LAND DEGRADATION IN DRYLANDS: RESETTLEMENT AND BOREHOLE PROVISION IN GAM, NAMIBIA

DISSERTATION

By

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ABSTRACT

Land degradation has been recognised as a major economic, social and environmental problem, with more severity in arid and semi-arid regions of Africa. Throughout the dryland regions of Africa natural resources are deteriorating at an accelerating pace. This ecological degradation is caused by overexploitation of resources, and severely undermines Africa's economic future which is largely dependent on agriculture. Amongst the main factors contributing to land degradation in drylands are human actions that ignore the resilience limits of drylands. The ecology of drylands requires land uses that allow flexibility and mobility rather than imposing stability.

During the last century, technology and cultural changes have altered the pattern of exploitation of arid and semi-arid areas. Most often the changes are driven by economic needs or national governments policies. Governments tend to make decisions, even if well intended, without prior assessments of the environmental suitability of the intended sites. In most dryland regions the tendency has been towards development of permanent settlements in under-utilised areas leading to increases in population densities beyond the areas' ecological capacity. The result has been overutilisation of natural resources particularly around available water points. This has in turn led to accelerated ecological and cultural decline, and has enhanced the process of land degradation.

This dissertation provides a theoretical framework of ecological characteristics and the socio-economic adaptations of dryland environments. The factors contributing to land degradation in arid and semi-arid lands are examined. Examples are drawn from a resettlement programme and the subsequent provision of boreholes in a semi-arid area in Gam, Namibia. The dissertation specifically seeks to examine the Government of Namibia's political decision on a resettlement programme in Gam and evaluate the impacts of resettlement on ecological and socio-economic variables in Gam.

The methodology employed included: a comprehensive literature review; semi-structured interviews with key stakeholders and informants in Windhoek and in Gam. Literature review and interviews were supplemented by observations of the physical environment in

the study area where qualitative estimation of change was ascertained by communities through informal interviews.

The Gam resettlement programme was a Government of Namibia's political decision to resettle people in the ostensibly uninhabited area in Gam. However, the decision for selecting Gam did not take into consideration the environmental constraints of the area. As a result the resettlement has led to a sudden population increase of people and livestock exceeding the carrying capacity of the area. The increase in livestock population has led to a sudden change of land use from seasonal, extensive grazing to permanent, intensive with negative impacts on the environment. Generally, the provision of water has tempted the people to change their former transhumant mobility to sedentary, non-rotational farming. Thus, the resilience of the Gam are through the mechanism of human and animal migrations has been impaired.

Based on the evaluation of land degradation radiating from the boreholes in the Gam resettlement area, the dissertation has demonstrated that inappropriate land use frequently emanating from development or policy objectives is the basic cause of land degradation in arid and semi-arid environments.

Following this conclusion the dissertation recommends that, in order to achieve sustainable productivity in drylands, national governments must acknowledge the biophysical constraints and the socio-economic adaptations of dryland environments in their policies and plans. Programmes for environmental management must become integral parts of policies and overall development strategies. Moreover development programmes and policies should enhance the livelihood security of local communities, *inter alia* through recognition of their customary rights over natural resources and the capability of rural communities in resource management.

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LIST OF ABBREVIATIONS

CDCS	Centre for Development Co-operation Services
EEAN	Environmental Evaluation Associates of Namibia
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
ICRAF	International Centre for Research in Agroforestry
LSU	Large Stock Unit
MET	Ministry of Environment and Tourism
MLRR	Ministry of Lands, Resettlement and Rehabilitation
NAPCOD	Namibian Programme to Combat Desertification
NDP 1	First National Development Plan
PACD	Plan of Action to Combat Desertification
PRA	Participatory Rural Appraisal
SARDEP	Sustainable Animal and Range Development Programme
UNCOD	United Nations Conference on Desertification
UNEP	United Nations Environment Programme
WASP	Water And Sanitation Policy

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CHAPTER ONE

1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Land degradation is a term most commonly used to describe the central process in environmental degradation which is prevalent throughout arid and semi-arid regions (Centre for Development Co-operation Services (CDCS), 1992). Most oftenly land degradation has been used interchangeably with *'desertification'*, a term which generally defines an advanced stage of land degradation or "irreversible degradation in drylands" (Barrow, 1991, p.145). Land degradation refers to degradation resulting from a multitude of factors related to human activities and associated demands on the environment, rather than factors related to the climate. 'Desertification' on the other hand embraces both.

The United Nations Environment Programme (UNEP) (1994) has recognised land degradation as a major economic, social, and environmental problem, with more severity in arid and semi-arid regions of Africa. Following the United Nations Conference on Environment and Development held in Rio in 1992, a Plan of Action to Combat Desertification (PACD) was adopted by the United Nations with the goal of preventing and arresting land degradation (Swift, 1996 citing UNCOD, 1977a p.7).

Subsequent to PACD, a Convention to Combat Desertification was prepared by UNEP in 1994 with the aim on improving the livelihoods of drylands inhabitants (Swift, 1996). Land degradation, particularly in Africa, was classified as a process caused by complex interactions among physical, biological, political, social, cultural and economic factors (UNEP, 1994).

During the last century, technological and cultural changes have altered the pattern of exploitation of arid and semi-arid areas (Ludwig, 1985). Most often the changes are driven by economic needs or national governments policies. Strong central governments tend to make decisions, even if well intended, without prior assessments of the situation on the ground or consultations with local communities.

In most dryland regions, the tendency has been towards development of permanent settlements leading to great increases in population densities. The result has been overutilisation of natural resources particularly around available water points (Ludwig, 1985). Exploitation of natural resources has resulted in accelerated ecological and cultural decline and degeneration, and has enhanced the process of land degradation (Naveh, 1992).

In Namibia, colonial government policies in the past drove people and large number of livestock into 'homelands' with low productivity (Seely *et al.*, 1994). This disrupted indigenous strategies and coping mechanisms for surviving in a dryland environment. Overpopulation in these marginal areas resulted in environmental degradation with negative impacts on the livelihoods of poor people in the 'homelands' (Werner, 1994). Similarly, the present massive resettlement operations of repatriated and landless people, and the subsequent provision of boreholes in dry areas might not always ensure viability of such settlements (Seely *et al.*, 1994). In 1994, for instance, the Government of the Republic of Namibia decided to resettle the Herero community that had been living in Botswana since 1905 in the Gam area (MPhil. Baseline Report, 1997). In order to resettle these people in Gam, it became necessary to install a water supply in the area. Thus, boreholes had to be supplied as an emergency water supply (MPhil. Baseline Report, 1997). Notwithstanding that boreholes were provided to enable the resettlement of the Herero returnees in Gam, it seems that little or no environmental assessment was undertaken in the planning and provision of boreholes (MPhil. Baseline Report, 1997).

Due to the concern that no environmental assessment was carried out, the Namibian Programme to Combat Desertification (NAPCOD), commissioned a retrospective assessment of the environmental impacts of emergency borehole supply in 1996. This included boreholes which were drilled and installed as emergency boreholes in the drought of 1992/93 as well as those supplied as part of the on-going rural water supply development programme. The study was commissioned through the Ministry of Environment and Tourism in Namibia (MET).

The overall aim of the research was to establish a scientific basis from which the planning process for future emergency boreholes and other boreholes may get informed (MPhil. Baseline Report, 1997).

The study was undertaken by a team of eight students enrolled for the Environmental Science Masters Course in the Department of Environmental and Geographical Science at the University of Cape Town, South Africa. During the investigation, individual students focused on different aspects of the borehole provision in Namibia. Information was collected at national, regional and community levels. Finally, a Baseline Report was compiled for the client, and this formed the basis of this dissertation.

During the preparation of the report, it emerged that imposing new land uses in dryland regions such as Gam could lead to unsustainable utilisation of resources with ultimate degradation of the land.

1.2 PROBLEM STATEMENT

The wide-spread environmental degradation in Africa is fundamentally socio-economic and political in nature (Darkoh, 1993). However, political and social conditions in most African countries have not been conducive to open debate about environmental problems, nor the establishment of efficient public bodies to deal with the issues (Darkoh, 1993).

