process of this study, starting from gathering quantitative data to analysing such data. GIS was used to pre-process collected data, store data, evaluate the data, manipulate data and present data of all the secondary spatial datasets gathered for use in this study. GIS was also used to gather, manage, process and analyse spatial and non-spatial data from participatory mapping, FGD and PRA in order to turn the data into meaning information, as presented in chapter 5.

4.5 Specific Research Methods Used in the Study

4.5.1 Introduction

This section provides explanations on how research methods such as consultative meetings, Focus Group Discussions (FGD), Participatory Rural Appraisal (PRA), participatory mapping aided by GIS, field and participant observations and SWOT analysis were applied in this research. The research methods were used to elicit the required data and information. Since these research methods are linked to the research objectives as presented in chapter 1.

4.5.2 Consultative Meetings

In this study, consultative meetings were used as a tool to achieve the research objective of producing a SWOT analysis for the evaluation of the outcomes of participatory mapping aided by GIS for sustainable land use management in Namibia. The method helped to complement other methods applied in the study and to gather existing information and knowledge relevant to the study. The consultative meetings also helped the participants acquire more knowledge from the researcher on how to be involved in participatory mapping in the implementation of integrated land use planning.

The interview method was used in this study for the following reasons:

- Experts have a deep insight into aggregated knowledge; and
- To gather specific knowledge about participatory mapping, GIS and land use planning processes and strategies in Namibia.

Various consultative meetings took place in Mariental, Rehoboth and Windhoek with different experts, target groups and individuals. These consultative meetings took place during the years 2010, 2011 and 2012. Expert consultative meetings are instrumental for gathering viewpoints, opinions and perceptions about the research when conducting qualitative research. In the view of Sevillo (2012), stakeholders' consultative meetings offer expert knowledge which can be divided into three dimensions:

- *Technical knowledge:* The interviewee expert can offer specific knowledge about a certain subject with details, such as on laws and policies;
- *Process knowledge:* The expert is able to give information on routines, specific interactions and processes due to their direct involvement with the subject.
- *Explanatory knowledge:* The interviewed person can converse about subjective interpretations of relevance, rules and beliefs as well as ideas or ideologies and their inconsistencies.

It is often difficult to investigate and gather this kind of insight and knowledge with other methods as experts' views, opinions, perceptions and local communities' knowledge can be understood best by interactive and participatory means. This may help provide further contacts in other local communities and experts in related field of study. In addition, local communities and experts are frequently motivated people who are willing to cooperate and exchange knowledge.

FGD, PRA and participatory mapping as initially applied in this study were tested after consultative meetings. The testing date and time of these particular approaches were set with the targeted participants. The FGD, PRA and participatory mapping approaches were piloted in February 2010 with five (5) government officials, four (4) non-governmental organisations officials and three (3) farmers of the Hardap region respectively. The process of piloting the FGD and PRA yielded a positive feedback, which indicated that the content of questionnaire was well understood and that there are the suitable methods for the study. The tested participatory mapping approaches (sketch and photo-mapping) also yielded a positive feedback and showed to be suitable for the study. The relative high numbers of

stakeholders were representatives from local communities, government expert and non-governmental organisations.

4.5.3 Focus Group Discussions (FGD)

Focus group discussion refers to the style of interview that is designed for small groups (Berg, 1998). The purpose of interviewing various stakeholders was to measure and draw on their experience and expertise to achieve the following research objectives of the study:

- To conduct a SWOT analysis for evaluation of outcomes of participatory mapping aided by GIS for sustainable land use management in Namibia; and
- To produce frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia.

The above research objectives were realised by gathering different viewpoints, opinions and perceptions through FGDs (see Appendix A on page 259) with local communities and experts in Namibia. A focus group discussion questionnaire survey is a form of structured guided questions for a group discussion involving a facilitator and a group of people with knowledge and interest in a particular topic. Section A of the FGD have questions on the background information of the participants in relation to their gender and age. Section B of the FGD questionnaire survey dealt with land use activities and infrastructure with question of land use, infrastructure and natural phenomena availability and land dispute resolution. Section C of the FGD questionnaire survey is about the use of participatory mapping, with questions relating to the use of participatory mapping and maps.

Bless and Higson-Smith (2000a:110) state that “a focus group consists of between four and eight respondents who are interviewed together.” Marczak and Sewell (1990 as cited in Mundia, 2007:51) explain that “a focus group typically consists of seven to ten people who are unfamiliar with each other.” Clifford and Valentine (2003:119) has different views on FGDs — they maintain that “a focus group is a group of people, usually between six to twelve, who meet in an informal setting to talk about a particular topic that has been set by the researcher.” This research required a minimum of seven (7) and a maximum of ten (10) focus group discussion participants in its separate meetings. The number of participants was determined based on models in the existing literature such as Bless and Higson-Smith, 2000b; Clifford and Valentine (2003) and Mandara (2007).

The FGDs in other studies were successful, appreciated and acceptable in participatory mapping and GIS research as confirmed by Mandara (2007) in the field of planning and coordination and natural resource management. In this study, the participants were selected based on the existing constituencies in which the participants live, population variation, types of land use in the region. This selection helped in incorporating different fieldwork sites covering high settlements and towns of Hardap region with active participants in development issues. The participants were selected based on their knowledge related to and required for the research topic. The focus group participants were carefully selected according to explicitly stated criteria, which are knowledge of the study area and knowledge of the research topic.

The focus group discussion was conducted in unstructured and semi-structured interviews. The advantages of FGDs are that the participants are able to discuss the issues in question with each other. It also provided opportunity for participants to learn from each other and to solve important land use issues which they were confronted with. FGDs method also takes advantage of the fact that the participants naturally interact with each other and that participants are encouraged by others to participate in the discussions.

The FGD for this study required participants from experts, local communities or communal farmers of the identified sites within the six different constituencies of the Hardap region. Three meetings were held in each site within the six constituencies of the Hardap region, each lasting four hours or longer. Figure 4.4 depicts a picture of local people in Kalkrand participating in one of the FGD sessions.

Figure 4.4: FGD Session in Kalkrand
Photo by: Lisho Mundia, 2011

The FGD (see Appendix A on page 259) was divided into two sections. The first section gathered information from experts in different line ministries and various organisations. The second section was used to gather information from local communities in the Hardap region. The ministries from which experts' information were gathered includes the MLR; the Ministry of Regional, Local Government, Housing and Rural Development (MRLGHRD); the Ministry of Agriculture, Water and Forestry (MAWF); the Ministry of Mines and Energy (MME) and the Ministry of Environment and Tourism (MET). Other government partner organisations such as the National Planning Commission (NPC), Namibia Statistics Agency and relevant stakeholders such as farmers and researchers were also involved. The meetings helped to gather meaningful inputs, recommendations and information considered in this study as per the research aim and objectives.

4.5.4 Participatory Rural Appraisal (PRA)

PRA can be described as a family of approaches that enable people to express and analyse the realities of their lives and conditions, to plan themselves what action to take and to

monitor and evaluate the results (Wageningen UR Centre for Development Innovation, 2008). Kumar (2002:29) stated that “participatory method showed a way out to participation in planning. Hence it was received with enthusiasm as even the non-literate and less articulated people could participate meaningfully in depicting their situation by making maps and diagrams and by producing plans to change their situation.”

Kumar (2002:29) stated that “PRA provided a space for many more poorer and marginalised people to articulate their problems and indicate what could be done to improve their conditions.” This led to a popular surge in favour of the participatory methodology. A number of participatory approaches with varying terminologies have since come into practice over a period of time. RRA was first to appear. RRA was then used to denote related rural appraisal. It later evolved into PRA or participatory rural appraisal (Kumar, 2002).

Kumar (2002:40) further stated that “the principles of PRA have evolved over time, interestingly; new principles are still being added to the list. What distinguishes these principles is that these are induced rather than deduced, and based on practice and experience of what works and what does not work.” Chambers (1997 cited in Kumar, 2002: 40) has listed “the following principles shared by both PRA and RRA:

- a reversal of learning: outsiders learning from local people;
- learning takes place rapidly and progressively;
- offsetting the usual biases of development enquiry towards the powerful and the accessible;
- optimising trade-offs between the costs and the benefits of detailed research,
- triangulating or cross-checking between participatory methods; and
- seeking diversity".

The study employed PRA (see Appendix B on page 263) as a means of gathering different viewpoints, comments, inputs and information from land use planning experts, and community members respectively, on use of the environment and land use in the Hardap region. This was significant in order to respond to the research objective of producing frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia. Because of the qualitative nature of this study, participatory rural appraisal was used in this study for further interactiion with experts and local communities in gathering their viewports and knowledge. A range of qualitative data and descriptive information were collected by means of participatory rural appraisal methods.

The PRA was applied in this study in order to gather indigenous knowledge and processes which empower local people with basic mapping skills for integrated land use planning. Like FGD, the PRA required a minimum of seven, but not more than ten attendants in the separate meetings of local villagers, local settlers or communal farmers of the six different constituencies of the Hardap region.

4.5.5 Participatory Mapping Aided by GIS

A map is a powerful medium for the representation of ideas and the communication of knowledge about places. It has been used by geographers to store spatial information, to analyse and generate ideas and to present results in a visual form. Maps are not just artefacts - mapping is a process reflecting a way of thinking (Clifford and Valentine, 2003).

In **participatory sketch mapping**, the features on the maps are usually not to scale. The features were sized to match the relative importance that participants attach to them. If properly facilitated, the process is documented and features are recorded on a legend necessary for interpreting depicted symbols. Since features presented are not scaled consistently or georeferenced, there is the probability of subjective interpretation of the final output. Participatory sketch mapping requires the following steps:

- defining the mapping context and community issues;
- technical and logistical preparation;
- making the mental map;
- analysing the mental map; and
- conducting an optional transect walk.

Participatory sketch mapping done on the mapping units on Figure 4.2: Locality map of fieldwork sessions begins by giving the participants an overview of the community context. Then explaining the issues to be addressed through a mapping exercise and explaining the reasons why ground or sketch mapping is an appropriate mapping approach for tackling the identified community issue/s.

Logistical preparation requires selecting the mapping venue, determining a suitable number of participants and the composition of the group (such as gender, age or ethnic group) and identifying the area to be mapped and how the participants arrange themselves, for example, sitting in a circle. Technical preparation requires assembling and confirming the

adequacy of the mapping materials, orienting the participants with respect to direction, and agreeing on the mapping extent and the appropriate paper size. Participatory sketch mapping was done on large sheets of paper varying in size between A3 and A0.

Participatory mapping took place in different units of land within the six constituencies of the Hardap region. Participatory sketch mapping and photo-mapping were used with local communities' participation in their respective areas in order to respond to the research objective of producing participatory land use maps from different units of land within the six constituencies of the Hardap region by local communities. Participatory sketch mapping and photo-mapping were used to gather spatial knowledge from the participants by producing stand-alone maps. Different colour pens we used to distinguish between features to represent real world features, such as points, lines and polygons. With regard to photo-mappings, this was performed on prints of geometrically corrected satellite images, aerial photographs and orthophotos.

To make the map, the participants were invited to sketch their mental maps and perceptions on the ground or on paper. The participants visualise space-related features. These may vary depending on the characteristics of the participants, for example, whether they are men or women, youth or elderly. A legend is then created and is agreed-upon by the participants to represent various themes such as land cover or land use and infrastructure and features such as roads, river, schools and houses. Figure 4.5 shows an example of a legend for a sketch map which was used in this study. By using different symbols in the legend to represent different features, participants depict their mental maps and perceptions on the sheet of paper. The rule is to attain the KISS principles - Keep It Short and Simple (KISS) by limiting the number of different features on one map to a minimal number that the eyes can observe. In order to emphasise the KISS-approach, it was communicated to the participants to focus on drawing or delineating the following land uses: residential, business and cemetery, which they know and are able to explain.

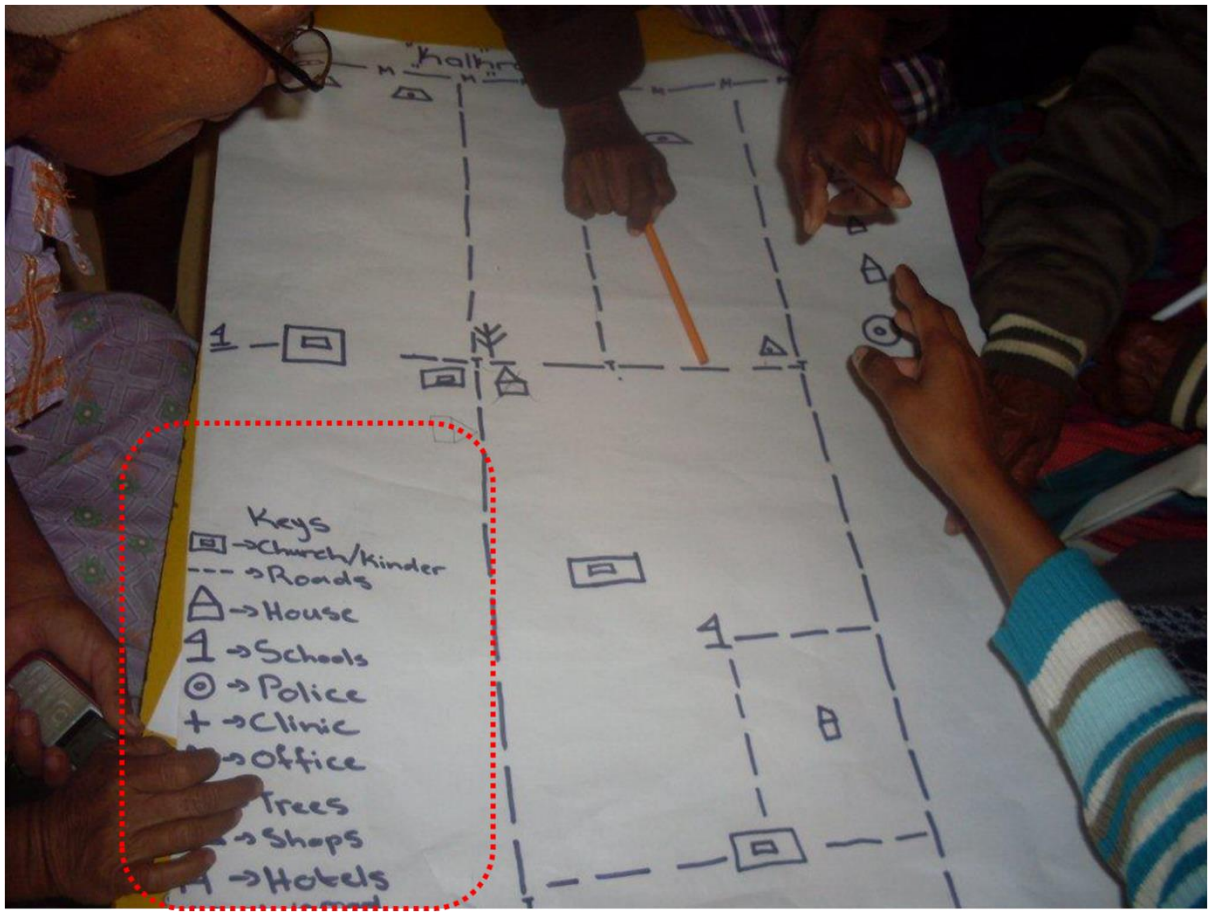


Figure 4.5: Sample legend for a sketch map
Photo by: Lisho Mundia, 2011

Once the maps were completed, participants performed a verification process to validate the mental map to determine characteristics such as position, patterns, trends and relationships. Mental map analysis helps answer key questions such as:

- What is in the area?
- Where is the feature located in the area?
- What are the names of the features?
- How features are spatially related?
- How the built areas are spatially related.

After the participants completed the mapping process, a transect walk (applied on all sketch land use maps) was done for ground truthing to verify the land use and facilitating further in-depth discussions with the aid of a completed sketch map. It has to be pointed out that this is not possible for ground drawn maps. Participants walked along a few cross-sectional directions that best represent the geographical features under consideration in the mapped

area. The transect walk is usually performed by developing a narrative or pictorial description of the cross-sectional findings.

Participatory photo-mapping achieved the objective of producing participatory (by local communities) land use maps of different units of land within the six constituencies of the Hardap region. This was achieved with the use of two participatory mapping techniques (sketch and photo-mapping). Below are some examples of types of maps and imagery that are commonly used as base maps for participatory mapping:

- topographical maps;
- orthophoto imagery ;and
- aerial photographs.

The base map, which can be an ortho-photo or topographical maps, used for community mapping should show basic geographical features such as rivers, roads, coastlines and usually topography or terrain features. These natural features or landmarks, as depicted on Figure 4.6, serve as reference points to orientate the participant.

A base map, like Figure 4.6, should have a scale, north arrow and should always be georeferenced. The map grid on such a base map serves as a reference for locating geographical features. The north arrow serves as a reference for directions. The scale serves as a reference to get an idea of relative feature sizes and distances between features. Base maps provide the basic geographical reference information to enable users to locate geographical features.

There was a need to use **GIS** for creating land use maps from existing land use data of the Hardap region. Comparison of desired and undesired land uses was done with the participation from local, regional and national stakeholders. The use of GIS also contributed to help respond to the main research objective which is to produce a comprehensive user-friendly digital georeferenced database for integrated sustainable land use management in the Hardap region to be used by the MLR.

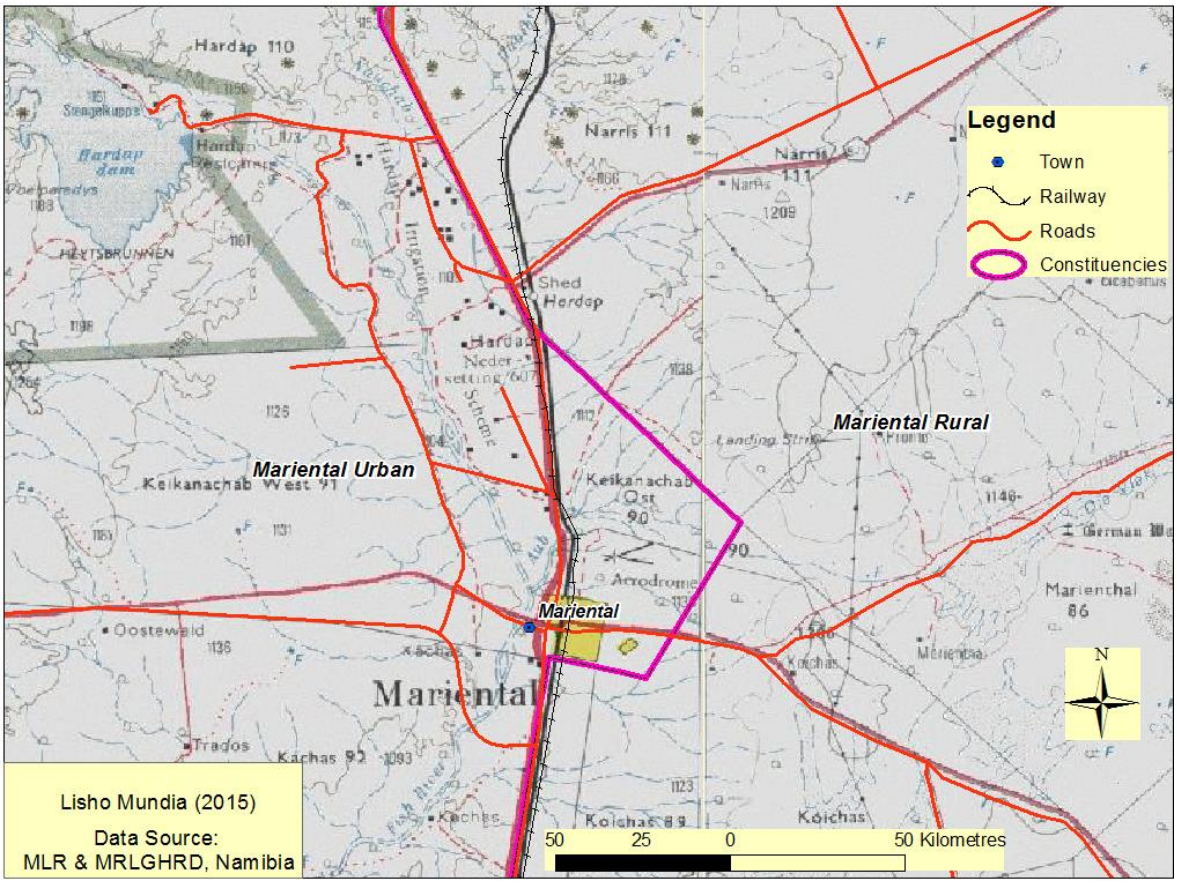


Figure 4.6: Base map for participatory photo-mapping

A database was created to store all collected spatial data and participatory maps. The spatial data, participatory maps and produced GIS maps were all stored in a digital georeferenced database which was developed using Geopublisher software. The software was also further used for storing of all participatory maps, storing raster and vector data (points, lines, polygons and surfaces) which were then customised to meet the requirement of this study. The software was chosen to be used for spatial data management in this study because it was suitable for managing and monitoring different land use planning data and information.

The ArcGIS 9.x software was chosen as it is compatible with most handheld GPS for downloading and uploading spatial data and it is widely available and commonly used in Namibia. Spatial data processing such as overlaying and other qualitative mapping processing and analyses was conducted using the *ArcGIS 9.x* software after verifying the land use categories with the local communities and line ministries. The land uses were delineated with the help of the land users in the local communities. Müller and Wode (2003:01) state that “in this process villagers delineate their land use on transparencies laid over an orthophotograph.” Semi-detailed sketch and photo-maps of these areas were

prepared by the researcher at appropriate scales (1:25 000 to 1: 50 000), using ortho-photo and topographic mosaics as backdrop. The results of the delineation mapping were then overlaid on the digital raster imagery in the *ArcGIS 9.x* software. The results were then verified with the point data (water points, public telephone points and telecommunication poles) collected by means of a GPS and the existing secondary data for final analysis.

Spatial data processing was done using all the available spatial base data from secondary sources in the study area. As spatial base data did not meet all requirements with regards to coordinates and attributes, spatial data such as location of water points, public telephone points and telecommunication poles were also collected by the researcher, using *handheld GPS*[7] instruments to supplement the existing spatial base data.

Other secondary data such as farm datasets, roads, water infrastructure, telecommunication infrastructure and towns' datasets were edited by the researcher in the pre-preparation of the datasets in order to meet the integrated land use planning data standards as required in this study and in accordance with national spatial data standards of Namibia.

The line ministries, partner organisations such as non-governmental organisations and local authorities were the main sources of spatial data, such as ortho-photos, topographic maps, GIS vector data, and satellite images, and other information relevant to this study. These organisations and authorities are the data custodians, main ministries and organisations to which sustainable integrated land use planning is of vital concern in Namibia.

Further data descriptions and data values were captured as attributes for each land use dataset. These land use datasets were data such as the land sizes, the land ownership, the present land use, the potential future land use and the respective development potential or problems, risks or environmental hazards (to be presented in chapter 5).

4.5.6 Observations

Field observations conducted during the process of participatory mapping, PRA and FGD contributed in achieving the aim of developing frameworks and guidelines for participatory mapping. The objectives of the field and participant observations were discussed with the communities and other stakeholders throughout the research. It was important to carry out field and participant observations in order to verify and respond to the research objective of

[7] Global Positioning System is a constellation orbiting the earth at a height of 12,600 miles; five monitoring stations and individual receivers (Steede-Terry, 2000:03).

producing frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia.

The participants of the focus group discussions provided valuable information about the participatory mapping approach. Observation of participants involves spending time being, living or working with people or communities in order to understand them (Clifford and Valentine, 2003:133). Observation, according to Marshall and Rossman (1999:107), “entails the systematic noting and recording of events, behaviours, and artifacts (objects) in the social setting chosen for study.” Bless and Higson-Smith (2000a:104) maintain that “participant observation is a very demanding means of gathering data and may involve extended periods of residence among respondents.” In this study, group observation was conducted at several stages in the research and participant interaction in the data exploration, data review, and map navigation stages was carefully monitored. A number of participatory actions were observed — these include:

- participant interaction and use of the participatory mapping techniques;
- informal discussion among focus group members;
- situations of uneasiness among participants in the participatory model;
- the willingness and unwillingness of group members to involve themselves with sketch and photo-mapping; and
- the note-taking phase.

During the observation of the participants, the focus group members and the researcher became involved in informal discussions regarding issues related to data representation, data access, and local knowledge integration with expert data. These observations were recorded through note-taking and digital photographs of activities. The process of interacting with the focus group during the workshops provided the researcher with close contact with the participants and a better understanding of and sensitivity to their needs and desires to engage in the integrated land use planning process.

4.5.7 SWOT Analysis

The Strengths, Weaknesses, Opportunities and Threats (SWOT) method was used to evaluate the outcomes of participatory mapping aided by GIS for sustainable land use management in Namibia. The SWOT analysis was realised by gathering knowledge through FGD and consultation meetings with local and regional communities from the Hardap region

and different experts in Namibia with relevant experience of land use planning and GIS. The SWOT analysis was used to establish the interactions between local people and experts during the focus group discussions and the participatory mapping activities. Assessments of how SWOT analysis method contributed to the research process were discussed with the participants accordingly.

Lai and Rivera (2006:01) state that “the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is an environmental scanning tool used to facilitate discussion and identify key criteria in situation analysis and problem solving. It is most often used in marketing or management strategy development. SWOT is a flexible tool that can be applied to situations and problems in a wide range of disciplines.” Gupta (2000) in the study titled ‘*SWOT analysis of geographic information: The case of India*’, used SWOT analysis to evaluate the geographical information of India SWOT analysis helps in identifying and evaluating strengths, weaknesses, opportunities, and threats that land use planning organisations and project implementers face in given circumstances and to develop options to deal with external threats and exploit opportunities by matching external possibilities with internal capabilities.

According to Carver (2001:67) “the industry standard strategic response to any SWOT analysis is simply to build on your strengths, address your weaknesses, exploit the opportunities and neutralise any threats. The same can be said of participatory mapping and GIS.”

SWOT analysis is a tool commonly used as part of strategic planning processes. It is a way to structure community members’ ideas, thoughts and beliefs related to a particular decision such as selection of a mapping method or a combination of mapping methods to meet one or more goals. Gupta (2000) concluded in the study that “geographical information is today being extensively used in decision-making processes because it has become a fundamental element to provide better understanding about one's surroundings.” Strengths and weaknesses focus on the internal factors (within the community), while opportunities and threats reflect the influences of the external environment affecting the organisation, community or activity. These may include cultural, political, economic, environmental, technical and other dimensions.

The SWOT analysis helps identifying a strategy and related actions to build on positive factors and to mitigate the potential impact of or overcome negative factors. The procedures used to conduct a SWOT analysis in this study were as follow:

- Invite participants (same participants as for participatory mapping);
- hand out marker pens to all members;
- display sheets of paper, each displaying a SWOT grid (for example, strengths or weakness) respectively;
- clarify the specific item to be assessed and define terms, for example, strengths, weaknesses, opportunities and threats, in the context of the internal and external environments of the community;
- verify that everybody has a clear understanding of the objective of the SWOT analysis;
- ask the participants to think of all the strengths, weaknesses, opportunities and threats;
- gather the ideas and opinions, write them on the SWOT grid or paper;
- ask one participant to read the grids aloud one at a time and encourage discussion on each issue;
- ask if the participants have any more points to add after they have heard everyone else's point of view;
- facilitate the analysis of results;
- give the participants enough time to think about their answers; and
- discuss results with the participants and solicit agreement.

4.5.8 A Review of Research Objectives

This research integrates local communities' knowledge in integrated land use planning using participatory mapping approaches such as sketch mapping, photo-mapping, FGD, PRA and GIS technology to respond to the main research objectives. Participatory mapping is a methodological approach which brings forward the geographical features in the form of a map and the socio-economic aspects in the form of a description through discussions with different participants. Within this context, integrated land use plans are socially constructed. The main research objectives guided the methods and processes of the research. In order to be able to orient the data collection, data analysis, data interpretation and data utilisation of the research, Table 4.1 provides the details on how each research objective was approached with the respective research method(s) and process. This research addressed some clarity and responses to the five core research objectives presented in Table 4.1.

Table 4.1: Research objectives and process of the methodologies

Objective/s	Methodology/ies applied	Participants
1. To produce participatory land use maps from different units of land within the six constituencies of the Hardap region by local communities	Participatory sketch mapping and photo-mapping	Involved local communities' participation in their respective areas
2. Produce land use maps of the Hardap region from existing land use data for comparison of desired and undesired land uses.	Generating land use maps from existing land use data of the Hardap region using GIS	Involved local communities' participation in their respective areas and inputs from experts' inputs and researcher's technical knowledge.
3. Produce a SWOT analysis for evaluation of outcomes of participatory mapping aided by GIS for sustainable land use management in Namibia	Focus group discussion and consultation meetings	Involved experts, local community and scientific literature reviews
4. Produce frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia	Focus group discussion, PRA and photo-mapping	Involved local communities' participation in their respective areas
5. Conceptualisation and setting up a user-friendly comprehensive georeferenced digital database for sustainable land use management in the Hardap region to be used by the MLR	GIS software (Geopublisher) and the focus group discussion	Required experts' involvement and GIS experience

The research methodologies were decided upon to respond to the primary research objectives of the study in the context of integrated land use planning. Furthermore, they represent an important contribution towards the integration of local and expert knowledge for participatory analysis. Participatory mapping in this context offers opportunities for communities to generate and document local knowledge about land use planning.

By developing a greater understanding of a changing world with regard to land use, land use planning and mapping communities' perceptions of their land use activities, there is potential to understand and overcome the differential complex nature and problems of land use in Namibia. Local knowledge could augment "expert" knowledge about land uses for complementary outcomes. Furthermore, such integration could promote the development of land use mitigation strategies based on the integration of local and other types of knowledge. Land use coping mechanisms might incorporate such strategies within an overall livelihood

strategy. The integration of participatory mapping provides insight about differential land uses and some guidelines towards the development of appropriate integrated land use planning mitigation policies for the Hardap region and the Namibian community as a whole.

4.6 Sampling Methodology for the Study

4.6.1 Introduction

This section provides details on the data sampling methodology applied in this study. Firstly, it begins by describing the population and sampling size utilized for the Hardap region, secondly it explains the stratified random sampling method and lastly it outlines the process of processing of spatial and non-spatial data.

Bless and Higson-Smith (2000b:84) define sampling as “a technical accounting device to rationalise the collection of information and to choose in an appropriate way the restricted set of objects, persons and events from which the actual information will be drawn.” Mouton (1996:134) also refers to sampling as the process of selecting objects or phenomena when it is impossible to have knowledge of the entire population of the phenomena. It is also regarded as the process of drawing conclusions about unknown population parameters from the known sample statistic.” Therefore, the term sampling means taking any portion of a population as representative of that population.

The type of sampling employed in this study is probability sampling using the stratified random sampling method. Seaberg (1988:254) writes that “in probability sampling each person in a population has the same known probability of being selected.” This means that the selection of persons from a population is based on some form of random procedure.

4.6.2 Population and Sampling Size Utilized for the Hardap Region

Ideally, the research would consider the entire population, but in reality this is impossible, compelling the research to settle for a sample. A sample is a portion or a subset of a larger group called a population. It is therefore important that the sample characteristics be the same as those of the population (May, 2001). According to Clifford and Valentine (2003:223), “sampling is the acquisition of information about a relatively small part of a large group or population, usually with the aim of making inferential generalisation about the large group. Sampling is necessary in research because it is often not possible, practicable or desirable to obtain information from an entire population.”

Six sites were identified within the study area. One site was identified in each constituency within the Hardap region. The sampling was restricted to the six constituencies of the Hardap region in order to allow each constituency to be represented in the study. The rationale was for the sample to be representative of the six constituencies' classes and different lifestyles of the participants reflected within the whole study area. This was done deliberately to achieve a well-represented sample with views from the societies that are quite diverse in land-related issues. Another reason was to ensure that the unique characteristics of the six different constituencies within the Hardap region were adequately represented. This was achieved by selecting participants from each constituency in the Hardap region, based on different land use types and locations.

A sample of 100 participants for the entire study area was the targeted population as shown in Table 4.3. Based on the literature of Bless and Higson-Smith, 2000b; Clifford and Valentine (2003) and Mandara (2007), a total of between seven (7) to ten (10) participants in each of the six sites were selected to participate in the FGD, PRA and participatory mapping. The sample was chosen because it was deemed inappropriate to represent the entire population of the study area. The total population in each of these sites was within the range of 300 to 500 people. This sampling was also done in accordance with the requirements of the methodologies, participatory mapping, FGD and PRA, applied in this study. FGD, for example, requires a minimum of seven (7) and a maximum of ten (10) participants. The sampling involved certain individuals with experience in urban and rural land issues from the respective fieldwork sites whose inputs to this study were deemed significant.

Data sampling is important for any research. According to Bailey (1982) "a relatively small sample size is adequate and can allow the estimate of sampling error, and it is quick to process." On the other hand there is an argument that the size of the sample is not necessarily the most important consideration. A large poor quality sample, which does not reflect the population characteristics, will be less accurate than a small one (May, 2001).

4.6.3 Stratified Random Sampling Method

Simple random sampling, systematic sampling, stratified random sampling, cluster sampling, purposive sampling and panel sampling are standard probability sampling methods. The stratified random sampling procedure was followed for this research project because the data of this study were mutually exclusive of the same characteristics. Stratified random sampling is the term used in dividing the population into different groups or strata, which are

mutually exclusive of the same characteristics, such as gender, race, home language or age. Table 4.2 indicates the stratified random sampling that has been applied to the Hardap region.

The Hardap region population was too large for the researcher to cover it all. Hence there was a need to sample the representation. Grinnell & Williams (1990:127) state that “in most cases a 10% sample population should be sufficient for controlling errors.” In this case, the researcher used 100 participants as sample (Table 4.2) that represented more than 30% of the population for the area of study. This means that the sample population has approximate characteristics relevant to the study.

Studying a sample proved to be more convenient, because it was physical and financially impossible to study the entire population. The sampling groups were divided into strata according to gender, age and land use types. According to Grinnel & Williams (1990:127) “it is sufficient to use 30% of sampled participants when basic statistical procedure is to be performed in any study.” In this study a similar approach was used. Samples included males and females from the age of 18 to 70 whose land use types vary in location, sizes and shapes. The selection of participants was based on various age groups, gender and different types of land use in the Hardap region. The researcher used stratified random sampling in order to draw sampling units from a stratum in proportion to the population size, gender, age and type of land use.

It is important to consider age and gender issues in land use planning for the purpose of inclusiveness. The Food and Agriculture Organization (2002:90) stated that “Gender differences in land tenure should be recognised if land objectives, such as increasing land productivity, providing affordable housing, or promoting sustainable resource management, are to be met.” Gender issues are important because without specific attention to gender inclusiveness, important segments of society may be excluded from the benefits of land administration, management and development.

Table 4.2: Stratified random sampling applied in the Hardap region

Population	Target Population	Proportion Sample	Gender	Age (years)
300 to 500	100	50 (50%)	Male: 50% Female: 50 %	18 to 70

4.6.4 Collection and Processing of Spatial and Non-Spatial Data

The analyses and processing of data was imperative before producing land use maps of the Hardap region from existing land use data for comparison of desired and undesired land uses. The data to be managed in a user-friendly comprehensive georeferenced digital database must be accurate for sustainable land use management of the region because it is perceived that it will be used by the MLR.

Throughout the study, some information was captured in field notes for processing and incorporation in the study. However, the main strategies for collecting data was through the defined methods such as FGD, PRA and participatory mapping. The gathered data was systematically processed after collection. The first step of analysing the FGD and PRA was to transform the raw data of the questionnaires and field notes into meaningful information. A total of hundred and fifty (150) questionnaires were distributed within the study area. A total number of seventy-five (75) of these were FGD and seventy-five (75) were PRA questionnaires. From the total number of distributed questionnaires, sixty-seven (67) FGD and thirty-eight (38) PRA questionnaires were returned as presented in Table 4.3. FGD interview sessions were split into two sections. The first section had thirty-eight (38) participants from local communities and the second had twenty-nine (29) participants from experts in land use planning and GIS. The FGD questionnaire on expert level was processed separately. A total of twenty-nine (29) FGD questionnaires on expert level were distributed and returned.

Table 4.3: Distributions of FGDs and PRAs survey techniques

Questionnaires Survey Techniques	Number of Questionnaires Distributed	Completed by Local communities	Completed by Experts	Returned
Focus Group Discussions	75	38	29	67
Participatory Rural Appraisal	75	38	Not applicable	38
Total	**150**	**-**	**-**	**105**

The experts' and local people's knowledge about participatory mapping in land use planning was gathered using the FGD and PRA techniques. The data gathered from local communities and experts were processed and presented separately. Qualitative data such as ordinal responses data and open-ended responses data were analysed using Microsoft Excel software. The Microsoft Excel software was chosen to capture and analyse data. This was because, firstly, most of the questions were closed-ended making their capturing easier

than capturing of open-ended, for example “yes” and “no” responses. Secondly, the respondents did not give long answers to the open ended questions. The shorter answers made it easy to capture answers as “themes.” The questionnaires were numbered from one (1) to twenty-nine (29) for the FGD and one (1) to thirty-eight (38) for the PRA respectively, to easily document the total number of questionnaires received from the respondents.

Spatial data gathered from secondary sources, and participatory mapping approaches were analysed using ArcGIS 9x software. The spatial and non-spatial data were stored and managed in ArcCatalog. Non-spatial data gathered through FGD, PRA and consultation meetings were all categorised in Microsoft Excel software.

All non-spatial data such as land use categories and land ownership information was linked to georeferenced files with matching spatial data and displayed as maps. All non-spatial (attributes) data were linked to spatial data and valuable information such as land use, land rights and land infrastructure were derived and geographically represented as maps. Other outputs from these non-spatial data were presented as charts and graphs.

A spatial object can have many attributes associated with it. In GIS the data to be displayed can be stored and managed in a database. The data in a database can be manipulated, queried, analysed and displayed as a map. The displaying of data can be manipulated using cartographic techniques to be able to produce maps which can easily be interpreted by users to support decision-making processes in land use planning. Information such as area sizes, distances and directions can be extracted and interpreted from maps. Also, certain spatial data can be read and understood easier on maps than in numeric form such as charts. Non-spatial data were joined with related spatial data and displayed as maps. Traditionally this has been achieved through tables and graphs. In this study, some non-spatial data were assigning numeric values and linked to spatial data, the researcher then used numeric values to produce spatial distribution maps.

4.7 Chapter Conclusion

The chapter covered the aspects of the research methodology of this study. The chapter explained and discussed the process on how the research data was gathered.

The FGD and PRA investigated local people’s views, opinions and perceptions on the state of participatory mapping and land use planning. FGD, PRA and participatory mapping were

employed in this study to gather evidence about the impacts that participatory approaches has in incorporating local communities' views, opinions and perceptions in the process of land use planning. Given the complex task of land use planning, participatory mapping methods were used in this study to investigate how local people can provide information about land uses and its conditions for official integrated land use plans in Namibia. Experts in land use planning and GIS were involved in this study via FGD, SWOT analysis and GIS techniques.

It was already established during the data gathering phase that the research aim, which is to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management in Namibia, would be attainable. It was also evident that the methodology applied in this study would realise the aim and set objectives of this study. Table 4.1 provided more detailed of the research methodologies with relation to objectives of this study. It can be seen in the table that each objective has its research method(s) in order to accomplish such an objective. The table further shows the required type of participants for each research methodology applied in this study.

This chapter outlined the research methodology applied in the study. The research objectives set and organised in Table 4.1 outlined the link to the research methods. The main research methods (participatory mapping, FGD and PRA) were also described and discussed.

The next chapter presents the research results. The chapter discusses and show results attained using the research methods which were presented in chapter 4. Chapter 5 also responds to the research objectives and questions set in chapter 1.

Chapter 5: Presentation of Research Results

5.1 Introduction

Chapter five (5) describes the experiences and results of the participatory mapping, and the use of GIS for sustainable land use planning in Namibia. In order to explore how participatory mapping aided by GIS might enhance the outcome of land use planning, a number of participatory approaches and focus group discussions were held in various parts of the Hardap region in Namibia. The participatory mapping activities and completed focus group discussions (FGD) provided evidence which can be developed further to provide advanced participatory approaches and tools for use in future land use planning.

The presented research results are based on the analysis of the experience and knowledge gained from the FGD, participatory rural appraisal and participatory mapping. The chapter examines the results in relation to the five research questions outlined in the first chapter. As stated in chapter one, the five research questions are as follows:

1. What land uses are found in the Hardap region and are these known to its local communities?
2. What are the best mapping procedures for developing regional land use maps by the land use planning experts and relevant stakeholders?
3. What is the role of participatory mapping aided by GIS in land use planning and management in Namibia?
4. What sustainable methods, frameworks and guidelines are required for participatory mapping aided by GIS in land use planning to ensure sustainable land management in Namibia?
5. How can the methods, frameworks and guidelines which are suggested for land use planning via participatory mapping aided by GIS be implemented to ensure sustainable land management in Namibia?

This chapter is structured according to the objectives mentioned above. The participatory land use maps (section 5.2) are explained. In section 5.3 the land use maps produced with GIS for comparison of desired and undesired land uses is discussed. Section 5.4 deals with the results of FGD, PRA and SWOT analysis for evaluation of the outcomes of participatory mapping aided by GIS. Section 5.5 presents the frameworks and guidelines for participatory mapping aided by GIS and section 5.6 deals with the research results of the Georeferenced digital database which is then followed by the chapter conclusion.

5.2 Participatory Land Use Maps

5.2.1 Introduction

The main objective of this section is to discuss the land use maps of different units of land within the six constituencies of the Hardap region created by means of participatory mapping by local communities. The various challenges associated with participatory mapping approaches and implementations in Namibia are explored and, in turn, the differing processes of participatory mapping implementation are considered in this research. Geographers tend to put landscape into different models depending on their field of expertise (Wu and Isaksson, 2008:8). Landscape can therefore become alien to geographers while their mental picture and perceptual experience are intact. One can use different participatory mapping approaches such as sketch and photo-mapping to understand landscape.

Chapin, Lamb and Threlkeld (2005:623) mention that “the first indigenous mapping projects were carried out in Canada and Alaska in the 1950s and 1960s and became a standard approach in land claiming in First Nations during the 1970s.” These were components of larger studies documenting land use and occupancy for the purpose of negotiating aboriginal rights (Chapin *et al*., 2005). Recently, new participatory approaches such as participatory GIS and crowdsourcing are used in spatial planning to map land rights of local communities in different countries such as Ethiopia, Cameroon, South Africa, Botswana and many others.