Lack of knowledge, resources and administrative capacity have all contributed to hinder the emergence of appropriate and effective administration and co-ordination of environmental matters (Darkoh, 1993). As a result, national economic policies do not take cognisance of the total environment and indirectly encourage short term overuse of resources leading to land degradation (Seely *et al.*, 1994). Moreover, the impact that people can have on the ecosystem is most likely to be governed more by the constraints of laws and government policies than anything else (Seely *et al.*, 1994).

The failure to combine political decisions with ecological and socio-economic variables means that governments do not acknowledge environmental constraints to political decisions (Winpenny, 1991). It is rare for land degradation to receive attention as an integral feature of government policies. Land degradation is normally 'compartimented off' as a desertification problem or the arid lands issue (Winpenny 1991).

It is now well recognised that destructive and irreversible changes are not only caused by intensified pressure of exploding human populations on their scarce resources, but also by careless resource exploitation and by ill-fated development and settlement schemes (Naveh, 1992). Resettlement programmes risk causing land degradation because their component projects appear to be poorly designed and managed and do not respect the constraints of the physical environment (Naveh, 1992).

The Gam resettlement programme represents a government resettlement scheme established in a semi-arid environment which was previously used seasonally by pastoralists in Namibia. This dissertation evaluates the impact of the provision of boreholes in the Gam resettlement area. Emphasis will be on environmental impacts as a result of land use changes.

1.3 AIMS AND OBJECTIVES OF THE DISSERTATION

The dissertation aims to examine the Namibia's government decision on a resettlement programme in Gam and evaluate the impacts of resettlement on ecological and socio-economic variables in Gam. Specific objectives include, to:

- give a conceptual framework of dryland environments
- define land degradation and give a description of different forms of degradation in drylands
- describe the biophysical environment and major land uses in Gam
- evaluate potential human impacts on the natural and socio-economic environment of the area
- recommend how planning can be undertaken in future taking cognisance of the total environment.

1.4 DESCRIPTION OF THE STUDY AREA

This section gives a brief description of the geographical location of Gam and its climatic characteristics. The section also points out the important features of the area which contributes to the rationale of choosing Gam as a study area.

1.4.1 GEOGRAPHICAL LOCATION

Gam is located in the Otjozondjupa region in north eastern Namibia on the western edge of Kalahari Basin. Otjozondjupa is one of the 13 regions of Namibia which were established by the Delimitation Commission in 1992 (Figure 1.1) (MPhil. Baseline Report, 1997). Gam as well as Bushmanland became part of the region thereafter. Initially, Gam was a district in the former Hereroland East, which comprised of eastern Otjozondjupa (Figure 1.2) with the communal lands of western, central and eastern Bushmanland (Botelle and Rohde, 1995).

The Gam resettlement area includes the south-eastern corner of the Otjozondjupa region, and the north-eastern corner of the Omaheke region. It borders the Okamatapati area to the west, the veterinary control fence to the south (Eiseb) the international boundary with Botswana to the east and the 20° latitude to the north (Figure 1.3) (MLRR, 1993).

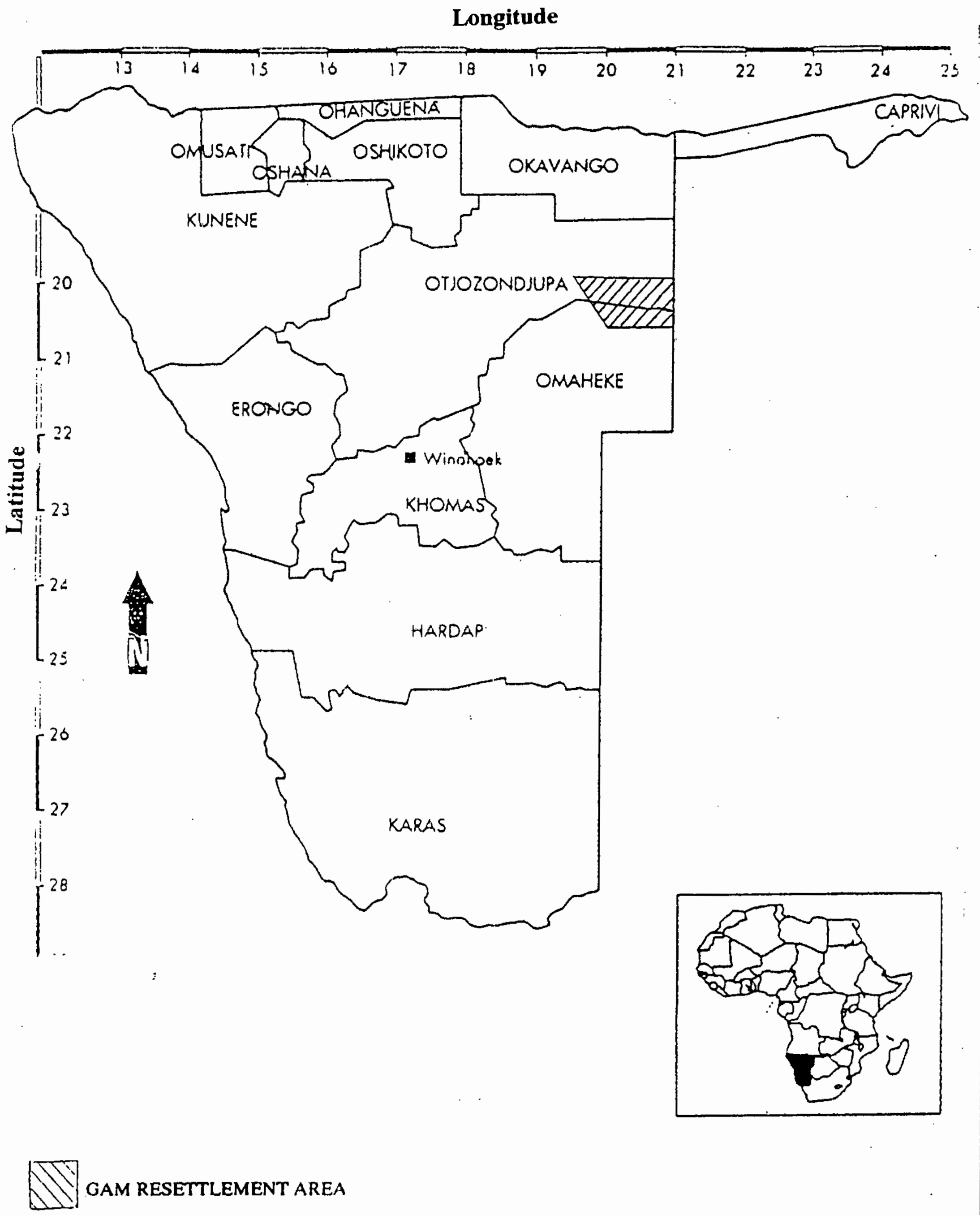

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Figure 1.1: Location of Otjozondjupa Region in Namibia

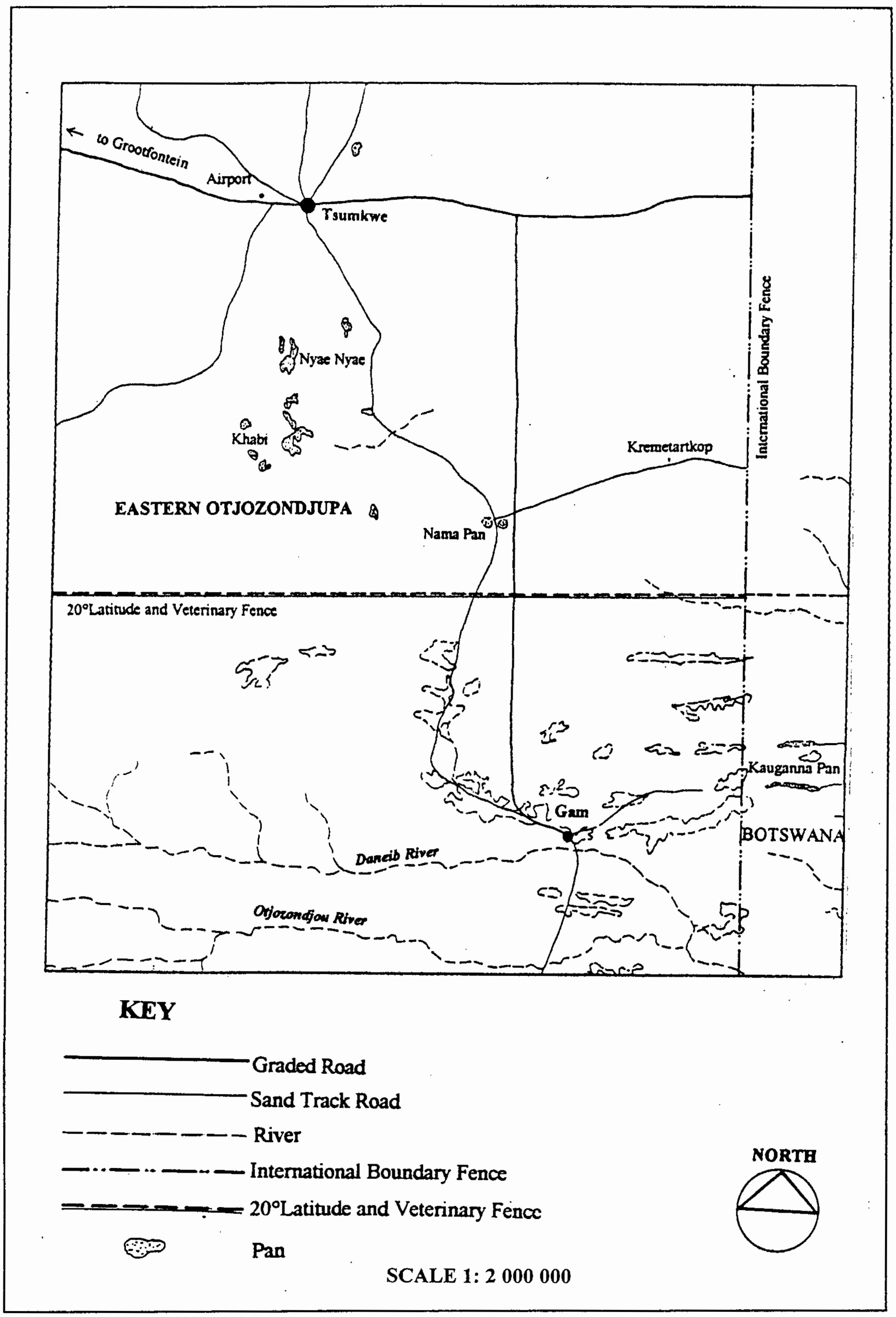

Figure 1.2: Location of the Former Gam District in Eastern Otjozondjupa

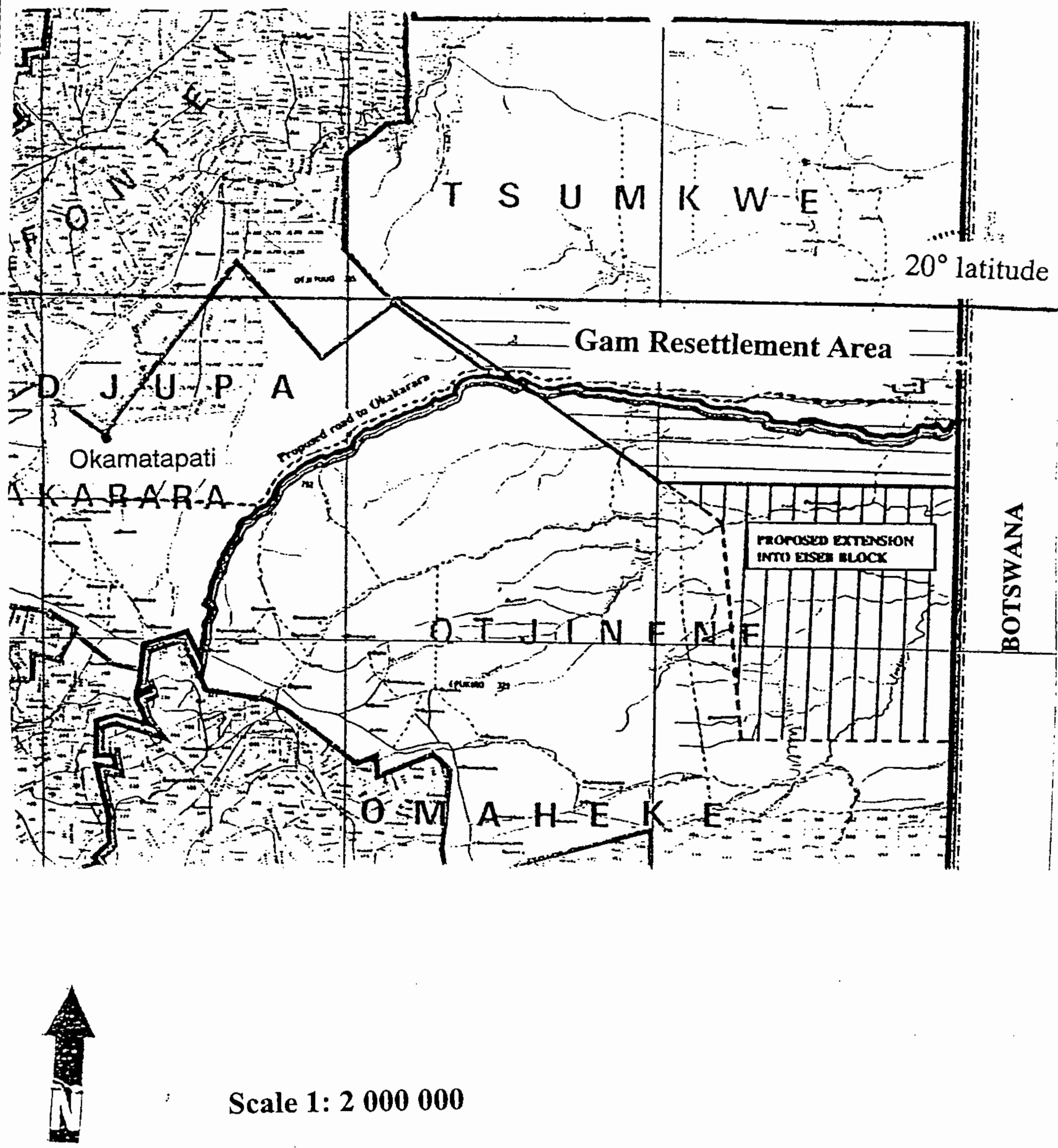

Figure 1.3: Location of the Gam Resettlement Area in Otjozondjupa Region

1.4.2 CLIMATE

Climatic conditions in Eastern Otjozondjupa are typical of a large part of southern Africa. The climate of the area is semi-arid and is characterised by low annual precipitation, periodic droughts of varying severity and high rates of evaporation (Botelle and Rohde, 1995).

- **Rainfall**

Gam area lies within a zone in which the average rainfall ranges between 450 and 500 millimetres annually (Figure 1.4) (Botelle and Rohde, 1995). Ganzi, the nearest town where climatic data are recorded, has a twenty eight year mean annual rainfall of approximately 435 mm (Environmental Information Services and EEAN, 1994). The average number of rainy days in a wet season is 42 (Botelle and Rohde, 1995). Although annual rainfall tends to be highly variable both in time and space and usually occurs as a discrete seasonal event, most rain falls between November and April. In terms of variability, the average deviation, expressed as a percentage of the annual average, is 25 %.

Rainfall is the factor limiting the rate of plant growth in semi-arid systems like Gam. Thus, the seasonality, spatial and temporal variability in rainfall has important implications for management and utilisation of crops and natural vegetation (Botelle and Rohde, 1995).