5.2.2 Participatory Land Use Maps of the Hardap Region

5.2.2.1 Introduction

This subsection provides the participatory mapping results in the six constituencies of the Hardap region in Namibia. The sketch mapping and photo-mapping techniques were used to gather land use information in each constituency of the Hardap region. The results are presented per constituency.

5.2.2.2 Participatory Mapping in the Rehoboth West Urban Constituency

In the Rehoboth West Urban Constituency, participatory mapping took place in the Rehoboth formal urban area. The size of the mapped area is estimated to be approximately 1500 square metres. It is managed and administered by the Rehoboth Town Council. Seven (7)

local community members participated in the mapping activity. In this area, the participants mapped various land uses, such as industrial, business and related infrastructure.

As can be seen in Figure 5.1 and 5.2, residential, general residential and open spaces are the main land uses identified and mapped by the participants in the Rehoboth formal area. The main road leading to Windhoek in the north and Gibeon in the south can be viewed on the map. The gravel roads providing access to both residential areas and general residential areas are also shown. During the sketch mapping exercises, the participants did not map land cover adjacent to the mapped areas because the emphasis were on land use. However, the land covers were mapped when the participants delineated the same area using an aerial photograph (Figure 5.2) as base material for photo-mapping technique. New information about other land uses and land covers were mapped using the aerial photograph.

In the Rehoboth formal urban area, the participants were eager to share their land use issues. Some participants shared their knowledge and opinions about how the town council of Rehoboth rejected their subdivision and consolidation applications for land adjacent to their erven. Through the briefing and random communication with the participants, the researcher is of the opinion that the participants have reasonable knowledge about land use and their rights regarding their respective land.

Although the maps are not to scale, the researcher recognizes the understanding of the participants concerning sizes of their land and history of their land. The participatory mapping exercises were observed by the researcher to be good methods for bringing communities together to share their knowledge of the various land uses and their experience of their surroundings. The local communities' experience contributes in a meaningful way to the development of land use plans. This is also supported by the current related legislations on land use planning which requires strong participation of local communities in developing and compiling land use plans.

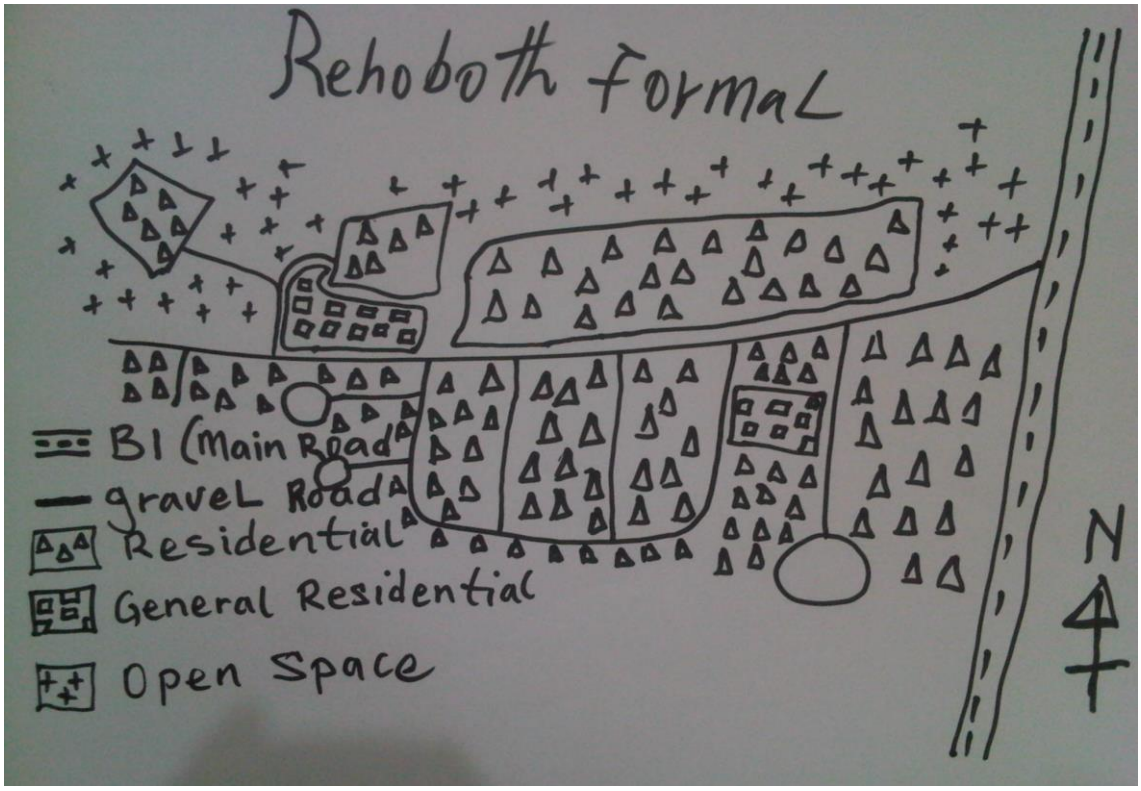


Figure 5.1: Sketch map of Rehoboth urban area section
Mapped by: Rehoboth local community members, 2012

Figure 5.2, a map based on an aerial photograph shows comparable results to that of the sketch map results. New information are visible on the photo-map, this include the riverbed in the south, the garage land use including a filling station in the south-eastern part of the map and industrial land use in the far south. The open spaces and general residential land uses remained constant on both maps in most parts of Rehoboth formal area in Figure 5.1 and Figure 5.2. Although the aerial photograph was two years old and did not depict some of the recently constructed buildings, the participants were able to identify the land uses using the recently constructed buildings on the image as reference. The participants indicated that they found it easier to interpret the aerial photographs than a sketch map.

When discussing the aerial photographs, questions were raised as to how the participants benefit from land zoned as general residential. The participants indicated that the land tenure on general residential zoned land allows the land owner to rent out his or her built units of land to a specified maximum number of tenants.

Industrial land use was indicated as undesired by many participants. This was because land used for industrial purposes (such as welding work) is one of the main causes of noise in the neighbourhood.

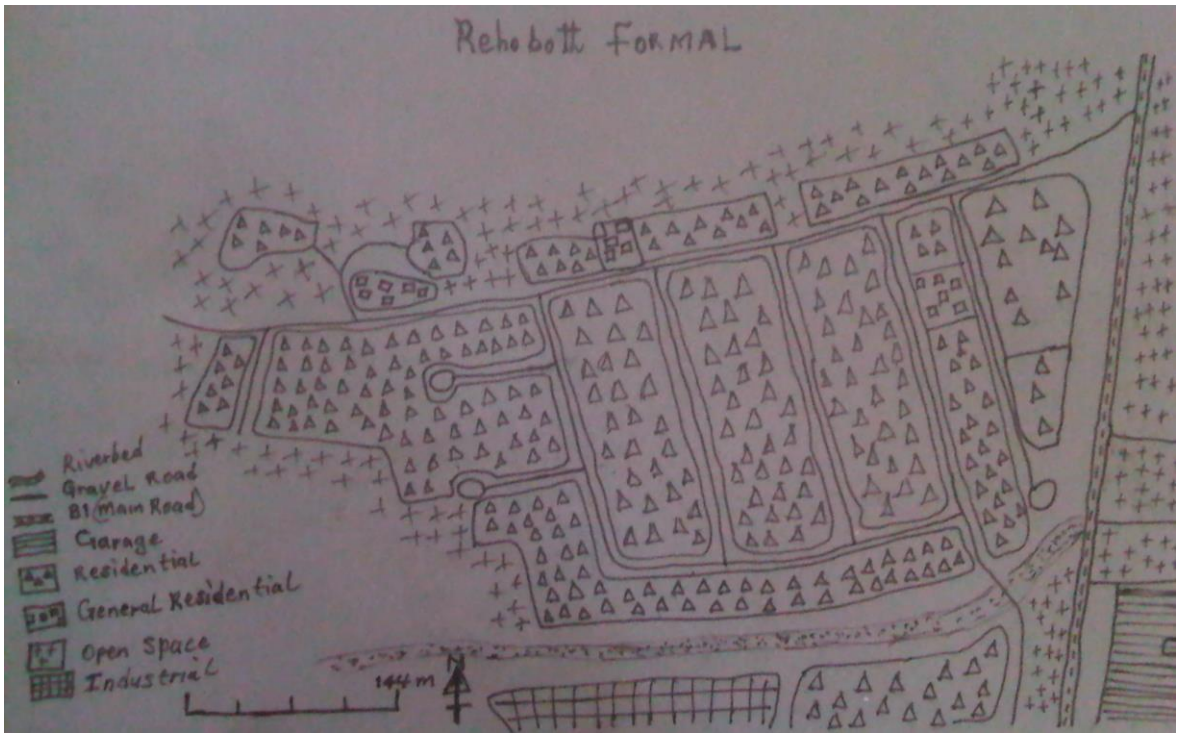


Figure 5.2: Photo-map of Rehoboth urban area section from an aerial photograph of 2010
Mapped by: Rehoboth local community members, 2012

The gravel roads with dead ends (cul-de-sacs) were clearly delineated as shown in Figure 5.2. The area is serviced with electricity, sewerage, voice and data telecommunication infrastructure and streetlights. The most common mode of transport, as stated by the participants is private cars and taxis.

5.2.2.3 Participatory Mapping in the Rehoboth East Urban Constituency

In the Rehoboth East Urban Constituency, the participatory mapping activity took place in Rehoboth Block E, Extension 1. The mapped area size is estimated to be 2 500 square metres. Seven (7) local community members participated in the mapping activity. Block E. Extension 1 is a description given to the land by the early town planners of the Rehoboth Town Council. It is an informal settlement situated in eastern Rehoboth. According to Shack Dwellers Federation of Namibia (2009:31) the “informal settlement was established in 1983. People in this settlement came from Bahnhof Station and the old location of Rehoboth town.”

The major land uses in this settlement as depicted on the sketch map (Figure 5.3) are residential, institutional facilities (schools), business (shops) and church. Institutional facilities such as schools can be seen at the centre of the map. The participants indicated that the most desired land use was residential because it provides them with access to land

on freehold tenure. Institutional facilities was also indicated as preferable because of the need for their children to attend school. There are infrastructure such as built houses and roads in this informal settlement as depicted on the sketch map (Figure 5.3). The nearest primary school was also mapped and was observed by the researcher to be accessed at a mean distance of about 600 metres to serve the communities members in the Rehoboth Block E, Extension 1. A secondary school was about the same distance away from the participants' site in the Rehoboth Block E, Extension 1. This kind of mapped results suggests that "land use is characterised by the arrangements, activities and inputs by people to produce land use change or maintain a certain land cover type" (Food and Agriculture Organization, 1999: 32). There is also a clinic which was observed to be accessed at a mean distance of about 500 metres by the community. The community members stated that part of Rehoboth Block E, Extension 1 belongs to the Town Council of Rehoboth. The remaining part of the land was bought by the community members at a cost of between N$ 300 and N$ 400 per erf in the year 1999. This was also confirmed by the Rehoboth Town Council.

Although the sketch map shows the main land uses and basic infrastructure in the settlement (Figure 5.3), no emphases were put to indicate the numbers of houses represented in their respective locations in this informal settlement. Figure 5.3 shows that more efforts were put on mapping roads, businesses (shops) and institutional facilities (schools), than other land infrastructure such as sewerage points, telecommunication infrastructure and dumping sites.

A church and natural features such as river and dunes are shown on the sketch map. There were observed residential houses along the riverbed and dunes which were not depicted on the sketch map. This can possibly be a result of lack of participation, lack of understanding of land use features or lack of knowledge of the settlement by the participants. Repeated sketch mapping exercises confirmed that this kind of sketch mapping capability can be improved.

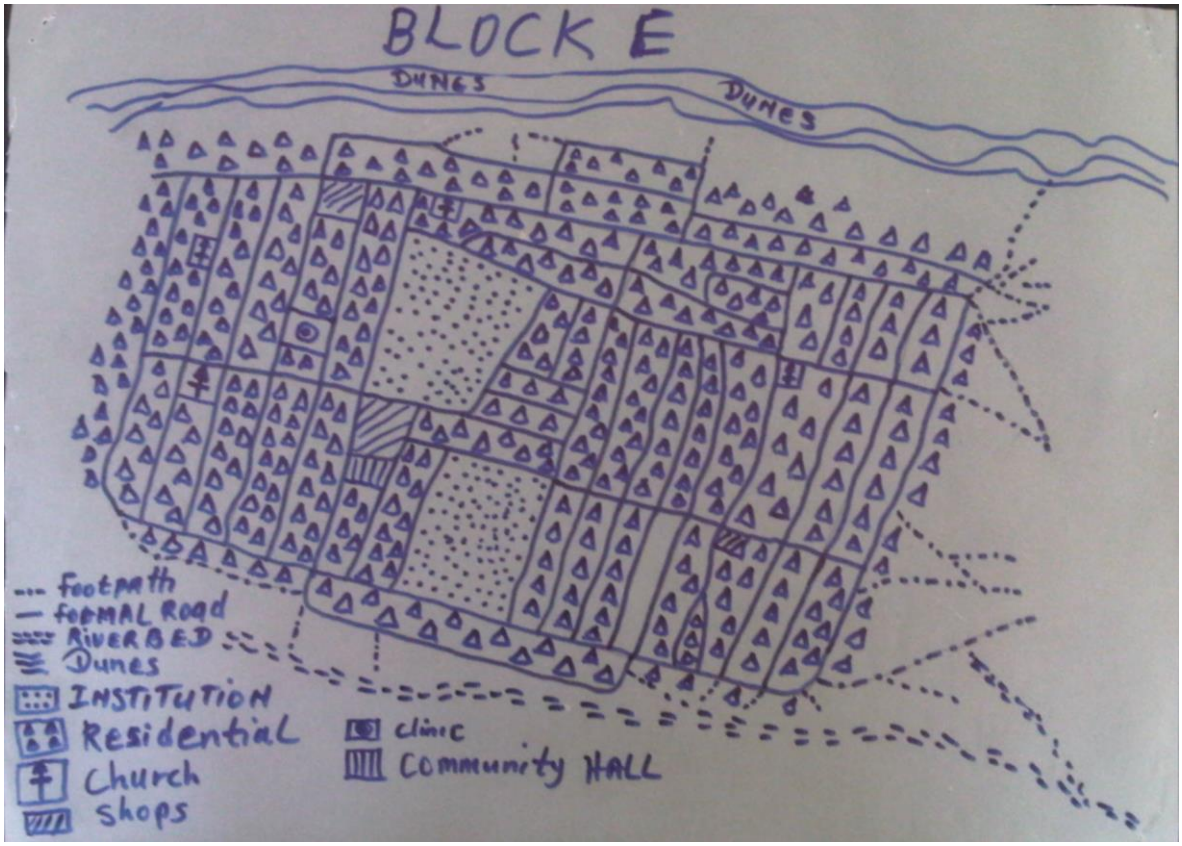


Figure 5.3: The sketch map of Rehoboth Block E, Extension 1 area
Mapped by: Rehoboth Block E local community members, 2012

The researcher observed that there are no waterborne toilets in this settlement. People use removable buckets, pit latrines as well as the bush to relieve themselves. A public prepaid water system is available to the community. Few households in the area have in-house sanitation facilities with proper water connection.

The participatory mapping results may help contribute to improved service delivery to the communities as maps can be used to measure infrastructure services provided to the communities. The appropriate government ministry could then take appropriate steps in planning and budgeting for basic services such as community toilets and community water points in the informal settlement.

5.2.2.4 Participatory Mapping in the Rehoboth Rural Constituency

In the Rehoboth Rural Constituency, the participatory mapping took place in a village called Kalkrand, managed and administered by the Kalkrand Village Council. The mapped area size is estimated to be 3 000 square meters. Seven (7) local community members participated in this participatory mapping activity.

In this area, both the sketch and photo-mapping approaches were undertaken. The local community mapped their land uses and related infrastructure such as roads and showed their knowledge about the land uses.

Figure 5.4 and 5.5 demonstrate that residential, business (shops, offices), church, institution, open spaces and sport fields were the main land uses identified and mapped by the communities in Kalkrand. Although the maps are not to scale, a very good understanding of their land was confirmed. The participatory mapping exercises in this area can be understood by the researcher as a good method for bringing members of a community together. They were encouraged to share their knowledge and experience of their surroundings. The participants mentioned that open space are undesired land use within Kalkrand because they believe the land has to be occupied by landless people. They also indicated that the Kalkrand land belongs to individual farmers in the Hardap region. The town council was in negotiation with the landowners (farmers) to purchase the land for residential purposes.

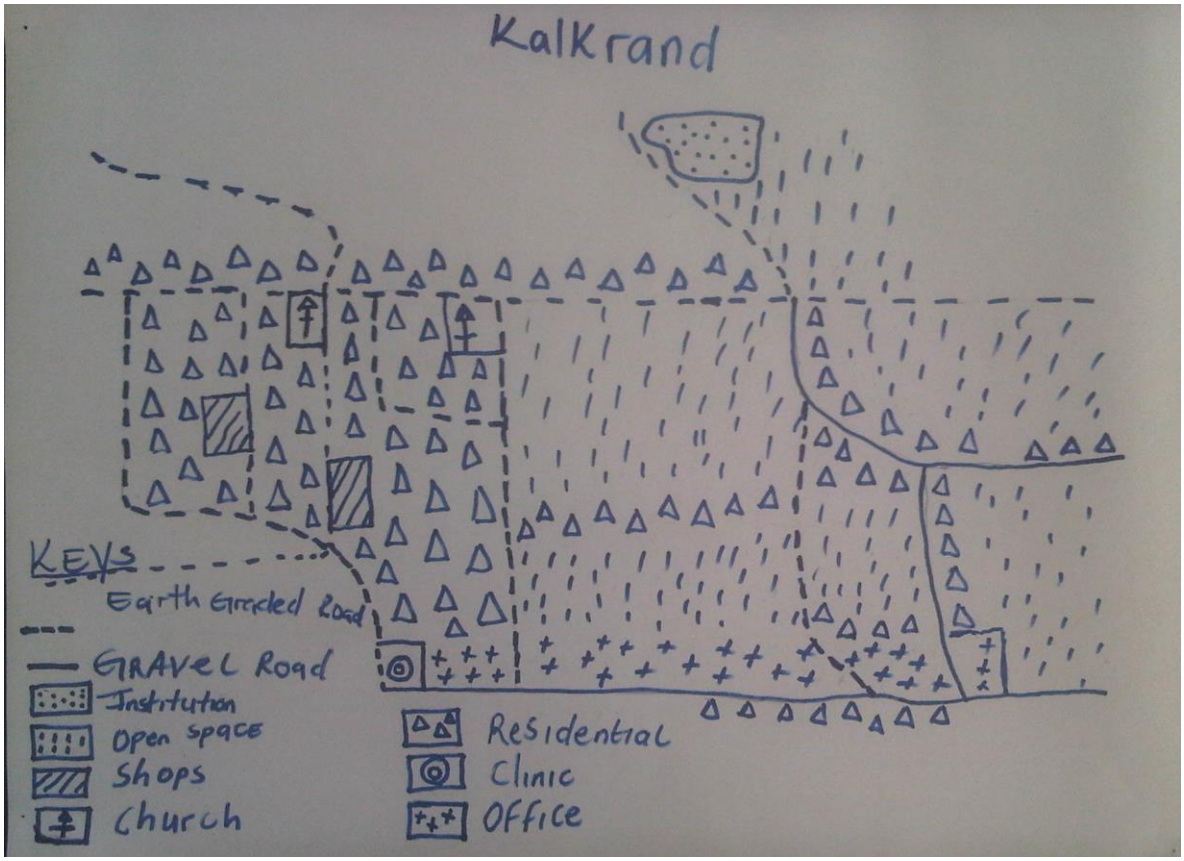


Figure 5.4: Sketch map of Kalkrand' village
Mapped by: Kalkrand local community members, 2011

Figure 5.5, a map based on interpretation of an aerial photograph shows different results compared to the sketch map results. The land uses on the photo-map (Figure 5.5) were more than on the sketch map. Such similar results could mean that the aerial photograph was well interpreted as the aerial photograph contained relevant data which depicted the current land uses and it was understood better by the participants to compare and describe features depicted on it.

Figure 5.5: Photo-map of Kalkrand from an aerial photograph of 2010
Mapped by: Kalkrand local community members, 2012

Different land uses were mapped using the aerial photograph as base material. Beside gravel roads there are earth graded roads. The most common mode of transport is road transport. Most people use private cars and taxies, whereas others use donkey carts with few people walking to various places, this was shared by the local community. Streetlights are also provided in the settlement but do not cover the entire village settlement. The participants also confirmed that community members in Kalkrand participated in the installation of water pipes as part of a community project supported by the village council. Information concerning community engagement projects is important for consideration in the process of land use planning.

5.2.2.5 Participatory Mapping in the Mariental Rural Constituency

In the Mariental Rural Constituency the participatory mapping took place in Stampriet. The mapped area size is estimated to be 2 500 square metres. It is managed and administered by the Stampriet Village Council. Nine (9) local community members participated in this activity in this area. As confirmed by the village council officer and the community members, every part of the land in this village belongs to the Stampriet Village Council.

The Shack Dwellers Federation of Namibia (2009:44) stated that "the estimated number of households is 500 and the estimated population is 2,500. There are a few brick houses and the rest are made of corrugated iron sheets." Figure 5.6 represent the sketch map of Stampriet Village as drawn by the local community.

The various land uses within Stampriet were mapped on the sketch map (Figure 5.6). These land uses are residential, industrial, cemetery, open spaces and institutional. Infrastructure and services such as roads, buildings, bed and breakfasts (B&B), a clinic and a service station can be found in the village. An informal settlement (see north eastern part of Figure 5.6) was also plotted on the map. With regard to natural features, a seasonal river water channel was observed in some parts of the Stampriet village.

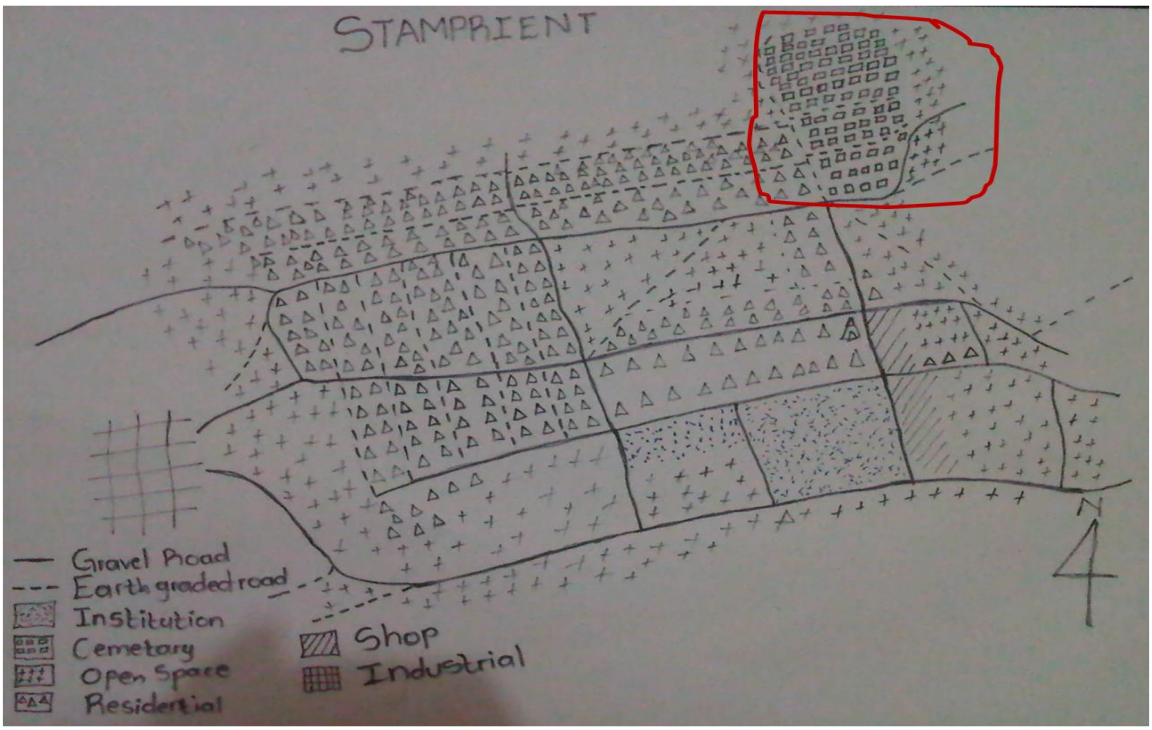


Figure 5.6: The sketch map of the Stampriet area
Mapped by: Stampriet local community members, 2012

As in the case of infrastructure and natural features as shown in Figure 5.6, the maps based on the interpretation of aerial photographs (Figure 5.7) was more detailed with additional infrastructure such as gravel and earth graded roads which were not mapped in the sketch map. This is acceptable for two participatory mapping methods to produce different results.

Some of the existing land use which were shown on both sketch and photo-maps by the local communities are the cemetery, open spaces, industrial and institutional such as schools.

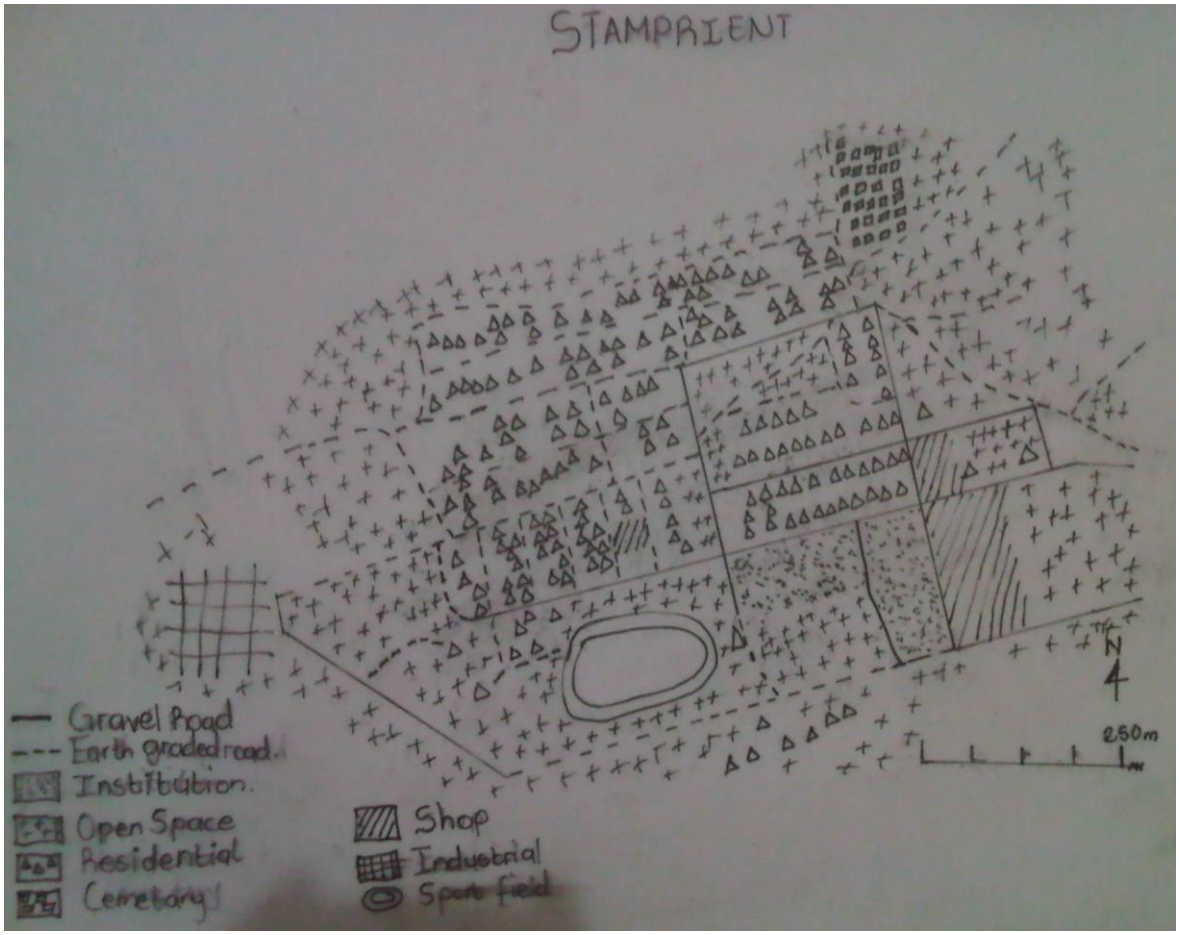


Figure 5.7: Photo-map of Stampriet from an aerial photograph of 2010
Mapped by: Stampriet local community members, 2012

In participatory mapping, it is important to map with understanding. Basic knowledge of infrastructure development is useful in mapping in order to produce understandable maps. Figure 5.7 shows some of the isolated buildings not serviced by roads. The examples of such buildings are those next to the sports field. Since the results in Figure 5.7 were based on the features which were visible on the aerial photograph and what is known to the

participants, there was a need for better interpretation of infrastructure relationship. For example, the understanding of a building to always have access to a road is required for the participatory mapping participant to be able to interpret the aerial photograph better. This conclusion is applicable and relevant to all participatory mapping.

Some of the services observed by the researcher, which are provided to the local communities in Stampriet, include public water taps for lower income households, as well as electricity for those who can afford to connect. The existence of schools, the police station, churches and a graveyard was also mapped in this area. There are no constructed roads except for the main tarred road. There are streetlights provided in the village of Stampriet.

5.2.2.6 Participatory Mapping in the Mariental Urban Constituency

In the Mariental Urban Constituency, the participatory mapping took place in the informal settlement called Oshiwana Penduka. The mapped area size is estimated to be 2400 square metres. Eight (8) local community members participated in this mapping activity. The name “Oshiwana Penduka” is a plea that means “to wake up the nation”, presumably to the plight of the informal settlers.

The estimated number of households is 650 with an estimated population of 4 000 (Shack Dwellers Federation of Namibia, 2009). With the exception of three brick houses, all the houses are shacks built with corrugated iron sheets. The Shack Dwellers Federation of Namibia (2009:44) stated that “people in this informal settlement came from different towns and some people came from farms. Most parts of this informal settlement land in this area belong to the Municipality of Mariental, only few people bought individual plots.” The nearest police and fire station is in town which is about 1.5 kilometres away from the Oshiwana Penduka settlement. The researcher observed that the residents are provided with serviced gravel roads, earth graded roads, electricity and streetlights. The participants confirmed during the FGD that people without electricity make use of candles, paraffin, gas and firewood. Public garbage drums are also available for solid waste management purpose.

The sketch map produced by the local community of Oshiwana Penduka reveals that the community’s land is serviced with basic facilities such as water points, community toilets and roads (Figure 5.8). The residential erven in this informal settlement are well planned and have serviced roads. The sketch map further reveals that there is a church and open spaces in the area. A seasonal river was observed by the researcher in Oshiwana Penduka informal settlement.

Discussions during the participatory mapping activity in this area helped to get insight on the future development of this informal settlement. The local residents stated that the municipality had been in contact with them to help support them to upgrade the informal settlement from corrugated iron houses to brick housing structures. This was then confirmed by the Municipal official in Mariental, but the process of implementation had not started at that time and was confirmed to be a lengthy process.

Figure 5.8: The sketch map of the Oshiwana Penduka area
Mapped by: Oshiwana Penduka local community members, 2012

5.2.2.7 Participatory Mapping in the Gibeon Constituency

In the Gibeon Constituency, the participatory mapping took place in the informal settlement called Helena Pieters Section. The mapped area size is estimated to be 2 500 square metres. Seven (7) local community members participated in the mapping activities of this constituency. Both the sketch and photo-maps were compiled in this informal settlement. The Shack Dwellers Federation of Namibia (2009:41) stated that it had been established in 1970 and people had come from the areas surrounding Gibeon. Legally, the land belongs to the village council of Gibeon. The residents were given permission by the village council of Gibeon to occupy the land, but no written agreement was signed.

The estimated number of households in the informal settlement is 300 people. Few households live in brick houses while most of the families live in corrugated iron houses. The estimated population living in informal houses is about 1 500 (Shack Dwellers Federation of Namibia, 2009). It was also observed that there are about five prepaid water taps. There are no schools, clinics or other social services in this informal settlement. Some local community confirmed that they only access social services via facilities in neighbouring settlements.

Figure 5.9 reveals that facilities such as water points, toilet points and roads are provided to the Helena Pieters Section. These services are not well structured; this was shared by the local community. Land uses such as businesses (shops), residential and open spaces were mapped on the sketch map. Land covers such as river beds were observed by the researcher. The proclaimed road to buildings in this informal settlement is earth graded roads. A sewerage swamp[8] can be seen towards the west of the settlement.

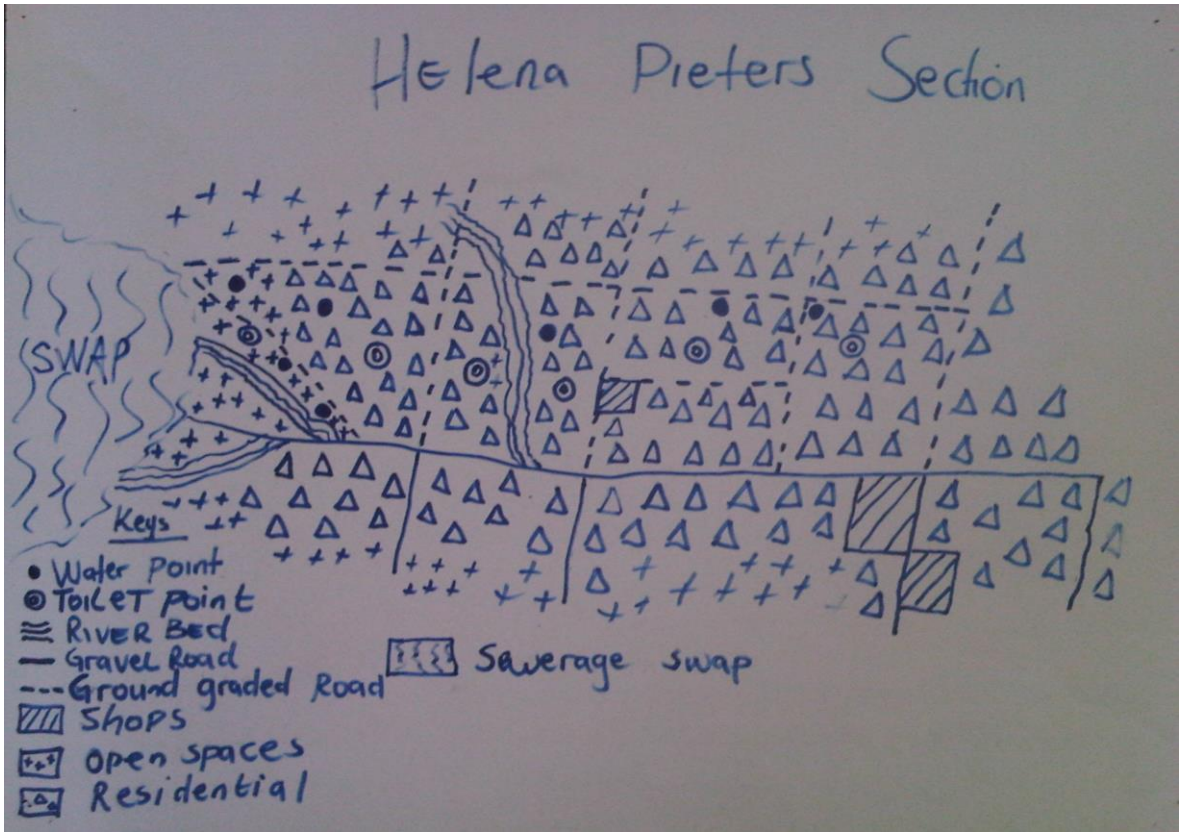


Figure 5.9: The sketch map of the Helena Pieters Section area
Mapped by: Helena Pieters Section local community members, 2012

[8] The word 'swamp' is referred to as 'swap' in the participatory maps.

Figure 5.10 shows that the features mapped by the local community are few compared to features mapped on sketch map on Figure 5.9. This was because the aerial photograph of 2010 depicted only a few housing structures, roads and river beds in the informal settlement. The limitation of this map is due to poor resolution and poor quality of the aerial photography used in the participatory mapping. Such limitations in the quality of the aerial photographs had been expected by the researcher and resulted in disadvantaging the photo-mapping approach. The delineation making use of photo-mapping is of poor quality aerial photographs, which can be avoided when good quality aerial photographs are available.

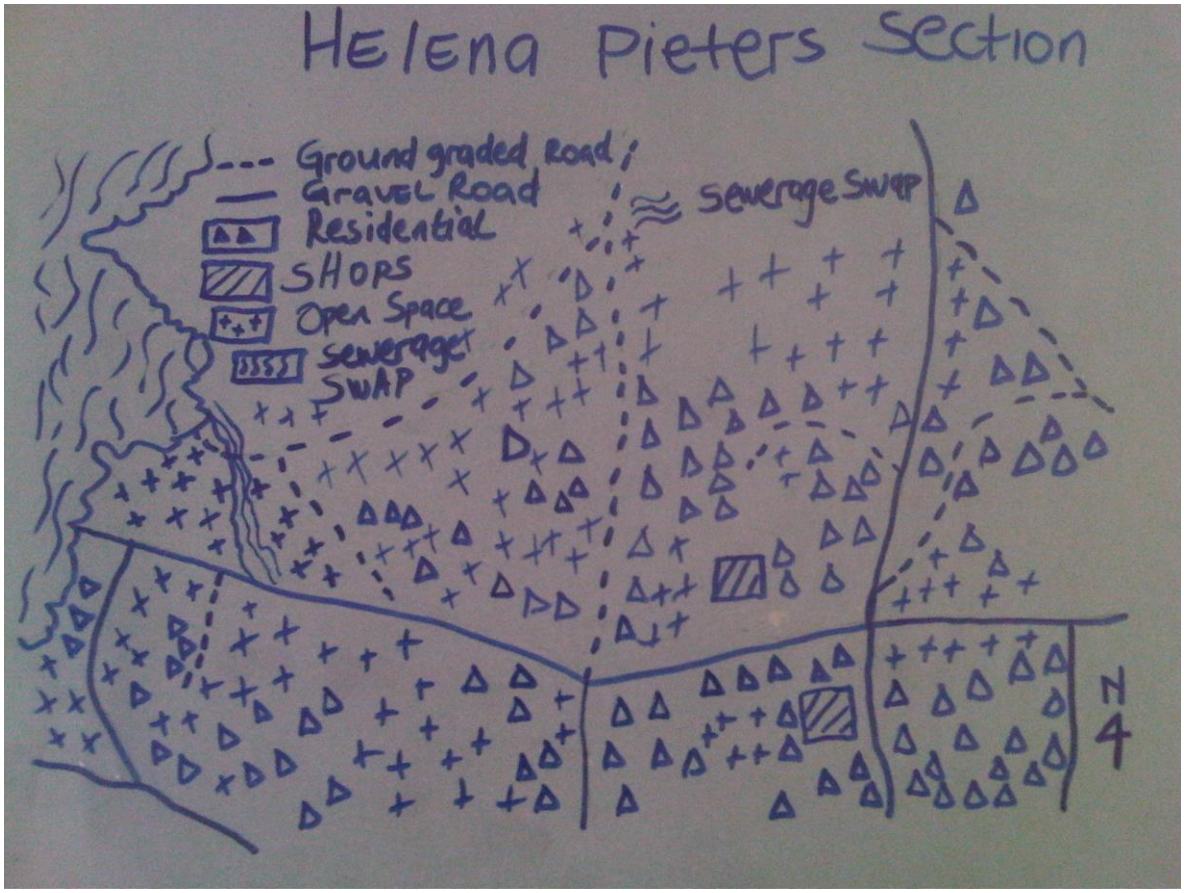


Figure 5.10: Photo-map of the Helena Pieters Section area from an aerial photograph of 2010

Mapped by: Helena Pieters Section local community members, 2012

As can be seen in Figures 5.9 and 5.10, there are no proper roads in this informal settlement. Residents mostly walk to various places. There are no public services. The mean distance to the nearest police station is two kilometres from Helena Pieters Section. The community members confirmed that they are not involved in any development activity because there is no development at all in this area.

5.2.3 Comparison of Outcomes of Various Participatory Mapping Methods

5.2.3.1 Introduction

This subsection provides a comparison of participatory mapping techniques (sketch and photo-mapping) results gathered within the six constituencies of the Hardap region in Namibia. The advantages and disadvantages of both sketch mapping and photo-mapping methods, and challenges for the participants during participatory mapping exercises are also presented.

5.2.3.2 Comparison of Sketch and Photo-Mapping Results

The two methods, sketch and photo-mapping, were used to produce participatory maps. Knowledge and opinions were gathered from the participants within the Hardap region on land uses as per the objective. The participatory mapping exercises were applied to different units of land within the Hardap region. The information for the maps was gathered from the residents of the various units of that land. The information on different land uses such as business, residential, industrial, garage, institutional, open spaces and roads were obtained from the participants. Information on land cover such as rivers, riverbeds, dunes and sewage swamps was also provided and mapped by the participants.

The sketch map information mapped by the participants at times differed from information mapped by the participants from the aerial photograph through the method of photo-mapping. The difference in information outputs is due to the characteristics and limitations of each method. However, results from each method were compatible and complementary to each other.

This study confirmed that maps can be created from relevant information by drawing on a piece of paper large enough for participants to mark on the map after discussing where the many buildings, structures and infrastructure are located. According to Wu and Isaksson, (2008:23) “participatory maps cover the heterogeneous subjects mentioned by the locals, including land use, movement routes, places that once existed and those that still exist.” Although several areas were mapped within the Hardap region, they are not categorised or weighed against each other. The International Fund for Agricultural Development (2009:13) defines sketch mapping maps as “represents key community-identified features on the land from a bird’s eye view.” Photo-mapping is based on an aerial photograph as base material. This means that location based information is delineated based on the resolution, scale and

accuracy of the aerial photograph. Based on the two different definitions, characteristics and research findings on the sketch and photo-mapping, the two types of maps are different in their precisions of feature locations as well.

5.2.3.3 Advantages and Disadvantages of Participatory Mapping Methods

Participatory sketch and photo-mapping maps have both advantages and disadvantages. Some of the advantages of sketch and photo-maps produced through participatory mapping are that they:

1. are easy to explain;
2. can be used to collect additional primary data;
3. are inexpensive tools to record information on how the land is used;
4. can be used for further studies in the areas of geography, social and environmental science and for any mapping needs where residential areas need to be mapped;
5. can be stored electronically as a picture once the map is scanned or the picture is taken with a digital camera;
6. can be printed as needed when is stored electronically;
7. can be mailed electronically as needed when is stored electronically.