- **Temperature**

The region has temperatures that are typical of an inland semi-desert region, with hot days and cool nights (Malan, 1995). Mean monthly air temperatures vary between a minimum of 4°C for winter nights to 32°C for summer nights. On average, the maximum day temperature exceed 30°C for 150 days a year, while frost occurs an average of 10 nights a year in the lower-lying areas such as the dry river beds (Environmental Information Services and EEAN, 1994).

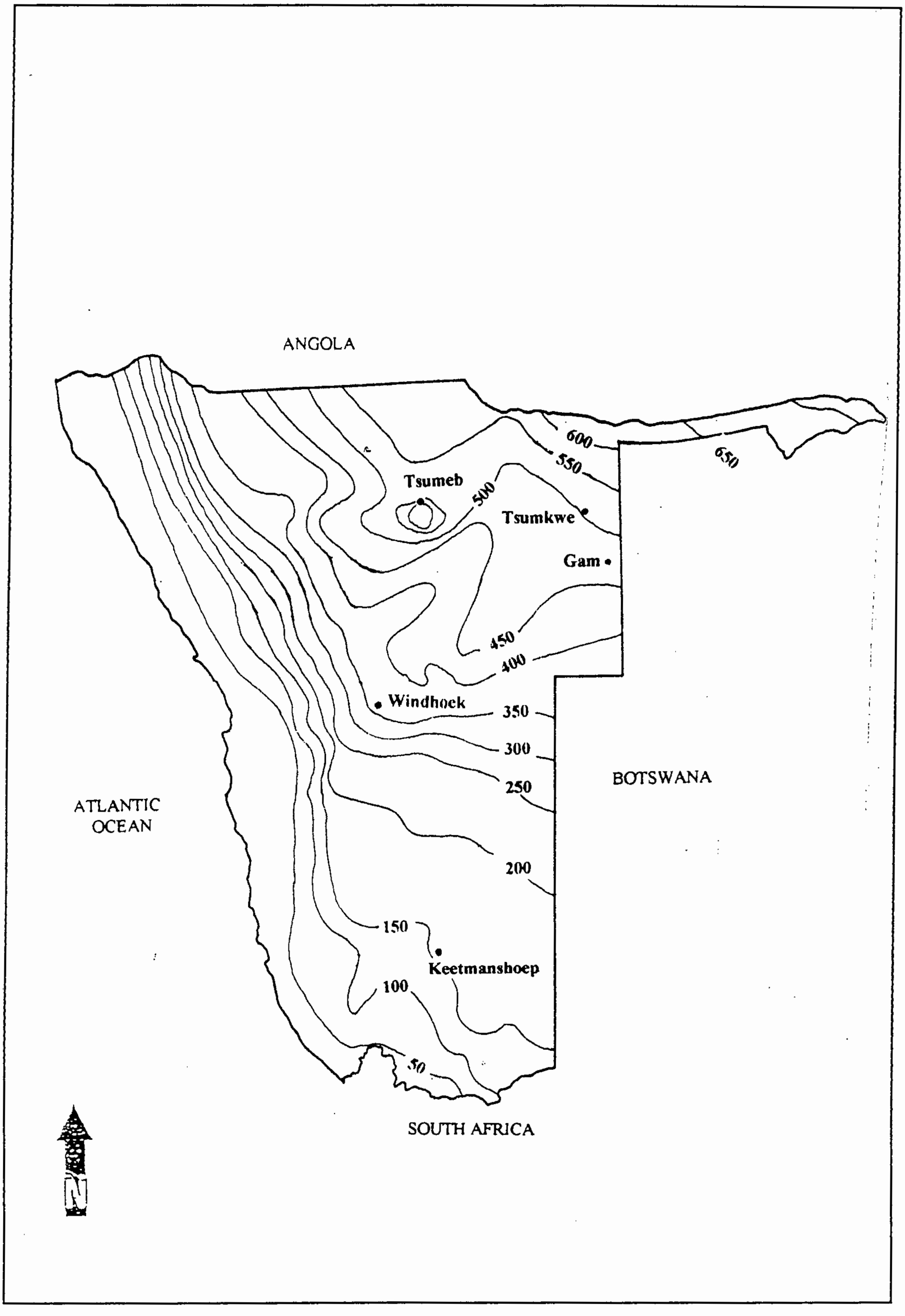

Figure 1.4: Mean Rainfall Map of Namibia (MPhil. Baseline Report, 1997)

- **Evaporation**

There are no direct recordings of potential evaporation in the area, but it is estimated from a correlation with humidity, as 2750 mm per annum. In the months of heaviest rainfall (January to March), potential evaporation is three times the rainfall (Environmental Information Services and EEAN, 1994).

The geographical location and climatic characteristics of Gam represent conditions typical of a dryland region. With most of the precipitation lost through higher evaporation rates, an area such as Gam is classified as a marginal land, where productivity is low and highly sporadic in response to rain (Darkoh, 1985). Due to the handicaps imposed by low and unreliable rainfall, most of the area is not suitable for arable farming, but for animal husbandry.

Based on these climatic characteristics, Gam can be classified as a dry region. This implies that successful land use strategies in a dry area such as Gam ought to be adapted to the above mentioned biotic conditions. Introduction of new land uses in such an area could lead to ecological unbalances and degradation of resources.

1.5 METHODOLOGY OF THE STUDY

The methodology employed in gathering data for this dissertation involved two stages. Firstly, all the eight students in the study team collected initial information for compiling a Baseline Report for the client. Secondly, the author collected additional information specifically for this dissertation.

1.5.1 APPROACH TO THE BASELINE REPORT

The group approach used to gather information for the Baseline Report involved different methods found appropriate for particular situations. Every member of the group was involved in all the methodologies, though, at some stage individuals had to focus on particular issues.

This was one of the strategies used in order to cover the wide range of issues involved and also to make effective use of the short period assigned for the study. The methodologies employed include:

- **Literature Review**

A comprehensive review of relevant literature was undertaken by the group and this provided an insight into the nature of the study. The review of literature was done from publications and reports obtained from relevant ministries in Namibia.

- **Interviews**

Semi-structured interviews were conducted with key stakeholders and informants in Windhoek and in Gam region. The stakeholders included line ministries which are involved in the Resettlement Programme in one way or another, researchers, and the resettled communities. As indicated in the MPhil. Baseline Report (1997), all interviews were carried out between November, 1996 and March, 1997.

- **Field Work**

The literature review and interviews were supplemented by physical observations in the field. Informal interviews were done with the communities at the study sites. Translators were used whenever the community members and the study group failed to communicate effectively.

Observation of the physical environment and estimation of change was done with the help of the community through informal interviews. The primary components which were observed included:

Soils

Soil characteristics were described through field observation and discussion with people in the study area. Qualitative analysis of soils was carried out within 600 metres radius of each borehole site as well as around the households. The analysis involved examination of changes in soil texture and compaction with distance from the borehole.

Description of soil texture was done in the field based on a simple set of tests for determining the class of soil texture (MPhil Baseline Report, 1997) (a detailed explanation of the components employed in the description of soils is given in Appendix 1). In addition, a comparison was done of soil components from each borehole site to soils in the surrounding veld or land in terms of their potential to support vegetative growth (MPhil. Baseline Report, 1997). A summary of the soil components description based on the findings from the study area is presented in Table 1.1.

Vegetation and Land Use

Qualitative vegetation description for the sites were based on field observation and informal interviews with people living at the study areas. Vegetation was described in the area within a distance of about 600 metres radius from the borehole (MPhil. Baseline Report, 1997). The type and state of vegetation cover, including whether perennial or annual grass, whether is was bush or grass dominating; and a qualitative assessment of bushes for browse pressure was noted around the homesteads and boreholes.

Informal transect walks with farmers were also done up to 600 metres from the borehole to ascertain vegetation condition using the distance from the borehole as a direct gradient for analysis. Discussions were also held during the transect walks on grazing management and the quality and quantity of grazing. The findings of vegetation characteristics are presented in Table 1.2.

Infrastructure

Observations were made as regards borehole infrastructure such as pumps installation, reservoirs, animal watering troughs and taps. A distinction between watering points for animals and where people drew water for domestic use was also made.

Water Quality

To assist assessment of health impacts of boreholes, water samples were collected from the borehole visited and analysed for total dissolved solids, and coliform and *E.coli* counts.

1.5.2 APPROACH TO THE DISSERTATION

This dissertation has based on field information that was compiled for the Baseline Report. The assessment of the environmental impacts of boreholes in the Gam resettlement area involved visiting three of the seven boreholes which had been successfully installed (MPhil. Baseline Report, 1997). The three sites included: Otjimihama (borehole no. WW 34463); Otjiserandu (borehole no. WW 34846); and 'borehole number 5' (borehole no. WW 34451). The location of the three boreholes is shown on Figure 5.1.

However, despite using the Baseline Data, further analysis was done by the author using the following approach:

- additional literature review
- theoretical framework of dryland environments and land degradation
- a review of the biophysical environment and land use in Gam prior to the resettlement programme; and
- evaluation of human impacts and changes in land use due to the resettlement programme.

1.6 ASSUMPTIONS AND LIMITATIONS

ASSUMPTIONS

- It is assumed, on the grounds of its geographical, climatic and ecological characteristics, that Gam is an appropriate representation of dryland regions in sub-tropical and tropical Africa.
- The dissertation will be relevant to most arid and semi-arid regions in Africa.
- Information gathered from the field work, which also form the Baseline Report, gives a true picture of the study area.

LIMITATIONS

- A period of three months allocated for writing the dissertation, and the geographical distance to the study area were the main constraints that have contributed to lack of an in-depth analysis of information and also limited further follow ups.
- Data collection from the field was done by different people amongst the group depending on the circumstances at the visited sites, this might have affected consistence in the information gathered.
- Time spent on field work, the nature of the study and accessibility to the sites in a wet period contributed to the small sample area covered and to a lack of sufficient data.

1.7 STRUCTURE OF THE DISSERTATION

The dissertation is structured in the form of six chapters. Chapter one is an introductory chapter. It presents background information to the study; problem statement; aims and objectives of the dissertation; description of the study area (which also forms the basis for the rationale for choosing the study area); methodology or approaches to the Baseline Report and to the dissertation; and assumptions and limitations.

Chapter two narrates a theoretical framework of 'drylands'. The chapter concentrates on theories that provide a basis for arguments on issues relevant to the Gam resettlement area. Included in this chapter are: a definition of drylands; ecological characteristics of dryland environments as well as ecosystem stability and resilience; land use and socio-economic adaptations in drylands; and, implications of changing land use in a dryland environment.

Chapter three provides an overview of the process of land degradation. It examines the definition of land degradation as it has been defined by various authors. Perceptions of land degradation are also highlighted.

Causes of land degradation are discussed with more emphasis on the human causes of land degradation, both intentional and unintentional. Forms or mechanisms of land degradation are also examined in this chapter.

In chapter four the biophysical environment and land use of the Gam resettlement area are defined. The chapter describes the biophysical components of Gam which are later evaluated subsequent to the resettlement programme in the next chapter. These components include: soils; groundwater; vegetation; and, wildlife. The history of land use in the area is also discussed in this chapter.

Chapter five deals with the evaluation of human impacts in the Gam resettlement area. Human impacts on the environment are discussed on the basis of degradation indicators identified during the field study. These indicators include conditions of the biophysical components: soil degradation; groundwater or borehole yield; vegetation degradation. The impacts of the resettlement on the socio-economic aspects are evaluated by addressing the grazing patterns and rangeland management. Included in this chapter is a section giving an account on the characteristics and causes of land degradation in Gam. It highlights on the political and socio-economic factors in Namibia contributing to land degradation in the resettlement area.

Chapter six outlines the conclusions and recommendations arising from this dissertation.

CHAPTER TWO

2. DRYLANDS: A THEORETICAL FRAMEWORK

2.1 INTRODUCTION

'Drylands' is a term used to define those environments characterised by permanent, seasonal or periodic significant moisture deficiency (Barrow, 1991). All arid and semi-arid lands found in both the southern and northern hemispheres fall into this category (Manshard and Ruddle, 1981). However, in the context of this study, only arid and semi-arid regions within the tropics and sub-tropics of Africa will be discussed.

Ecologically, drylands have the highest potential for deterioration under human activities such as agricultural, silvicultural, and pastoral land use systems. According to Manshard and Ruddle (1981), the term fragile is normally used to designate such areas which, once disturbed by human activities, have a low resilience.

This chapter provides a theoretical framework for drylands. It reviews the ecological characteristics, indigenous land use and socio-economic adaptations in arid and semi-arid environments. The chapter also highlights the biophysical and socio-economic implication of changing or introducing new land uses in an arid or semi-arid environment.

2.2 ECOLOGICAL CHARACTERISTICS OF DRYLAND ENVIRONMENTS

Drylands are characterised by climatic variability through both time and space. Rainfall levels are low and erratic. Most of the precipitation, which usually occurs in short duration storms, is lost through high evaporation and transpiration rates (Darkoh, 1985). With evaporation rates higher than precipitation, aridity, as distinct from drought is a permanent feature of climate (Drought Task Force, 1996).

The basic ecological characteristic of drylands is that primary productivity[1] is limited by the scarcity or absence of water (Ludwig, 1985). Although other factors such as soil conditions can limit plant growth in some areas, generally plants will flourish in arid and semi-arid environments if water is made available (Manshard and Ruddle, 1987). Perennial plant distribution is therefore, controlled by soil moisture. Ludwig (1985) argues that plant production in drylands maintains a balance with the long-term average of available water. Apart from vegetation, water availability in particular regulates the way people and their livestock, as well as wildlife, live, move and settle in an arid country (Jacobson *et al,* 1995).

Environmental problems experienced in arid and semi-arid lands today are essentially ecological in nature (Darkoh, 1993). When subjected to inappropriate use, these fragile environments undergo severe ecological disruption and degradation (Manshard and Ruddle, 1981). For example, all the rangelands of arid and semi-arid zones have deteriorated to an alarming degree owing to prolonged and intensive overuse (Manshard and Ruddle, 1981).

2.2.1 ECOSYSTEM STABILITY AND RESILIENCE

From an ecological point of view, sustainability of an ecological system is judged on the basis of its ability to maintain its stable or equilibrium state or by its resilience[2] after disturbance (Tisdell, 1991). When an area is disturbed, two conditions must be met if it is to return to its non-degraded state; that is, to the stability and resilience characteristics that the area formerly possessed. Firstly, the disturbance must be temporary. Secondly, it must be of a low magnitude and duration so that the changes resulting from the disturbance have not set in motion changes that alter the fundamental environmental conditions of the area (Leakey, 1996). If these two conditions are not met, the resulting land degradation type is considered to be non-reversible and long term.

[1] Primary productivity is defined as the rate of organic matter (biomass) accumulation (Ludwig, 1985).
[2] Resilience is the capacity of a system to absorb change without significantly altering the relationship, relative importance, numbers of individuals and species of which the community is composed

If the catalyst causing land degradation is temporary and of low enough intensity such that crucial thresholds have not been reached, once the stimulus has been removed the area will revert back to its previous non-degraded state (Wyrant, 1996). Under these conditions, land degradation would be classified as both short-term and reversible. If the catalyst results in system changes that are too extreme for the area to absorb, a new balance will emerge in the form of a totally different productivity level for the area (Leakey, 1996). When productivity is lower, the system has degraded.

Sullivan (1996), argues however, that the productivity of a dryland ecosystem is better described by its variability through time and space, than by its average values. Thus the production potential of both grassland and livestock in arid lands is dominated by rainfall. This is in contrast to the fundamental equilibrium dynamics of conventional ecology; where ecosystems are viewed as isolated and closed biotic systems, the components of which gradually 'equilibrate' to stable, external conditions (Sullivan, 1996). The predetermined end-point, or 'climax' of this irreversible evolution towards equilibrium is a perfectly balanced biotic community which is stable through time unless disturbed. The sources of such disturbance are always perceived as external to the (closed) biotic system.