The disadvantages of sketch and photo-mapping maps produced through participatory mapping are that they:

1. are static maps;
2. is lack of flexibility, because data cannot be added or removed;
3. are not interactive;
4. are not as effective as expected in this study, as the participants' level of understanding has an influence on their drawings;
5. can be too vague and sketchy.

There are general similarities of both sketch and photo-mapping maps. However the outcome of the two might be different. Table 5.1 shows some of the differences encountered during this study.

Table 5.1: Differences between sketch and photo-mapping in LUP

Sketch mapping	***Photo-mapping***
• Sketch maps are drawn directly from memory and therefore not to scale.	• Photo-maps are approximate to scale drawing when the base aerial photograph is georeferenced.
• There are roughly drawn maps which may be inaccurate but can be quickly created.	• Photo-mapping is usually drawn on large scale (for example 1:25 000 to 1: 50 000).
• Sometime the information on the sketch maps can be too vague.	• Features are drawn in their true position (within limitations of scale).
• Creating a map from memory can be a time consuming exercise as usually more than one person is involved who draw information from memory only.	• Maps can be completed promptly when the features are clearly visible.

5.2.3.4 Challenges during Participatory Mapping Exercises (Participants Perspective)

Some of the encountered challenges for the participants of participatory mapping in general are that drawing a feature in the field is very time consuming. Some of the challenges encountered were that:

1. approximately 50% of the participants had difficulty reading maps and aerial photographs, so in many cases the community members misread some of the features;
2. approximately 50% of the participants had difficulty orienting themselves to aerial photo-maps because there were few recognisable landmarks;
3. it is difficult to keep the participants focused to map land uses only. The participants had to be reminded to concentrate on mapping land uses and related geographical features. That situation can be challenging to the researcher as the participants can easily divert to land covers.

As a tool to facilitate decision-making in land use planning, participatory mapping methods should contribute to adding value to the development of integrated land use plans as it gives a platform where participants discuss their use of land and contribute to those land uses'

management. Different land uses were mapped with the two participatory methods of sketch and photo-mapping by different participants and in different areas within the Hardap region. Land management challenges such as land use conflict resolution and land allocation are typical examples where stakeholder participation is needed. In many developing countries such as Namibia, Zimbabwe and Zambia, information on the local social values on cultural landscapes is completely missing, and natural resources are under constant pressure from various stakeholders (Fagerholm and Käyhkö, 2009).

5.2.4 Contribution of Participatory Mapping to Sustainable Land Use Planning

In this study participatory mapping was identified as an important approach in land use planning, particularly in sharing land use ideas among participants and collecting data related to socio-economic issues. Participatory methods, if applied properly, allow the user to grasp the intangible and invisible through a concrete medium that can be shared with others. Participatory mapping is significant for all areas of land use planning and natural resource management. The study supports participatory mapping as a potentially viable tool, technique and methodology to gather local community knowledge and create media that permit different voices to enter into dialogue with one another.

Another purpose of participatory mapping was to gather and share information about different land uses among different participants in different areas of the Hardap region. The participatory mapping methods proved to be an excellent process for allowing local people of all ages to engage with their surroundings and heritage. In an inspiring and motivating way they were encouraged to use their land appropriately, such as avoiding using residential land for industrial purposes.

In addition, the participatory mapping activity offered advantages of allowing local communities to learn about basic map-making. The participatory mapping method proved also to be a catalyst in stimulating memory and in creating visible and tangible representations of the natural environment. The time spent working on the legend allowed for greater clarity on meanings, and the relationship between natural land features and land use features. The participatory maps can be used to capture both land use and natural features.

Many researchers in different parts of the world have taken advantage of various mapping methodologies, for example, highly participatory approaches such as PRA to the newer

participatory approaches such as participatory photo-mapping, participatory GIS, crowd sourcing and more complex spatial technologies, such as GIS. Based on the knowledge that the participants showed, the researcher is of the opinion that the participants could contribute to the development of land use plans as they know their area better than an outsider (researcher). Recently, local communities are included in the discussion phases that precede the implementation of land use planning projects (Emery, 2000). Land use planning experts should strive to have the broadest possible knowledge base to achieve the best possible results.

The demand for participatory approaches is far greater than what can be delivered, and the distribution of indigenous mapping initiatives has been extremely uneven (Chapin *et al*., 2005). Approaches involving the people who live in the area such as participatory mapping promote community engagement in planning, sharing ideas among participants and it helps generate new information. Broadening public participation, data access, local knowledge integration and community empowerment are key concepts in a participatory mapping approach to land use planning.

5.2.5 Conclusion

The major objective of this section, namely 'to produce participatory land use maps in different units of land within the six constituencies of Hardap region by local communities', was achieved. Different participatory land use maps from different small units of land within the Hardap region were produced by local inhabitants. The land uses produced through participatory mapping has different contents. Land uses such as residential, cemetery, business, institutional and general residential were explained and discussed by the inhabitants. Among the discussions by the inhabitants were the general land issues such as land allocation, land rights, population dynamics of the land units. The information gathered from the participants through participatory mapping can contribute to the process of integrated land use planning. The knowledge on historical land rights and geographical context of the area are some of the fundamental requirements in land use planning.

The research question namely: "What land uses are found in the Hardap region and are these known to its local communities?" was answered as no new land uses were found which had not been known to the inhabitants of the Hardap region. The study revealed a few illegal land uses such as industrial (welding works) and garage (performing motor repairs) on residential land use within the Hardap region which were known to only a few participants. These findings are also supported by the results presented in this section.

5.3 Land Use Maps Produced with GIS for Comparison of Desired and Undesired Land Uses

5.3.1 Introduction

The main objective of this section is to share the land use maps from the Hardap region compiled from existing land use data for comparison of desired and undesired land uses. GIS technology, specifically ArcGIS 9x software was used to analyse, visualise and display the GIS data and produce maps. Geopublisher software was used to store, manage, and integrate all produced GIS and participatory maps. The various challenges associated with land use maps and implementations of ILUP in Namibia were explored. Consecutively, the differing processes of GIS implementation such as data storing, data managing, data processing and data representation were considered in this study.

5.3.2 Land Use Planning Maps Produced for Different Areas in the Hardap Region

5.3.2.1 Introduction

This subsection provides results of land use planning maps produced with a GIS for different parts of the Hardap region. The land use planning maps were produced from existing land use data gathered from various ministries and organisations. Maps of relevant land use planning such as land ownership map, land use maps of Mariental and Rehoboth, rural land use and mining land uses were produced. The maps of different development initiatives within the Hardap region are also presented. Land use maps are required for determining the land use trends in various areas of the Hardap region. Land use maps are important for people who develop land in the Hardap region to know which types of land uses will be allowed on a specific piece of land.

Land use planning is viewed as the process of identifying the optimal and sustainable use of a given piece of land concerning its environment and socio-economic conditions. The FAO (1996) defines land use planning as the process of choosing and allocating the most suitable land use for a given piece of land amongst other competing land uses. Land use planning has been one of the key issues in rural and urban development for many years in Namibia and worldwide. In 2010, under the new Integrated Land Use Plans (ILUPs) project, GIS was

confirmed to be useful in producing land use planning maps by the Directorate of Land Reform of the Ministry of Lands and Resettlements (MLR) under the Government of the Republic of Namibia (GRN) as the directorate responsible for developing ILUPs. During the course of this study, land use maps were produced with the aid of GIS technology. The land use maps are particularly important for implementation of sustainable land use planning because land use maps can be used to support local land management and planning (Di Lisio and Russo, 2010).

Despite the usefulness of GIS in society, Chapin *et al.* (2005:629) maintains that "no matter what the advantages of GIS might be, the fact remains that it is complex, highly technical, and expensive, especially for rural villagers, who lack basic facilities such as electricity and computers." However, GIS has become a very useful and important tool in land use planning. Holistic planning involves input from multiple, interrelated data sources and types. In order for a GIS to accomplish the success of integrating multiple interrelated data and different data types, a great deal of information must be considered simultaneously. A GIS allows access to large amounts of information quickly and efficiently (Coleman and Galbraith, 2000).

According to the Environmental Systems Research Institute (ESRI), (1996, cited in Coleman and Galbraith, 2000:1), "Geographical information systems can be used to visualise information in new ways that reveal relationships, patterns, and trends not visible with other popular systems." A GIS is a thematic mapping system, meaning it can be used to produce maps based on themes such as soils or hydrology. Map features can be linked to corresponding information contained in a database. The advantage of GIS is that it is a dynamic system rather than a static system, making it easy to update, edit, and reproduce maps. Multiple layers of maps can be quickly displayed in a variety of overlays, scales, and combinations to fit the needs of the user (Coleman and Galbraith, 2000).

5.3.2.2 Land Ownership in the Hardap Region

One type of map that did not exist until recently is a map showing land ownership in the Hardap region. The data used to produce the ownership map was sourced from the MLR as the custodian of any land-related data in Namibia. This is an important map, because it can be used when analysing potential land use, conflicts and dynamics in an area. In this research different layers were used to obtain and identify different land ownership information within the Hardap region. At the beginning of this study, ownership was not clearly defined, such as whether the land belongs to private individuals or the respective

local authorities. As a result, conflicts regarding ownership of the land were observed. Where applicable, the gathered spatial data about land ownership was verified with the MLR and was correctly recorded in the ownership column field of the attributes table. Four different main land ownership groups were identified, as outlined below:

1. Central government and state land,
2. Local authority land,
3. Traditional authority land, and
4. Private land.

Figure 5.11 depicts the Hardap region's land ownership map which was produced using the MLR's data. It depicts that the majority of land is private land on freehold tenure. Figure 5.11 further shows that about 10 pieces of proclaimed local authority land are visible in the region.

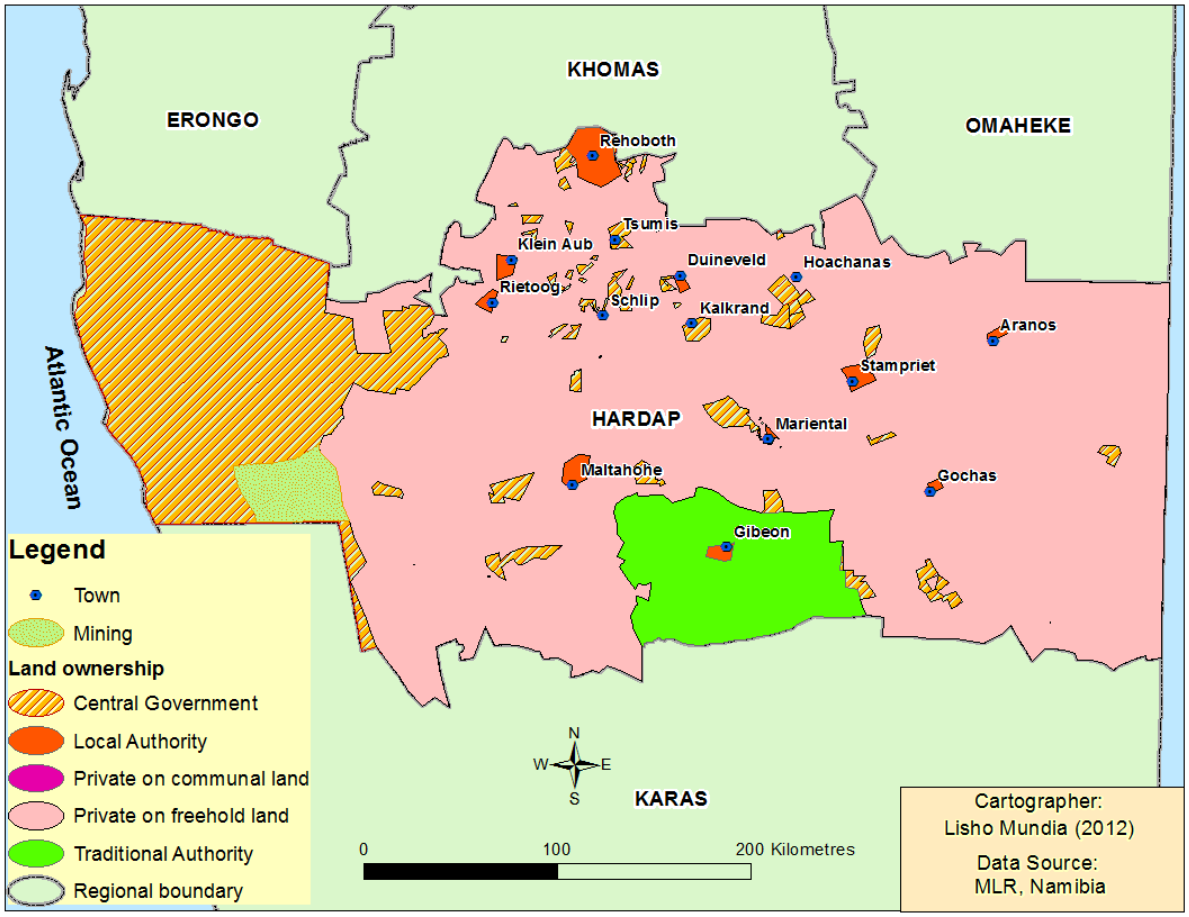


Figure 5.11: Hardap land ownership map

The four main ownership groups applicable to the Hardap region scenario can be further subdivided into land ownership sub-categories as depicted in Table 5.2 below. The

subcategories include the central government, the local authority, the traditional authority (communal land) and privately owned land. Traditional authorities in the Hardap region own the smallest portion of land in the far south of Hardap region (Figure 5.11). There are mining owned by private investors in the Hardap region. Central government owned land were also observed in the region.

Table 5.2: Types of land ownership in the Hardap region

Category	***Subcategories***
Central government (state land)	• Resettlement farms • National game parks • National parks • Farms owned by government
Local authority	• Urban areas: these include towns, villages, settlement areas
Traditional authority land (communal land)	• Communal land
Private land	• Freehold commercial farms • Private game parks • Affirmative action loan scheme farms

In the process of creating the land ownership map of the Hardap region, some additional categories and subcategories of resettlement farms, urban areas, and private game parks were created. The information of these categories and subcategories were verified with the MLR before the land ownership map was created. The verification of data was done because there were places where the ownership was uncertain. The data were entered as resettlement areas on the GIS layer and communal land on the spread sheet from the same data provider. Also, some land ownership was identified in which the ownership had a category of “government” while the subcategory and information from MLR and MRLGHRD indicated ‘privately owned land’.

5.3.2.3 Detailed Urban Land Uses

Another geographical coverage produced during this study was a detailed urban land use map for Mariental town, which is a major town in the Hardap region. The proclaimed towns and villages with urban land uses in the Hardap region are Rehoboth, Kalkrand, Stampriet, Gochas, Aranos, Rietoog, Duineveld, Hoachanas, Maltahöhe and Gibeon. Schlip, Klein Aub and Tsumis are settlements; hence they do not have official proclaimed boundaries. The developmental activities of these areas were interpreted on the colour ortho-photo and during field observations. Different structures such as houses roads and shops were observed.

The land use map of Mariental, depicted in Figure 5.12, shows that land use varies in sizes and shapes as expected. The Mariental land use map is dominated by residential land use. The map further depicts land use such as business, cemetery, educational, residential, general residential, government, industrial, institutional, municipal land, public open space, and the undetermined.

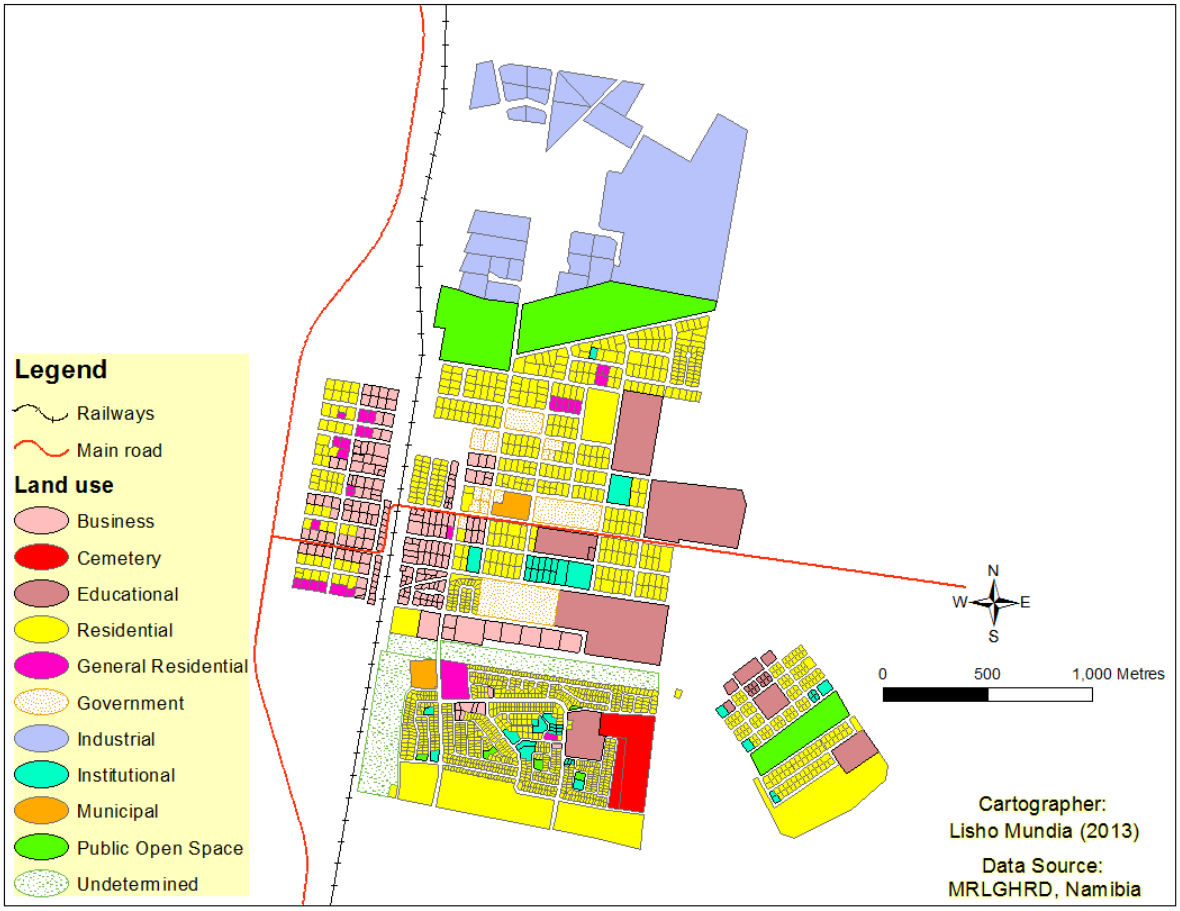


Figure 5.12: Mariental urban land uses

Rehoboth is the second major town in the Hardap region. Administratively, the town of Rehoboth is managed by the Rehoboth town council. It is a town of approximately 20 000 inhabitants in central Namibia just north of the Tropic of Capricorn.

The urban land use map produced for Rehoboth town was dominated by residential land use than the Mariental land use map as there is a high demand for Hardap residents to live close to the City of Windhoek in order to have easy access to jobs.

The land uses of Rehoboth are depicted in Figure 5.13. The figure shows that land use varies in sizes. The map further depicts land use such as municipal which can be seen in the

eastern part of the town. The map shows land uses such as businesses, cemetery, educational, residential, general residential, government, industrial, institutional, municipal, and public open space. The undetermined land uses are visible in Rehoboth town.

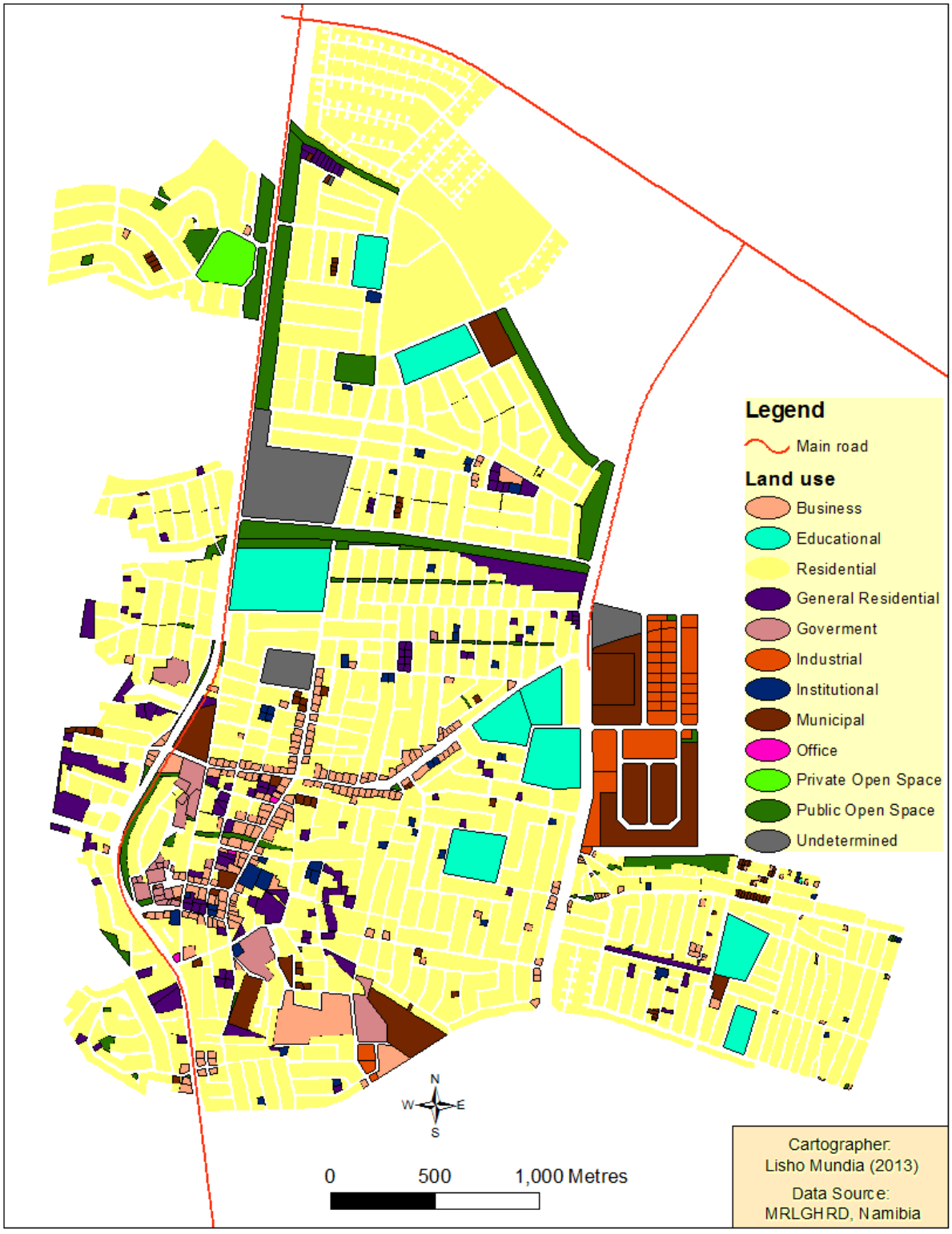


Figure 5.13: Rehoboth urban land uses

Educational land uses are found in the central and eastern part of town. Business land use is seen in the central and southern part of the town. Figure 5. 13 further illustrates that general residential land uses are more dominant in the south and in the centre of the town. Residential and general residential are the desired land uses according to the participants of the focus group discussion in Rehoboth because there is no sufficient provision for housing. Residential land use provides the residents with the right to occupy the land for residential purpose, while the general residential land use gives more rights to allow the owner to rent out units of land to more tenants.

The land use maps produced using GIS differ from the land use maps produced by local communities through participatory mapping. Land use maps produced from existing land use data using GIS reflect the registered land use. Maps produced by local communities through participatory mapping are sketchy; some represented the illegal land use activities such as industrial activities on residential land, but are not clearly depicted cartographically. It is difficult to measure areas, directions and distances with land use maps which were designed by drawing from memory using participatory mapping techniques. Areas, directions and distances can be measured on the land use maps produced with the use of GIS technology. Participatory land use mapping is restricted to small areas where land use needs to be recorded. GIS land use data were used to map bigger areas such as the entire Mariental and Rehoboth towns.

5.3.2.4 Rural Land Uses and Mining in the Hardap Region

Different rural land use maps depicting agriculture and mining in the Hardap region were also produced, and are shown in Figure 5.14 and 5.15. The data used to produce different rural land uses and mining map was gathered from different sources in relevant ministries and organisations as indicated in the data source section of the respective maps. Different rural land uses were indicated on the map in Figure 5.14 by means of GIS mapping techniques. Registered and emerging conservancies, government agriculture resettlement farms, other government or parastatals and small stock commercial farming were some of the rural land uses indicated using data provided by the MLR and MRLGHRD. The polygons depicting the boundaries of protected parks and reserves, which are publicly and privately managed, were provided by the MET. The MLR provided the information for urban and peri-urban areas. Mining data was provided by the MME.

Tourism and commercial agriculture required a more elaborated mapping process in order to be included in a rural land use map. The land use maps for tourism and commercial

agriculture areas were produced and were labelled as Figure 5.16: Map of tourism attractions of the Hardap region" and "Rural land use map in Figure 5.14" depicting agricultural land uses. The MAWF and the MET supplied information about known tourism accommodation facilities and agricultural land productions.

Figure 5.14 is a thematic map of rural land use in the Hardap region. In addition to the types of land ownership categories mentioned, resettlement farms were included as a major rural land use for resettlement of previously disadvantaged landless people to produce food for consumption on those farms. Infrastructure such as roads and railway networks and major towns were incorporated as basic geographical features. It can be observed in Figure 5.14 that the Hardap region's rural land use is dominated by commercial farming. A few demarcated communal pieces of land can be spotted in the northern and southern parts of the Hardap region. Resettlement farms are mainly confined to the central part of Hardap with a few in the south.

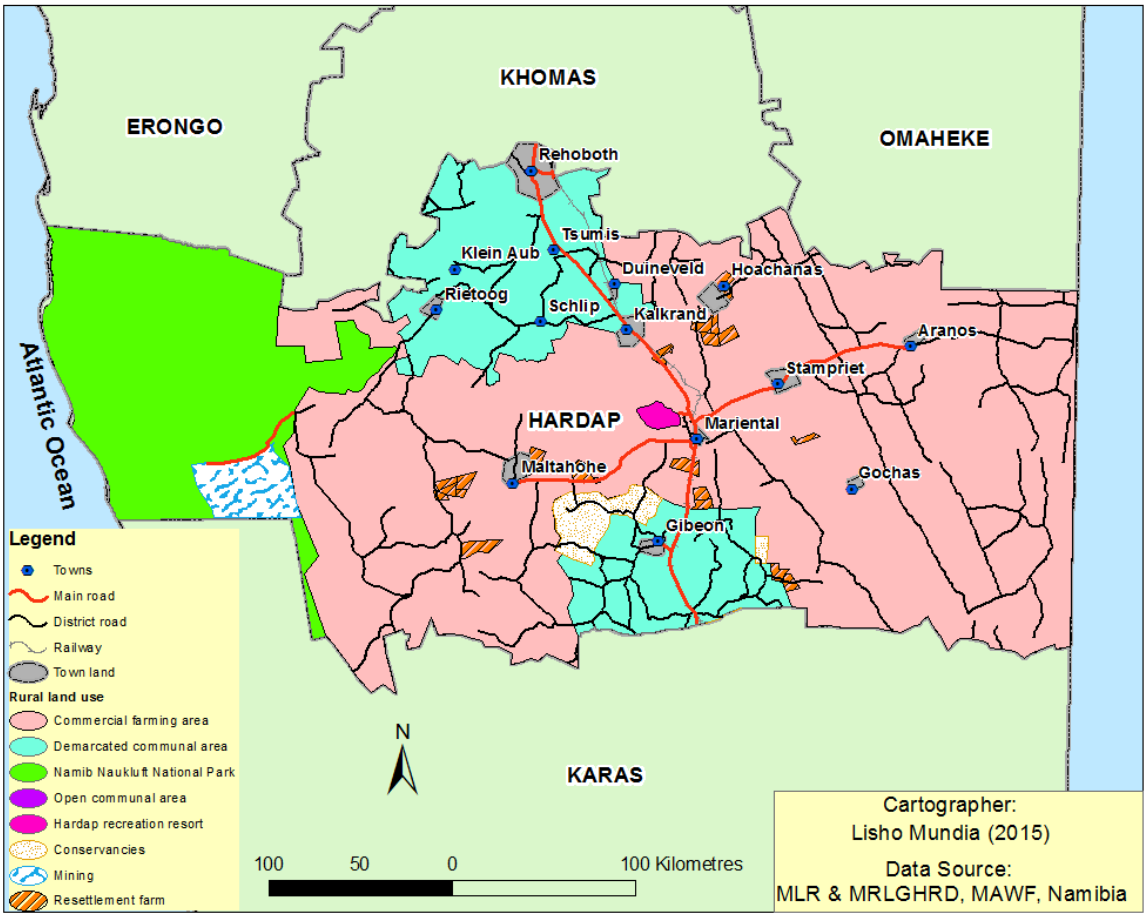


Figure 5.14: Rural land use map

Rural land use maps are important for two main reasons. Firstly, they provide a baseline for

a map of production land use such as agriculture and mining in the Hardap region. Secondly, it provides valuable information about socio-economic issues and ownership of land. Lastly, it helps the MLR to cross-reference key information such as agriculture land and communal land for the integrated land use plan of the Hardap region among other government and private institutions and actors. Figure 5.15 shows the map of mining licences and exploration prospecting licences in the Hardap region. The figure shows that mining licences and exploration prospecting licences are located mainly in the western part, along the coastal area of the Hardap region. Other mining licences and exploration prospecting licences can be found in the northern and eastern part of the Hardap region and a few in the south.

The recent surge in prices of base and rare metals, nuclear energy, fuels and precious stones have led to increased exploration in Namibia. There are more exploration projects in the coastal zone of the Hardap region. The exploration prospecting licences (see Figure 5.15) deposits in the coastal area of the Hardap region are of low grade and cannot presently be mined commercially (NACOMA, 2009).

The Namib Naukluft Park was originally a closed diamond mining area (Diamond Area Number 2), and prospecting mining. In recent years, a few licences for exploration and mining have been issued to various exploration companies in the northern part of the Namib Naukluft Park as it is shown on Figure 5.15. For the offshore waters of the Hardap region exploration licences have been granted for precious stones and petroleum (NACOMA, 2009). Exploration licences are important data in land use planning as they deal with the land's valuable natural resources such as diamonds, coal, and others. The mining land uses are desired by the residents of the Hardap region for job creation purposes. The mining land uses for a variety of mining rights such as coal, diamonds and marbles are all over the Hardap region (Figure 5.15).

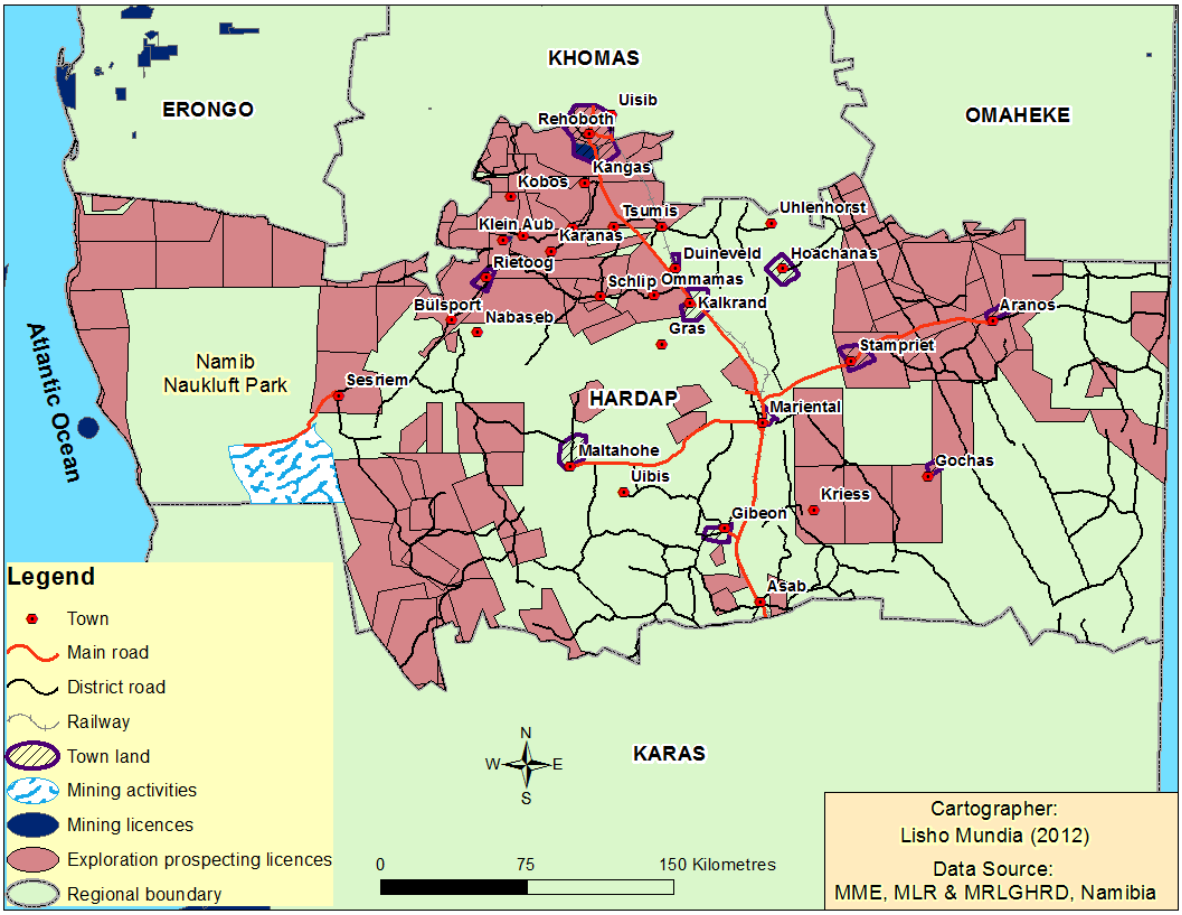


Figure 5.15: Mining operations, Mining licenses and exploration prospecting licences in the Hardap region

5.3.2.5 Tourism and Infrastructure of the Hardap Region

Tourism facilities and enterprises of the Hardap region are desired by the residents for job creation purposes. Figure 5.16 shows a map of tourism facilities of the Hardap region. The map shows various types of tourism facilities and enterprises. The facilities and enterprises are backpacker hotels, bed and breakfasts, caravan and camping sites, guest farms, guest houses, hotels, lodges, permanent tented camps, rest camps, self-catering accommodation and tented lodges.

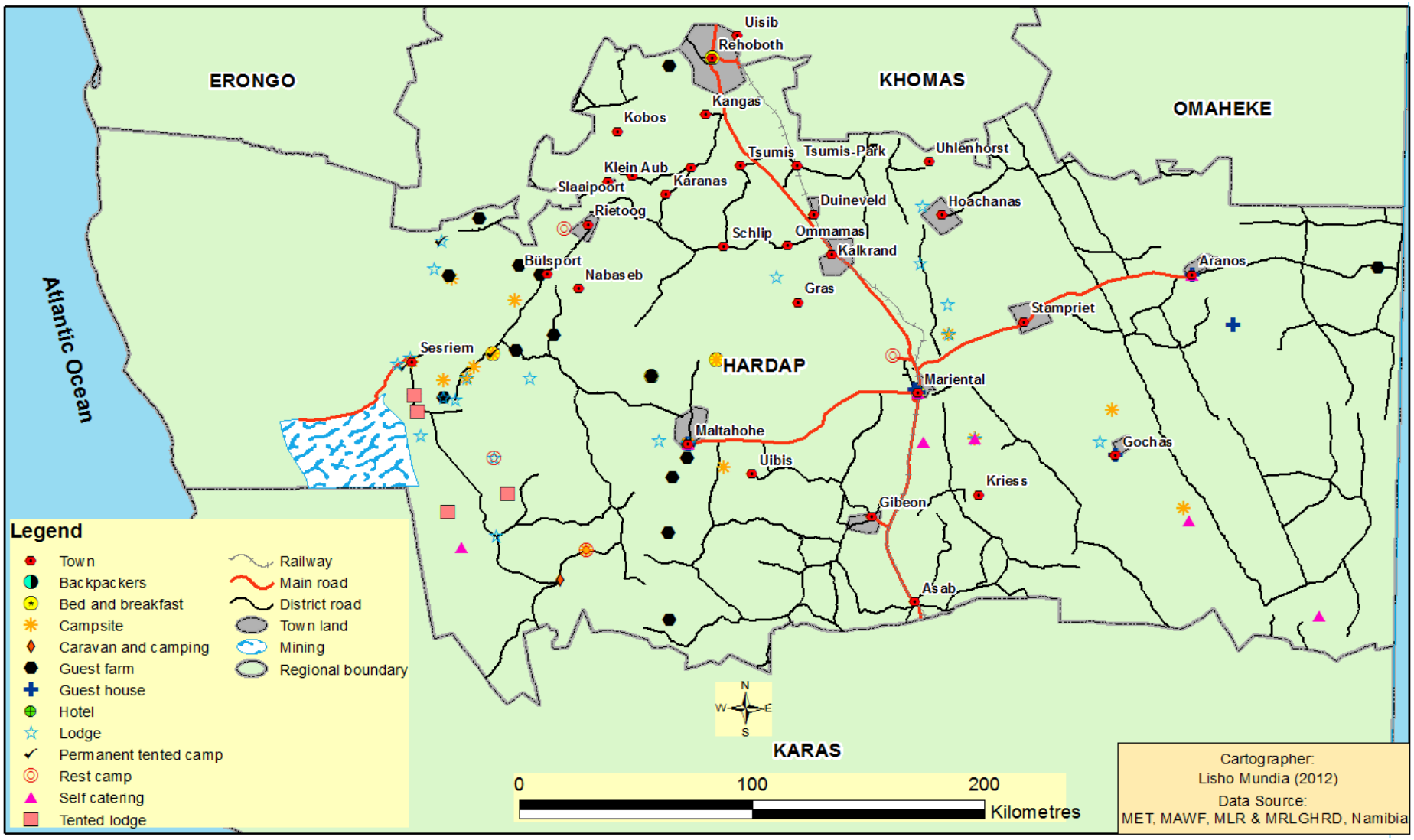


Figure 5.16: Map of tourism attractions of Hardap region

The transport infrastructure in the region makes the area accessible for tourists. Most farms with tourism accommodation facilities in the Hardap region are fully operational with some providing campsites, rest camps, lodges and camping facilities. The Hardap Recreation Resort is shown on the map. The Hardap Recreation Resort areas are important for consideration in land use planning as there contribute to socio-economic status of the region and are attractive to tourists.

Tourism has been booming in Namibia since independence in 1990, but the development of the tourism industry is more focused on the north-west and the north-east Namibia, such as Etosha in the Oshikoto region and the Caprivi region. The greatest paradox is that much of the Namib Desert, which is world renowned, spectacular and unusual, lies in the Hardap and the Karas regions. However, there are very few tourist attractions to visit in the Namib Desert (Mendelsohn, 2007).

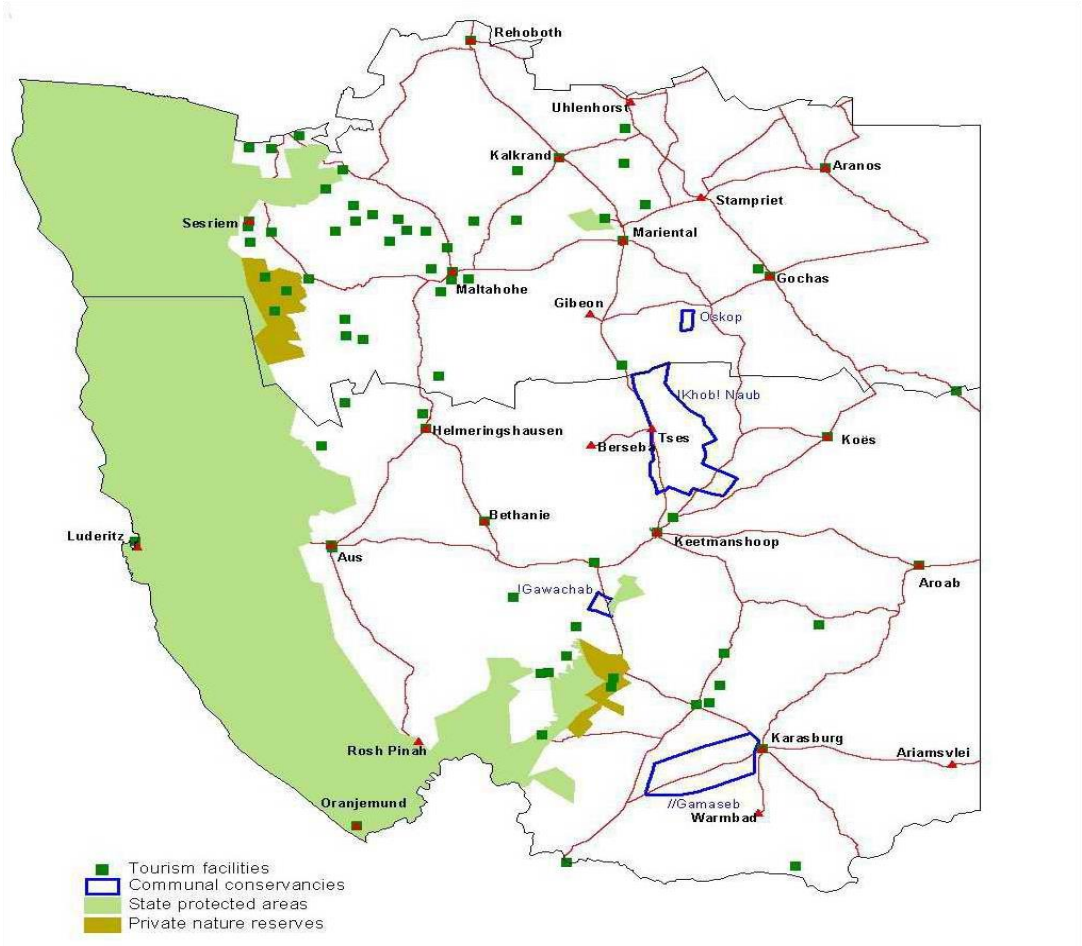


Figure 5.17: Tourism locations and facilities
Source: Mendelsohn (2007:07)

Mendelsohn (2007:02) further stated that “one major recent development that contributed to the growth of the tourism industry elsewhere in Namibia is the establishment of conservancies in communal land.” There are now four such conservancies in the Hardap and Karas regions. The four conservancies are Oskop, //Khobi Naub, /Gawachab and //Gamaseb as shown in Figure 5.17. The development of communal conservancies followed that of conservancies on freehold farms during the 1970s with the provision of new legislation allowing freehold farmers to make commercial use of wildlife for tourism purposes. The same rights were extended to communal areas when legislation was changed after independence of Namibia, with the passing of the Nature Conservation Amendment Act in 1996 (Mendelsohn, 2007).

In terms of infrastructure the Hardap region is unique and distinct from the other regions in Namibia. The region has a combination of many different land uses ranging from mining, agriculture to conservancies serviced with airfields, roads and railway infrastructure. The Hardap region has many small airfields with various types of surfaces and purpose. The airfields were for old mining operations in the region. Some airfields have sand surface runways, gravel runways, earth-grated runways, tarred runways and some has a combination of sand and gravel runways. It can be noted that some of these airfields are currently underutilised, while others have completely closed (Government of Namibia, 2006b).

In terms of road and railway infrastructure, the Hardap region is well accessible with railways, main roads and district roads, as can be seen in Figure 5.18. The railway line runs from north to south connecting towns such as Rehoboth, Kalkrand, Mariental and Gibeon. As depicted in Figure 5.18, different road infrastructure such as main and district roads connects all proclaimed towns such as Rehoboth, Klein Aub, Schlip, Kalkrand, Mariental, Maltahöhe, Gibeon, Stampriet and Aranos in the Hardap region.

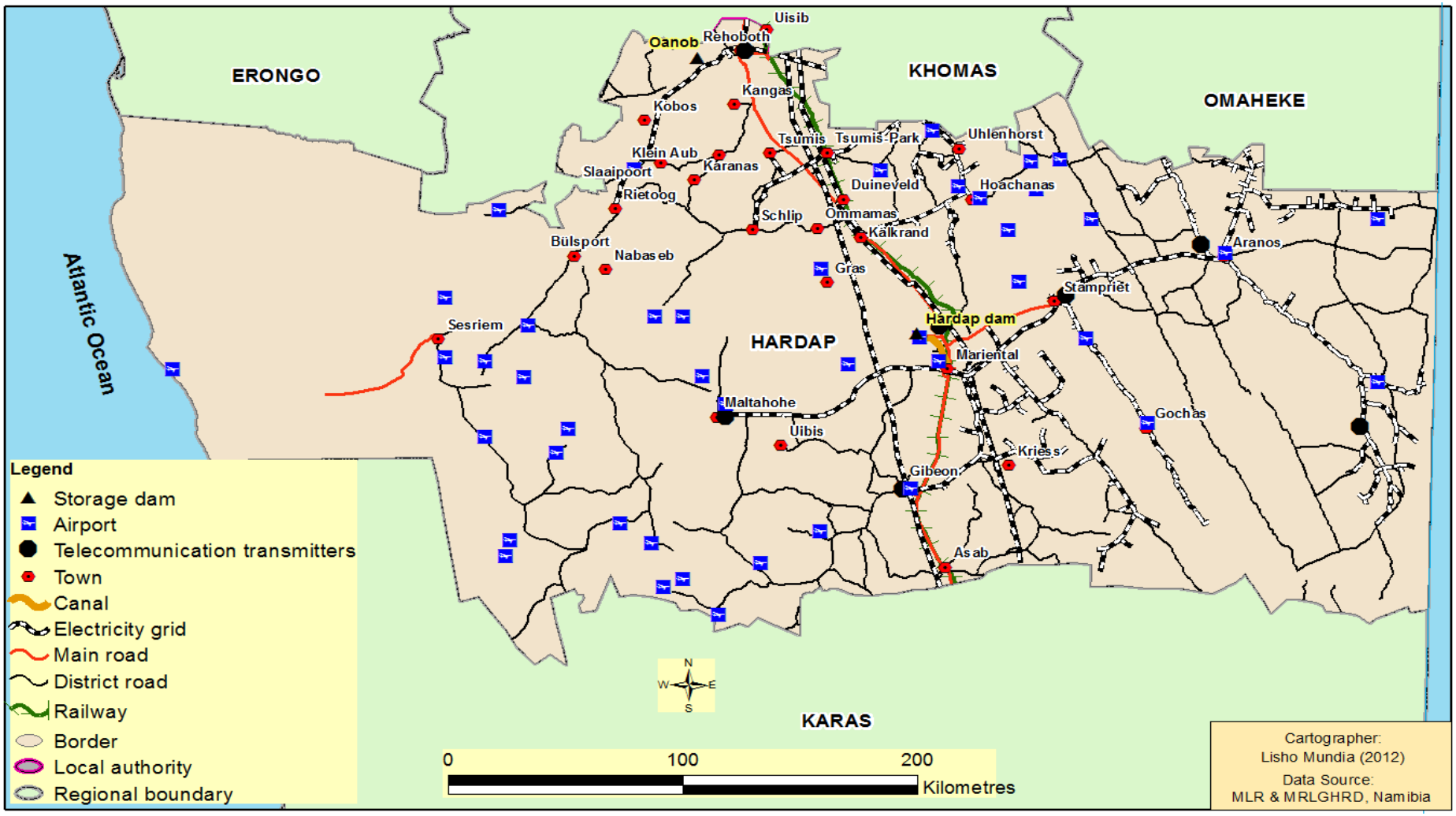


Figure 5.18: Infrastructure in Hardap

The infrastructure map of the Hardap region (Figure 5.18) shows the water canal network connection from the Hardap Dam to Mariental, and other parts of the region. The railway line is shown on the map crossing the centre of the Hardap region. The railway lines support main towns from Asab through Mariental, Rehoboth to the central part of Namibia, such as Windhoek, from where it connects to other parts of the country, such as the north and north central parts of Namibia.

The existing infrastructure such as roads, canals and railways are the starting point in the process of land use planning. The existing infrastructure are usually used as base information for land use planning. Furthermore, these infrastructure can help with integrated land use planning to support and justify the need for expanding or building new infrastructure. Existing infrastructure are also a requirement for all physical planning in the region.

5.3.2.6 Livestock Densities of the Hardap Region

The Hardap region's average livestock densities are mainly in the range of 0-19 livestock per square kilometre in the region. Figure 5.19 depicts that the northern part of the region has high livestock densities. The lower livestock densities are visible in the eastern part of the region. There are no livestock in urban areas because of the municipal regulations restricting livestock on proclaimed municipal land in Namibia.

There is low livestock density in the western part of the Hardap region, because most part of that land is a nature reserve and is used for mining. Weather and climate influence the low livestock density. The coastal zone in the western part of the Hardap region has low numbers of livestock. Coastal areas are dominated by the cold weather because of the north-flowing Benguela current of the Atlantic Ocean that brings very low precipitation (less than 50 mm per year). There is frequent dense fog and lower temperatures than in the rest of the country.

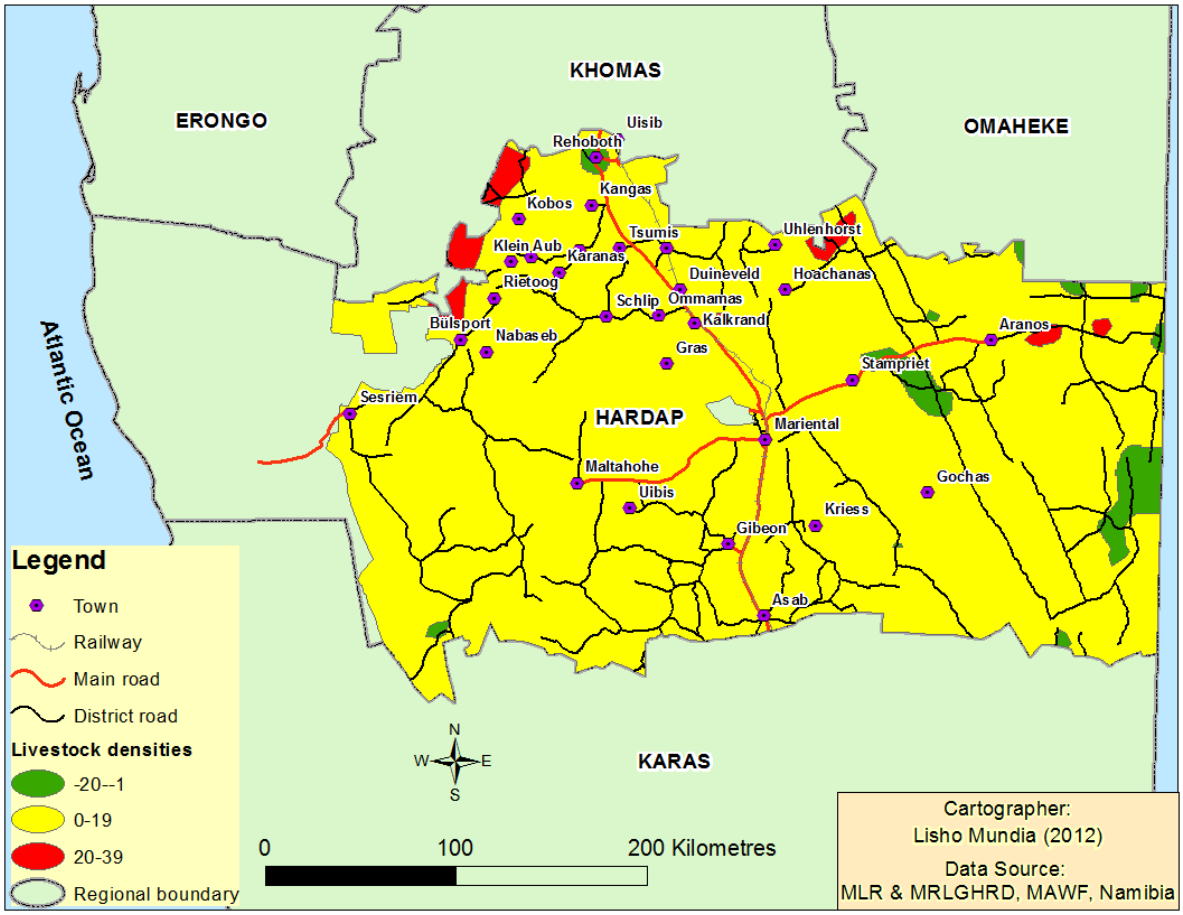


Figure 5.19: Average livestock densities per square kilometre

5.3.2.7 Hydrology and Geohydrology of the Hardap Region

With regard to hydrology and geohydrology of the Hardap region, the river catchment map of the region is shown in Figure 5.20. The figure depicts that the region has five catchments, namely: Tsondab, Tsauchab, Tsoris, Fish, Auob and Nossob. Auob catchment is visible along the eastern part of the watershed. The perennial water pans in the eastern part of the region are also represented on the map.

The Hardap region has rivers ranging from main rivers to minor rivers in the central part of the region. A few minor rivers are visible in the western part of Hardap region. The main rivers are visible in the eastern part of the Hardap region (Figure 5.20).

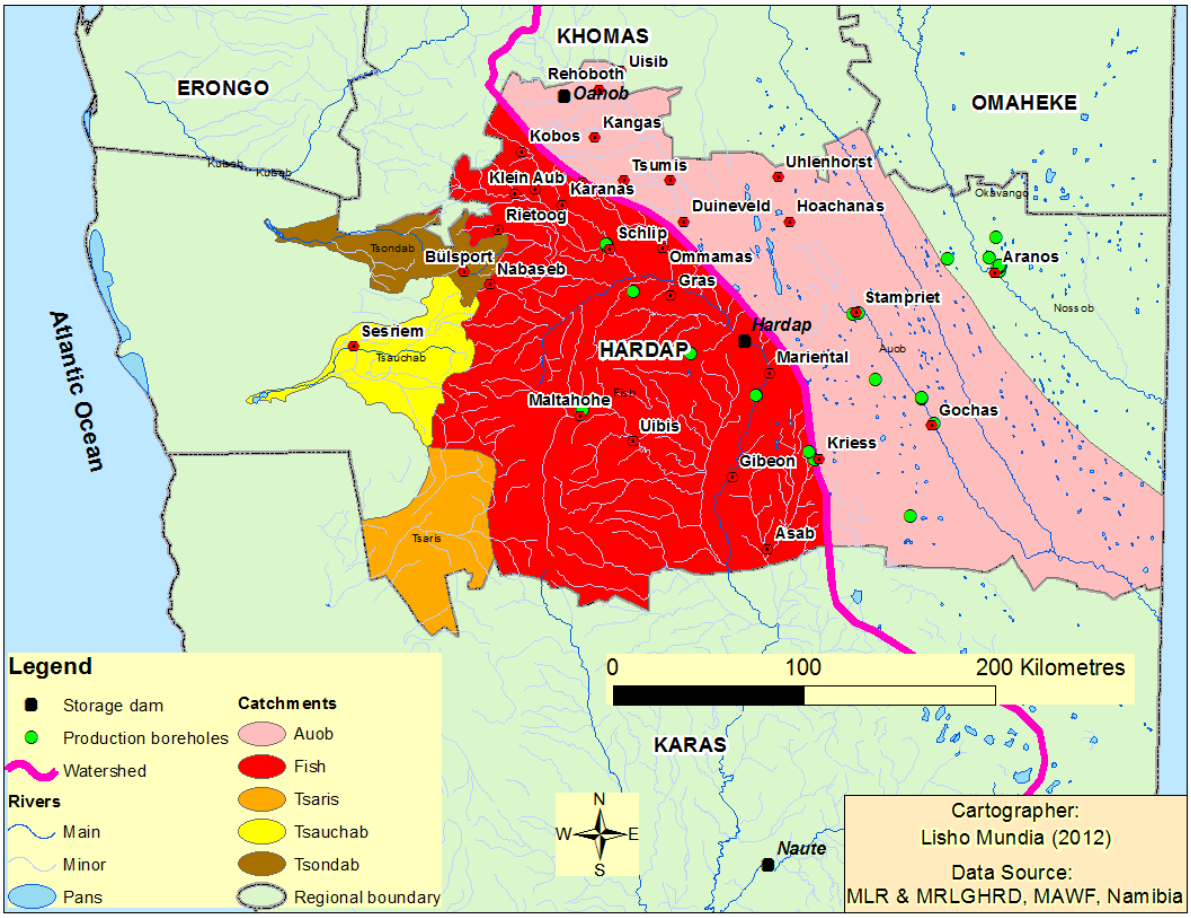


Figure 5.20: River catchments in the Hardap region

The two major water storage dams in the region are the Oanob and the Hardap dams. The Oanob dam stores and provides water to the people of the Rehoboth West and Rehoboth East constituencies. The Hardap dam provides water to both the Mariental urban and some parts of the Mariental rural constituencies. Other sources of water in the region are boreholes and wind pumps. Boreholes are found mainly in the central and eastern parts of the Hardap region. The locations of boreholes in the Hardap region are influenced by factors such as groundwater availability and population distribution. Also the western part of the Hardap region's groundwater cannot be used for human consumption because it is saline water.

5.3.3 Land Development Initiatives in the Hardap Region

5.3.3.1 Introduction

A number of development initiatives are currently being implemented in the region. These were explored because they are desired land development initiatives with favourable land productions. The explored development initiatives have the potential to provide attractive

infrastructure development desired by local communities. Some of the development initiatives explored include the Bernafay cooperative resettlement farm community, shown in Figure 5.21, the Hoachanas resettlement shown in Figure 5.22 and the Uibis rural community in Figure 5.23. The desired land development initiatives will be explained and discussed below.

5.3.3.2 Bernafay Cooperative Resettlement Farm

Bernafay cooperative resettlement farm is not well-known to many residents of Hardap region. It is, however, desired by the farmers and residents in the surrounding areas, including those in Stamprient and Gochas because of its good soil types for farming. Bernafay was established as a 'co-operative resettlement scheme' with vegetable gardens and subsistence agricultural activities from which income is expected for the resettled farm residents. Bernafay is a surveyed commercial farm of 3 729 hectares purchased in 1995 by the Government of Namibia for resettlement purposes and for a co-operative irrigated crop farming project (Government of Namibia, 2006b). It falls under the responsibility of the Ministry of Lands and Resettlement. It is located southeast of Mariental on the southern end of the Stampriet Artesian Aquifer within the Mariental rural constituency of the Hardap region; situated between the towns of Gochas to the south and Stampriet to the north, as shown in Figure 5.21.

The Government of Namibia (2006b:17) stated that "a total of 89 people live on Bernafay in 14 households (a mean of 6.4 people per household). The majority of the older people were born on commercial farms in the surrounding area. Several families lived in Bernafay when it was bought, one of whom originally came from the Kavango region. Others moved from the surrounding areas to the farm for formal resettlement."

The Bernafay farm has boreholes with electricity pumps which supply water to the main farmhouse, the surrounding dwellings and the crop fields. The community makes use of drip and sprinkler irrigation systems on the farm. An extensive water pipe network is used. There are three boreholes located in the grazing lands one of which is powered by a diesel pump, and two others are powered by electricity. The Ministry of Lands and Resettlement provides accommodation, water, electricity, farming advice, marketing support, seed, tractor repairs and other basic services. All residents live in brick buildings, although some houses lack sanitation facilities.

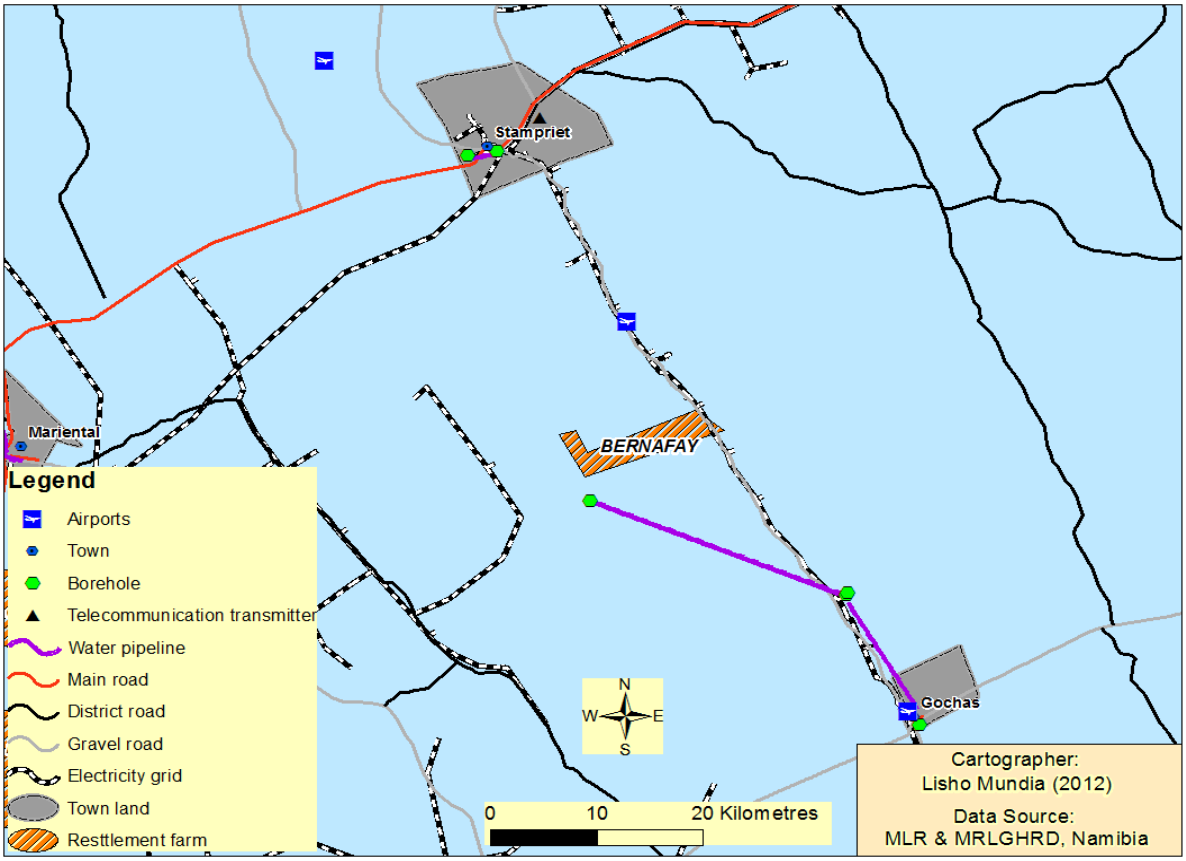


Figure 5.21: Bernafay cooperative resettlement farm community

The farm residents have access to grocery shops within 10 to 15 minutes walking distance, and mobile and landline phone network coverage. There is a kindergarten, a primary school (grade 1-7) and an adult literacy centre. With regard to health service, a mobile clinic visits the farm once a month.

On the farm, vegetables are planted mostly for subsistence farming, but surplus is sold to other local communities in the nearby areas and in Mariental. The farm is known for its citrus plantation which consists of 17 rows of 55 trees of oranges, and 9 rows of 55 trees of tangerines and lemons. The community also produce a small number of grapefruit and cumquat trees on the farm.

5.3.3.3 Hoachanas Settlement

The Hoachanas settlement is another development initiative by the Government of Namibia in the Hardap region. Hoachanas has become a desired settlement to many local communities because of its good infrastructural development such as shops, roads, schools, telecommunication facilities and health services. The settlement is situated in an area meant to attract potential investors and further development to an attractive holiday destination for

national and international tourism. As it can be seen in Figure 5.22, Hoachanas is located north-east of Mariental in the flat headwaters area of the Auob river in the Mariental Rural Constituency. It is now a proclaimed settlement area falling under the Regional Council and the Ministry of Local Government, Housing and Rural Development. The settlement occupies an area of about 22 000 hectares. Several other resettlement farms border the Hoachanas resettlement.

Figure 5.22 show that the gravel road connects Hoachanas settlement with Kalkrand on the tarred road 53 kilometres to the west. Other gravel roads connect the Hoachanas settlement with Uhlenhorst, 27 kilometres north and with Stampriet, 63 kilometres south. The earth graded roads shown on the map provides access to farms and villages to the east of Hoachanas. Some old surface airfields within Hoachanas and surrounding areas can also be spotted on the map.

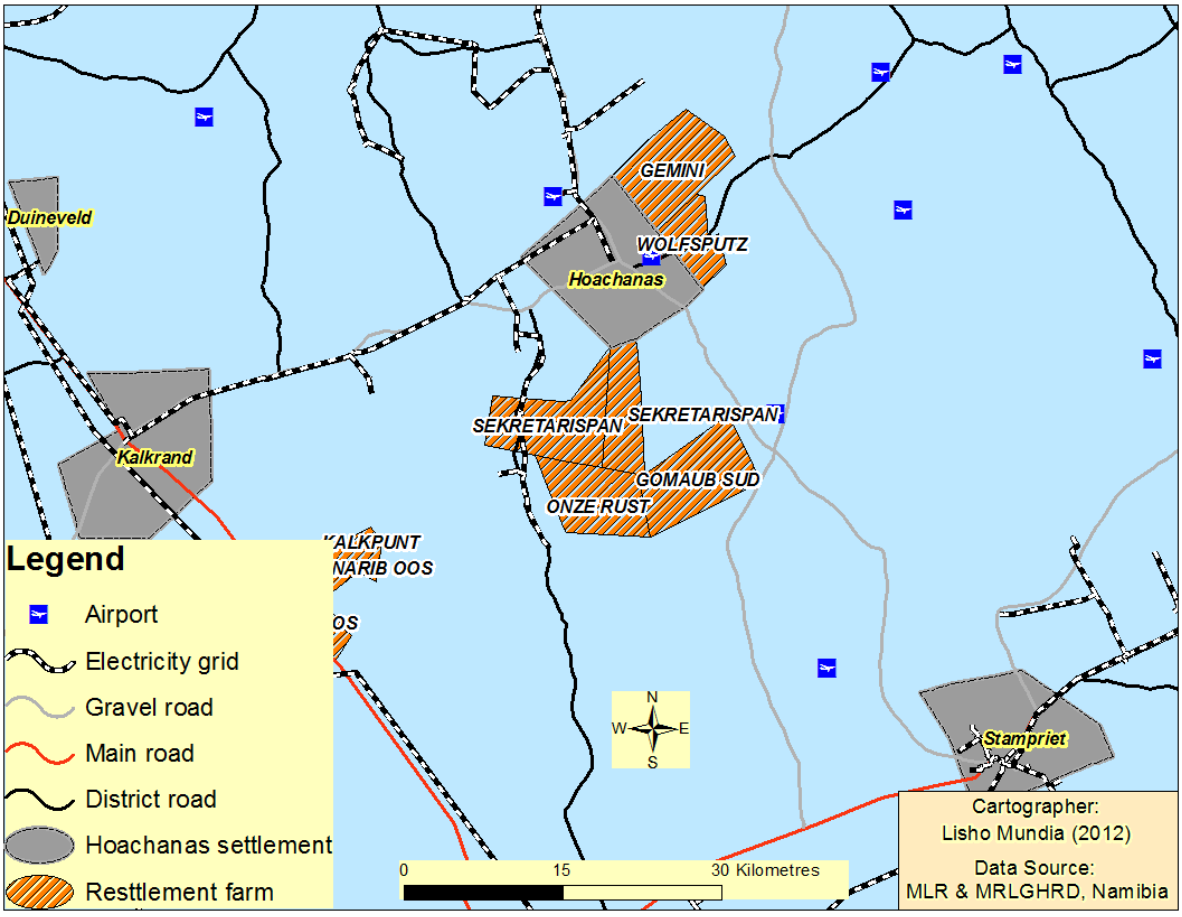


Figure 5.22: Hoachanas settlement[9]

Hoachanas was traditionally the centre of a Nama-speaking clan, the Rooinaisie. According

[9] The two Sekretarispan farms represented on Figure 5.22 are not consolidated into one property

to the 2001 census an estimated number of 2 671 people live in the settlement, the majority of whom are Nama-Damara speaking. There are approximately 310 households situated in Hoachanas. The settlement has an average of 7.4 persons per household. The majority of people in the Hoachanas settlement live in the main settlement while a few others own a second dwelling in the surrounding areas on resettlement farms (Government of Namibia, 2006b).

The researcher made a number of observations regarding infrastructure and services. Only a few of the private houses are brick constructed. The majority of the houses are built with corrugated metal sheets. Most properties are fenced and demarcated as proclaimed residential land use, commercial and business land use. The clinic, the police station, the settlement office, retail stores and farmers' auction pens are the brick constructed properties serving the communities. The settlement includes two government schools. One of the schools has hostel facilities. With regard to sport and recreation, the community has three soccer fields. Two water pumps and a booster station provide good quality water to the entire settlement. Only a few households have tap water on their residential premises. Flush toilets are provided in privately owned shops and hostels as well as in the government buildings such as the schools, the clinic, the settlement office, and the police station.

Telecommunication services such as voice telephone services, data telephone services and mobile telephone services are also available in the settlement as well as pre-paid electricity. The settlement has street lights provided to the clinic, a police station, a settlement office and retail stores serving the local communities. Public transport is provided by private taxi operators. Agriculture extension and veterinary services are also available.

5.3.3.4 Uibis Settlement

Another development initiative that was identified is the Uibis settlement. Uibis is desired by its residents and local communities from surrounding areas for its fast growing infrastructure development such as shops, schools, electricity and telecommunication which support the local communities. Uibis' development is not well known to most of the residents of the Hardap region (Government of Namibia, 2006b). Uibis is a rural, un-proclaimed settlement located within the Gibeon Constituency of the Hardap region. It is about 26 kilometres southeast of Maltahöhe and 70 kilometres west of Gibeon (Figure 5.23). The 12 702 square kilometres settlement is located in a relatively good farming area in arid, southern Namibia. The land has potential to produce food for residents and within the Hardap region. The recent initiative in upgrading the provision of water, electricity and telecommunication

infrastructure will attract tourists and enhance the residents' well-being and improve their socio-economic status.

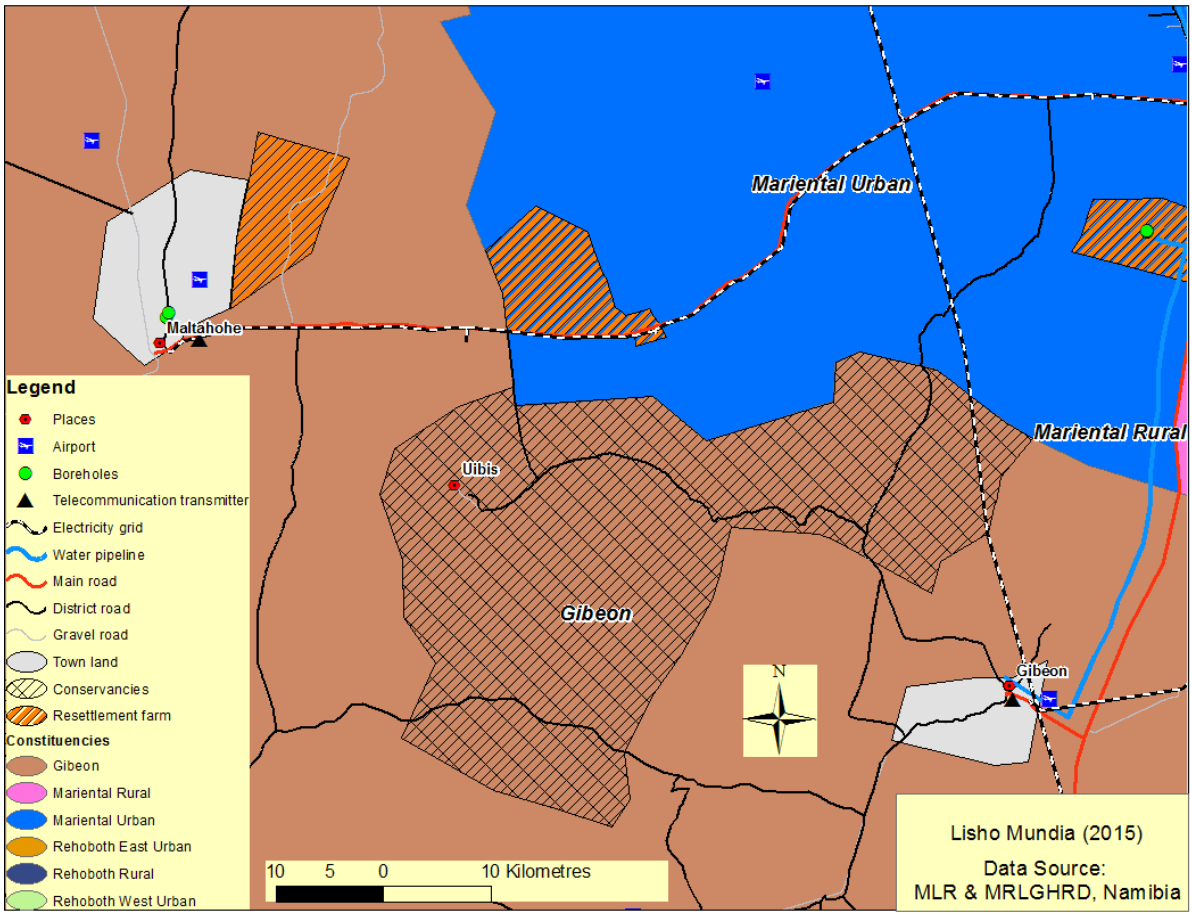


Figure 5.23: Uibis rural community

About 385 people live in 63 households in and around the Uibis settlement and other neighbouring villages (Government of Namibia, 2006b). The majority of people living in the Uibis settlement were born there, while only few came from other regions.

The major water source is ground water. It is extracted by using diesel and three wind pumps in three locations to supply the scattered locations around Uibis. The water is stored in several plastic tanks within the Uibis farmhouse which is then distributed to the community by pipes and taps. The school, its hostel and the five brick houses belong to the government. Teachers have tap water connected directly to taps and flushing toilets in the five brick-constructed houses. To service the school facilities effectively, a wastewater disposal system was constructed by the Government of Namibia.

Most houses are constructed with corrugated sheets and a few with bricks. The local shop,

however, is a brick building. Most people use solar energy for heating water and cooking. There is a big approved rural electricity provision project underway which people believe will be of real benefit. Telephone lines and public telephones are also available in the settlement. Most people engage in farming activities within the settlement. Women who are over the age of 60 are engaged in sewing traditional Nama dresses. Some people are known to sell wood to earn extra income.

5.3.4 The Contribution of GIS to Sustainable Land Use Planning

GIS is increasingly important in the sense that people from different backgrounds can share common information and access common land information systems to provide flexibility in working together. Spatial information remains a key element in land use planning. GIS support land use planning by reducing the challenges of data acquisition, integration and sharing across jurisdictions and varying data systems. Interoperability remains a vital issue that is amplified by social and political differences in the country. GIS can be used to its full potential in many applications. In this study, the capabilities of GIS used in land use planning are data storing, data management, data analyses, data manipulation and data representation. Ideally, in best practice, GIS is used in phases such as data management, data input, data analysis and data representation. The researcher is of the opinion that the most important value of GIS in sustainable land use planning is the data. The aspects of data management, data processing and data representation are also important for sustainable land use plans in the country as it provides meaningful information to users.

Geographical Information Systems supported data management, such as collect and store, and retrieval operations, queries and display, for compilation of land use maps of the Hardap region. GIS technology is used to describe the spatial data geometries and locations of various types of geographical phenomena (Bae, Alkobaisi, and Leutenegger, 2010). The three specific contributions of a GIS in this study are:

1. managing spatial data,
2. processing of spatial data. and
3. compiling land use maps.

GIS technology contributed to managing the spatial data gathered from different organisations and ministries in Namibia. The data gathered were structured according to their models (vector and raster) and groups such as land, hydrology, climate, geology and others. The data processing was done using ArcGIS 9.x to help produce easily readable outcomes from the data.

Land use plans can also be generated using optimisation methods such as GIS technology (Arciniegas, Janssen and Omtzigt, 2011). Different land use, infrastructure and natural resources were mapped using GIS technology in order to produce visual representations of land use data.

Integrated management of the complex problem of land use planning can be improved by means of spatial information systems. In this study, participatory mapping data provided an input to the GIS environment. In its application of land use planning, GIS can portray boundaries and deal with enormous differences in scale. These maps become a powerful tool for local communities, facilitators, extension workers, researchers and decision-makers to be used for identification of location-specific problems, analysing relevant causes and finding options or possible solutions for land disputes within the community.

The use of spatial data in land use planning is essential to manage the sustainable and equitable use of land through participatory local planning. Factors which lead to effective community-based land use planning include:

1. clarify legal status of the land use rights for individuals and communities;
2. having a strong stakeholders awareness of their reliance on land for subsistence and economic development, both in the short and long term; and
3. availability of information on the current status of and trends in the use of land resources.

In recent decades, GIS-based land use planning has contributed immensely to sustainable development. There have been many studies on land use planning for cities, townships, industrial areas and districts in India (Bobade, Bhaskar, Gaikwad, Raja, Gaikwad, Anantwar, Patil, Singh and Maji, 2010). The studies have made reference to GIS-based land use planning as a success. GIS-based land use planning is being practiced in many developing nations like Mauritius, South Africa, India and Botswana (Johnson, Deshmukh and Kale, 2010) with developed nations already in advanced stages of using GIS in sustainable land use planning.

In summary, given the large quantity of land use planning data that needed to be compiled for this study, GIS was used as an efficient tool for organising, storing, analysing, displaying and reporting the spatial information. GIS allowed the efficient creation of maps that were produced from the available land use planning data.

5.3.5 Conclusion

The main objective of this section was to produce land use maps from the Hardap region from existing land use data for comparison of desired and undesired land uses. The various land use maps representing different land use activities and locations were produced from previously gathered secondary spatial and non-spatial data. Although no land conflicts were identified in the study area many potential land development initiatives such as the Bernafay commercial farm, the Hoachanas settlement and the Uibis rural community were identified and mapped.

The research question with regard to the best mapping procedures for developing regional land use plans in Namibia was validated because the study shows that GIS technology and number of local participation had been considered before in spatial planning. GIS technology and local participation are important components in spatial planning such as ILUP. In order to complement the knowledge of the government and private organisations' experts', local community participation in IRLUP in Namibia is highly encouraged. The next section in this chapter presents the results of the Focus Group Discussions (FGD), Participatory Rural Appraisal (PRA), the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis for the evaluation of outcomes on participatory mapping.

5.4 FGD, PRA and SWOT Analysis Results for Evaluation of Outcomes of Participatory Mapping

5.4.1 Introduction

The main objective of this section is to share the results of the FGD, PRA and SWOT analysis that was done to evaluate the outcomes of participatory mapping conducted in the Hardap region for integrated sustainable land use management in Namibia. The section provides results gathered from local communities of the Hardap region as well as experts[10] in land use planning, geography and GIS. The various challenges and benefits associated with participatory approaches such as the FGD, PRA and SWOT analysis outcomes and implementations in Namibia were explored. Various processes of these participatory approaches are considered in this study.

[10] An expert is a person with extensive knowledge or ability based on research, experience, or occupation in a particular area of study.

5.4.2 FGD for Local Knowledge on Participatory Mapping and LUP

5.4.2.1 Introduction

Participatory land use planning has been promoted worldwide as an alternative to top-down land use planning (FAO, 1998, cited in Fagerholm and Käyhkö, 2009). There are various degrees of participation. It is understood in this study as an active involvement of the land users in the identification of their need for land; the need to participate in the planning of such land; and the need for land use planning tools. The fundamental belief of participation is that the land users know their situation best and thus should play a key role in land use planning. Another objective, sometimes also on the hidden agenda of donors, is the objective of politically empowering local communities through participatory planning.

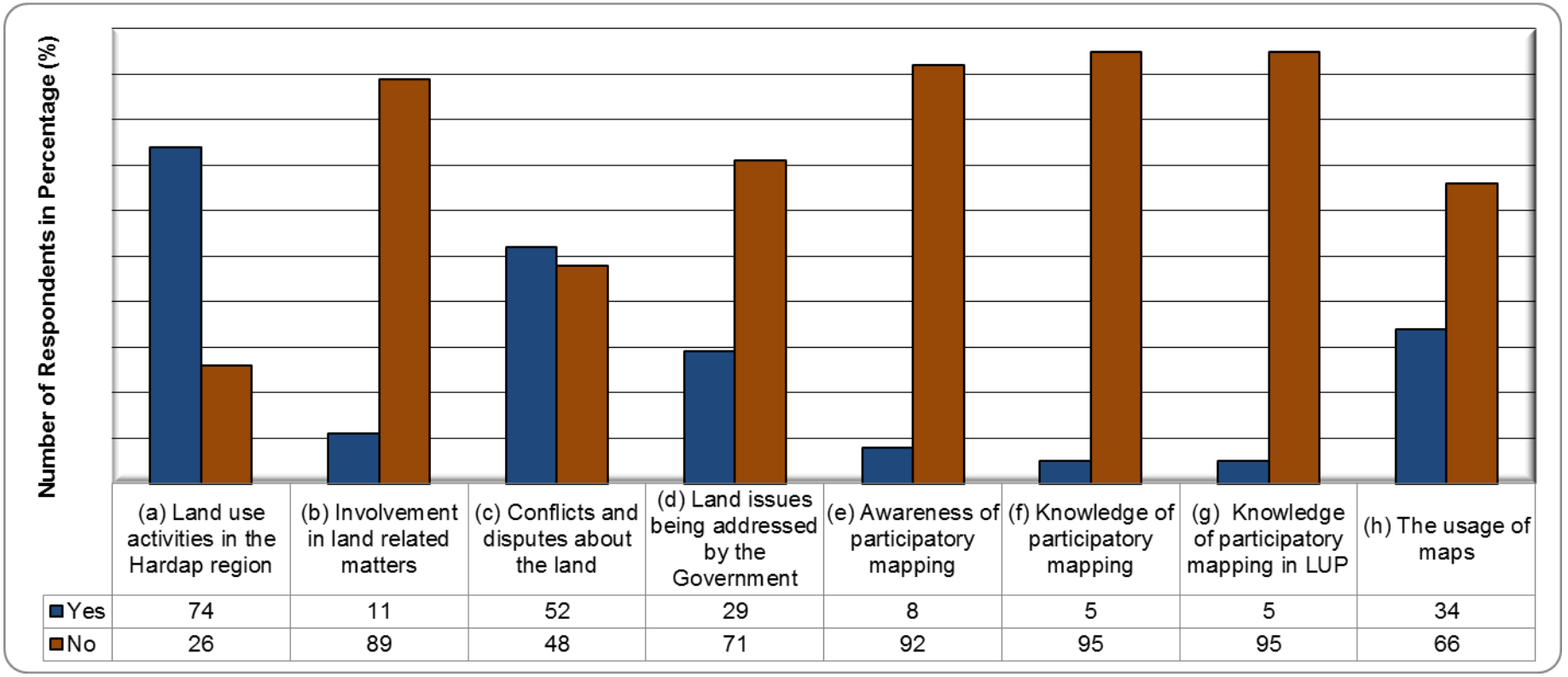
Thirty-eight (38) FGD questionnaires were completed by way of various group discussions which were conducted in a variety of places and constituencies in the Hardap region.

5.4.2.2 The FGD Questionnaire Survey Results for Local Communities

Section A of the questionnaire (Appendix A on page 259), was used to gather information on gender, age categories, towns and regions of the respondents in Namibia. The FGD and PRA were both conducted within the six constituencies of the Hardap region, namely: Rehoboth West Urban, Rehoboth East Urban, Rehoboth Rural, Mariental Rural, Mariental Urban and Gibeon.

Although the FGD was intended to gather information from most parts of the Hardap region, it was carried out in five different units of land within the six constituencies of the Hardap region. The units of lands were selected because they differ in the use of the land. These land use types includes urban, peri-urban and rural land uses.

Section B of the FGD questionnaire was used to gather information about land use activities and infrastructure. The results shows high number (74%) of participants with land use activities and infrastructure on their land (see Figure 5.24(a)). The question was intended to measure knowledge, opinion and experience in land use planning. The participants showed knowledge of their land uses. The responses show that commercial farming, subsistence farming and residential are the most common land use activities.



	(a) Land use activities in the Hardap region	(b) Involvement in land related matters	(c) Conflicts and disputes about the land	(d) Land issues being addressed by the Government	(e) Awareness of participatory mapping	(f) Knowledge of participatory mapping	(g) Knowledge of participatory mapping in LUP	(h) The usage of maps
Yes	74	11	52	29	8	5	5	34
No	26	89	48	71	92	95	95	66

Figure 5.24: FGD on Local Knowledge about and Involvement in Participatory Mapping and LUP

The infrastructure provided to the participants on their land (see Figure 5.25) is dominated by roads (30%), houses (27%), followed by the electricity (16%). This information is critical for integrated land use planning process of the Hardap region.