Sullivan (1996), argues further that the extension of assumption of ecosystem equilibrium derived from the framework of the equilibrium dynamics (conceived in the context of northern temperate zones) is extremely problematic for arid systems. Accordingly, Scoones (1995a) regards arid and semi-arid zones where rainfall is highly variable as 'non-equilibrium' systems.

This again contradicts with theories of equilibrium systems as regards vegetation changes and livestock population. In equilibrium systems vegetation changes are perceived to be gradual and livestock populations are limited by available forage in a density dependent manner in the sense that excessive animal numbers cause negative effects (Scoones, 1995a). Therefore in equilibrium systems, stock numbers (carrying capacity) can be determined and maintained from year to year.

In arid and semi-arid areas however, where primary productivity is largely determined by extremely variable stochastic rainfall events, there is little opportunity for the population to reach a ceiling of ecological carrying capacity (Scoones, 1995b).

These non-equilibrium systems have important implications for farming and rangeland management. Farming practices are required that place emphasis on flexible responses to uncertain events, and on mobility to allow the optimal use of a heterogeneous environment (Scoones, 1995a). Therefore, management systems have to cope with large quantitative fluctuations in resource availability. Sullivan (1996) argues that although patchy degradation in arid and semi-arid environments does exist; much of what is described as degradation in drylands may be part of the normal range of variations displayed by these fragile systems.

However, the question of fragility versus stability[3] in drylands should not be separated from the degree and quality of human impact, not only because humans are part of the ecosystem, but also because virtually no ecosystem still exists that has not been influenced by human activity to a greater or lesser extent (Tisdell, 1991). Ibrahim (1987) argues that in most of the arid and semi-arid areas, resilience through the mechanisms of human and animal migration has been extremely impaired during the last 100 years due to changes of land use systems and processes of urbanisation.

2.3 LAND USE AND SOCIO-ECONOMIC ADAPTATIONS IN DRYLANDS

Traditional pastoral nomadism represents a rational and sophisticated adaptation to the fragile ecosystem of the arid and semi-arid zones. Yet this adaptation conflicts with the nature and objectives of modern states and bureaucrats. Pastoral values and attachment to their livestock are oftenly considered (based on colonial and anthropological theory) with some mystical significance used to explain the "obviously non-economic" behaviour of the pastoralists (Beck, 1980).

[3] Stability is the ability of a system is to return to its previous equilibrium state after a temporary disturbance.

Manshard and Ruddle (1981 citing Widstrand, 1975) argue that such views about pastoralists remain prevalent among politicians and administrators of national governments today.

2.3.1 LAND USE

Sustained human use of drylands has been closely adapted to the low and erratic precipitation through the traditional responses of pastoral nomadism or rain-fed cultivation in the moister areas (Manshard and Ruddle, 1981). Livestock is moved in accordance with the unpredictable nature of rainfall and ecology, as well as the unpredictable nature of water points (Scoones, 1995a). Johnson and Lewis (1995) state that the knowledge of local limits and how to prevent overuse is an integral part of resource use in many dryland pastoral systems. For instance, when grazing is finished around a certain water point; animals are moved to another water point. Thus, lack of grazing makes water unusable, and sets in motion the process of stress and movement that operate to conserve the basic land resource (Johnson and Lewis, 1995).

Rohde (1994) states that survival strategies used by people living in communal areas in arid and semi-arid environments are complex. "Flexibility, resilience, mobility, adaptation and mutual accommodation ..." describe the means "... with which communal farmers are able to overcome some of the major hazards which affect farming in a productively marginal environment in an unpredictable climate" (Rohde, 1994, p.1).

2.3.2 LOCAL ECONOMIES AND GRAZING LAND MANAGEMENT

Pastoral nomadism is one of the rational forms of adaptation to the ecologically fragile arid and semi-arid environment. In essence an arid or semi-arid environment experiences rainfall that is seasonal and sporadic in both time and space; a dry season of varying length and severity; and intense evaporation. In addition, water resources as well as availability of grazing are both uncertain and intermittent (Beck, 1980). Pastoralists inhabiting such zones have responded to uneven distribution of water and feed by migration.

Large areas of grazing can be used only during the short rainy season, when there is an abundance of temporary water pools on the soil surface, but for most of the year the herds must be taken to moister areas where water and pasture are readily available. Complicated variations in the temporal and areal distribution, as well as the quality and quantity of water and grazing resources, give rise to the complex variety of pastoral systems and nomadic movements (Scoones, 1995b).

Transhumance[4] is an integral part of nomadic adaptation, and represents a flexible adjustment to a varied environment. Moreover, careful analysis by pastoralists on how best to achieve their goals by manipulating locally available resource, results in selection of the best subsistence animals and the complementary species (Manshard and Ruddle, 1981). The animals herded have distinct requirements and the selection of several species enables the pastoral inhabitant of the marginal environments to exploit ecological niches that would otherwise remain under-utilised or even unused. In this way, the nomadic economy is ensured against natural hazards, an ever-present threat to the less drought resistant animals.

Risk is minimised by maintaining capital reserves in different animal commodities and in different geographical locations. Manshard and Ruddle (1981) consider camels and goats to be the domestic stock best adapted to arid and semi-arid ecosystems. Both consume a wide range of vegetation and utilise many plant species that are totally unacceptable to other livestock. Both animals prefer to browse; moreover, both can go for long periods without water.

Many of the socio-economic institutions of pastoral nomadic groups function as a complement to the cultural-ecological adaptations of migration and herd diversification in minimising risk of hardship in times of drought, rather than as mechanisms to maximise possible economic return.

[4] Transhumance refers to seasonal movement of livestock between specific areas driven by fodder and water needs

Risk minimisation has also been cited as the overriding concern for most farmers in the communal areas where reciprocity and risk spreading strategy is reflected in the way people live (Rohde, 1994). Risk spreading as a survival strategy takes place through extended family and exchange relations. According to Rohde (1994), these survival strategies have led to the evolution and operation of different security or support systems, such as sharing of resources as well as food in times of hardships.

2.4 IMPLICATION OF CHANGING LAND USE IN A DRYLAND ENVIRONMENT

For any land system there are trade-offs in the use of the system. The ecology of drylands requires land uses that allow flexibility and mobility rather than imposing stability (Sullivan, 1996). Actions that ignore the resilience limits of the area, and that discount the differing impacts that variable technologies can have on the system, are likely to initiate serious and long term degradation (Ibrahim, 1987).

Ibrahim (1987) argues further that, despite the well-developed resiliency of the vegetation of the arid and semi-arid areas, one should not conclude that the original density and composition of the degraded vegetation cover is fully retrievable. By maladaptive methods of land use, humans have so changed the original ecological balance that the natural ability for regeneration has been drastically weakened. Moreover, through overcultivation, overgrazing, excessive tree felling and fires, a change in the density of the original, natural vegetation has taken place.

In many nations in arid and semi-arid environments, legislative and administrative measures have been enacted against the nomadic use of land by restricting, hindering and controlling the movement of people and livestock (Beck, 1980). For example, the government of Syria has explicitly stated its aim to do away with nomadism and its attendant social organisation; other governments such as Saudi Arabia and Jordan, are encouraging settlement of pastoral nomad and are facilitating the encroachment of sedentary agriculture on the lands traditionally devoted to pastoral nomadism (Manshard and Ruddle, 1981).

These policies, which encourage the concentration of livestock and people, include drilling of boreholes in an area without permanent water, and the encouragement of permanent settlements to previously mobile populations (Sullivan, 1996).

Although some schemes to sedenterize and modernise nomadic economies or to provide economic alternatives to pastoral nomadism have been successful, in large part most of the development schemes have been poorly conceived and poorly implemented, leading to concentrations of livestock and human populations which exert pressure on land resources (Naveh, 1992).