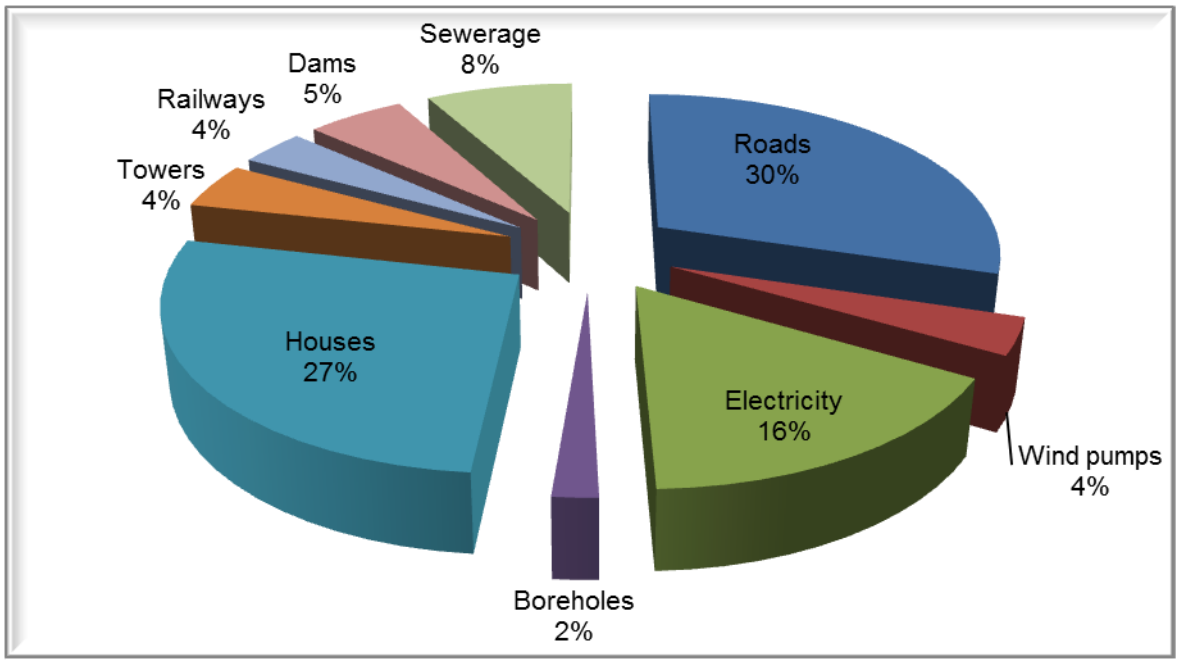


Figure 5.25: Major infrastructure

The opinion of the participants with regard to infrastructure (Figure 5.25) is that roads and houses exists but are not available to everyone. This was expected because the dominant land use type is residential. The information about electricity use was also expected because not all residential and agricultural land has electricity.

The perception of the participants with regard to land-related matters as shown in Figure 5.24(b) indicates that 89% of the participants do not attend any land-related programmes in the region. The result shows lack of participations in land-related matters in meetings, workshops, conferences and training by the participants in the Hardap region.

Rivers, streams, wells, mountains, trees and other natural phenomena such as dunes are part of the landscape (Figure 5.26). Natural phenomena are important for consideration in land use planning process because their impact on the land is measured in consideration of the existing natural phenomena (for example, rivers) and land use. Figure 5.26 shows that rivers are the major natural phenomena used by many participants in the region by 33% dominantly, followed by trees 31%, mountains 20%. The perception of participants with

regard to natural phenomena was unexpected to dominate with rivers because of the poor rainfall in the southern part of Namibia.

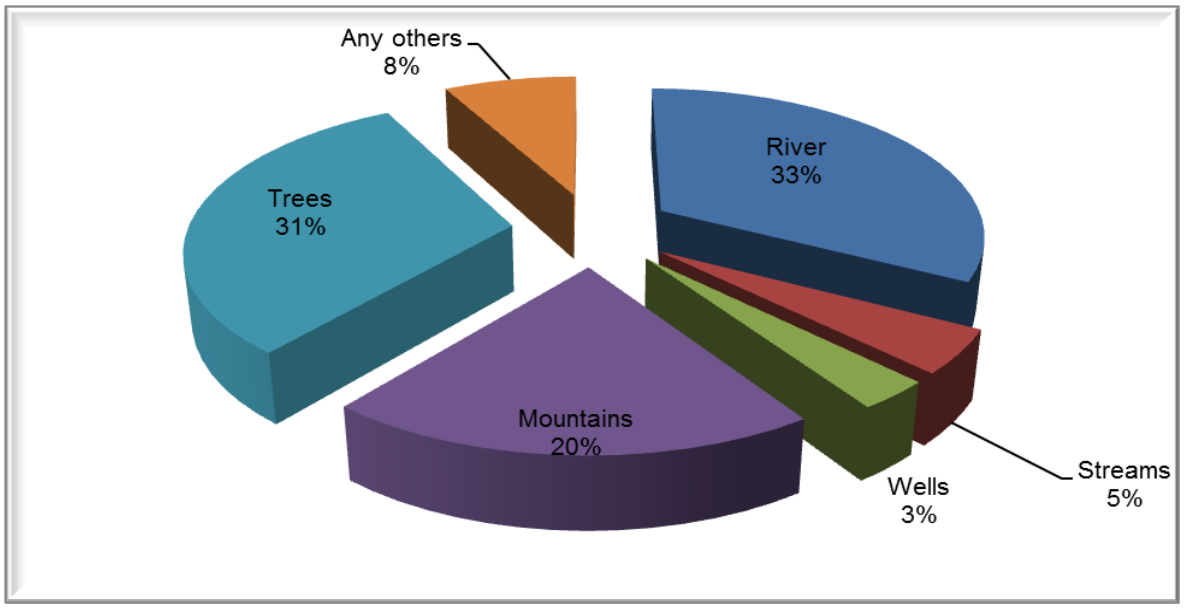


Figure 5.26: Commonly used natural phenomena in Hardap region

With regard to land conflicts and disputes, Figure 5.24(c) depicts that at least 52% of the participants indicated that they have land conflicts and disputes. Some of the land conflicts and disputes indicated by the participants includes fighting for land grabbing, disputes on unclear erven boundaries and farm boundaries, fear of being evicted from privately owned land, municipalities relocating residents from one place to another place. The FGD also reveals that most of the local people face delays in land conflict resolution. Some are left without solutions on their land problems or issues.

The ultimate support to local communities in land use planning and management of land resources by relevant government ministries and organisations must be strengthened. It is important for the relevant local government ministries and organisations to be able to support local residents to the point where they are fully capable of addressing and solving the problems of the country (Food and Agriculture Organization, 1999). The majority of participants indicated that their land issues are not addressed by the responsible and relevant organisations. Only 29% of the participants indicated that their land issues are addressed on time by responsible organisations as shown in Figure 5.24(d).

In Section C of the FGD questionnaire, the participants indicated that they never heard of participatory mapping before. Figure 5.24(e) indicates that 92% did not know about the

participatory tool, while only a few participants had heard of participatory mapping. This suggests that the research question concerning the role of participatory approaches aided by GIS in land use planning and management in Namibia was validated because there is a need for participatory approaches and GIS in ILUP. It can therefore be concluded that the implementation of ILUP without incorporating local knowledge through participatory approaches will result in poor land use planning in Namibia.

The participants also indicated that they had never used participatory mapping before. The results are depicted in Figure 5. 24(f). The figure indicates that almost none of the participants took part in participatory mapping exercises before. A few farmers that had done participatory mapping before, indicated that they had participated in such an exercise for agricultural land use activities. The results suggest that farmers have more knowledge about tools and methods to manage their land compared to ordinary land users.

The participants were also asked about their knowledge and experience on the usage of participatory mapping in integrated land use planning. The result indicates that only 5% used the tool in land use planning as seen on Figure 5.24(g). The participants also indicated that about 34% of the participants use maps in land use planning (see Figure 5.24(h)).

Some local community members in the Hardap region use maps in their land use activities as depicted in Figure 5.27. Of those few local community members using maps, about three quarters use hard copy maps, 18% use hand drawn maps and only 6% use dynamic maps[11]. The results suggest that the participants know how to read maps.

[11] Dynamic maps are lively animated maps, where the content is viewed only and the user cannot modify any content.

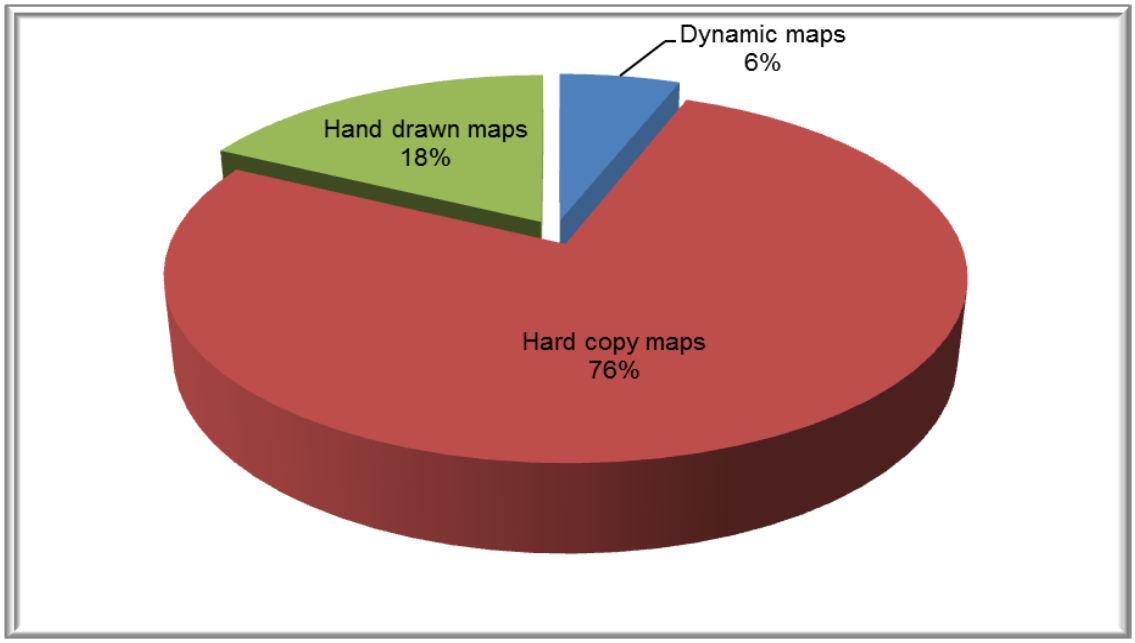


Figure 5.27: The use of maps and kind of maps used by the participants

Section D of the FGD questionnaire gathered general comments of the local communities on participatory mapping in land use planning. Table 5.3 provides some comments provided by different local respondents within the Hardap region.

Table 5.3: Local land users' general comments and suggestions (FGD)

“Here in Kalkrand, we live in a private owned land for more than 20 years now.”
“I grow up in Kalkrand, but up to today I don't have a piece of land I can call my land. I still live in a private land.”
“The land that we get is not serviced; there are no proper fences for erven land, no water. You have to struggle to get an erf in this place also, only some people are getting land.”
“We use to map and colour the locations of condom points in our area, together with the help of our clinic staff member.”
“We still live in the informal settlement for over 10 years now. When will government help us formalise our houses and give us this land permanently?”

The comments in Table 5.3 suggest that the participants of Kalkrand live on private land. The opinion of the participants confirm claims of forcedly been relocated to different pieces of land by the local authority because of lack of secure tenure by the residents. Some participants claim poor service delivery, such as water to the community.

The capability of the participants on using a participatory mapping approach was also confirmed. The participants indicated that they use to map and colour the locations of condom points in their area with the help of clinic staff members.

5.4.3 PRA for Local Knowledge on Participatory Mapping and LUP

5.4.3.1 Introduction

The participatory rural appraisal (PRA) (see Appendix B on page 263) at local level was done with the same local participants who carried out the FGD in the Hardap region. Thirty-eight (38) questionnaires were distributed and completed during various field group participatory discussions and in different places and constituencies in Hardap.

5.4.3.2 The PRA Questionnaire Survey Results for Local Communities

Section B of the PRA (see Appendix B on page 263) gathered information on land use purpose and understanding of participatory land management tools such as PRA and maps in the Hardap region. The collected knowledge and experiences from the participants revealed that the majority of land occupants use land for residential, farming, businesses and other activities such as educational (kindergardens). Figure 5.28 show that residential land use is the most dominant (68%), followed by farming (17%), business with slightly less than 10% and any other uses (6%). Some of the other land use activities indicated by the participants are educational (crèches).

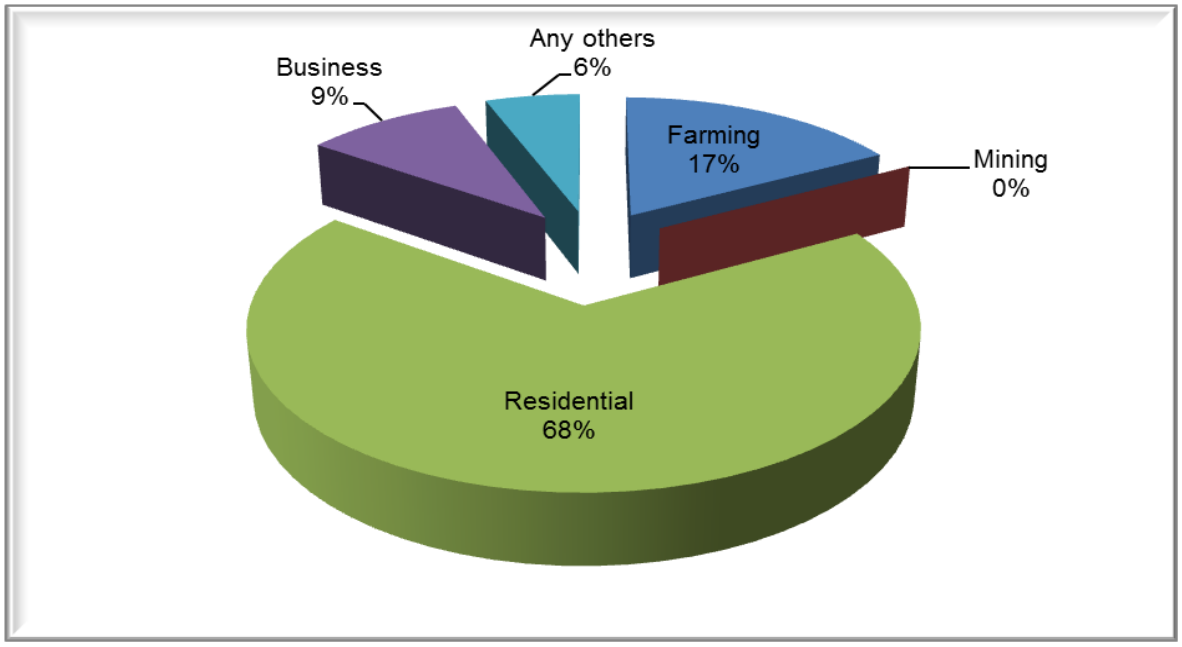


Figure 5.28: The main land uses of the land

With regard to the question as to whether there are any organisations providing land-related services to the community or land owners in the Hardap region, Figure 5.29(a) depicts the answers. The bar graph depicts that 38% of the participants in this survey indicated that they

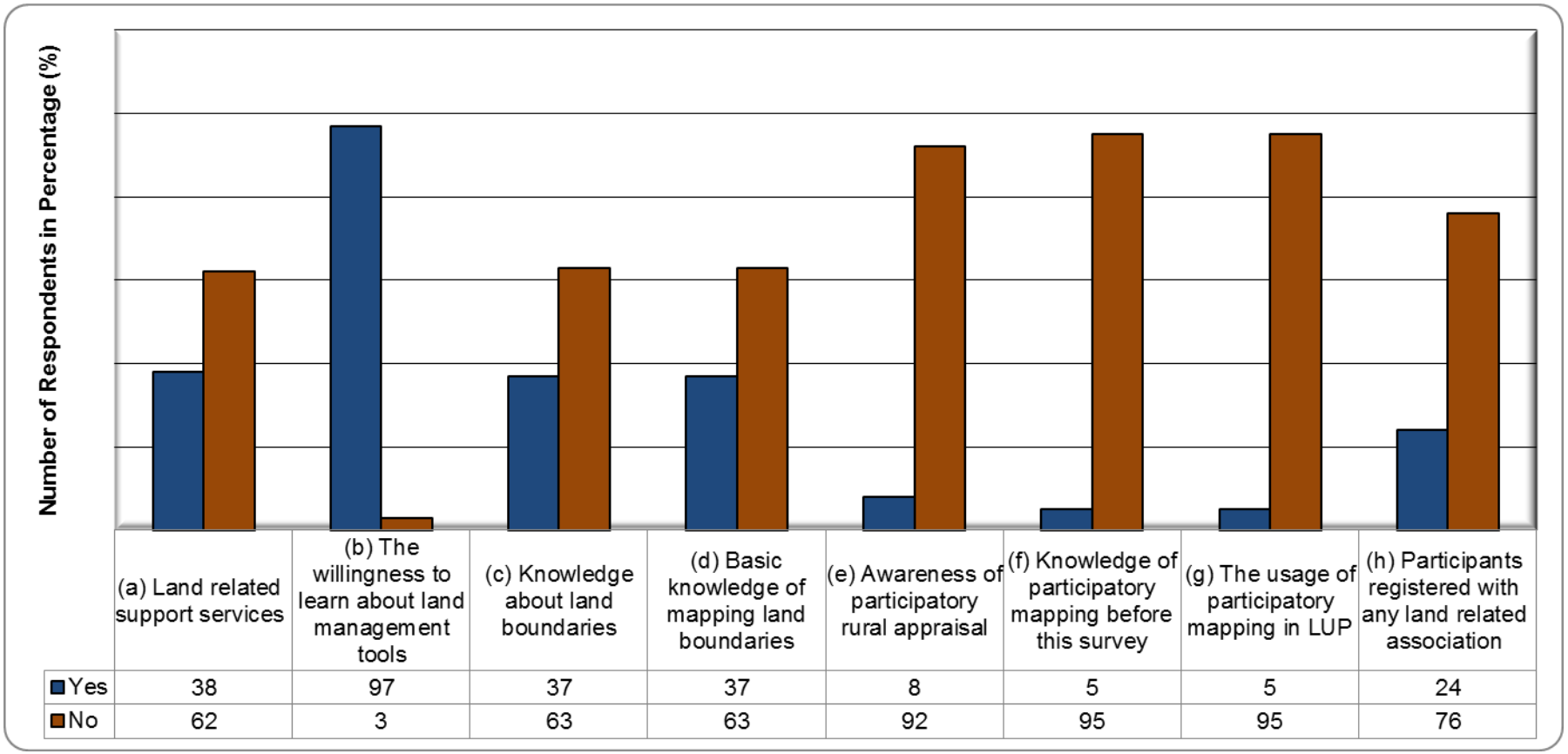
do receive such a service. Some of the organisations indicated by the communities for proving the services include:

- farmers associations,
- municipalities,
- town councils,
- village councils,
- Namibia housing action group, and
- Shack Dwellers Federation of Namibia (SDFN).

The nature of services and support provided by these organisations include basic farming support trainings by farmers associations, land management and administration in towns and village councils by local authorities such as town and village councils. The Namibian housing action group and SDFN supports poor and low income people in buying, upgrading and managing of their land, housing and information.

Beside the support received by some of the land users in the Hardap region, there are a great number of local participants eager to learn how to manage their land. This is depicted in Figure 5.29(b); the bar graph shows that almost all land users want to learn about participatory land management tools such as FGD, PRA and the use of maps.

This study further revealed that about three quarter of the participants understands approximately half of the issues on land management. The results are depicted in Figure 5.30; about one quarter does not understand any of the land management issues and none fully understand the land issues. The result suggests that there is determination and willingness by the participants to manage their land properties and land use planning activities within their surroundings.



	(a) Land related support services	(b) The willingness to learn about land management tools	(c) Knowledge about land boundaries	(d) Basic knowledge of mapping land boundaries	(e) Awareness of participatory rural appraisal	(f) Knowledge of participatory mapping before this survey	(g) The usage of participatory mapping in LUP	(h) Participants registered with any land related association
Yes	38	97	37	37	8	5	5	24
No	62	3	63	63	92	95	95	76

Figure 5.29: PRA on Local Knowledge about and involvement in Participatory Mapping and LUP

Although some local communities have knowledge about certain land management issues, there was still a lack of knowledge or understanding on how to deal with issues concerning land boundaries and the basic knowledge of mapping these boundaries on a piece of paper. Figure 5.29(c) indicates that about 63% of the local residents do not know exactly where the boundaries of their land are. This indicates a need to proper participatory land management tools to be taught to local communities on how to use the tools. Participatory land use planning tools are important for local communities to be applied for proper land management purposes, because the tools help enhance corporation of local communities' knowledge and the experts' knowledge of land use planning processes.

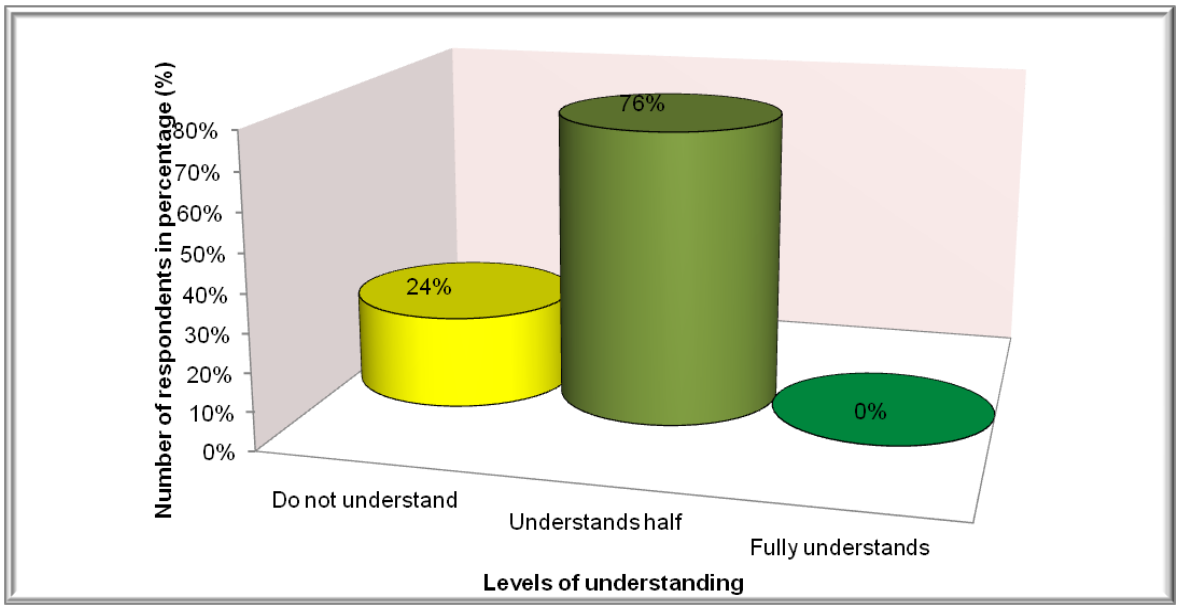


Figure 5.30: The level of understanding of land management issues

The local communities also indicated lack of knowledge of their land boundaries. This suggests that their knowledge of land boundaries is comparable to that of mapping their boundaries. The results shown in Figure 5.29(d) indicate that only 37% of the local communities can map their land boundaries on a piece of paper. The results suggest that the research question on the role of participatory approaches in land use planning and management in Namibia was validated as the participants have little knowledge about the mapping, but good knowledge of socio-economic issues, such as issues surrounding their life style.

Section C of the PRA gathered information on basic knowledge on participatory rural appraisal and land-related training or support in the Hardap region. Figure 5.29(e) shows that about 92% of the local land users in the region do not know what the PRA tool signifies.

It is suggested that the research question about the local communities' engagement through participatory approaches in land use planning activities was validated because there is lack of local community empowerment in land use planning. The results portrayed in Figure 5.29(f) also show that about 95% of the participants in the Hardap region had never done participatory mapping before participating in this project.

Figure 5.29(g) show that only 5% of the participants had used PRA tool in integrated land use planning (ILUP) in the region. This shows that many of the participants have never used PRA tool in ILUP before (Figure 5.29(g)). The participants who indicated to have used PRA tool in ILUP also indicated that they used it in rural land assessment study.

Twenty-four percent (24%) of the participants in the Hardap region are members of the Farmers Association and Shack Dwellers Federation of Namibia, but not all belong to a land association (Figure 5.29(h)).

Some of the general comments and suggestions about PRA tool and land use in the Hardap region from the land users are presented in Table 5.4.

Table 5.4: Local land users' general comments and suggestions - PRA

"We live in a reserve, it could be much better to have our own land for farming purpose."
"I do like to learn more about basic participatory rural appraisal and land management related tool."
"This is a good tool; it keeps me updated with the features in my land."
"I like this tool, together with the mapping exercise."

The comments in Table 5.4 indicate that the participants lack security of tenure on their land. The participants have indicated willingness to learn about using participatory rural appraisal tools for land management purpose. The participatory rural appraisal tool used in this study was also appreciated by the participants as indicated in Table 5.4.

5.4.4 FGD for Experts Knowledge on Participatory Mapping and LUP

5.4.4.1 Introduction

The experts' knowledge was gathered through the FGD approach. Three (3) FGD meetings with different group of experts took place in Namibia. One meeting took place in the Hardap region and two in the Khomas region respectively. The meetings in Khomas region were important because most decision-makers on central government level are from Khomas

region. The Hardap region was important in order to allow experts' views and inputs about land use planning and GIS in the Hardap region. The FGD questionnaire surveys (see Appendix A on page 259) were completed by the participants to gather many different suggestions, opinions and comments which are presented in this study.

It should be mentioned here that it was too expensive to travel around the entire Hardap study area to gather experts' knowledge on land use planning, GIS and geography. The FGD questionnaire survey was therefore emailed to some experts who had been absent in the meetings. Gathering experts' knowledge was important because they have valuable insight knowledge of the Hardap region's land use planning situation and are involved in the decision-making process of Hardap region's land use planning.

5.4.4.2 The FGD Questionnaire Survey Results of Experts

Section A of the questionnaire gathered information on gender, age categories, hometown and region of the respondents in Namibia. The experts' know-how on the use of participatory mapping methods in land use planning was gathered from many parts of Namibia.

Section B of the FGD was used to collect information on land use activities and infrastructure in the Hardap region. The land use activities and infrastructure discussion was important to have different inputs and viewpoints from experience of experts who know the Hardap region. The decision-makers and experts from the Hardap region's regional government on land use planning and GIS duties, shared their views, inputs and knowledge about land uses and infrastructure of the region.

The FGD questionnaire survey results as summarised in Figure 5.31(a) shows that 24% of the participants from Hardap region are engaged in land use activities which include subsistence and commercial farming and business activities. Those that are involved in land use activities indicated that they have infrastructure such as roads, wind pumps, electricity, boreholes, houses, towers, railways, dams, reservoirs and sewerage.

The question about infrastructure was important in order to gather the opinions and perceptions of experts in land use planning, geography and GIS with regard to available infrastructure development in the region. The development planners, town planners, land surveyor, GIS experts and geography experts in the Hardap region are knowledgeable about the various infrastructure development initiatives in the entire region as they serve in numerous development committees.

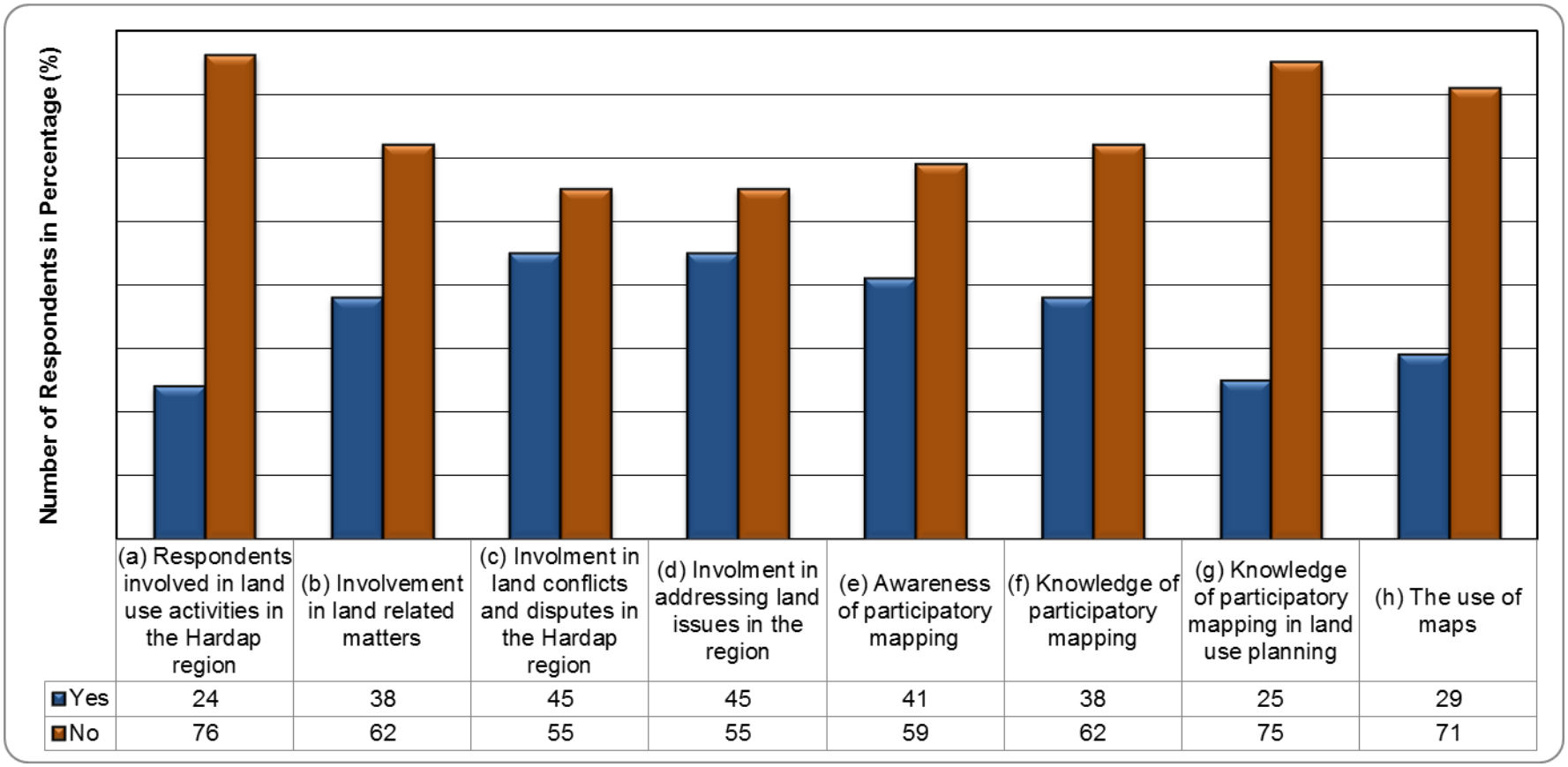
The knowledge and opinions gathered from experts helps in the awareness of existing infrastructure and in determining the need for more infrastructure development in the Hardap region with comparison to other regions.

The natural phenomena found on their land were indicated as rivers, streams, wells, mountains, vegetation and trees. The questionnaire survey results also show that 38% of the participants are members of associations that deal with land-related matters as Figure 5.31(b) shows.

Through the FGD questionnaire survey many land conflicts and disputes in the Hardap region were unwrapped. These include conflicts and disputes such as:

1. fighting for land due to poor land tenure,
2. unclear land boundaries,
3. border or boundary disputes in communal areas,
4. family disputes over communal plots,
5. Illegal fencing in communal land,
6. jurisdiction of traditional authorities over land boundaries,
7. border or boundary disputes on farming units,
8. unrecognised traditional authority, and
9. eviction of farm workers by the new farm owners.

The FGD questionnaire survey results indicated that just fewer than 50% of the respondents have experienced land conflicts or disputes in the Hardap region. This result is depicted in Figure 5.31(c). From the survey one can infer that land issues are not addressed properly by responsible government ministries or organisations in the region. Figure 5.31(d) shows that 45% of the respondents who has land in the Hardap region were of the opinion that land issues such as conflicts and disputes are addressed well.



	(a) Respondents involved in land use activities in the Hardap region	(b) Involvement in land related matters	(c) Involment in land conflicts and disputes in the Hardap region	(d) Involment in addressing land issues in the region	(e) Awareness of participatory mapping	(f) Knowledge of participatory mapping	(g) Knowledge of participatory mapping in land use planning	(h) The use of maps
Yes	24	38	45	45	41	38	25	29
No	76	62	55	55	59	62	75	71

Figure 5.31: FGD on Experts' Knowledge about and involvement in Participatory Mapping and LUP

Section C was used to gather information about knowledge and experiences of the use of participatory mapping in Namibia. Figure 5.31(e) show that almost two-thirds of the respondents had never heard of participatory mapping before. This is a testimony that the approach is still new to many Namibian experts in land use planning and GIS. Despite the fact that experts are well aware of the existence of participatory mapping in different fields, only a few have know-how on the use of it. The participants' views, opinions and perceptions are depicted in Figure 5.31(f). The figure shows that 62% of the experts never used participatory mapping in Namibia before.

The study results confirm that the role of participatory approaches in land use planning and management in Namibia is not known and documented in Namibia. There is lack of knowledge with regard to use of participatory approaches in ILUP.

As indicated in Figure 5.31(f), 38% of experts have knowledge of participatory mapping. The study shows (Figure 5.31(g)) that only a quarter of experts have previously used or participated in a participatory mapping approach to land use planning. However, some of the participants listed the participatory mapping projects in which they participated — the projects include:

1. field verification of topographical map of the Kunene and the Caprivi regions respectively;
2. field validation of map of the Karas region;
3. integrated land use planning in the Karas region;
4. identification of existing infrastructure in the Tsumeb area;
5. geo-environmental issues in the Tsumeb area;
6. natural resource and community forest mapping in Northern Namibia; and
7. vegetation classification in Northern Namibia.

The FGD questionnaire survey also gathered knowledge and experience of map usage by the participants. The results depicted in Figure 5.31(h) shows that 71% of experts use maps for various purposes. The compilation of different land use maps by the participants was undertaken to measure the level of knowledge, perceptions and opinions of the participants. The kinds of maps used by the participants provided answers to the objective of producing participatory land use maps from different units of land within the six constituencies of the Hardap region by local communities.

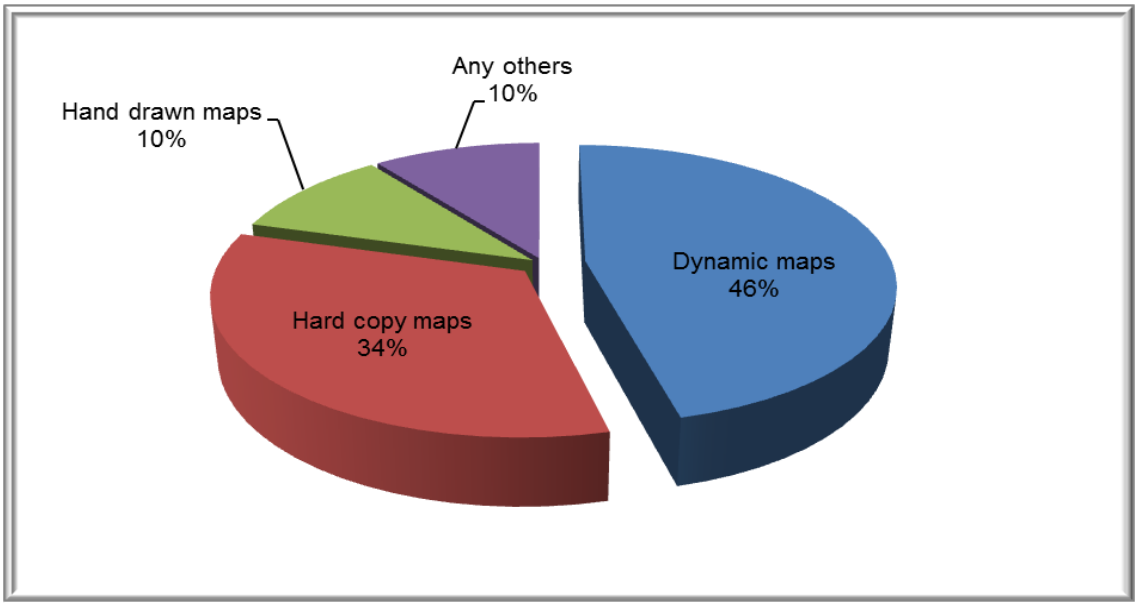


Figure 5.32: Kinds of maps used by the participants

The figure shows that different types of maps are used by the participants. The three kinds of maps used most frequently are hand drawn maps, dynamic maps and hardcopy maps. Figure 5.32 shows that dynamic maps are most used (46%) by the participants. Other types of maps listed by the participants were digital maps and Google maps. They also referred to satellite images.

Section D of the FGD questionnaire survey gathered some general comments by the participants on participatory mapping in land use planning. Table 5.5 represents the comments and suggestions provided by the participants.

The participants provided their opinions and insights on the usefulness of maps, participatory mapping approaches, GIS and the research in general. The general comments, suggestions, opinions and insights of the participants in Table 5.5 contributed to the realisation of the research objectives.

The participants view maps as useful tools in land use planning. The participatory mapping approaches are regarded as important by the participants because the methods incorporate local communities' knowledge in land use planning. The participants are of the opinion that the use of GIS and participatory mapping should be implemented in relevant ministries, local authorities and private sectors in order to cater for local, regional and national integrated land use planning. The research was also commended as useful by the participants.

Table 5.5: Participants' general comments and suggestions

"Maps are very useful in land use planning work and life in general. I try very hard to be around GIS project but I never heard of participatory mapping."
"It's a very good methodology for Namibia case."
"Participatory mapping is a powerful tool and the future is promising for indigenous people. During this high technology era, participatory mapping can also be effective and efficient for spatial representation combined with interactive mapping technology on the web."
"Participatory mapping is a concept that should be encouraged within institutions that are dealing with land use planning because it empowers the community by getting them involved in the planning process."
"There is a need to establish/implement the use of GIS and participatory mapping in relevant ministries, municipalities, village councils and other private sectors because there are very important and useful tools that can be used by different professional from lower to higher level such as in the field of engineering, land use planners, surveyors and valuers to mention but a few who can be able to sustain and utilise the available resource in the region for the benefits of the local people as well as regional and national level." "Through GIS application I believe that land management and environmental projects will be well maintained and sensitive area will be identified."
"Participatory mapping is a most useful tool to use in the community. Since the community members know very well of their environment such as land use changes and resources distribution. The community activist, traditional leaders and senior people should always be considered as first priority for any development concerning their community."
"You are doing a very good research, and first of its kind by a regional outsider. I wish you complete it successful. I think there are many other land use activities and concepts in the region that you can look at, in a more detailed study to get a clear overview of the land use activities in Hardap region."

5.4.5 SWOT Analysis Results of Participatory Mapping Aided by GIS

In this study, it is important to gather existing experiences of the participants and the acquisition of knowledge about how land should be used. This was done by using a participatory approach for data collection. Two methods of participatory mapping were applied in this study namely sketch mapping and photo-mapping. The steps, outcomes and purpose of these two methods are different. Clifford and Valentine (2003:176) believe that "utilising a variety of data collection methods and a division of labour that consciously builds upon the strengths of each member of the team is one way to assure widespread participation." A SWOT analysis was conducted as a means of organising some of the issues and factors promoting and acting against participatory methods (Carver, 2001). A SWOT analysis was conducted in the local communities and experts. Some experts were selected from the fields of land use planning, geography and GIS within the Hardap region and others from the central government in the Khomas region who are familiar with the Hardap region's development. A summary of the results of the SWOT analysis are provided in Table 5.6. The table shows views and opinions of both local communities and experts from government ministries and other organisations.

Sketch mapping was found to be difficult for first time users and a very time consuming approach. This was because of the amount of time required by participants to verify certain geographical features within their environment before they started sketching the maps. In addition, lack of basic mapping skills by some community members contributed, as the sketch maps sometimes turned out to be unclear. It was, however, found to be a useful participatory tool in collecting information about issues surrounding the communities and how they live.

Photo-mapping was based on delineation of features interpreted from aerial photographs. This method was selected by the participants as it proved to be easier than other forms of mapping, such as sketch mapping. The interpretation process involved delineating features which the participants could recognise, describe and explain. Interpreting an aerial photograph or a small part of an aerial photograph was less problematic for the users. The features which were unclear on the map could be verified on the ground. The mapped features were based on what could be observed on the aerial photographs. Different features on aerial photographs were described using different keys as legends. Those keys were then used to explain the symbols depicted on the map.

Table 5.6: A SWOT analysis focusing on the results of participatory mapping aided by GIS in LUP in Namibia

INTERNAL FACTORS	
Strengths	***Weaknesses***
1. Participatory mapping approaches and GIS are recognised as the best practice tools for involving local communities' contributions to participatory land use planning. 2. Participatory mapping approaches can be understood by local communities involved. 3. Government recognises local communities' opinions and viewpoints in land use planning country-wide. 4. Participatory mapping provides the platform to gather good knowledge of local resources from the local communities. 5. There is an acceptable theoretical knowledge of participatory mapping by local communities and experts in relevant offices. 6. Participatory mapping has been accepted in most countries as a tool for collection of data on the participant's experiences and their surroundings for land use planning. 7. Participatory mapping promotes community awareness, institutional strengthening and empowerment of local inhabitants. 8. Participatory mapping can be used as a tool in managing and reducing conflicts between community members. 9. GIS helps manage, integrate, identify, locate, and analyse natural resources in Hardap region. 10. GIS provides the integration of all the data gathered from participatory mapping and other sources. 11. GIS allows efficient data manipulation, retrieval and presentation of spatial data.	1. No land use planning policies exist to implement the integration of participatory mapping aided by GIS into the integrated land use planning. 2. The decentralisation of land use planning processes in Namibia is not fully deployed to regional and local levels as it is only known at national level. 3. Participatory mapping approaches are not widely recognised at grassroots level for land use planning in the Hardap region.
EXTERNAL FACTORS	
Opportunities	***Threats***
1. The Spatial Data Infrastructure (SDI) policy to be tabled to parliament could open doors for enormous reorganisation of spatial data management.	1. Ignorance of some of the office-bearers responsible for planning and decision-making. 2. Serious time constraints involved in participation processes.

2. Participatory mapping promotes ownership of resources, information sharing and consultation on land matters. 3. Participatory mapping promotes sharing of natural resources such as rivers, forests, and many others. 4. Participatory mapping promotes information awareness. 5. Participatory mapping promotes sharing of benefits such as infrastructure. 6. Participatory mapping is been implemented as best practice for local knowledge gathering in other countries such as Kenya and South Africa.	3. Participation may be costly.

5.4.6 Conclusion

The major objective of section 5.4 was to describe opinions and experiences about participatory mapping approaches aided by GIS for sustainable land use management in Namibia obtained by means of a SWOT analysis. The SWOT analysis was used to evaluate the outcomes of participatory mapping aided by GIS for sustainable land use planning in Namibia. Participatory mapping aided by GIS were used to gather opinions, perceptions and views from local communities and experts in the Hardap region. Participatory land use maps produced by local communities we used for comparison of desired and undesired land uses in the Hardap region.

The research question dealing with the role of participatory mapping approaches aided by GIS in land use planning and management in Namibia was validated. This is because the study result shows that the importance, the strengths and opportunities of participatory approaches in ILUP exists in Namibia. However, there is still a lack of know-how about participatory methods, specifically participatory mapping in order to support land management programmes in Namibia.

5.5 Frameworks and Guidelines for Participatory Mapping Aided by GIS

5.5.1 Introduction

The main purpose of this section is to share the frameworks and guidelines for participatory mapping aided by GIS technology in sustainable land use management in Namibia. Various challenges such as lack of participatory methods awareness to gather local communities and experts' knowledge in land use planning and the benefits such as incorporating local communities' knowledge in land use planning in Namibia were explored. Different processes of incorporating local communities and experts knowledge into the implementation of ILUP were explored in this study.

5.5.2 Participatory Mapping Aided by GIS for LUP in Namibia

GIS is a tool that combines ordinary descriptive information with geographical location to create meaningful, clear and attractive maps that can be applied to development needs (USAID, 2000; cited in Tripathi and Bhattarya, 2004). Because of the nature of indigenous knowledge systems, GIS technology can facilitate the inclusion of indigenous participatory

knowledge in local decision-making processes. Jordan and Shrestha, 1999, cited in Tripathi and Bhattarya (2004:4) maintain that “there is an increasing interest in the use of GIS in a participatory context, with this development either causing alarm or being seen as providing a potentially valuable tool.”

Participatory mapping and other planning tools should be seen as sets of methods to help understand problematic situations in certain areas and to provide the foundation for development planning. The starting point of applying participatory planning approaches is gathering knowledge of the local people. The aim of applying such planning tools should be the creation of a framework for communication and learning. Some important participatory planning tools are sketch mapping, transect walking, focus group discussions and semi-structured interviews. While FGD initially was developed mainly as an alternative to information collection by questionnaire surveys, PRA also devotes the planning responsibilities and the enhancement of decision-making process to the villagers. Outsiders such as researchers are supposed to act as catalysts in processes of participatory land use planning.

5.5.3 Framework and Guidelines for Participatory Mapping Aided by GIS in ILUP

Local communities want to have an integral and meaningful role in making decisions about their own future. The growing bodies of international law, fiscal and policies from many countries support an increasing interest in understanding the natural, cultural, and spiritual world of local communities (Emery, 2000). Land development projects are beginning to include traditional knowledge in land use planning and implementation when local communities are directly or indirectly affected. The frameworks and guidelines capitalise on that informed interest. Emery (2000:3) is of the opinion that frameworks and guidelines should recommend that all stakeholders be given the opportunity to provide and accumulate wisdom from people who lived for uncounted generations on the same land.

The frameworks and guidelines were derived from an empirical study. The frameworks and guidelines for successful participatory mapping aided by GIS for LUP are imperative for consideration in future land use planning in Namibia. The research produced the frameworks and guidelines for gathering local people's knowledge in integrated land use plans for consideration by all responsible government ministries and organisations. The frameworks and guidelines should not be seen as enforced steps in the process of the implementation of integrated land use planning, but as a contribution to many existing guidelines of how to

incorporate local communities' knowledge in land use planning activities. The frameworks and guidelines for participatory mapping aided by GIS were done in accordance with the decentralised administration system of Namibia. Based on the guidelines, the research also produced a GIS database for land use planning using the Geopublisher software which will be presented in section 5.6 of this chapter.

Table 5.7 provides the frameworks and guidelines for participatory mapping aided by GIS in LUP. The guidelines were derived from focus group discussions and participatory mapping carried out in difference parts of the Hardap region during the study. Focus group discussions, participatory rural appraisal and participatory mapping are participatory approaches that can be used to generate non-spatial and spatial data, which can be captured in a GIS. Spatial data can be transferred into a GIS for detailed data processing, analyses, updating, manipulation and presentation of such data as meaningful information to meet specific objectives. The frameworks and guidelines of conducting ILUP were proposed to have four different frameworks which are described in Table 5.7. The frameworks in the table provide the base for the major activities within a broad participatory framework. The guidelines outline specific activities to be carried out within the framework.

The frameworks and guidelines presented in Table 5.7 were used and compiled after conducting participatory mapping meetings as they were derived from the empirical study. The third and fourth frameworks were not part of the study. However, the third framework was tested by scanning one participatory map and digitising the map to produce a GIS map. The fourth framework was prepared once the study was completed and the participatory maps were accepted by the researcher for this study, since these frameworks requires giving feedback to the local community.

Table 5.7: Frameworks and guidelines for participatory mapping aided by GIS in LUP in Namibia

FRAMEWORK ONE: PREPARATORY WORK FOR PARTICIPATORY MAPPING	
Guidelines	**Requirements**
1. Collect primary and secondary data about natural resources and socio-economic conditions. 2. Select site for participatory mapping according to identified objectives of ILUP. 3. Decide on size of participatory group discussions, 7 to 10 persons is recommended. 4. Select participants from the study area to represent the community population. 5. Choose the appropriate base map print-out or sketch map size, preferably an A0-size is recommended. With regards to photo-mapping, scales depend on the desired level of detail and on local environmental situation, but ideally should be approximately 1:5 000. 6. Use the transparent drawing papers to be fixed accurately on top of the base map (when dealing with photo-mapping). For different land uses, different transparencies should be used, but the transparent drawing papers should be fixed accurately on top of the aerial photograph. The outer boundaries of the base map and the registration marks have to be clearly marked on the transparent drawing paper map for future data processing in GIS. 7. A GPS receiver can complement data collection of boundaries (such as future plans, ownership) for measurements of plots greater than 10 hectares. An instant verification of mapping results in the field can be done with an additional transect walks within the surrounding areas.	1. A coordinate system, grids, scale and a north arrow need to be printed on the base map. The map projection and map date should be indicated (when dealing with photo-mapping), as well as the name of the village. 2. Stationary: double clips to temporarily fix the transparencies securely on top of the aerial photographs [when dealing with photo-mapping], permanent and white board markers of different colours. 3. A handheld GPS with accuracy up to five (5) metres is required.
FRAMEWORK TWO: PARTICIPATORY MAPPING EXERCISES	
Guidelines	**Requirements**
1. The village meeting should be scheduled for half a day to one day according to the specific interests of the project and the size of the area to be mapped. A short introduction should provide: • the purpose of mapping the area (for example the land use to be mapped), • sufficient information about the approach of participatory mapping, • a brief explanation of the techniques to be used for mapping, • the year and month of publication on the base map used (if photo-	1. Participants should be clearly informed in advance about the purpose of participatory mapping, and the place and date of the meeting. The meeting point should be on an elevated vantage point with a good view of the surrounding landscape. The facilitator has to ensure that all users have equal opportunities to participate in discussions and

mapping), and • enough opportunities to clarify remaining questions. 2. Participants should have sufficient (about 1 hour) time to get familiar with the base map (if photo-mapping). 3. Orientation could be facilitated through the identification of the location and the recognition of easily identifiable landmarks such as towers, roads and residential areas. 4. Mapping activities should start with either important or easily recognisable features like major infrastructure such as roads, hospitals and schools within the village. 5. The participants have to evaluate if land use changes occurred over time. Seasonal land use changes need to be mapped as well. 6. Land use classifications have to be discussed and explained carefully before land use types are being marked using agreed symbol set. 7. As the boundary is a legal entity of land, it is important that the positions of known boundaries are marked accurately. 8. The facilitator should allow users to direct their own discussions. 9. The facilitator or an assistant should record the process and outcomes.	express their real opinion and expectations. 2. The facilitator should spend more time listening than talking.
FRAMEWORK THREE: DATA CAPTURING AND PROCESSING	
Guidelines	**Requirements**
1. Spatial data should be entered into a GIS program by the GIS expert for further processing after data collection through compiled participatory land use mapping. There are different options to transfer the data to the GIS. Two options for this are: • to scan the papers for data transfer, and • onscreen digitizing of geographical features visible on the base map. 2. The projection system of the secondary GIS data should be the same as that of the aerial photograph to be used for overlaying purpose. 3. Every vector feature of the resulting GIS data file (such as shapefile) need to have an identity code (ID) for the land use class and one identity code for the local names. 4. Finally the map layout has to be designed. Cartographic conventions should be used for the colour, and symbol sets; and cartographic elements such as map title, scale, coordinate grids and the date of map compilation has to be added to the map.	1. Small crosses should be drawn (with a thin permanent pen) on the transparency drawing paper at the intersections of the coordinate system gridlines of the base map. These crosses will be used to later georeference the scanned transparency paper map by using GIS software.

5. The GIS data compiled from participatory mapping should be used to contribute to land use plans and different land use maps.	
FRAMEWORK FOUR: FEEDBACK TO STAKEHOLDERS	
Guidelines	**Requirements**
1. After the data analysis and map compilation are finalised, a printout of the participatory photo-map or sketch map should be taken back to the local communities so that the product can be verified and be re-adjusted if necessary. 2. The original base map should be handed over to the villagers after data capturing has been done. 3. The sketch maps have to be handed back to the villagers or local communities for record keeping.	1. Information to be provided on the map should be the year and month of compilation for the photo or sketch map; the identified land boundaries; date of data collection; a key to land use categories; village name; and scale. 2. One copy of the sketch map should remain in the village to be used as a decision-making tool by villagers during their village meetings.

The growing movement toward integrating participatory methods and GIS indicates that no individual approach currently meets society's changing information needs (Weiner, Harris *et al*. 2002; Mapedza, Wright *et al*. 2003; Mbile, DeGrande *et al*. 2003; Robiglio, Mala *et al*. 2003; Kienberger, Steinbruch *et al*. 2005, cited in Vajjhala, 2005). Combining participatory mapping methods and GIS requires an assessment of their respective strengths and weaknesses for different applications and is essential for professionals such as development planners and community stakeholders alike (Vajjhala, 2005). The participatory methods aided by GIS should have three attributes:

1. spatial and social objectives,
2. accuracy and precision in map displays, and
3. representativeness and comprehensiveness of spatial information.

Collectively, the three attributes of the mapping methods aided by GIS defines the fundamental process of integrating participatory mapping methods aided by GIS. The social aspect of the three attributes focuses primarily on the issues surrounding people as to *how* they live. The spatial aspect focuses on *where (location)* people live.

5.5.4 Conclusion

The main purpose of this section, namely to produce frameworks and guidelines for participatory mapping aided by GIS technology, involving local community knowledge in sustainable land use management in Namibia, was achieved. The four frameworks with guidelines for each framework give examples of incorporating participatory mapping approaches such as sketch and photo-mapping (see Table 5.7).

The research question of this section which states: "what sustainable methods, frameworks and guidelines are required for participatory mapping aided by GIS in integrated land use planning to ensure sustainable land management in Namibia" was validated. This is because the study confirmed that participatory approaches such as sketch and photo-mapping can be used as tools for gathering data from local communities for sustainable land use planning in Namibia. This opinion about sketch and photo-mapping is also supported by the results presented in this chapter.

5.6 Georeferenced Digital Database for Land Use Planning

5.6.1 Introduction

The main purpose of this section is to share the concepts, explanations and procedures about the established georeferenced digital database that can be used as a model by the MLR for sustainable land use planning in the Hardap region. Geopublisher software was used for compiling the georeferenced digital database for storing and managing of raster and vector data (points, lines, polygons and surfaces), which was then customised to meet the requirements of the research objectives. In addition, the processes of compiling the georeferenced digital database were considered. This resulted in exploring the challenges and benefits associated with the georeferenced digital database in Namibia.

5.6.2 The Developed Georeferenced Digital Database

De By, Georgiadou, Knippers, Kraak, Sun, Weir and van Westen (2004:165) stated that "large computerised collections of structured data are what we call a database." A database management system (DBMS) is a software package that allows the user to set up, use and maintain a database. Like a GIS allows setting up a GIS application, a DBMS offers generic functionality for database organisation and data handling (de By *et. al*., 2004). The established georeferenced digital database provides custom, flexible and dedicated data management functionalities to decision-makers and in this particular case, people and institutions responsible for land use planning. The georeferenced digital database was designed for:

1. providing timely, transparent and easily readable outputs;
2. streamlining the production of maps, thus reducing time and cost requirements; and
3. transforming data and information into knowledge.

The process of designing a georeferenced digital database included a number of steps as illustrated in Figure 5.33. The database design was composed into six steps. The steps are a continuation of activities from stage 1 to stage 6, but are not necessarily strictly sequential. The entire process makes provision for feedback which means that the researcher can still revisit earlier stages during a later stage.

Dobesova (2012:20) stated that "Geographical Information Systems (GIS) maps are prepared in GIS software and based on data stored in a database. During the conceptual database design stage, the graphic editor of a database model is recommended." The

conceptual database modelling stage was the second phases of the georeferenced digital database design. The process of designing the georeferenced digital database in steps is very useful as it contributes to enhance the understanding of the database for the administrator and users. The phases of the database design were applied during the identification of the key data layers, data structures, as well as refining and compiling documentation describing the database model. The georeferenced digital database designing steps are further explained in Table 5.8.

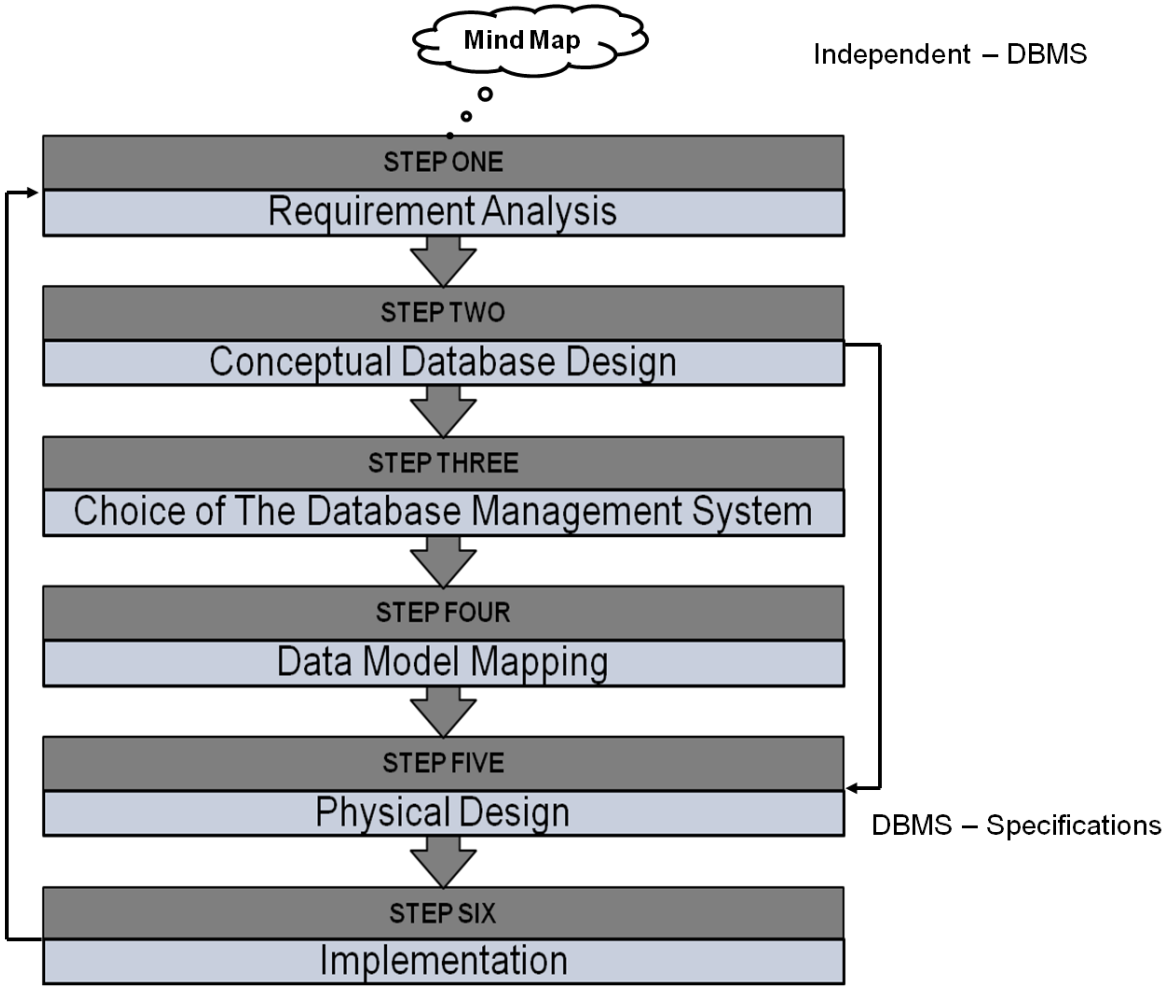


Figure 5.33: Steps undertaken in the design of a georeferenced digital database
Source: Adapted from: de By *et al.*, 2004

Before starting with the process a *mind map* needs to be drawn up. This is the step where the researcher starts identifying the need, purpose and importance of the georeferenced digital database in the land use planning process. Once the need, purpose and importance were identified, Step 1, *Analysis of requirements,* is undertaken, followed by the design of the conceptual database, choice of the database management system (DBMS), data model

conceptualisation, physical design and eventually the implementation. The purpose of each step and activities to be carried out during the respective stages are provided in Table 5.8.

Table 5.8: Steps and explanations in designing the georeferenced digital geo-database

No.	Steps	Purpose and activities
0.	Mind map	The need for and importance of the georeferenced digital database were identified during this stage.
1.	Analysis of requirements	The main purpose of this stage was to document the data requirements of the users such as MLR and other relevant stakeholders. The typical activities were: 1. Identification of application areas and user groups. 2. Analyses of existing documentation of relevant policy documents, forms and reports. 3. Analyses of current operating environments and the intended use of the information.
2.	Design of conceptual database	During this stage, the data types of the database were examined, resulting from the data requirements analysis set in Stage 1.
3.	Choice of the database management system (DBMS)	The best deployment platform for implementing the produced schema was established. The activities were to identify the: 1. type of database management system (for example relational, network, deductive or object oriented). 2. user and program interfaces. 3. types of query languages.
4.	Data model mapping	During this stage, the transformation of the generic DBMS conceptual schema into the data model of the chosen DBMS was done.
5.	Physical design	The main purpose was to choose the specific storage structures and access paths for the database files. The activity included database testing before it was released for use.
6.	Implementation	The implementation of the database application programs and the database operation were the main purposes. The activities included that of maintaining the database and continuity of populating GIS data into the database.

The georeferenced digital database that was developed allows many customised functionalities such as storing, viewing, querying, maintaining and manipulation of data. The database has customised metadata describing the state and condition of the data. The metadata included the descriptions of layer titles and the shape of the layers to continue improving the availability of spatial data documentation in Namibia. Metadata will help the Ministry of Land and Resettlement and other stakeholders to infer the necessary descriptive information, such as content, quality, condition and currency.

The georeferenced digital database has been customised to the Namibia projection system standard. The projection and geographical coordinate system was adopted for the Hardap

region's georeferenced digital database system because it is a Namibia-based system. Table 5.9 shows the projection system parameters. The data imported into the georeferenced digital database will automatically change the general projection into the Namibian projection and geographical system standard.

Table 5.9: Projection system parameters of Namibia

Projection type	Transverse Mercator
Projected coordinate system	Transverse Mercator
Geographical coordinate system	GCS WGS 1984
Datum	WGS 1984
False easting	600000.000000
False northing	10000000.000000
Central meridian	17.000000
Scale factor	1.000000
Latitude of origin	0.000000
Linear unit	Meter (1.000000)
Scale	Local, Regional and National

The georeferenced digital database of the Hardap region has a numerous layers. Some of the main layers are thematic themes which include administration, natural environment, socio-economics and topography. The specific participatory maps and other land use maps and data stored in the database of the Hardap region are outlined in Table 5.10.

The database is one of the main outputs of this study. The research objective of the study namely to conceptualise and set up a user-friendly comprehensive georeferenced digital database was attained by developing the georeferenced digital database. The database can be used as a model by the MLR for sustainable land use planning in the Hardap region.

The georeferenced digital database contains layers of graphic information and their relational databases that are transformed into maps. The information allows the user to view a composite of a specific area, adding an array of graphically oriented decision-making tools to the land use planning process. The interface of the georeferenced digital database system is depicted in Figure 5.34. The extracted thematic map of the Hardap region's land ownership is depicted in Figure 5.35.

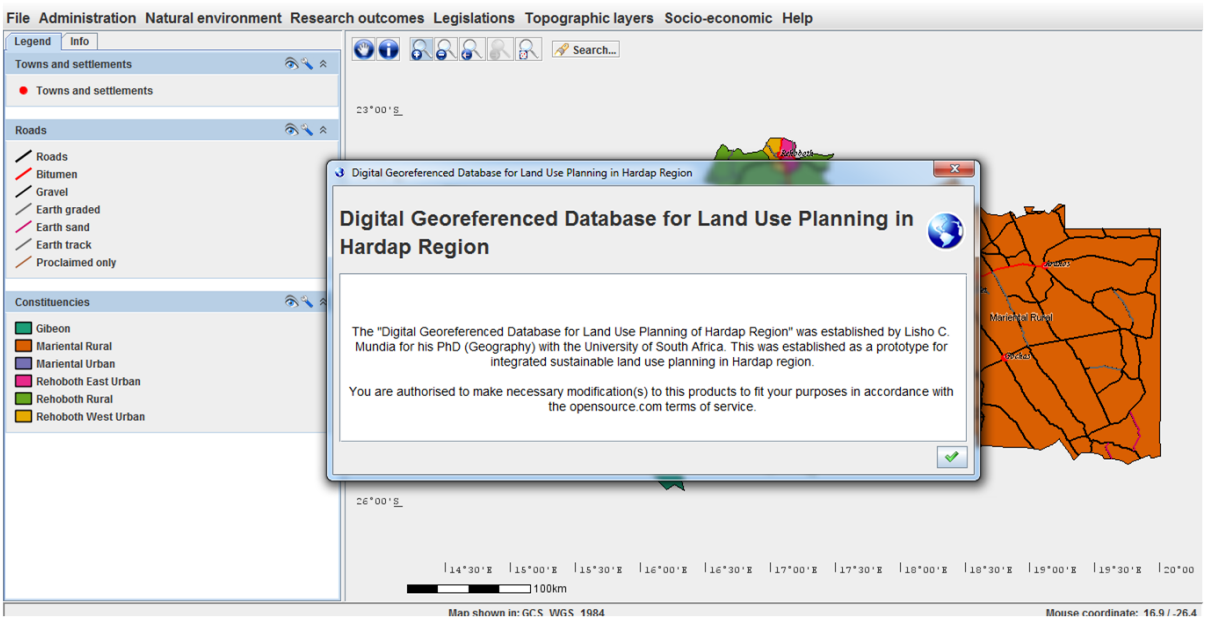


Figure 5.34: The interface of the georeferenced digital database

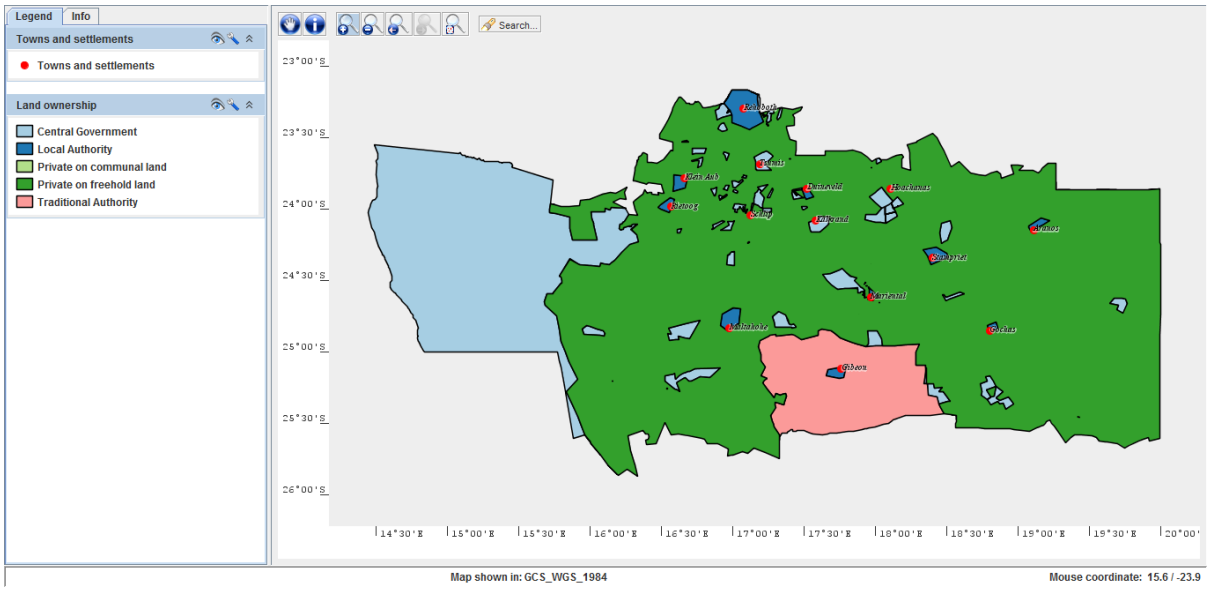


Figure 5.35: Screen shot of a thematic map of the land ownership of the Hardap region created from the georeferenced digital database

5.6.3 Implementing the Proposed Georeferenced Digital Database

Since land use planning is mainly the responsibility of the MLR, the proposed georeferenced digital database should be maintained by the MLR in the Hardap region in co-ownership with other key organisations such as the MAWRD and MET. The georeferenced digital database can be shared with users on CD, DVD, USB device, external hard-drive, a network or the Internet. As mentioned earlier, the software used to establish and develop the geo-database is platform-independent and open-source.

The implementation of the georeferenced digital database by the MLR will include the collection of necessary datasets such as GIS layers and remotely sensed data, such as aerial photographs. The most recent available vector and raster data in Namibia (see Table 5.10) were captured in the georeferenced digital database system. The database will help improve the integration of a variety of spatial information sourced using a GPS receiver and remotely sensed data. The results of participatory mapping will help support the implementation of the ILUP in the Hardap region.

Table 5.10: Data available in the georeferenced digital geo-database

Vector Datasets	
Feature Dataset Name	**Feature Layer Names**
Administrative	• Political boundaries • Constituencies • Magisterial districts • Land registration division • Town lands • Namibian territory • Traditional authority areas
Boundaries	• Boundaries of the political regions • Boundaries of the constituencies • Magisterial districts boundary • Land registration divisions boundaries • Town lands boundaries • Namibian boundary • Traditional authority boundaries
Population	• Master sample frame 2000 • Enumeration areas 2000 • Household income and expenditure
Agro-ecological zones (AEZ)	• AEZ areas • Growing period zones
Natural resources	• Vegetation units • Geology • Soils • Water areas (including rivers) • Minerals
Climate	• Rainfall • Temperature
Cadastral	• Municipal boundaries • Town boundaries • Village boundaries • Settlement boundaries • Traditional authority boundaries
Technical infrastructure	• National roads • Other roads • Railway

	• Water pipelines (existing) • Water pipeline (planned) • Electricity lines (existing) • Electricity line (planned)
Public social infrastructure	• Educational facilities • Health facilities • Ministerial offices • Place of worship • Others
Land use	• Farming areas • Production/farming areas (mainly irrigation) • Resettlement areas • Urban and peri-urban • Areas set aside for EPLs (Exploration Prospecting Licences • Areas set aside for Mining licenses (MLs) • Tourism • Conservancy • Community forest areas • National parks • Urban and peri-urban land use •
Development initiatives (identified diverse spatial development projects)	• Bernafay resettlement farm • Uibis local community • Hoachanas resettlement • And many more
Zoning	• Regional zoning (LUP - Hardap) • Conservations • Tourism development areas
Topographic grid indices	• GRID for 100K (point grid for 100k topographic map sheets) • GRID for 250K (point grid for 250k topographic map sheets) • GRID for 50K towns (point grid for 50k topographic map sheets, major towns) • Map sheet index for 50K • Map sheet index for 50K major towns • Map sheet index for 100K • Map sheet index for 250K • Orthophoto index for 25K
Participatory maps	• Open spaces • Residential land • Roads • Railways • Industrial land • Land zoned for business purposes • Cemeteries • Riverbeds • Tree and shrub vegetation • Municipal land
Biodiversity	• Bird diversity • Frog diversity

	• Mammal diversity • Plant diversity • Reptile diversity • Scorpion diversity • Termite diversity
Raster Datasets	
Feature Dataset Name	**Feature Layer Names**
Hardap DEM fill	• 30 meter digital elevation model for Hardap region.
Hardap hillshade	• Hillshade product derived from 30 meter Hardap DEM (Digital Terrain Model)
Topographical sheets for 250k	• Georeferenced and topographic map sheets at a scale of 1:250 000 for Hardap
Topographical sheets for 50K major towns	• Georeferenced topographic map sheets at a scale 1:50 000 for all major towns in Hardap
Topographical sheets for 100K	• Georeferenced and mosaic topographic map sheets at a scale of 1:100 000 for the Hardap region

The implementation of the proposed georeferenced digital database system by the MLR and other relevant stakeholders will require development of needs investment in infrastructure in terms of computers, software and well-trained manpower to handle the different tasks involved such as to maintain and manage the database. The proposed georeferenced digital database was built independently as a stand-alone system. The spatial datasets in the georeferenced digital database can be shared with other digital database system and used in any existing GIS system, such as ArcGIS, Quantum GIS and ILWIS. The integration of different database system is realistic as major organisations in Namibia have already implemented the use of GIS software for different purposes such as mine resource planning and agriculture, but requires expansion for more applications.

5.6.4 Contribution of a Georeferenced Digital Database

A Geographical Information System (GIS) was used in this study for storing, managing, processing, manipulating and presenting spatial data. A GIS was also used for exploring large datasets for multi-purpose within the land use planning (Bae *et al*., 2010). The georeferenced digital database have substantial advantages over the traditional manual filing cabinet approach, such as transparency of decisions, a homogenous approach, quick response, responsive reaction to dynamic situations, ability to simulate scenarios and capacity to handle large amounts of data. The contribution of the georeferenced digital database can be viewed in the following three ways:

1. The database**:** A database tool of the ILUP that offer an organised mechanism for storing, managing and retrieving land use information.
2. The maps**:** A set of land use maps and natural resources maps that show features on

the earth's surface. Maps of the geographical information can be constructed and used as windows of the database to support queries, analysis and editing of the information.

3. The model**:** A model show abstraction of reality used to represent geographical features; examples are vector or raster data models processed in GIS software. The model contains sets of rules and procedures for representing a phenomenon or predicting an outcome.

Specific contributions that the georeferenced digital database has in this study are:

1. managing and maintaining the spatial and non-spatial data;
2. storing and managing participatory mapping result into the GIS database;
3. processing of spatial and non-spatial data; and
4. compiling of land use planning maps.

5.6.5 Conclusion

The major objective of this section was to explain and demonstrate the procedures used in the development of the georeferenced digital database for sustainable land use planning of the Hardap region. The georeferenced digital database is used to store and manage the existing spatial data and non-spatial data. The georeferenced digital database incorporated the outputs of study which are the participatory land use maps and GIS land use maps.

The research question on the frameworks and guidelines suggested for land use planning using participatory mapping aided by GIS to be implemented to ensure sustainable land management in Namibia was validated. This is because the study results show that a georeferenced digital database is an important tool in managing not only spatial data, but also non-spatial data.

5.7 Chapter Conclusion

The main aim of this study was to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management. Primary and secondary data were analysed in order to evaluate the existing land use of the Hardap region. Participatory mapping was conducted in different parts of the Hardap region where different participatory land use maps were produced. Some maps were produced using GIS to show different land uses, the existing natural geographical features and infrastructure in

the Hardap region. A SWOT analysis (summarised in Table 5.6) was produced to evaluate the output of both sketch and photo-mapping. The SWOT analysis also complemented the development and compilation of frameworks and guidelines as presented in Table 5.7 for evaluation of participatory mapping aided by GIS in land use planning.

The georeferenced digital database was established using the Geopublisher software. The spatial database was used to store and manage the existing land use data sourced from different government ministries. The participatory mapping outputs such as sketch and photo-maps were produced in various parts of the Hardap region.

This chapter presented the research finding as per the methodologies used in this study in order to respond to the set objectives of the study. The chapter presented key elements of sustainable land use planning, such as recognition of stakeholders; enabling policy and regulatory environment; effective institutions at local, regional, and national level; accessible knowledge base; platform for negotiation and set of planning legislations. Recognition of different stakeholders and their different objectives is essential, both in equitable sharing of benefits of development and in anticipating likely conflicts and including mitigation measures in the land use plan. The stakeholder concept can be extended to cover the upcoming generations who have an interest in conserving land for their benefit. The unborn generations can generate knowledge though participatory methods to understand the history of land use planning. A simplistic approach to planning may not recognise such differences.

In the next chapter, the results obtained from the analysis will be used to generate summaries and discussions of the research to the implementing government ministries and organisations. The summaries and discussions are intended to assist in outlining essential aspects of the use of participatory mapping aided by GIS in sustainable land use planning. The key research aim is to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management in Namibia. Chapter 6 provides a discussion, recommendations and a conclusion of the key findings, based on the analyses of the data as reported in the preceding chapters. The final chapter provides the key recommendations based on the research findings. These recommendations will help decision-makers to understand the importance of participatory mapping methods. If adopted, the recommendations will enable land use planners, development planners and decision-makers in pursuing the use of participatory mapping methods to improve participation in integrated land use plans (ILUPs) at local level for future implementation.

Chapter 6: Discussion of Research Findings, Recommendations and Conclusion

6.1 Introduction

The main aims of this chapter are to present and deliver the discussion of the research findings, recommendations and conclusion. The chapter provides the respective discussions of the research methodology applied and the research findings. The observations made during the research were interpreted to response to the research objectives and the methodologies employed in this study.

The findings of the study, which are discussed in this chapter, demonstrate how the results are supported by the research methodology employed in this study. The research results are responses based on the five research objectives, which are strongly reflecting the research questions as listed in chapter one (1).

6.2 Evaluation of Research Methodology Used

6.2.1 Consultative Meeting

Consultative meetings with experts and targeted individuals in institutions and different ministries and NGOs was a very helpful method to get a better picture about the land use planning background, the usage of GIS and participatory mapping by different ministries and organisations in Namibia. Consultative meetings brought some first impressions and paved the way for further data collection and in-depth exploration of relevant literature.

The method proved useful and was implemented in the study to help bring about awareness of new data and knowledge about land use planning, participatory approaches and GIS. The information, data and knowledge gathered through consultative meetings contributed to the results of this study. This was because data and knowledge were gathered from experts and government officials involved in decision-making with land use planning in Namibia. The method can be used in future studies which are related to land use planning, geography, GIS and participatory approaches.

6.2.2 Sketch Mapping

Sketch mapping was found to be a useful method to bring local people together to share data, information and knowledge. The reasons for compiling sketch maps and the respective land use categories were explained to participants. The information and knowledge shared with the participants during sketch maps were:

- to identify and map present land uses and natural resources in their areas;
- to interpret the present forms of land use;
- to identify and discuss problems and conflicts in land use, such as areas with many land conflicts;
- to discuss issues pertaining to land tenure, access and control over land and resources; and
- to identify areas with potential for alternative land use and development.

The main aim of the sketch mapping approach in this study was achieved. The sketch mapping was done through mapping the local communities' different land uses, the natural resources and infrastructure on the paper. The land use maps produced by means of sketch mapping approach was discussed with the participants with the aid of FGD and PRA tools. The produced sketch maps were verified by the researcher by means of field observations and other land use information obtained from secondary sources.

Despite the fact that some maps produced by means of the sketch mapping approach were sketchy, it was proven that by conducting repeated participatory mapping exercises and detailed explaining the aim of sketch mapping to the participants, the skill can be improved. The researcher had to constantly remind the sketch mapping participants about the purpose of mapping and continue to observe the participants during the entire process of sketch mapping.

6.2.3 Photo-Mapping

Different types of images such as satellite images, aerial photographs and topographical maps of national or regional can be used for photo-mapping. The use of aerial photographs for photo-mapping was the preferred method in this study. It was proven easier for local populations to work with this type of photograph as they easily recognise both the natural features and the infrastructure related to land use activities. As the participants were generally not good at interpreting maps, the idea was to use the Keep It Short and Simple (KISS) approach for the community to maintain interest and understand what they were

doing. The approach was kept short with regard to its explanation and simple for the participants to understand and delineate land use features on the aerial photographs. It was difficult at times to delineate land use features on a small scale and low resolution aerial photograph. Photo-mapping was found to be preferable to be used on the aerial photograph with high resolution and large scale in order to allow the local community to be able to clearly interpret and delineate the land use feature in question.

When using aerial photographs as base material for photo-mapping, the KISS approach worked perfectly well after repeated explanation of the purpose of mapping. The basic cartographic elements such as north arrows, the date of the aerial survey and features were clearly visible on the aerial photographs. It was preferable to use aerial photographs in photo-mapping as built-up structures are relatively easy to identify on the aerial photograph. Aerial photographs were used to guide the participants to map and interpret the land uses. The participants were supported with explanations about the features on the aerial photographs by the researcher. During the process of photo-mapping, the participants had to be constantly reminded that they have to map land uses not just infrastructure such as roads and telecommunication towers.

6.2.4 Participatory Rural Appraisal (PRA)

PRA shares some of its principles with Rapid Rural Appraisal (RRA), which include direct learning from local people, offsetting biases, optimising trade-offs, triangulating, and seeking diversity. In addition, it includes its own principles which concern the behaviour of outsiders facilitating analysis by local people, local people practicing critical self-awareness and responsibility and sharing knowledge (Mascarenhas *et al., 1991,* cited in Chambers, 1994). Other researchers consider PRA to be a set of tools, which Chambers (1994) stated that it is the “unfortunately misconceptions about the PRA method.” In another study, Kumar (2002:320) stated that “PRA is a set of methods, approaches, beliefs and attitudes. The application of PRA methods is not sufficient to yield satisfactory results. Therefore the basic principles of PRA should also be incorporated in order to gather and yield the appropriate beliefs and attitudes, knowledge and opinions. One of the major concerns of PRA practitioners has been the neglect of the particular aspects that are central to PRA.”

PRA has been used in natural resources management such as soil and water conservation, forestry, fisheries, wildlife and community planning, programs for women and the poor, agriculture, health and food security. This method has evolved and spread from Ethiopia to India, Kenya, Sudan and other countries. In early 1994 it was known to be widely practiced

in countries such as Bangladesh, Botswana, Ethiopia, francophone West Africa, India, Indonesia, Kenya, Nepal, Nigeria, Pakistan, the Philippines, Sri Lanka, Sudan, Uganda, Vietnam, and Zimbabwe, while initiatives have been taken in other countries as well.

Hundreds of non-governmental organisations (NGOs) have adopted PRA and developed applications, as have a number of government departments (Chambers**,** 1994). The use of PRA methods is increasingly being explored by students and faculty in universities for research, and by training institutes for fieldwork (Kumar, 2002).

Behaviour, attitudes and sharing of ideas are the three basic components of PRA. Their significance have been recognised in that sequence in the study done by Mascarenhas *et al.,* as cited in Chambers (1994). In Chambers' (1994) study, the PRA participants' behaviours, attitudes and knowledge sharing were the main reasons for which information was gathered using a participatory approach such as PRA. The three basic components of information gathering were also identified as major components of PRA in this study.

PRA was the first method to be recognised by Chambers (1994) in incorporating local people's views in land use planning. Other methods such as consultation meetings and focus group discussions were adaptations of those already widely used in land use planning. Finally, there were also new methods, such as participatory mapping. Participatory methods enables local people to now do what outsiders, such as researchers or planners usually do. This includes contributing to the planning of land use (Chambers, 1994).

6.2.5 Focus Group Discussions (FGD)

Focus group discussion was a very helpful method to get a better picture about the political and socio-economic background regarding the use of land in the Hardap region. Three FGD meetings were held in each of the six sites of land within the six constituencies of the Hardap region. The FGD meetings produced some positive impressions gathered from the responses of the participants. The FGD was found to be a useful and suitable tool in integrated land use planning because it can gather both the socio-economic and environmental data which are important in land use planning. The representation of the participants should be improved in future research related or similar to this study.

Focus group discussion can be described as a very revealing method due to the direct contact, comments and advice of experts and local communities (Clifford and Valentine, 2003). Thus, this method made an important contribution to the research. It allowed for land

use issues and participatory methods to be discussed. The method widened the perspective on the investigated topic.

In summary, it can be claimed that this particular method is recommendable in studies of a similar nature which will consider the land use planning aspects to:

- assess cultural issues on land use of the community to allow broad understanding of the past land use issues;
- evaluate the work of the land boards responsible for land use planning in the regions to identified the link with the local communities and other stakeholders;
- gather information about land use changes, and understand the reasons behind land use change in relation to certain policies and frameworks; and
- have equal representation of both local community members and experts in the focus group discussions to help gather different perceptions, views and opinions.

In the context of geography, focus group discussion contributed to the evaluation of the participants' knowledge of land use planning and land use maps in the Hardap region. Generally, the participants answered the FGD questions and provided new ideas concerning desirable and undesired land uses.

6.3 Interpretation of Research Findings

6.3.1 Introduction

The aim of this section is to bring upfront insight of interpretation of the research findings by using evidence from the Hardap region. The section provides interpretation of participatory mapping, land use planning maps compiled using GIS, SWOT analysis, frameworks and guidelines for participatory mapping aided by GIS and findings on the georeferenced digital database.