Programmes are represented as neat isolated packages. For instance, "water development schemes" or "vaccination projects" are, in the absence of integral and complementary programmes, attractive only to central planners. Ground water has been developed to provision the livestock of pastoral nomads. Hitherto, migratory movements of the nomad were geared to the availability of water and forage. When a secure supply of water is assured, nomads often increase herd sizes beyond carrying capacity or even settle permanently near a particular watering site. The limiting factor then becomes forage, and severe over-grazing is the common result.

Manshard and Ruddle (1981) cite conflicts over land rights and the carrying capacity as being among the first category of problems. Most of the settlement schemes result in conflicts over land right issues between previous land users and the new settlers resulting in unsustainable land uses. In addition, the low carrying capacity of seasonally used areas fail to support big numbers of proposed livestock on a permanent basis.

The second category of problems include changes that occurs as responses of the aquifer to pumping out of water from underground, regressing water tables and changes in the quality of aquifers and vegetation changes (Manshard and Ruddle, 1981).

When such ambiguous incentives fail, governments resort to drastic de-stocking systems, further alienating the pastoralists (Beck, 1980). De-stocking programmes that have as an ultimate aim the reduction of herd sizes and composition, are commonly perceived as attempts to tamper with family relationships in pastoral societies where herd and family are often mutually defining concepts (Manshard and Ruddle, 1981).

2.5 CONCLUSION

Drylands are characterised by climatic variability through both time and space. In addition, these areas experience low productivity due to a scarcity or absence of water. Ecologically, arid and semi-arid environments have a low resilience, and when subjected to inappropriate use, they undergo severe ecological disruption and degradation.

Drylands ecosystems have been defined as 'non-equilibrium' systems in which populations, or abiotic components are not in a long-term balance with other elements of the system; thus they are unpredictable and sometimes undergo complex dynamic behaviour. These 'non-equilibrium' systems have important implications for land use and resource management in drylands. Pastoral nomadism has been pointed out in this chapter as one of the rational forms of adaptation to the ecologically fragile dryland environment where water resources and availability of grazing are both uncertain and intermittent. Thus, availability of water and grazing control the mobility of pastoralists and their animals.

However, a thorough understanding of the physical, biological and human problems of the arid and semi-arid lands is lacking. This deficiency commonly results in the pastoralist's view of his animals and their environment conflicting severely with the scientist's and administrator's perspective on the relationship between animals and their environment; an incompatibility of viewpoints that has dire consequences for the management of grazing in drylands.

Attempts to change nomadic pastoral economies and land use have subsequently failed principally due to a lack of understanding of the ecological and pre existing social factors operating in arid and semi-arid environments. Most of the programmes aimed at pastoral nomads emphasise increasing the agricultural component of their economies and greatly reducing the focus on livestock, in order to sedenterise them in permanent settlements.

Supported by localised projects to develop ground water resources and improved veterinary services, this re-orientation of a nomadic society towards external inputs has in many instances led to an unregulated growth of livestock numbers and to a rapid severe deterioration of the environment. Degradation of the environment occurs due to changes imposed on the original ecological balance which weaken the natural ability of regeneration. Causes of land degradation in dryland and different mechanisms involved in the process are elaborated on in the next chapter.

CHAPTER THREE

3. LAND DEGRADATION: AN OVERVIEW

3.1 INTRODUCTION

The term 'land degradation' is a relatively new addition to the scientific vocabulary, as a result there is a lack of universal agreement on its precise definition given the many factors which may be responsible (Barrow, 1991; CDCS, 1992; Johnson and Lewis, 1995). However, there is a general agreement with respect to the usage of the term concerning two critical aspects of land degradation.

Firstly, there must be a substantial decrease in biological productivity of land systems that impair sustainability or the ability of the land to continue to produce indefinitely (Johnson and Lewis, 1995). Secondly, this decrease is the result of processes resulting from human activities rather than natural events (Barrow, 1991; Cardy, 1993; Johnson and Lewis 1995). Thus, the results of exogenic forces such as erosion and climatic change as well as natural catastrophic events such as earthquakes, volcanic eruptions, and flooding, unless exacerbated by human activities, lie outside the realm of land degradation, even though the areas can become less productive biologically due to these natural changes (Johnson and Lewis, 1995).

This section provides some of the definitions of land degradation as it has been defined by different authors. Perceptions that people have of land degradation as well as the causes are discussed. Forms or different mechanisms of land degradation will also be addressed.

3.2 DEFINITION OF LAND DEGRADATION

Land degradation has been defined by the United Nations Environmental Programme (UNEP) in the United Nations Convention to Combat Desertification, (1994, Article 1(f) p.7) as:

> *"the reduction or loss, in arid semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and /or water; (ii) deterioration of the physical, chemical and biological or economic properties of the soil; and (iii) long-term loss of natural vegetation."*

This definition distinguishes land degradation from a number of similar terms such as desertification[5] which are sometimes loosely interchanged (CDCS, 1992).

On the basis of how the term is currently being used, land degradation can therefore be defined as "the substantial decrease in either or both of an area's biological productivity or usefulness due to human interference" (Johnson and Lewis, 1995, p.2).

Because *biological productivity* is determined not only by the attributes of land resource but also water properties, land degradation incorporates those aspects of hydrologic domain that are significant in a given area (Johnson and Lewis, 1995).

Usefulness is also a crucial attribute of land degradation. The biomass productivity in an area could remain constant, yet land degradation might still occur. Overgrazing for instance, could affect soil fertility and result in a diminished ability of the land to support the growth of palatable plants species. When the vegetation cover re-establishes itself after grazing pressure is reduced, the quality of grazing would be lowered (Kambatuku, 1994). Though the grass cover (biomass) will be similar in density to the initial cover, the species that replace the original vegetation often are not palatable. As a result the carrying capacity of the area will be lowered, and only a small number of livestock can now survive on these lands (Behnke, *et al.*, 1993). Thus after this change the area is no longer as valuable to its inhabitants. This decrease in an area's biological productivity and usefulness may be either reversible in the short term or irreversible in the long term.

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[5] "Desertification" by UNEP definition, means land degradation in arid , semi-arid and dry sub-humid areas resulting from various factors, including climatic and human activities.

In tems of the above definition not all resources and environmental deterioration fall within the rubric of land degradation. For example, desertification, if it is the result of increasing aridity due to climatic change, it is not a manifestation of land degradation. However, if the increased desert like conditions are a result of over-utilisation of renewable resources and other human activities, then desertification of the area is an example of land degradation (Johnson and Lewis, 1995).

Notwithstanding that desertification is sometimes used to denote land degradation; basically the two terms define different stages of degradation. Desertification is generally viewed as an advanced stage of land degradation or "irreversible degradation in drylands" (Barrow, 1991, p.145). At the United Nations Conference on Desertification (UNCOD), desertification was defined as a "diminution or destruction of the biological potential of the land which can lead ultimately to desert-like conditions" (UNCOD, 1978). Manshard and Ruddle (1981) define desertification as a process whereby desert conditions are increased either in the intensity or extent as a consequence of reduced biological productivity resulting in a reduction of plant biomass and an area's capacity to support livestock and crops. The United Nations Environmental Programme defines desertification as "land degradation in arid, semi-arid and sub-humid areas resulting from various factors, including climatic variations and human activities" (United Nations Convention to Combat Desertification, (1994, Article 1(a) p.7).

Although a number of definitions for land degradation exist as indicated in the above discussion, essentially they all address the same process. For the purpose of this study a summation of these definitions will be adopted. Land degradation will be used to mean "reduction in either or both of an area's biological and economic productivity or usefulness due to human interference in drylands". Desertification on the other hand refers to an advanced stage of land degradation and/or long-term, irreversible degradation in drylands due to human activities.

3.3 PERCEPTIONS OF LAND DEGRADATION

The processes of land degradation and desertification are not limited to the twentienth century. History has shown that land degradation has had negative impacts on other land uses such as agriculture (Barrow, 1991). Johnson and Lewis (1995) provide examples of ancient civilisations disrupted as a result of abusive land exploitation in Mesopotamian irrigation. Only recently (from the early 1970s), however, have degradation processes commanded attention from policymakers at the regional and global levels. International concern about what was happening in drylands was mobilised on large a scale during the 1970s, culminating in the United Nations Conference on Desertification (UNCOD), held in Nairobi in 1977 (Swift, 1996).