6.3.2 Findings on Participatory Mapping in the Hardap Region

It is imperative to mention that a number of relevant and useful literature regarding land use planning, participatory approaches and GIS was found in various publications. The literature exposed and used in this research was found to be a great component in benchmarking the findings of the study. Burton (2000:137) confirms that "information search and information management skills are the fundamental building blocks of all research." The literature used in this study, in one way or another, supported the application of participatory mapping aided

by GIS in land use planning for the sustainable integrated land use planning.

According to Rambaldi and McCall (2010:01) “participatory mapping depends on the social, economic, political and institutional environment in which it takes place; it thus depends on many external and internal factors.” What are the factors and conditions that increase the likelihood that a participatory mapping project will be successful? To answer this, it must first be defined what is meant by success. Success has different meanings to different people.

Some local land users taking part in a participatory mapping activity may be pleased with the outcome, for example, it may lead to them being offered employment. Participatory mapping does not attempt to absolutely define a “successful” conclusion for a participatory mapping process; rather, it relies on the generally accepted criteria in participatory approaches of seeking to deliver an outcome, such as maps and spatial information and a working process that aims to:

- satisfy the majority of local land users;
- support the more disadvantaged and less articulate local land users;
- not cause unwarranted harm to any local land user;
- create and support more autonomous initiatives by the actors within the community and thus has a good potential of being sustained; and
- achieve the intended concrete results, for example, relevant map-making.

A participatory mapping activity that achieves these objectives can be considered successful. An important element in determining whether a mapping activity is successful is whether all parties are clear about the primary purpose of it. All participatory mapping activities have one or more purposes which affect the importance of the different enabling or disabling factors (Rambaldi and McCall, 2010). In this study, the purpose of participatory mapping was to evaluate the understanding of the local communities’ environments in terms of land use, the local communities’ basic sketch mapping capabilities, and the participants’ opinions, experiences and knowledge with regard to land use planning. The purpose of participatory mapping from the participants’ perspective was to produce participatory land use maps and for them to explain the mapped land uses. During the process of participatory mapping and explanation of the land use by the participants, the researcher was able to gather the participants’ experiences and knowledge for consideration in the process of ILUP.

The basic condition of enabling processes involving participatory mapping is “clarity of

purpose" which is a clear agreement to the purpose(s) of the activity among the people in the lead community, people in the lead organisation and other stakeholders. This clarity cannot always be assumed. It is important for the actors to develop their long-term vision and commitment so that the purpose becomes transparent. Ultimately, success can only be measured in the long term. In other words, it could be measured if the study area were to be assessed many years later. Only then could one determine whether the intervention had been a success or not (Rambaldi and McCall, 2010).

It can be argued that working with participatory mapping techniques is initially time consuming and therefore costly. The participatory mapping exercises in this study had to be repeated because of initial poor results. In the first attempt of participatory mapping, the local communities focused on mapping infrastructure rather than land use. The mapping process took longer because it had to be explained repetitively — in some groups it was explained twice while in others it was explained three times. It appeared, however, that once instructions were understood by the local communities, the participatory mapping proceeded faster. Gobin *et al*., 2000, cited in Verlinden & Dayot (2005:166) discussed "costs of conventional methods versus participatory mapping, concluding that in the end it is cheaper because the results are already useful and adapted to local circumstances as opposed to having to go through a process of local adaptation." This suggests that an initial investment in participatory research is worthwhile. In this study, participatory mapping was found to be more favourable in small areas.

In this study the results of participatory mapping are very sketchy as the participants drew up the maps according to their opinions and viewpoints rather than documenting actual land uses, making participatory mapping a good tool to use in soliciting participants' opinions in land use planning. It is difficult to measure areas, directions and distances from participatory land use maps. The biggest stumbling block for working with participatory methods is the disbelief of many scientists and extension officers towards indigenous knowledge, making it difficult to institutionalise the approach (Verlinden & Dayot, 2005).

Factors influencing the successful implementation of a participatory mapping initiative include external and internal factors. External factors refer to the broader environment within which the analysed issues, situations or groups are situated. Internal factors pertain to an organisation, a community, a group of people or staff engaged in a project with a participatory mapping component (Rambaldi and McCall, 2010).

Both external and internal factors may be enabling or disabling. Examples of external and

internal factors are presented in Table 6.1. These examples provide information on attitude, commitment and recognition of government official, local communities and the researcher towards participatory approaches. The table further outlines a summary of issues of legislation, local support and the impact of literacy on participatory approaches.

Table 6.1: External and internal factors influencing the success of participatory approaches

EXTERNAL FACTORS (GOVERNMENT)
• Positive attitudes of government officials, researcher or consultant towards local communities during the participatory mapping phase; • Clear explanation of objectives to be met with the participatory approaches; • Government initiatives towards sustainable integrated land use planning; • International legislation such as the "UN declaration on the rights of indigenous peoples" influence consideration of local communities in land issues; • National policies and legislation on land uses and tenure issues; and • National policies addressing issues identified by government for local communities to safeguarding their land resources.
INTERNAL FACTORS (OUTSIDE GOVERNMENT)
• There is a positive working relationship with researchers and the local communities in the region; • There is existing recognised community internal structure such as community leaders available for proper communication; • The existing community organisations programmes contributed positively to discussions of land use planning; and • The existing knowledge concerning land issues among the participants contributed to gathering more information about participatory approaches in land use planning.

Source: Rambaldi and McCall (2010)

Kumar (2002:60) emphasised that sketch mapping, "if applied in bigger villages or slums, local people may not be fully aware about all of the houses and other details. It also takes more time and people tend to lose interest." Kumar (2002) further stated that both sketch and photo-mapping are effective in small and medium sized localities, preferably localities which have between 150 and 350 households. The researcher tested the approach first in the Rehoboth Block E and the Stampriet areas which are bigger areas with over 400 households. The results of the sketch and photo-mapping were very poor and too sketchy

which prompted the researcher to repeat the mapping exercises. The researcher decreased the size of the area to be mapped (Rehoboth Block E and the Stampriet). In bigger areas, the participants could not produce more detailed land use maps as they could not recall of every land use in their environment, making it difficult to even discuss some land uses.

6.3.3 Findings on Land Use Planning Maps Compiled Using a GIS

An important driver of land use in the Hardap region has been the assumption that improved livelihoods for most rural residents will be achieved through improved and increased livestock farming. Government and donor inputs have focused on strengthening the agricultural sector with limited results (Government of Namibia, 2010). It is a misconception that most rural people earn their income from agriculture. Their income is derived from a variety of livelihood activities, as it is represented on livestock densities map (figure 5.19) in chapter five. A growing number of people are leaving rural areas and settling in major towns of the region (Mendelsohn, 2007). Rehoboth and Mariental in the Hardap region are the most affected towns because these are the major towns. Some residents of the Hardap region move out of the region to other regions. This suggests that any land use plan for the Hardap region needs to recognise the benefits and limitations of farming for supporting livelihoods. The researcher is of the opinion that such a land use plan needs to aim to keep options open for the development of other livelihood activities based on the comparative advantages of the region. Livelihoods and farming activities are important for inclusion and depiction in the integrated land use plan in cooperation with relevant stakeholders, such as local communities and different line ministries. Land use maps depicting residential, general residential, industrial, business, mining, agriculture and tourism were produced in this study and were presented in chapter five. These maps are important for outlining and describing the socio-economic aspects such as roads, railways and water infrastructure of the Hardap region.

Tourism was identified as one of the potential development solution in the Hardap region. There are some areas of the region where tourism has a comparative advantage over other forms of tourism activities and should be actively promoted. The areas along the Hardap Dam, the Oanab Dam, the Namib-Naukluft Park and Gibeon village land — surrounded by river water channels were identified as tourism growth areas. In those tourism development areas, other forms of land use such as irrigated farming could be a secondary development solution. The tourism map (see Figure 5.16) in chapter five depicts the locations of the tourism attractions in the Hardap region. A tourism development plan could be established for different tourism zones using GIS through the regional council working with the MET and

the MLR. The plan could aim to manage tourism growth and optimise returns to the region without causing negative environmental impacts and without diminishing the tourism product. In addition, suitable areas for tourism development should be identified in other areas within the region using GIS and participatory methods to engage the local communities.

The state of the current policy and legal frameworks are that land use plans are developed in an uncoordinated way (Government of Namibia, 2010). Sectoral plans are developed and implemented in isolation (Government of Namibia, 2010). In the Hardap region, for example, small-scale commercial farms have been allocated to individuals on land that is already occupied by people who have lived on the land for many years. The same piece of land is partially within a settlement area called Hoachanas. The settlement (Hoachanas) is likely to be proclaimed as a village council with its town land in the year 2015 and expands its borders due to high demand of urban land and population influx in the area.

6.3.4 Findings of the SWOT Analysis

The participatory approaches explored in this study, the FGD, PRA and participatory mapping are all important methods for analysing complex social problems. A SWOT analysis was used in this study to derive social information to help contribute to the understanding of how best to enhance sustainability of integrated land use planning in Namibia. Downey (2007:5) stated that “a SWOT analysis is a simple, but widely used tool that helps in understanding the strengths, weaknesses, opportunities and threats involved in a project or business activity.”

The participants were from the groups of local communities and experts who are knowledgeable in the fields of geography, GIS and land use planning in the Hardap region. Table 6.2 show the summary of the SWOT results incorporating inputs from experts and the local communities of the Hardap region.

The SWOT analysis in Table 6.2 has two components. These are the internal and external factors influencing the SWOT results. Strengths and weaknesses are internal factors, whereas opportunities and threats are external factors of the SWOT results. The table summarises the strengths concerning the local communities’ willingness to engage in participatory land use planning and the available services in the areas. The weaknesses highlight the issues of land and support to land management programmes in the region. The opportunities highlight the aspect of government support to local communities in the region to address land issues. Lastly the threats listed in the table summarises the issues

concerning longer period of time taken by government officials to address land issues in Hardap region.

Table 6.2: Summary of the Identified SWOT results from local communities and experts in the Hardap region

INTERNAL FACTORS	
Identified Strengths	***Identified Weaknesses***
• The local community members are willing to learn about participatory approaches in land use planning. • The local communities have basic knowledge concerning their land issues and are aware of their environment. • Basic services are available on the land. • The communities support each other.	• There is no security of land, thus they do not know their land boundaries. • There is limited support regarding land management issues from government officials within the region. • Some local communities live on private land.
EXTERNAL FACTORS	
Identified Opportunities	***Identified Threats***
• The Government of the Republic of Namibia (GRN) is aware of the local communities' land use problems. • The GRN is always willing to listen and help the communities. • The majority of the local communities without security of land have lived longer than 10 years in the land they occupy.	• It takes a long time for concerns to be addressed by government officials. • Relocation of local communities to other places within their constituencies.

A grid presentation of the results of a SWOT analysis facilitates the quick assimilation of the key features and highlights of the different results gathered from participants in the Hardap region. The SWOT grid differentiates between strengths and weaknesses concerning the land and local communities in the study area. The different probabilities of threats or opportunities are also incorporated and are presented in relation to each other in table 6.2. At first glance, the SWOT analysis was not underpinned by a rigorous analytical framework on which to base the chart. The researcher then requested the participants to address one item at a time such as strengths, followed by weaknesses, opportunities and lastly the threats. The SWOT grid presented in chapter five allowed the SWOT results to be plotted in a logical and meaningful way.

6.3.5 Findings on Frameworks and Guidelines for Participatory Mapping aided by GIS in LUP

The communal land reform Act of 2002 and other related legislations are active and complement the land-related legislations. However, Namibia does not have an approved

National Land Use Planning Policy or set of guidelines for carrying out integrated land use planning. A number of regional land use plans have been developed, but these do not consider potential conflicts between competing or incompatible forms of land use and some plans do not categorise land use in its actual geographical location. In addition, little guidance or direction is available on how land use plans are to be implemented.

Land use is driven by its designation as communal, freehold or urban land. This is done by taking into consideration the priorities and policies of line ministries, the agendas of the private sector and donor funded projects and the priorities of land holders in trying to make a living. Projects and activities are often developed in isolation without regard to existing or other potential land uses. The capability of the land to support a particular land use is often not taken into account.

There is some degree of integrated land use planning taking place at community level where community forests and conservancies have been established under sectoral legislation. Communities, with the help of government experts, need to develop forest management plans in terms of the forestry legislation. The forest management plans should cater for the conservancies' wildlife utilisation and tourism plans that include zoning areas of land for wildlife and tourism.

The main aim of this study was to develop "frameworks and guidelines for participatory mapping aided by GIS for effective integrated land use planning and management." The frameworks and guidelines produced were presented in chapter five of this thesis. They were produced in a table and provide explanation of required inputs in each process. The frameworks and guidelines provide context with regard to land use planning, participatory approaches and it elaborates on how ILUP could then address:

- participatory methods and stakeholder involvement as well as collaboration among relevant institutions in the planning process (Haub, 2009);
- the integration of all relevant plans, including development plans, sector plans, lower level plans and national plans (Haub, 2009);
- the integration of relevant legislations and regulations for the sustainable and environmentally friendly utilisation of land resources; and
- the use of geographical information technology to steer implementation and monitoring (Haub, 2009).

The project on “modelling integrated land use planning” by MLR was successfully completed in the Karas region in 2010 and it is presently being piloted in other regions of the country. The development and adoption of the frameworks and guidelines into the integrated land use planning could contribute to the sustainable land use planning in Namibia.

Sustainable land management (SLM) through integrated land use planning frameworks and guidelines are crucial in order to minimise improper use of land and land degradation. SLM should be advocated in developing countries such as Namibia as it further provides frameworks and guidelines for rehabilitating degraded agricultural land and ensuring the optimal use of land resources for the benefit of present and future generations. Furthermore, integrated land use planning frameworks and guidelines are based on four common principles:

- land-user-driven and participatory approaches;
- integrated use of natural resources in ecosystem and farming systems;
- multi-level and multi-stakeholder involvement; and
- targeted policy support and institutional support, including development of incentive mechanisms for SLM adoption and income generation at the local level.

Sustainable land use planning by way of sustainable land management applications requires collaboration and partnership at all levels. This collaboration should include the land users, technical experts and decision-makers in order to ensure that the causes of inappropriate land use planning and corrective measures such as frameworks and guidelines to sustainable land use planning are properly identified and discussed. It is important that the policy and regulatory environment enables the adoption of the most appropriate management measures. Sustainable land use planning is considered an imperative for sustainable land development and plays a key role in harmonising the complementary, yet historically conflicting goals of production of land and environment.

The Food and Agriculture Organization (FAO) has introduced and promoted a range of SLM programmes and approaches, such as farmer field schools, conservation agriculture, catchment and farming systems approaches to integrated land management and better land husbandry, *gestation des terrors* (trigger land development) and local land planning, integrated plant and pest management and sustainable forest management (Food and Agriculture Organization, 1999). It is the responsibility of the government to ensure that the requirements for sustainable land use planning are put in place, or that the conditions are

created for local communities' involvement. Effective implementation of ILUP depends on initiatives by rural people. Obtaining popular support for the programme is more important than speed in making the necessary changes. Ultimately, the partnership between the Namibian government and people is the key to the success of a sustainable land use planning programme.

Salimi et al., (2008) indicated that it is possible to plan for the appropriate use of land and to enhance the present management of land use by utilising GIS. Other researchers, such as Chirowodza et al., (2009:42) stated that "the aim of the participatory mapping and transect walks is to provide a space for communities themselves, to describe and to define their communities." Bonnett (2008:96) also stated that "one of the areas where a participatory approach is being employed is within environmental research that draws on so-called 'indigenous knowledge'." Wickham, 1990, cited in Bonnett (2008:96) also mentions "the idea of indigenous knowledge in an isolated village in Bali, Indonesia. The villagers were asked to complete village maps showing topography and land use." The frameworks and guidelines; and different participatory maps and GIS land use maps were produced in this study in line with the research objectives. This study was oriented to geography as a field of study, complimented with literature from the fields of land use planning and GIS. The study results were supported by existing literature.

6.3.6 Findings on the Georeferenced Digital Database

The availability of complete up-to-date data is still a concern in many regions of Namibia. Apart from optimal data collection systems, the current data collection, maintenance and updating system in Namibia is still a concern. This is due to the current inter-institutional relations that are marked more by mistrust and competition than by cooperation and coordination. Although land use planning depends on data availability, it can also become a tool to create and share data. The developed georeferenced digital database can be shared with relevant stakeholders in land use planning.

This study confirmed that there is a great need for digital databases of spatial data in Namibia. A number of advantages regarding digital databases were identified during the study. The advantages of a georeferenced digital database are manifold and mainly the same as for any type of computerised database, such as outlined below:

- *Increasing efficiency of spatial and non-spatial data retrieval*: data can be searched

and retrieved quicker from a computer than from a filing cabinet with paper documents.

- *Saving physical space*: the *spatial and non-spatial data* can be stored in a much smaller space than their paper equivalent.
- *Increasing efficiency of spatial and non-spatial data maintenance and updating*: computerised data can be updated easier and quicker than if stored on paper.
- *Better and more efficient spatial and non-spatial data sharing*: the same dataset can be shared over longer distances through a network. It can also be linked to other datasets if they share similar attributes.
- *Significant increase in efficiency of spatial and non-spatial data back-up and distribution*: it is easy and especially quick to make a copy or back-up of a large dataset on a computer in comparison to making copies from the paper documents.

Other anticipated findings about the georeferenced digital database are that, during land use planning, institutions can actually build confidence, identify common objectives and start some partial cooperation, for example, in the form of data exchange or joint use of data within one GIS. This could be important tools and approaches to bring about a common understanding about land use in Namibia.

6.4 Unanticipated Findings

Decentralising land use planning functions into regions has already been realised, but the administration and functional structures in the Hardap region are different to the established functional responsibilities in the central Khomas region. The capacity of those structures differs between different institutions and regions. In the Hardap region, decentralisation of land management process has only been partially achieved. The region has a limited number of employees and infrastructure to manage and support land use planning programmes.

The available limited number of land use planning employees in the Hardap region has no clear mandates regarding the tasks of land allocation, land use planning and resolving land disputes in the region. There are no guidelines on how to conduct participatory land use planning in a useful and lasting way.

A GIS database is available in Windhoek, Khomas region, from where all regions can source their data. Some of the available GIS data still lack context such as proper attribute information to describe the spatial data relevant to land use planning in the Hardap region.

In general, spatial data and information are under-used in land use planning in African countries (Environmental Information Systems – Africa, 2002). The study conducted by Environmental Information Systems – Africa (2002) maintains that "*there are a number of factors that undermine the ability of a country to use spatial information effectively in land use planning process."* Some of the factors include lack of awareness about GIS, lack of base data; lack of data sharing mechanisms and lack of well-trained personnel in GIS.

As demonstrated in the literature review (chapter 2) of this study, sustainable land use planning has been applied in many developed and developing countries. The results of this research shows the benefits of participatory approaches contributing to the improvement of land use planning tools which can be applied in integrated land use planning in Namibia.

Local land users' rights in the Hardap region are still a concern and needs to be secured. The existing unresolved land use rights can easily lead to land users' exclusion or eviction. Hence, if local land users' rights are not secure, they need to be secured during the integrated land use planning process.

There is limited existing knowledge and experience about techniques such as GIS, geo-visualisation and participatory methods such as PRA and participatory mapping in Namibia. Therefore it is imperative to create awareness on the positive impacts of integrated land use planning on current land use rights and their holders. Land use planning can also be explicitly used to improve tenure security for local users of land.

6.5 Implications for Future Action

This research aimed at contributing to the development of frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management. The future implications is that GIS is proving to be essential in many fields of study and will most likely to be involved in other applications not yet envisioned. As such, one may anticipate that GIS will provide some of the necessary tools needed to progress in the understanding of land use in a variety of contexts, such as geography, urbanism, agriculture, climatology as well as ecology, to name a few. This will therefore help the society in decision-making endeavours when confronted with the state of constant and cumulative demand for land and degradation of natural environments.

Based on the literature reviewed, it can be concluded that not much research has been done on participatory mapping and the use of GIS for integrated land use planning in Namibia. Therefore, there is a need for participatory mapping approaches to be used in future land use planning in order to cater for the inputs of local communities. GIS technology is vital for integration of different datasets. Throughout this research, multiple datasets have been used and assembled. Most of these are spatial by nature and could be useful for other types of research.

Participatory mapping, GIS technology and the capacity to use these methods and technology have huge potential for more informed and more conscious decision-making. However, if individuals or institutions are not empowered to make decisions then sustainable land management cannot be well implemented. Establishing frameworks and guidelines for land use planning (see Table 5.7) that enable local people's involvement, enhances decisions about land use planning. These are critical factors because sustainable land management must be built on stakeholder and land user involvement at local level.

Planning and management of land resources are integral parts of any development programme. Planning and management of both rural and urban development are critical for the social well-being of citizens, which is why all planning should incorporate the inputs of residents (Food and Agriculture Organization, 1999). Land use planning has often had negative connotations because it was traditionally associated with top-down procedures. In centrally planned cities such as Windhoek, land users (residents) have been well-informed on how to use their land based assessment of the capability or suitability of land for a particular type of land use.

Sustainable land use management can only be achieved if pluralistic land uses under the umbrella of long-term social, economic and ecological values are appreciated and taken into account in land use planning (Fagerholm, & Käyhkö, 2009). There is a need for broader understanding of the complexity of integrated land use planning on aspects of human nature, human interaction in contemporary cultural landscapes, especially in political decision-making. This broader understanding of the complex human nature, the dynamics of interaction and cultural landscapes can be better understood using participatory approaches, which involve direct interaction with the local communities.

6.6 Recommendations

In this study, as presented in chapter five, participatory mapping was found to be a very important method in integrated land use planning in Namibia. The methods (sketch and photo mapping) can be recommended as good techniques to be used in bringing local communities and experts together to share their experience, opinions and perceptions about land uses. Although the participatory maps are not "reliable" due to distortion of features and inaccurate measurements as compared to GIS maps, the maps can be used for gathering information about different historical issues pertaining to land within the community. Participatory methods are recommended to be used in Namibia as it allows awareness about proper use of land to the society and also provide the platform for sustainable land use planning discussions with the involved participants.

The participatory mapping methods represent an interactive partnership and integration of knowledge and resources (see Table 6.3), between government and local communities to address their common concerns in managing land resources sustainably for mutual benefit. Table 6.3 represents some of the integrative and interactive components of participatory mapping which are critical for consideration when deciding on best approaches for participatory land use planning.

Table 6.3: The integrative and interactive components of participatory mapping

Integrative	***Interactive***
• It combines elements of both the bottom-up approach based on grassroots participation, and traditional top-down approach of land resource assessment and evaluation of opinions. • It takes into account the complex biophysical and socio-economic variables which determine the land use system. • It considers legal and institutional aspects which facilitate the implementation of the plan, and • It integrates sketch and photo maps.	• It is a negotiation process, in which land users interact among themselves and with specialists. • Different levels (national, regional and local level) interact in the planning process. • It collects all the necessary local knowledge in statistical reports, sketch maps, photo maps and tabular formats.

It is recommended that commitment from both the government and local people be emphasised to implement participatory mapping and relevant participatory land use planning tools. This is consistent with emerging principles of good governance worldwide, and viewed as a prerequisite to sustainable land management. Integrated land use planning for sustainable land management is always demand-driven, although the demand may result from a problem or development opportunity either perceived at local, regional or national government level. This marks a welcome departure from previous top-down land use planning procedures in which plans were often prepared as routine instruments of land development.

The potential of land use planning to contribute to diverse development objectives and to solve major development challenges needs to be made more public. Most places on the earth are influenced by people who utilise the land and its resources and allocate specific land uses such as agriculture, mining, education, business, residential and many other land uses to it (Haub, 2009). Therefore, the challenge is to combine as many land uses on a piece of land as possible without destroying the land and its resources. Such combinations of land uses are acceptable in land use concepts and land use systems. The combination of different land uses can be addressed better by using GIS technology and involving the public.

It is recommended that town planners or related specialists act as facilitators in clarifying the objectives of the specific land use planning and in the involvement of some stakeholders and local communities in the process. This is because land use planning is managed by town planners and other experts from fields such as geography, GIS and land management. It is also important for the land use planning experts to start using participatory approaches in integrated land use planning to enhance the planning process by involving relevant stakeholders. Table 6.4 outlines some common available participatory approaches. The approaches or tools are intended for practitioners working on participatory land use planning and management. The approaches are useful for rural and town planners, development planners, geographers or GIS experts involved in the processes of land use planning and management.

Table 6.4: Commonly used and available participatory approaches

1. Case studies and stories, 2. Group discussions and activities, 3. Organisational analysis, 4. Participatory diagramming, 5. Participatory rural appraisal, 6. Photo-mapping, 7. Rapid rural appraisal, 8. Seeking and interviewing key informants, 9. Semi-structured interviewing, 10. Sketch mapping, 11. Transect walkings, 12. Trend analysis, 13. Ranking of community infrastructure, and 14. Compiling skills inventories.

Source: Wehrmann (2011)

Given the complexity of land use planning and management in Namibia involving the decentralised functions into central government, regional government, local authorities and traditional authorities, stakeholder involvement is highly recommended in the development of integrated land use plans (ILUPs). Because land use planning take into consideration many issues such as legislation, land cover, stakeholder interest, land tenure, and biophysical, and socio-economic aspects, the participation of experts from different fields is also important in land use planning. In order to ensure quality sustainable land use planning in Namibia, it is recommended that the responsible government ministries and organisations in Namibia facilitate the:

- development of a national land use planning policy that incorporates guidelines for participatory integrated land use planning;
- promotion of integrated and coordinated planning based on generic principles rather than sectoral agendas and priorities; and provides for the implementation of integrated land use plans;
- development and clarification of proposals for provision of secure group tenure over communal land that are sufficiently flexible to cater for the different conditions in different parts of the country and which take into account existing land management institutions which are responsible to manage community forests and conservancies. Such tenure arrangements should clearly enable local management and control of common grazing lands; and
- development of a national community-based natural resources management policy that provides an overall vision, set of objectives, set of common principles and

common strategies across the different sectors. This policy should emphasise the need for coordination and integration of approaches and set out ways of achieving this.

In addition to the above recommendations, a number of steps can be taken by relevant authorities to ensure that integrated land use plans in Namibia are implemented effectively. These steps are:

1. Relevant ministries should assign clear authority to the regional council (supported by regional officials) for implementation and oversight of the plan within the context of the regional co-ordination and development committee, which brings the line ministries and other key stakeholders together at the appropriate level.
2. Make the plan available to all councillors, constituency development committees (CDCs) and village development committees (VDCs), as well as to line ministries, relevant NGOs and development partners, land board members, land and agricultural committee members, conservancies and community forest committees.
3. Ensure that the plan is used to guide discussion and decision-making by the Regional Development Coordinating Committees (RDCC).
4. Ensure that the plan is made available to all traditional authorities who should use the plan to guide discussion and decision-making regarding land allocation and use.
5. The launch of the plan should be followed by a region-wide publicity campaign that explains the plan to relevant stakeholders such as the RDCC members, the CDCs and VDCs, traditional authorities, conservancies, community forest committees, farmers associations and key decision-makers in line ministries.
6. Development and recurrent budget funding should be applied to support and promote donor funding during the implementation of the plan.
7. The implementation of the plan should be monitored by the regional councils through the regional co-ordination and development committee and documented by the regional executive officer working in partnership with the senior officer in the MLR.

The produced frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia is recommended to be used as a tool in land use planning. Implementation of sustainable land use planning in Namibia requires a GIS to be able to manage, process and produce outputs from different types of spatial data collected in the process. The use of GIS is further recommended because land use planning involves complex data models and data types which can be managed and better processed using

GIS technology. The technology is also recommended to allow the Government of Namibia and relevant authorities to produce land use maps from existing land use data for comparison of desired and undesired land uses. With regard to GIS implementation in integrated land use planning, Barndt (1998:106) stated that “GIS software is a tool for processing information. Although GIS is often mistaken for map-making, the “I” for “Information” is the most important part of the Acronym.” Barndt (1998:106) is of the opinion that for “information to play a truly meaningful role in public participation it should be comprehensive, be accessible, managed, be current and be relevant information”

The complexity of land use planning involves different data types that are required to contribute to solving problems of land use. The use of GIS in land use planning is recommended because it has the ability to store, manage, analyse, process, manipulate and display different datasets as thematic layers related to decision-making about land use. GIS can be used to combine different layers of information for example land zones, flood areas and protected areas in order to reveal underlying interrelationships. GIS has the ability to store many themes of relevant information from which the user can choose which to combine for specific applications or challenges or scenarios. It can also be used to find most suitable sites for establishing a township and expansion of urban land. The potential of GIS is not yet fully exploited by most governments, partly because of the lack of awareness of what GIS can do and how it should be utilised. Although the usefulness of GIS is increasingly being realized, in most cases GIS is still used as an isolated technology and rarely used in the decision-making processes (Khan, 2013). Adopted from Khan (2013), below are the factors to be considered and recommended when government implements GIS:

- involve GIS earlier rather than later;
- create awareness among managers and decision makers;
- customise GIS positions and organisational structures;
- use open-source resources to demonstrate the capabilities where possible; and
- establish active coordination with other stakeholders.

GIS is a widely used technology in assessing and solving land uses problem. The collection and management of spatial data is not only a difficult task but expensive as well. Nevertheless the benefits of spatial data use through GIS have good return on investment to government and the Namibian society. GIS technology can reduce the time and cost of the planners in organising the data to arrive at a precise decision and conclusion. The

georeferenced digital database for sustainable land use management of the Hardap region to be used by the MLR is thus recommended to be used in developing ILUPs.

6.7 Research Contributions

The study contributes to the body of knowledge in spatial planning in Namibia and to the entire world. Spatial planning in this study contributes to the awareness of sustainable land use through awareness techniques of participatory nature; promoting territorial cohesion through a more balanced social and economic development of land; and improved access to information and knowledge through tailor-made comprehensive georeferenced digital database. The study also contributes to the social-economic activities which are taking place within the Hardap region such as upgrading of settlements into proclaimed villages and mass-housing projects. Spatial data gathered in this study was used as input for the development of a georeferenced digital database that can be used as a model by the MLR for sustainable land use planning in the Hardap region. The produced frameworks and guidelines for future participatory mapping aided by GIS technology will help guide decision-makers on how to harmonise the proper management of land use in Namibia. The developed maps will be provided to relevant stakeholders to help them in managing changes to land use patterns which will enlighten the stakeholders about the process of ILUP in Namibia.

Issues of spatial planning and impacts of proper integrated land use planning through the use of participatory mapping methods and GIS technology were addressed in this study in the context of geography. This study required a methodology that addresses issues of stakeholders and the ability to control unobserved the diverse aspects of land use planning issues, which was organised via various discussion approaches. Participatory techniques such as participatory mapping and focus group discussions proved to be extremely useful to gain deeper insight into particular issues affecting a community. However, as the data generated are qualitative in nature, it was difficult to report on it in a standardised manner or to compare with information from other locations in anything more than a descriptive manner (UN-Habitat, 2006). Based on the above reason, it was important to gather different insights about land use planning issues from stakeholders through holistic participatory approaches such as GIS and participatory rural appraisal for gathering and incorporation of knowledge at local and regional level in Namibia.

The relevant modern approaches to ILUP such as participatory mapping (sketch and photo),

focus group discussions and participatory rural appraisal contributed to the research as there were used to bring together different citizens to share their knowledge and experience pertaining to land use planning. The philosophical thought, postmodernism, was employed in this study to meet the objectives of the study. Postmodernism guided the qualitative methods such as participatory mapping, focus group discussions, participatory rural appraisal and interviewing with considerable practices in the context of geography. It was also confirmed in the study done by Bergman & Renwick (2005:08) that "most contemporary geographers employ three analytical methods: area analysis, spatial analysis and geographic systems analysis."

It can be concluded that the postmodernist perspective of this study are a suitable approach to all the research methods applied. Postmodernism perspective was supportive of this study in its context, as it included the conditions of perspectives. The study included the postmodernism's importance of various discourses, the importance of marginalised people and groups and the presence of "meta-narratives" or universals that hold true perspectives regardless of the social conditions (Creswell, 2007).

The spatial planning aspects were emphasised in the research methods through the use of GIS to contribute to the investigation of urban and rural land issues of the Hardap region; focusing on land uses, people, data management and processing issues. Because land use planning can involve complex issues such as having to deal with different kinds of data (such as the land human behaviour and environmental processes) the use of GIS contributed to effectively incorporate the aspects of spatial and attributes data. The ability to incorporate and manage different aspects of land use planning is one of the key challenges which exist in land use planning. Key challenges are complex and are both quantitative and qualitative in nature.

The spatial characteristics of different land use types in the Hardap region were also described and explained in terms of how land use influence human actions and the environmental. Through observations about physical development using spatial technologies such as GIS technology and human approaches to land uses, it is possible to provide expert viewpoints on how the various issues such as population growth and increased demand for land have a mutual effect on one another.

Geography as a discipline of study provided for the assessments and monitoring of human settlements (as seen in chapter 2), to present alternative land use scenarios and to empower and educate local communities (as demonstrated in chapter 4) about human and physical

aspects of their environment. The significance of this study, among others, include promoting GIS technology in sustainable land use planning, promoting community engagement in decision-making process, and gathering traditional knowledge and experiences on land use.

6.8 Suggestions for Further Study

The outcomes of the study trigger suggestions for further development and improvement of integrated land use planning, using participatory approaches integrated with GIS technology. One of the suggestions is that of incorporating the stakeholders' thoughts, opinions and experiences using participatory mapping, FGD and PRA on how the practice of participatory mapping could be turned into a more effective tool in land use planning and the decision-making process. An aspect that was emphasised during interviews is the need for data. However, it should be noted that such data should be easily assessable and it should also be possible to verify the data (Wu & Isaksson, 2008).

There is a need for research about participatory integrated sustainable land use planning programmes which would modernise the current state of land use planning in Namibia. The evaluated participatory mapping frameworks and guidelines can be used in other parts of the country in future as part of the integrated land use planning project tools. In physical and human geography, the technology of GIS, participatory mapping methods and land use planning application have played a vital role for many years. However, the application of proper local community participatory approaches has always been limited. Bonnett (2008:14) stated that "the world is a material reality. Humans need to give meaning to this reality. People have traditionally used the earth's physical and human features – topography, climate and settlement – to place themselves." geography plays a critical role in development of the spatial planning such as built environment in both urban and rural communities. The planning experts usually rely on knowledge of geographical space when deciding how best to manage urban and rural land use growth. As the cities of Namibia grow and more rural land are developed, ensuring sustainable land use growth and practical sustainable land use planning management are necessary goals.

In this research the contribution of participatory mapping aided by GIS within the context of geography was examined. Firstly, the economic benefits and implications of the participatory mapping approaches were analysed and described in chapter five based on data obtained from the focus groups and their sketch and photo-mapping. Then the Strengths,

Weaknesses, Opportunities and Threats (SWOT) of the participatory mapping aided by GIS in land use planning in Namibia was evaluated based on the outcomes of sketch and photo-mapping, focus groups, PRA and consultation meetings with experts and local participants.

The ultimate aim of the evaluation was to determine whether the participatory mapping approaches aided by GIS can be regarded as useful tools in integrated land use planning in Namibia. The key research aim was to develop frameworks and guidelines for participatory mapping aided by GIS for effective land use planning and management in Namibia. The frameworks and guidelines of the study can be used as a model toward sustainable land use planning.

The research addressed the socio-economic nature of participatory approaches and GIS technology implementation in land use planning. By giving equal consideration to both social and technological elements, it allows proper incorporation of stakeholder's knowledge and spatial data in the land use planning process.

The findings of this research contribute to the understanding of the status of participatory approaches and GIS developments in Namibia, and knowledge on how participatory approaches and GIS technology are perceived. The findings of the SWOT analysis presented in Table 5.6 suggest that the use of participatory approaches and GIS technology in Namibia is generally recognised but lack of awareness. This research also argued that social needs have to be recognised in the process of land use planning.

6.9 Conclusion

In this study, LUP was emphasised as covering all steps in a process extending from procurement of *data* through the processing, analysis, discussion and evaluation of that data right up to establishing consensus and making a decision on the form of land use planning to be practised. This includes clarification of the prerequisites for implementing and preparing, and initiating that implementation. However, in the context of technical co-operation, LUP does not usually provide for all planned measures to be carried out in their entirety. Thus this study recommends that the relevance of participatory approaches should be used in the assessments such as the fit between what society expects of land management authorities and what is required from the society to contribute to sustainable land use planning.

This study provides recommendations for future use of multiple datasets collected and

gathered for land use planning, management and land development. Most of the collected data in this study are spatial data and can be useful for other research and relevant government ministries and NGOs. The findings provided the discussions on how the research contributes to the body of knowledge in spatial planning.

The participants from local communities in land use planning are direct and indirect land users affected by the consequences of land usage. The decision-makers are representatives of the sponsors who often have political or economic influence; this includes government authorities, non-governmental organisations and processing industries for agricultural products. However, the most important target groups of land use planning are made up of the direct land users themselves as participants.

In this study, recommendations and conclusion regarding the importance of participatory approaches to integrated land use planning and the role of GIS, ensuring effective participation of all stakeholders and their representatives have also been emphasised. The study recommends the use of frameworks and guidelines for future participatory mapping aided by GIS technology involving local community knowledge in sustainable land use management processes in Namibia. These recommendations contribute to ensuring effective participatory land use planning processes, which require the choice of appropriate approaches, supported by an enabling environment at national, regional and local level. Present approaches to land use planning are not fully successful in coping with the growing needs of the population and related pressures on the environment. An important reason for the failure of the present approaches is their top-down style of land use planning and their obvious lack of involvement of land users in the programme design and implementation. This is exacerbated by the compartmentalisation of institutions which results in fragmented efforts and failure to integrate all relevant factors (Verheye, 1998).

The participatory approaches do not clearly recognise the role of technical solutions for optimising land use. Participatory approaches, however, stresses the need for a more active participation by the stakeholders throughout the planning and decision-making process (Verheye, 1998). It promotes the combination of top-down and bottom-up inputs towards more interactive land use planning. It further promotes understanding that a balanced partnership between supportive government agencies, external technical expertise and self-directing people-owned programmes might be far more effective than the traditional too technical, too sectoral and too top-down approach.

References

Alagan, R. 2007. Participatory GIS approaches to environmental impact assessment: A case study of the appalachian corridor H transportation project. Dissertation submitted to the College of Arts and Sciences at West Virginia University in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Geography. Department of Geology and Geography, Morgantown, West Virginia.

Amler, B., Betke, D., Eger, H., Ehrich, C., Kohler, A., Kutter, A., von Lossau, A., Müller, U., Seidemann, S., Steurer, R. and Zimmermann, W. 1999. *Land use planning methods, strategies and tools* - Eschborn, 1999 [Online]. Available from: http://www.mpl.ird.fr/crea/taller-colombia/FAO/AGLL/pdfdocs/gtz-lup.pdf [Accessed 22 June 2011].

Answers Corporation. 2010. *Geography dictionary: postmodernism* [Online]. Available from: http://www.answers.com/topic/postmodernism [Accessed 1 June 2009].

Arciniegas, G., Janssen, R. and Omtzigt, N. 2011. Map-based multicriteria analysis to support interactive land use allocation. *International Journal of Geographical Information Science.* Vol. 25 (12) 1931–1947.

Arentsen, M. Stam, R. and Thuijs, R. 2004. Postmodern approaches to space. [Online]. Available from: http://socgeo.ruhosting.nl/html/files/geoapp/Werkstukken/PostmodernSpace.pdf [Accessed 7 June 2012].

Association of Local Authorities in Namibia (ALAN). 1995. *Manual on town and regional planning practice in Namibia. Vol 2 - Reference Book*. Windhoek: Namibia Institute of Town and Regional Planners (NITRP).

Bae, W.D., Alkobaisi, S., and Leutenegger, S.T. 2010. IRSJ: Incremental refining spatial joins for interactive queries in GIS. *Geoinformatica* Vol. 14:507–543.

Bailey, K. D. 1982. *Methods of social research*. New York: Free Press.

Bak, N. 2004. *Completing your thesis: A practical guide*. Cape Town: Van Schaik.

Bansouleh, B. F. 2009. Development of a spatial planning support system for agricultural policy formulation related to land and water resources in Borkhar & Meymeh district, Iran. *PhD dissertation. Wageningen University and Research Centre (WUR),* International Institute for Geoinformation Science and Earth Observation (*ITC)* [Online]. Available from: http://www.itc.nl/library/papers_2009/phd/farhadi_bansouleh.pdf [Accessed 1 June 2009].

Barndt, M. 1998. Public participation GIS-barriers to implementation. *Cartography and*

geographic information systems, Vol. 25 (2) 105-112.

Bartolo, R.E., and Hill, G.J.E. 2001. A case study from Northern Australia: remote sensing and GIS technologies as a decision-making tool for indigenous land management. *Indigenous Knowledge and Development Monitor* [Online]. Available from: http://www.nuffic.nl/ciran/ikdm/9-1/bartolo.html [Accessed 7 July 2010].

Berg, L.B. 1998. *Qualitative research methods for the social sciences*. London: Allyn and Bacon.

Bergman, E.F. and Renwick, W.H. 2005. *Introduction to geography: people, places and environmen*t. Washington: Prentice Hall.

Bless, C. and Higson-Smith, C. 2000a. *Fundamental of social research methods: an African perspective*. Third edition. Lusaka: Juta Publications.

Bless, C. and Higson-Smith, C. 2000b. *Social research methods*. Cape Town: Creda Communications.

Bobade S.V., Bhaskar, B.P., Gaikwad, M.S., Raja, P., Gaikwad, S.S., Anantwar, S.G., Patil, S.V., Singh, S.R. and Maji, A.K. 2010. A GIS-based land use suitability assessment in Seoni district. Madhya Pradesh, India, *Tropical Ecology. Vol.* 51(1) 41-54.

Bogdan, R. and Taylor, S. 1975. *Introduction to qualitative research methods: A phenomenological approach to the social sciences.* New York: Wiley.

Bonnett, A. 2008. *What is Geography?* London: SAGE Publications.

Buckley, D.J. 2000. *An Introduction to Geographical Information Systems*. San Diego: Pacific Meridian Resources.

Budhathoki, N.R., Bertram, B. and Nedovic-Budic, Z. 2008. Reconceptualising the role of the user of spatial data infrastructure. *GeoJournal. Vol.* 72 (3-4) 149-160.

Burrough, P.A. 1986. *Principles of geographic information systems for land resource assessment.* Monographs on soil and resources survey. No. 12. New York: Oxford Science Publications.

Burton, D. 2000. *Research training for social scientists: A handbook for postgraduate researchers*. London*: SAGE Publications*.

Canadian Council of Forest Ministers. 2009. *Fact sheet - integrated forest land-use planning* [Online]. Available from: http://www.sfmcanada.org/english/pdf/LandPlan_FS_Eng.pdf [Accessed 22 June 2011].

Carver, S. 2001. *Participation and geographical information*. A position paper, ESF-NSF workshop on access to geographic information and participatory approaches using geographic information, Spoleto, December 2001 [Online]. Available from: www.shef.ac.uk/Bscgisa/spoleto/workshop.htm [Accessed 29 March 2010].

Casey, L., and Pederson, T. 2000. Mapping urban neighbourhood environments [Online].

Available from: http://www.ncgia.ucsb.edu/varenius/ppgis/papers/casey.html [Accessed 29 March 2010].

Chambers, R. 1994. Participatory Rural Appraisal (PRA): challenges, potentials and paradigm. *Journal of World* Development. Vol. 22 (10) 1437–1454 [Online]. Available from: https://entwicklungspolitik.uni-hohenheim.de/uploads/media/Day_4_-_Reading_text_7_02.pdf [Accessed 1 July 2011].

Chapin, M., Lamb, Z., and Threlkeld, B. 2005. Mapping indigenous lands. Washington, DC: Environmental law institute. Vol.34, 619-638.

Chilton, S. 2009. Crowd sourcing is radically changing the geodata landscape: case study of openstreetmap. *Middlesex University* [Online]. Available from: http://ns1.icaci.org/files/documents/ICC_proceedings/ICC2009/html/nonref/22_6.pdf [Accessed 6 October 2012].

Chirowodza, A., van Rooyen, H., Joseph, P., Sikotoyi, S., Richter, L and Coates, T. 2009. Using participatory methods and Geographic Information Systems (GIS) to prepare for an hiv community-based trial In Vulindlela, South Africa. *Journal of Community Psychology. Vol.37 (1) 41–57 [Online].* Available from: *www.interscience.wiley.com* [Accessed 6 May 2011].

Chrisman, N. R. 1987. Design of geographic information systems based on social and cultural goals. *Photogrammetric Engineering & Remote Sensing*. New York: 53 (10): 1367–1370.

Chrisman, N.R. 1997. *Exploring geographic information systems*. New York: John Wiley and Sons.

Christou, M.D., Struckl, M. and Biermann, T. 2006. *Land use planning guidelines in the context of article 12 of the seveso ii directive 96/82/ec as amended by directive 105/2003/ec*. European Commission, Joint Research Centre [Online]. Available from: http://ec.europa.eu/environment/seveso/pdf/landuseplanning_guidance_en.pdf [Accessed 9 June 2013].

Clarke, K.C. 1997. *Getting started with geographic information systems* [Online]. Prentice Hall Companion Website. Santa Barbara: University of California. Available from: http://wps.prenhall.com/esm_clarke_gsgis_4/7/1847/473050.cw/index.html [Accessed 29 March 2010].

Clifford, N, J., and Valentine, G. 2003. *Key methods in geography*. London: SAGE Publications.

Cloete, F., Wissink, H. and De Coning, C. 2006. *Improving public policy from theory to practice.* 2nd edition. Pretoria: Van Schaik.

Cloke, P.J. 1989. *Rural land use-use planning in developed nations*. St David's University College, Lampeter, London: Unwin Hyman.

Clouston, A. 2012. Crowd-sourcing - what are your thoughts? *New Zealand Geospatial Strategy* [Online]. Available from: http://www.geospatial.govt.nz/crowd-sourcing-what-are-your-thoughts [Accessed 6 October 2012].

Cohen, L. and Manion, L. 1994. *Research methods in education*. London: Routledge.

Coleman, A.L. and Galbraith, J.M. 2000. Using GIS as an agricultural land-use planning tool. Virginia Polytechnic Institute and State University Blacksburg, Virginia 24061-0402 [Online]. Available from: http://scholar.lib.vt.edu/ejournals/vaes/00-2.pdf [Accessed 4 August 2013].

Cooper, A.K. 2009. *Geoinformation perspectives on innovation and economic growth*. First Session of the Committee on Development Information, Science and Technology (CODIST-1) 28 April – 1 May 2009 Addis Ababa, Ethiopia.

Corbett, D., Rambaldi, G., Kyem, P.A.K., Weiner, D., Olson, R., Muchemi, J., McCall, M. and Chambers, R. 2006. *Overview: mapping for change – the emergence of a new practice* [Online]. Available from: http://www.iapad.org/publications/ppgis/ch01_overview_pp13-19.pdf [Accessed 26 March 2010].

Craig, W.J. and Elwood, S.A. 1998. How and why community groups use maps and geographic information. *Cartography and Geographic Information Systems*. Vol. 25 (2) 95-105.

Creswell, J.W. 2007. Qualitative inquiry & research design: choosing among five approaches. 2nd edition. London*: SAGE Publications*.

Crutcher, M. and Zook, M. 2009. Placemarks and waterlines: racialized cyberscapes in post katrina google earth. *GeoForum*. Vol. 40 (4), 523-534.

Davis, A.Y. 2009. Assessing sustainable land-use practices using geographic information systems. *Dissertation (PhD)*. Purdue University [Online]. Available from: http://0-proquest.umi.com.oasis.unisa.ac.za/pqdweb?index=6&did=1903351531&SrchMode=1&sid=2&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1269943382&clientId=27625 [Accessed 30 March 2010].

de By, R.A., Georgiadou, P.Y., Knippers, R.A., Kraak, M.J., Sun, Y., Weir, M.J.C. and van Westen, C.J. 2004. Principles of geographic information systems: an introductory textbook. Enschede, ITC. *ITC Educational Textbook Series 1*.

DeMers M.N. 2005. Fundamentals of geographic information systems. 4th Edition. Northwestern University: John Wiley & Sons.

Di Gregorio, A. and Jansen, L.J.M. 1998. *A new concept for a land cover classification system*. The Land. Vol. 2 (1) 55-65 [Online]. Available from: http://www.fao.org/docrep/004/x3810e/x3810e04.htm#g [Accessed 9 June 2013].

Di Lisio, A. and Russo, F. 2010. Thematic maps for land-use planning and policy decisions

in the calaggio stream catchment area. Italy: *Journal of Maps.* Vol. 20 (10) 68-83.

Dobesova, Z. 2012. Database modelling in cartography for the "Atlas of Election". Geodesy and cartography. Czech Republic: *Taylor & Francis Group*. Vol. 38 (1) 20-26.

Downey, J. 2007. *Strategic Analysis Tools Topic Gateway Series. No. 34* [Online]. Available from: http://www.cimaglobal.com/Documents/ImportedDocuments/cid_tg_strategic_analysis_tools_nov07.pdf.pdf [Accessed 7 July 2011].

Duerden, F. and Kuhn, R. 1996. *Indigenous land-use information project*. Ryerson School of Applied Geography [Online]. Available from: www.ryerson.ca/geog/wwwsag/html/indigen [Accessed 7 July 2011].

Egenhofer, M. J. and Mark, D. M. 1995. Naıve geography. In A. U. Frank, and W. Kuhn (Eds.), Spatial information theory. *A theoretical basis for GIS lecture notes in computer sciences*. Berlin: Springer. Vol. 9 (88) 1–15.

Emery, A.R. 2000. Integrating indigenous knowledge in project planning and implementation. *Canadian International Development Agency* [Online]. Available from: http://www.acdi-cida.gc.ca/INET/IMAGES.NSF/vLUImages/ea/$file/IndiKnow-NP-e.pdf [Accessed 22 June 2011].

Environmental Information Systems-Africa (EIS-Africa). 2002. *Geo-information supports decision-making in Africa*. An EIS – Africa position Paper, Pretoria.

Fagerholm, N. and Käyhkö, M. 2009. Participatory mapping and geographical patterns of the social landscape values of rural communities in Zanzibar, Tanzania. *Helsinki: Fennia. Vol. 187 (1) 43–60* [Online]. Available from: http://www.landscapemap2.org/Fagerholm_Zanzibar.pdf [Accessed 7 July 2011].

Food and Agriculture Organization (FAO). 1996. *Guidelines for land use planning*. Food and Agriculture Organization of the United Nations. Development Series 1 [Online]. Available from: http://www.fao.org/docrep/T0715E/t0715e02.htm [Accessed 4 June 2009].

Food and Agriculture Organization (FAO). 1999. *The Future of Our Land - Facing the Challenge* [online]. Available from: http://www.fao.org/docrep/004/x3810e/x3810e03.htm [Accessed 21 June 2011].

Food and Agriculture Organization (FAO). 2002. Gender and access to land [Online]. Available from: ftp://ftp.fao.org/docrep/fao/005/y4308E/y4308E00.pdf [Accessed 4 August 2013].

Food and Agriculture Organization (FAO). 2005. *FAO's information system on water and agriculture* [Online]. Available from: http://www.fao.org/nr/water/aquastat/countries_regions/namibia/index.stm [Accessed 7 October 2012].

Fotheringham, A.S., Brunsdon, C. and Charlton, M. 2000. *Quantitative geography: perspectives on spatial data analysis*. London: SAGE Publications.

Goodchild, M.F., Steyaert, L.T. and Parks, B.O. 1996. *GIS and environmental modelling: press and research issues*. Port Collins: GIS World Books.

Government of Namibia. 2005. *Country Pilot Partnership (CCP) in Namibia for integrated sustainable land management. Programming framework report*. Windhoek: Ministry of Environment and Tourism.

Government of Namibia. 2006a. *Preliminary report, Namibia household income & expenditure survey 2003/2004*. Windhoek [Online]. Available from: http://www.npc.gov.na/publications/prenhies03_04.pdf [Accessed 4 July 2010].

Government of Namibia. 2006b. *Regional poverty profile: based on village-level participatory poverty assessment in Hardap region*. Windhoek: National Planning Commission.

Government of Namibia. 2007. *Namibia: land use planning and environmental sustainability Contributions to an analytical framework for sustainable land management*. Research Discussion Paper Number 76, October 2007. Windhoek: Ministry of Environment and Tourism and Ministry of Lands and Resettlement, [Online]. Available from: http://www.the-eis.com/data/RDPs/RDP76.pdf [Accessed 22 June 2011].

Government of Namibia. 2009. *National Spatial Data Infrastructure (NSDI) policy for the Republic of Namibia*. Windhoek: National Planning Commission.

Government of Namibia. 2010. *Land use planning framework for the Kavango Region of Namibia within the Okavango river basin*. Windhoek: Ministry of Lands and Resettlement [Online]. Available from: http://www.the-eis.com/data/literature/Kavango%20land-use%20planning%20framework.pdf [Accessed 22 June 2011].

Government of Namibia. 2011. *National spatial data infrastructure - The role of the Namibia Statistics Agency, the committee for Spatial Data and terms of reference for the NSDI secretariat and helpdesk*. June 2011. Windhoek: National Planning Commission.

Grinnell, R.M., and Williams, M. 1990. *Research in social work: a prime*. Itasca, IL: Peacock.

Gupta, R. 2000. *SWOT analysis of geographic information: The case of India* [Online]. Available from: http://www.ias.ac.in/currsci/aug252000/ravigupta.pdf [Accessed 7 July 2011].

Haklay, M. and Weber, P. 2008. OpenstreetMap: user-generated street maps. *IEEE Pervasive Computing*. Vol. 7 (4) 12-18.

Harmsworth, G. 1997. Maori values for land use planning. New Zealand Association of Resource Management (NZARM) Broadsheet. *Journal of Visualization in Modern Cartography*. Vol. 1 (1) 37–52.

Harris, T. M. and Weiner, D. 1998. Empowerment, marginalization, and community

integrated GIS. *Cartography and Geographic Information Systems*. American Congress on Surveying and Mapping. London: *Taylor & Francis Group*. Vol. 25 (2) 67-77.

Haub, O. 2009. *Understanding of Land Use Planning and Relevance in Namibia.* Series Number 1. Windhoek: Namibia Institute for Democracy, Ministry of Lands and Resettlement and Gesellschaft fur Technische Zusammenarbeit (GTZ).

Heywood, I., Cornelius, S. and Carver, S. 2002. *An Introduction to Geographical Information Systems.* 2nd edition. London: Prentice Hall.

Integrated Approaches to Participatory Development (IAPAD). 2010. *Participatory mapping toolbox* [Online]. Available from: http://www.iapad.org/toolbox.htm [Accessed 28 April 2009].

International Fund for Agricultural Development (IFAD). 2009. *Good practices in participatory mapping: A review prepared for the International Fund for Agricultural Development* [Online]. Available from: http://www.ifad.org/pub/map/PM_web.pdf [Accessed 25 March 2010].

International Geographical Union. 2012. What is geography? *International Geographical Union* [Online]. Available from: http://www.igu-online.org/site/?page_id=657 [Accessed 7 December 2012].

Johnson, C.P., Deshmukh, B. and Kale, M. 2010. *Conference proceeding on 'role of gis and remote sensing in the sustainable development of Mauritius'* [Online]. Available from: http://www.gsdi.org/gsdiconf/gsdi10/papers/TS23.2paper.pdf [Accessed 2 November 2012].

Kantabutra, V., Owens, J.B., Ames, D.P., Burns, C.N. and Stephenson, B. 2010. Using the newly-created ILE DBMS to better represent temporal and historical gis data. *Transactions in GIS*. Hoboken: Blackwell Publishing.Vol. 14 (1) 39–58.

Kennedy, M. 2002. *The global positioning system and GIS, an introduction*. 2nd edition. New York: Taylor & Francis.

Khan, M. 2013. GIS implementation: factors to consider. public management, January/February 2013 [Online]. Available from: www.icma.org/pm [Accessed 7 August 2013].

Kitchen, R. and Tate, N.J. 2000. *Conducting research in human geography: theory, methodology and practice*. Harlow: Prentice Hall.

Kraak, M.J and Ormeling, F. J. 2003. *Cartography: visualization of geospatial data*. 2nd edition. London: Person Education limited.

Kramer, S. and Amos, T. 2010. *Community asset mapping* [Online]. Available from: http://www.mrc.ac.za/crime/community_asset_mapping.pdf [Accessed 9 June 2013].

Kumar, S. 2002. *Methods for community participation: a complete guide for practitioners*.

New Delhi: Intermediate Technology Publications.

Lai, C.A. and Rivera, J.C. 2006. *Case teaching notes for "a lake runs through it . . .or is it a river? or something else?"* [Online]. Available from: http://www.sciencecases.org/tempe_lake/tempe_lake_notes.pdf [Accessed 7 July 2011].

Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. 2001. *Geographical information systems and science*. New York: John Wiley & Sons.

Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. 2005. *Geographical information systems: principles, techniques, management and applications*. 2nd edition. Abridged. New York: John Wiley and Sons.

Luxem, M., and Bryld B. 1997. *Introductory box: the CSD work programme on indicators of sustainable development.* Sustainability Indicators: A report on the Project on Indicators of Sustainable Development by B. Moldan, S. Billharz, and R. Matravers (2nd edition.). England: John Wiley & Sons. Vol. 9 (2) 6-12.

Maguire, D.J. 1991. *An overview and definition of GIS*. [Online]. Available from: http://www.wiley.com/legacy/wileychi/gis/Volume1/BB1v1_ch1.pdf [Accessed 27 May 2011].

Mandara, C.G. 2007. *Participatory GIS in mapping local context of conflicts over pastoral resources: a case study of Duru Haitemba, Babati, Tanzania*. Thesis (MSc). Enschede, ITC [Online]. Available from: http://www.itc.nl/library/papers_2007/msc/nrm/mandara.pdf [Accessed 2 June 2009].

Marshall, C., and Rossman, G. B. 1999. *Designing qualitative research*. 3rd Edition. London: SAGE Publications.

May, T. 2001. *Social research: issues, methods and process.* 3rd edition. Berkshire: Open University Press.

McCall, M.K and Minang, P.A. 2005. Assessing participatory GIS for community-based natural resource management: claiming community forests in Cameroon. *The Geographical Journal*. Vol. 171 (4) 340–356.

McCall, M.K. 2003. *Seeking good governance in participatory-GIS: a review of processes and governance dimensions in applying GIS to participatory spatial planning.* International Institute for Geo-Information Science and Earth Observation, Enschede, Netherlands. Habitat International. Vol. 27 (2) 549–573.

McCall, M.K. 2004. *Can participatory-GIS strengthen local-level spatial planning? Suggestions for better practice* [Online]. Available from: *http://www.gisdevelopment.net* [Accessed 6 May 2011].

McMillan, J.H. and Schumacher, S. 1997. *Research in education: a conceptual introduction*. New York: Longman.

Mendelsohn, J. 2007. A digest of information on key aspects of Karas and Hardap's geography [Online]. Available from: http://www.the-eis.com/data/literature/Mendelsohn%20J%20Karas%20and%20Hardap%20-%20A%20digest%20of%20information.pdf [Accessed 13 July 2011].

Mendelsohn, J., Jarvis, A., Roberts, C. and Robertson, T. 2002. *Atlas of Namibia: a portrait of the land and its people.* Windhoek: Ministry of Environment and Tourism.

Miles, M.B. and Huberman, A.M. 1994. *Qualitative data analysis.* (2nd edition.) London: SAGE Publications.

Miller, R.M. 2008. *The geology of Namibia. Vol 1, 2 and 3, Palaeozoic to Cenozoic*. Windhoek: Geological Survey of Namibia.

Minang, P.A. and McCall, M.K. 2006. *Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon* [Online]. Available from: http://www.communitycarbonforestry.org/NewPublications/Participatory%20GIS%20and%20local%20-%20Minang.pdf [Accessed 26 March 2010].

Mouton, J. 1996. *Understanding social research*. Pretoria: Van Schaik.

Müller, D. and Wode, B. 2003. *Manual on participatory village mapping using photomaps. Social Forestry Development Project (SFDP) Song Da*. Son La.

Mundia, L.C. 2007. The use of GIS in Flexible Land Tenure System (FLTS) at City of Windhoek – Namibia. *Thesis (MSc). Vrije Universiteit Amsterdam* [Online]. Available from: http://www.unigis.nl/downloads/msc/Lisho%20Christoh%20Mundia.pdf [Accessed 30 March 2010].

Mwazi, O. 2007. *Geocoding and census mapping with GIS in Namibia, Central Bureau of Statistics* [Online]. Available from: http://unstats.un.org/unsd/demographic/meetings/egm/CensusMappingEGM07/docs/PPT/Namibia.ppt [Accessed 30 March 2010].

Nabwire, N. 2002. *An integrated information system for decision support in sustainable land use planning: A Case Study Of Kunene Region Namibia.* Thesis (MSc) International Institute for Geoinformation Science and Earth Observation (ITC) [Online]. Available from: http://www.itc.nl/library/papers/msc_2002/nrm/bamulesewa_nabwire.pdf [Accessed 16 August 2012].

Namibia Development Corporation (NDC). 2000. *Regional development plan 2001/2002 – 2005/2006*. Hardap Region: Hardap Regional Council.

Namibia Statistics Agency. 2013. Namibia 2011 Population and housing census basic report. Windhoek: Namibia Statistics Agency.

Namibian Coast Conservation and Management Project (NACOMA). 2008. Review of existing institutional mandates, policies and laws relating to coastal management,

and proposals for change - study report. Namibian Coast Conservation & Management Project – NACOMA [Online]. Available from: http://www.nacoma.org.na/Downloading/ReviewExistingPoliciesAndMandates.pdfhttp://www.nacoma.org.na/Downloading/ReviewExistingPoliciesAndMandates.pdf [Accessed 7 July 2013].

National Geographic. 2001. What is geography? *National Geographic Education* [Online]. Available from: http://education.nationalgeographic.com/education/media/what-geography/?ar_a=1 [Accessed 7 December 2012].

National Planning Commission (NPC). 2008. *Project documents - GIS and statistics development in Namibia*. Windhoek: National planning commission.

Nedovic`-Budic, Z. 2000. Geographic information science implications for urban and regional planning. *Urban and Regional Information Systems Association* **(***URISA) Journal. Vol.12 (2)* [Online]. Available from: http://www.urisa.org/files/BudicVol12No2-7.pdf [Accessed 12 May 2009].

Neteler, M. and Mitasova, H. 2008. Open source GIS: a GRASS GIS approach (Online). Available from: http://www.springer.com/978-0-387-35767-6 [Accessed 1 October 2012].

Nethengwe, N.S. 2007. Integrating participatory gis and political ecology to study flood vulnerability in the Limpopo Province of South Africa. Dissertation (PhD). West Virginia University [Online]. Available from: http://0-proquest.umi.com.oasis.unisa.ac.za/pqdweb?index=12&did=1467888251&SrchMode=2&sid=9&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1269944316&clientId=27625 [Accessed 30 March 2010].

Noongo, E.N. 2003. *The orientation of data access and accessibility in Namibia. Environmental Information Systems*. Windhoek: Ministry of Environment and Tourism [Online]. Available from: http://geoinfo.uneca.org/sdiafrica/country%20information/namibia/nsdi%20namibia%20status1.doc [Accessed 4 September 2008].

Noongo, E.N. 2007. *The implementation of geographic information systems in Namibia*. Dissertation (PhD). University of Joensuu, [Online]. Available from: http://joypub.joensuu.fi/publications/dissertations/noongo_implementation/noongo.pdf [Accessed 2 June 2009].

Norman, T. 2005. *Geography:* New *dictionary of the history of ideas*. Encyclopaedia [Online]. Available from: http://www.encyclopedia.com/doc/1G2-3424300318.html [Accessed 28 March 2010].

Nyerges, T., Jankowski, P. and Drew, C. 2002. Data-gathering strategies for social-behavioural research about participatory geographical information system use.

International Journal of Geographical Information Science [Online]. Available from: http://web.ebscohost.com/ehost/pdf?vid=4&hid=2&sid=58779f52-5a24-46e3-910c-a5adca77f534%40sessionmgr103 [Accessed 2 June 2009].

Obermeyer, N.J. 1998. PPGIS: *The evolution of public participation GIS*. Indiana State University [Online]. Available from: http://dusk.geo.orst.edu/ucgis/web/oregon/ppgis.pdf [Accessed 22 June 2013].

Patton, M,Q. 2002. *Qualitative research & evaluation methods (3rd edition)*. Newbury Park: SAGE Publications.

Rambaldi, G., and McCall, M. K. 2010. *Unit M05U01 – significance of enabling and disabling factors for participatory mapping; in training kit on participatory spatial information management and communication. Italy: Technical Centre for Agricultural and Rural Cooperation (CTA), the Netherlands and International Fund for Agricultural Development (IFAD).*

Rambaldi, G., Chambers, R., McCall, M. and Fox J. 2006a. *Practical ethics for PGIS practitioners, facilitators, technology intermediaries and researchers* [Online]. Available from: http://www.ppgis.net/pdf/ch14_rambaldi_pp106-113.pdf [Accessed 26 March 2010].

Rambaldi, G., Kyem, P.A.K., McCall, M. and Weiner, D. 2006b. *Participatory Spatial information management and communication in developing countries* [Online] Available from: http://www.ejisdc.org/ojs2/index.php/ejisdc/article/viewFile/237/158 [Accessed 26 March 2010].

Randolph, R. 2004. *Environmental land use planning and management*. Washington: Island Press.

Rigby, D.L. 1997. *Methods in economic geography* in *challenges in economic geography: Global and local challenges to theory, practice, and teaching in economic geography.* Workshop held in Washington, DC, sponsored by the National Science Foundation (NSF) [Online]. Available from: http://www.geog.uconn.edu/aag-econ/glaswksp.pdf [Accessed 27 April 2011].

Robinson, A., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. 1995. *Elements of cartography* (6th edition.). New York: John Wiley and Sons.

Rosenberg, M. 2011. *Definitions of geography*. [Online]. Available from: http://geography.about.com/od/studygeography/a/geodefinitions.htm [Accessed 24 March 2011].

Royal Geographical Society. 2005. What is geography? *Royal Geographical Society* [Online]. Available from: http://www.rgs.org/geographytoday/what+is+geography.htm [Accessed 7 December 2012].

Royal Town Planning Institute (RTPI). 2001. *A new vision for planning: delivering*

sustainable communities, settlements and places – the need for action [Online]. Available from: http://www.rtpi.org.na [Accessed 27 January 2011].

Salimi, E.T., Soleimani, K., Roshan, M.K. and Sabetraftar, K. 2008. Land use planning for land management using the Geographical Information System (GIS) in the Loumir Watershed of Guilan Province in Northern Iran. *Caspian Journal of Environmental Sciences*. Vol. 6 (2) 141-149.

Schwedes, S and Werner, W. 2010. Manual for participatory land use planning facilitators: document produced in the framework of the Modelling Integrated Regional Land Use Planning project of the Namibian Ministry of Lands and Resettlement (MLR) and the German Technical Cooperation (GTZ. Windhoek. Ministry of Lands and Resettlement.

Seaberg, J.R. 1988. Utilizing sampling procedures. Social work research and evaluation. 3rd edition. Itasca, IL: Peacock.

Sevillo, L. 2012. TPM - Territorial Performance Monitoring annexes. Guidelines for Qualitative Analysis of Regional Governance System and Resilience [Online]. Available from: http://www.espon.eu/export/sites/default/Documents/Projects/TargetedAnalyses/TPM/FinalReport/ESPON_TPM_FinalReport_Annex_Framework_Qualitative_Analysis.pdf [Accessed 9 June 2013].

Shack Dwellers Federation of Namibia. 2009. *Community Land Information Program (CLIP) profile of informal settlements in Namibia* [Online]. Available from: http://www.citiesalliance.org/ca/sites/citiesalliance.org/files/NamibiaCLIP092.pdf [Accessed 16 June 2011].

Steede-Terry, K. 2000. *Integrating GIS and the global positioning system*. Redlands, CA: ESRI Press.

Tagg, J. and Taylor, J. 2006. PGIS and mapping for conservation in Namibia. *Participatory learning and action*, December 2006 [Online]. Available from: http://pubs.iied.org/pdfs/G02931.pdf [Accessed 22 February 2011].

Taylor, J., Murphy, C., Mayes, S., Mwilima, E., Nuulimba, N. and Slater-Jones, S. 2006. *Land and natural resource mapping by San communities and NGOs: experiences from Namibia. Participatory learning and action* [Online]. Available from: http://www.iapad.org/publications/ppgis/PLA54_ch10_taylor_pp79-84.pdf [Accessed 22 February 2011].

Tripathi, N. and Bhattarya, S. 2004. *Integrating indigenous knowledge and GIS for participatory natural resource management: state-of-the-practice.* The Electronic Journal of Information Systems in Developing Countries (EJISDC). Vol. 17 (3) 1-13.

Trung, N.H., Tri, L.Q., van Mensvoort, M.E.F. and Bregt, A. 2004. *GIS for participatory land*

use planning in the Mekong Delta, Vietnam [Online]. Available from: http://www.iapad.org/publications/ppgis/pgis_mekong_delta.pdf [Accessed 26 May 2011].

UN-Habitat. 2006. Meeting development goals in small urban centres - water and sanitation in the world's cities. London: United Nations Human Settlements Programme.

Vajjhala, S.P. 2005. *Integrating GIS and participatory mapping in community development planning.* ESRI International User Conference, Sustainable Development and Humanitarian Affairs Track, July 2005, San Diego, CA.

Venema, J.H., Alim, M., Vargas, R.R., Oduori, S. and Ismail, A. 2009. Land use planning guidelines for Somaliland. Technical Project Report. Nairobi: FAO.

Verheye, W.H. 1998. The *FAO-UNEP approach to land use planning - a review. FAO/UNEP Workshop on Integrated Planning and Management of Land Resources*. 30 March – 3 April 1998 in Mbabane, Swaziland [Online]. Available from: http://www.mpl.ird.fr/crea/taller-colombia/FAO/AGLL/pdfdocs/workshop.pdf [Accessed 21 June 2011].

Verlinden, A. and Dayot, B. 2005. A comparison between indigenous environmental knowledge and a conventional vegetation analysis in north central Namibia. *Journal of Arid Environments*. Vol. 62 (2) 143–175.

Wade, T, and Sommer, S. 2006. *A to Z GIS: An illustration dictionary of geographical information systems*. 2nd edition. California: ESRI Press.

Wageningen UR Centre for Development Innovation. 2008. *Participatory Rural Appraisal (PRA)* [Online]. Available from: http://portals.wi.wur.nl/ppme/?Participatory_Rural_Appraisal_(PRA) [Accessed 8 July 2015].

Walford, N. 2002. *Geographical data - characteristics and sources*. England: John Wiley & Sons.

Wehrmann, B. 2011. *Land use planning concept, tools and applications* [Online]. Available from: http://www2.gtz.de/dokumente/bib-2011/giz2011-0041en-land-use-planning.pdf [Accessed 23 November 2012].

Wehrmann, B. and Glavina, J. 2009. *Geographic Information Systems (GIS): the spatial dimension to development cooperation* [Online]. Available from: http://capacity4dev.ec.europa.eu/eu-working-group-land-issues/geographic-information-systems-gis-spatial-dimension-development-cooperation [Accessed 23 March 2010].

Weiner, D., Harris, T.M. and Craig, W.J. 2001. *Community participation and geographic information systems*. London: Taylor and Francis

World Bank. 1998. Indigenous knowledge for development a framework for action. World

Bank: Knowledge and Learning Center. [Online]. Available from: http://www.worldbank.org/afr/ik/ikrept.pdf [Accessed 16 November 2012].

Wu, C.J. and Isaksson, K. 2008. *Participatory mapping as a tool for capturing local perspectives on cultural landscape - case study of Ostlänken* [Online]. Available from: http://www.mistra.org/download/18.87749a811cbd4c4fb4800010902/Participatory+mapping+as+a+tool.pdf [Accessed 7 July 2011].

Zook, M., Graham, M., Shelton, T. and Gorman, S. 2010. *Volunteered geographic information and crowdsourcing disaster relief: a case study of the Haitian earthquake*. World Medical & Health Policy. Vol. 2 (2).

Explanation of Key Concepts

Coordinate system: A system that allows a position to be located in two-dimensional space. It has an origin, two axes and a unit of measurement.

Database Management System (DBMS): is a set of computer programs for organising information, at the core of which will be a database. The integration of spatial data (often proprietary to the GIS software), and tabular data stored in a DBMS is a key functionality afforded by GIS (Buckley, 2000).

Focus Group Discussion (FGD) is a form of structured group discussion involving people with knowledge and interest in a particular topic and a facilitator (Evaluate IT, n.d.).

Fundamental spatial data sets: spatial data for which there is a justified need for national consistency by multiple users in order for those users to meet their objectives. A fundamental dataset may comprise a number of compatible databases maintained by custodians in several jurisdictions.

Geographical Information Systems (GIS) is an integrated collection of computer software, data and methodologies used to view and manage information about geographic places; analyze spatial relationships; and model spatial process.

Geography: is defined as ‘‘concerned to provide accurate, orderly, and rational description and interpretation of the variable characters of the Earth’s surface.” (Norman, 2005)

Global positioning systems (GPS) is a constellation of twenty-seven NAVSTAR satellites orbiting the earth at a height of 12.600 miles; five monitoring stations and individual receivers (Steede-Terry, 2000:3).

Information: any data processed, organized or classified into categories to serve a useful purpose. It can be presented in voice, digital, printed, pictorial, image, and graphical or numerical formats.

Integrated Land Use Planning (ILUP): is a tool which provides a means for stakeholders, communities, individuals and civil society to engage in collaborative decision-making about land use and resource management within a defined area.

Integrated Sustainable Land Management (ISLM) refers to approaches to land and renewable natural resources management that bring together government line ministries and other sectoral service providers to jointly plan and coordinate support to local communities under the direction of these communities.

Land Administration: the processes of determining, recording and disseminating information about the tenure, value and use of land when implementing land management policies.

Land management: the activities associated with the management of land as a resource from both an environmental and an economic perspective.

Land use planning (LUP) is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options (Food and Agriculture Organization, 1996).

Land: the surface of the Earth, the materials beneath, the air above and all things fixed to the soil.

Metadata: is a structured summary of information that describes the data (data about data).

Participatory GIS (PGIS) is an emergent practice in its own right; developing out of participatory approaches to planning and spatial information and communication management (Rambaldi and Weiner, 2004; cited in Rambaldi *et al*. 2006:2).

Participatory mapping is a map-making process that attempts to make visible the association between land and local communities by using the commonly understood and recognized language of cartography (International Fund for Agricultural Development, 2009:6).

Participatory Rural Appraisal (PRA) can be described as a family of approaches, methods and behaviors that enable people to express and analyze the realities of their lives and conditions, to plan themselves what action to take, and to monitor and evaluate the results (Wageningen UR Centre for Development Innovation, 2008).

Photo-mapping is the photo-mapping approach is usually carried out on the printouts of geometrically corrected aerial photographs (orthophotos) placed in map coordinate systems (Rambaldi *et al*., 2006:6). Orthophoto maps are occasionally a source of accurate remotely sensed data that may be used for large scale community mapping.

Projection: formula to transform 3D spherical shape of earth onto a 2D surface.

Sketch mapping is a slightly more elaborate method. A map is drawn from observation or memory. It does not rely on exact measurements, such as having a consistent scale, or georeferencing. It usually involves drawing symbols on large pieces of paper to represent features in the landscape (Corbett *et al*. 2006:14).

Spatial Data Infrastructure (SDI): is a set of policies, standards and procedures under which organisations and technologies interact to foster more efficient use, management and production of spatial data.

Appendixes

Appendix A: Focus Group Discussion (FGD) Interview

Introduction

The purpose of this questionnaire is to gather data on background information, land use activities and infrastructure and the use of participatory mapping. The information will be gathered from different communities in Hardap Region's different constituencies. All gathered information will be used for study purpose only.

Note: The questionnaire is to be completed after presentation and discussion of its purpose.

Please answer all appropriate questions by marking the correct/most appropriate option with an [X]:

SECTION A: BACKGROUND INFORMATION

1. **What is your gender?**

   Male ☐
   Female ☐

2. **What is your age group?**

   16 – 20 Years ☐
   20 – 25 Years ☐
   26 – 30 Years ☐
   31 – 35 Years ☐
   36 – 40 Years ☐
   More than 40 years ☐

3. **Name the region and town you live in?**

   Town .....
   Region.....

SECTION B: LAND USE ACTIVITIES AND INFRASTRUCTURE

1. **Do you have any land use in Hardap Region?** (e.g. farm, mining, etcetera) If yes, name it and answer question 2.

   Yes ☐ .....

   No ☐

2. **What infrastructure are on this land?**

Roads	☐	Towers	☐	Sewerage	☐
Wind pumps	☐	Railways	☐		
Electricity	☐	Dams	☐		
Boreholes	☐	Reservoirs	☐		
Houses	☐	Any others	☐	.....	

3. **What infrastructure you do not have but would like to have?**

Roads	☐	Towers	☐	Sewerage	☐
Wind pumps	☐	Railways	☐		
Electricity	☐	Dams	☐		
Boreholes	☐	Reservoirs	☐		
Houses	☐	Any others	☐	.....	

4. **Are you involved in any land management related programmes in this region?**

   Yes ☐

   No ☐

5. **What natural phenomena are found on your land?**

River	☐	Vegetation	☐
Streams	☐	Trees	☐
Wells	☐		
Mountains	☐		
Any others	☐	.....	

6. **Did you or do you have land conflicts or disputes?** If yes, explain.

   Yes ☐ .....

   No ☐

7. **Are land issues addressed well by responsible ministries or organisations?**

   Yes ☐
   No ☐

SECTION C: THE USE OF PARTICIPATORY MAPPING

1. **Have you heard of participatory mapping before?**

   Yes ☐
   No ☐

2. **Have you used participatory mapping before?**

   Yes ☐
   No ☐

3. **Have you used participatory mapping in land use planning issues before?**

   Yes ☐
   No ☐

4. **If yes to question 3, name and describe how participatory mapping was used in land use planning?**

5. **If no to question 3, name and describe any project to which participatory mapping was used?**

6. **Do you use maps to locate or manage your land?**

   Yes ☐
   No ☐

7. If yes, which type of maps?

Dynamic maps ☐
Hard copy map ☐
Hand drawn map ☐
Any others ☐ ……

8. Name and discuss land issues which are managed by using maps?

SECTION D: ANY OTHER COMMENTS

Use the space below to provide any other comments here:

Appendix B: Participatory Rural Appraisal (PRA) Interview

Introduction

The purpose of this questionnaire is to gather data on the background information of the participants, land use purpose and understanding of land management, use of participatory approaches in land use planning. The information will be gathered from different communities in Hardap Region's different constituencies. All gathered information will be used for study purpose only.

Note: The questionnaire is to be completed after presentation and discussion of its purpose.

Please answer all appropriate questions by marking the correct/most appropriate option with an [X]:

SECTION A: BACKGROUND INFORMATION

1. **What is your gender?**

   Male ☐
   Female ☐

2. **What is your age group?**

   16 – 20 Years ☐
   20 – 25 Years ☐
   26 – 30 Years ☐
   31 – 35 Years ☐
   36 – 40 Years ☐
   Over 40 years ☐

3. **Name the region and town you live in?**

   Town .....
   Region.....

SECTION B: LAND USE PURPOSE AND UNDERSTANDING ABOUT LAND MANAGEMENT

1. **For what purpose (s) do you use the land that you occupy?** (Tick all categories that apply)

   Farming ☐
   Mining ☐
   Residential ☐
   Business ☐
   Any others ☐ ……..

2. **Are there any organisations providing land-related services/support to you?** (If any, name the organisations and the type of service).

   Yes ☐ ……..
   No ☐

   Services/support:

   ……

3. **Are you interested and willing to learn about land management methods (i.e. participatory mapping, PRA,** etcetera**) used in participatory land use planning?**

   Yes ☐
   No ☐

4. **Rank your level of understanding of land issues?**

   None ☐
   Medium ☐
   High ☐

5. **Do you know you land boundaries?**

   Yes ☐
   No ☐

6. **Can you map the boundaries of your land on a piece of paper?**

   Yes ☐
   No ☐

SECTION C: BASIC PRA AND LAND MANAGEMENT RELATED TRAINING

1. **Have you heard of Participatory Rural Appraisal (PRA) tool before?**

   Yes ☐

   No ☐

2. **Have you used participatory rural appraisal tool before?**

   Yes ☐

   No ☐

3. **Have you used participatory rural appraisal in land use planning activities before?**

   Yes ☐

   No ☐

4. **If "*Yes*" to question 3, name and describe the land use planning issues used by the participatory rural appraisal?**

5. **If "*No*" to question 3, name any activities participatory rural appraisal was used for?**

6. **Name any land management tools or methods that are used to manage land use planning issues on your land?**

7. **Are you a member of any land-related boards?**

   Yes ☐ ……

   No ☐

SECTION D: ANY OTHER COMMENTS

Use the space below to provide any other comments here that you would like to mention about:

Appendix C: Research Ethics Statement

Dear Participant

This letter is an invitation to consider participating in a study I am conducting as part of my PhD Degree in the Department of Geography at the University of South Africa (UNISA).

The rationale behind this research is to develop frameworks and guidelines for participatory mapping through GIS for effective integrated land use planning and management. The proposed research further intends to enhance the implementation of integrated sustainable land management by involving the local community through participatory mapping and interviews techniques in the Hardap region. This research therefore, will contribute to our understanding of the local spatial knowledge with regard to land uses and the statuses of how participatory mapping through GIS can help in integrated sustainable land use management.

Participation in this study is voluntary. It will involve the questionnaires interview of approximately 30 minutes in length to take place in a mutually agreed upon location. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, your response will be captured in the questionnaires to facilitate collection of information, and analyzed thereafter. Shortly after the interview has been completed, I will read out your responses to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained until the completion of the study in a safe storage. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

I would like to assure you that this study meets all ethical standards set out. However, the final decision about participation is yours. I hope that the results of this study will be of benefit to those individuals and institutions directly involved in the study, other institutions not directly involved in the study, as well as to the broader research community.

Thanking you in advance for your assistance in this project.

Yours faithfully
Lisho C. Mundia

Appendix D: Consent Form 1

I have read the information presented in the information letter about a study being conducted by Mr. Lisho Mundia from the Department of Geography at the University of South Africa. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be recorded into the questionnaires to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.
With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.
YES ☐
NO ☐

I agree to be interviewed.
YES ☐
NO ☐

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.
YES ☐
NO ☐

Participant Name: _____
Participant Signature: _____
Date: _____

Yours faithfully
Lisho Christoh Mundia

Appendix E: Consent Form 2

By writing my name and signing below, I acknowledge taking part in the questionnaires and participatory mapping techniques of this research. I fully understand my rights not to participate, withdraw from taking part and the confidentiality of the information.

Initials and surname	Date	Signature
E.S Bock	24/01/2011	EBock
I.L Simililo	" "	
H. Demunda	" "	HDemunda
P.I Haufiku	" "	PIH
S Kamo	" "	SK
T.S Isaes	" "	TSI
P.N Alberto	" "	Alberto
T.R Bayer	" "	Bayer
R Konjore	" "	RKonjore
P.R Hoeb	" "	Namases2C
L.C Namases	" "	
S.S erasmus		Erasmus
D.E Hongo	24/01/2011	DEhongo
C.S connie	" "	CS
L.S Isaaks	" "	ISaaks
R.P Afrikaner	" "	
K.S Marwin	" "	KSMarwin
B.C Namaseb	" "	Namaseb
R Davids	" "	RDavids
C.S Connie	24/01/2011	Connie
D.A Garoes	" "	Garb
M.T Eseb	" "	Eseb
K.C Nawses	" "	KCnawseb
C Houses	" "	Hou Sey
G.S Garaseb	" "	

25/01/2011

Appendix F: GIS Research Data Ethics Statement

This letter serves as supporting letter for GIS data to be used in the study I am conducting as part of the PhD Degree programme in the Department of Geography at the University of South Africa (UNISA).

In Namibia, the GIS (Geo) data are freely available, and it's no exception for study purpose. For this study, the GIS data have been freely accessed and will be used without any consent required. The GIS data are available on the following links:

- ◊ http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/main_namibia_atlas.html
- ◊ http://www.diva-gis.org/gData
- ◊ http://www.mapcruzin.com/free-namibia-maps.htm
- ◊ And other sites…

All the data are complete and cover the study area. The data also meets the accuracy standard for this study. The data can be used for study purpose, research and model demonstration, the data may not be given to the third party in the same/current state. All the data to be used and used for this research intent to produce information, and will not be sold or distributed to third party in its same or current state in anyway.

I trust this meets your ethical application approval requirements.

Yours faithfully
Lisho Christoh Mundia