Land degradation and desertification were debated in 1992 at the earth summit in Rio de Janeiro, and chapter 12 of *Agenda* 21 is devoted to these issues (UNEP, 1992). This chapter emphasises the global nature of desertification and details recommendations for action at national, regional, and international levels. Following *Agenda* 21, an international Convention to Combat Desertification was signed in 1994, with an emphasis on improving the livelihoods of dryland inhabitants (Swift, 1996).

Barrow (1991) argues however, that to establish whether land degradation has, or has not occurred, is occurring, or will not occur, demands that the past, present and future usefulness of the land be established. Moreover, evidence for desertification is diffuse and almost impossible to quantify (Swift, 1996). Agreement that land degradation is taking place and requires attention is sometimes difficult to achieve, at least in part, because the perception of utility varies; an increase in utility for one affected group may mean a decrease in utility for another group or groups (Johnson and Lewis, 1995).

The willingness that people, organisations, governments, etc. have to utilise and perhaps to protect an environment or a resource depends mainly upon their perception of utility which is influenced by both their attitude and plight (Barrow, 1991). For example, Falloux and Mukendi (1988, p.1 citing Julius Nyerere, 1985) substantiate this:

> *"Until the last few years, Africa regarded environmental concern as an American and European matter. Indeed, there was a tendency to believe that talk of the environment was part of a conspiracy to prevent modern development of our continent. Now we have reached the stage of recognising that environmental concern and development have to be linked together if the latter is to be real and permanent."*

One reason for the delay in recognising land degradation may be that many people have been conditioned to looking at economic indicators of development, and only when resource depletion translates into economic difficulties do they really 'notice' (Barrow, 1991). Land degradation then, is often seen as a consequence or 'side-effect' of development. The United Nations General Assembly Resolution 2626 (XXV) of 24th October, 1970 addressed this problem by suggesting that, to sustain development, its demands must be within the support capabilities of the land and the environment in general, otherwise degradation will take place.

People are more likely to react to more visible forms of land degradation such as land slide, yet, much land degradation is insidious. Gradual loss of soil fertility for instance, is one of the major threats to human well-being, but is not readily apparent, at least not readily apparent in its early stages (Barrow, 1991). Even when degradation becomes obvious, people may not wish to acknowledge it. Special interest groups and sometimes governments may discourage recognition or reaction to degradation (Barrow, 1991). It is common for a government to decree land use or any other activity and adhere to it; in spite of the unforeseen damages it causes in order not to counter the 'official line' (Blaikie and Brookfield, 1987, p.4).

Some people, particularly the poor and powerless, may react to problems, including land degradation, in a fatalic way (Johnson and Lewis, 1995). They may be perfectly aware of the problem and the long- term implications, but are unable or unwilling to do more than practise what they know to simply scratch a living. It is also common for those in authority to be sufficiently removed from the land; thus, they do not see degradation as a problem nor the efforts to counter it as worthwhile (Johnson and Lewis, 1995).

In such situations, solutions to land degradation may not be appropriate. Different processes of degradation could act synergistically and some have a cumulative effect, so recognition of the degree of threat may not be easy. The management of land degradation therefore entails a long term activity of responses or avoidance procedures, the application of which involves value judgements, wisdom and scientific skill (Johnson and Lewis, 1995).

While farmers' actions may be seen as the immediate cause of land degradation in drylands (particularly in Africa), the root cause lies in a range of economic and political parameters which are typically outside farmers' control (CDCS, 1992). Some of the factors that contribute to land degradation will be discussed in the following section.

3.4 CAUSES OF LAND DEGRADATION

It is known that physical environmental factors, especially climate, play a fundamental role in causing land degradation (CDCS, 1992). Landscapes throughout the world undergo transformation processes that include some form of natural degradation, but the processes are usually compensated for and counterbalanced by nature's inherent recovery ability (Barrow, 1991). Net degradation occurs whenever the degradation processes significantly exceed nature's restorative capacity.

The causes of land degradation, sometimes can be local and relatively simple, but sometimes degradation can be a result of complex global changes (Barrow, 1991). However, some of these changes can be partly caused by human activities (Barrow, 1995). There are clear trends indicating that the main factor in land degradation is the impact of human activity. CDCS (1992), argue that the human factor must be recognised as a catalyst for degradation. In the context of this study, only human causes of land degradation in drylands will be examined.

3.4.1 HUMAN CAUSES OF LAND DEGRADATION

The causes of land degradation are diverse and often complex. Johnson and Lewis (1995) argue that land degradation is a result of a multitude and complex natural process along with human values and constraints. Although environmental change and degradation have their origin in natural processes, it is clear that human utilisation of resources has had locally severe impacts on dryland ecosystems and on the soil-water balance (Kwapata, 1991).

However, identifying the level of human responsibility in any given situation is often a complex task (Barrow, 1991). The difficulty arises because humankind and nature are linked in an interactive system in which cause and effect, and process and response often blur (Johnson and Lewis, 1995). For example, adaptive capabilities of a particular resource use system may be overwhelmed by unexpected natural events such as a prolonged drought. In this context people "often are not entirely initiators of degradation and change but are incidentally in the way of environmental fluctuations" (Johnson and Lewis, 1995, p.14).

3.4.1.1 Intentional Causes of Land Degradation

Most human systems, regardless of the environmental, economic and cultural setting, attempt to minimise the variability of the natural phenomena as a strategy by which to improve their livelihood (Barbier, 1987). Because of the feedback that exists among the components of natural and human systems, a change in any component to meet specific direct goals often results in triggering a number of adjustments. The human dimensions of degradation are further complicated by two dimensions of degradational factors. Environmental change can be both intentional and unintentional in its causation (Johnson and Lewis, 1995).

Frequently people set out to initiate change knowing full well that some of the consequences will constitute degradation. For example strip mining inevitably produces degraded land and polluted water systems (Johnson and Lewis, 1995). Fire is used by

African pastoralists as a grassland management tool in order to: speed the growth of new forage; remove residue of old growth; stunt the growth and thus the competition for scarce water of less palatable plants; and rehabilitate the nutrient cycle (Manshard and Ruddle, 1981). These strategies have one thing in common; they reflect a conscious commitment to environmental change even when those changes represent a biological degradation in part of their habitat (Johnson and Lewis, 1995).

3.4.1.2 Unintentional Causes of Land Degradation

Despite the changes that accept the possibility of degradation with some stability, most of the degradation that occurs is of the unintentional variety. In most cases when humans promote environmental change through personal actions or policy implementation, they envisage the change as being for the better (Tisdell, 1991). However, the desired changes that occur are positive in the short term, but often negative in the long term (Barbier, 1987). For instance when deep boreholes are sunk into pastoral zones as drought relief measures, there is no intention to encourage overgrazing and erosion. The frequent negative consequences are often unexpected; and in most cases too expensive, difficult or impossible to reverse (Johnson and Lewis, 1995). The most common unintentional promoters of land degradation include: national government and economic policies, land policies and aid agencies. These are briefly examined below:

- **National government and economic policies.**

In most of the developing countries, national government and economic policies have direct effects on land degradation (Seely, *et al.*, 1994). Intentionally, most of the policy initiatives are geared to increase productivity and improve human well-being. Nonetheless, "the efforts have not been successful and have resulted in the degradation of the resource base on which people's livelihoods depend (Barbier, 1987; Falloux and Mukendi, 1988). Among other things, the long term environmental impacts of the policies are not well considered (Barbier, 1987). Moreover, most of the development strategies have focused largely on increasing the productivity within individual sub-sectors, without paying attention to the crucial interactions between sub-sectors" (Falloux and Mukendi, 1988). Dryland farmers and herders have been losers in such decisions.

An appropriate example to illustrate policy outcomes which have inadvertently contributed to land degradation is "desertification" (Swift, 1996). Development policies of most governments have failed to cope with the problem of desertification (Falloux and Mukendi, 1988); some have clearly exercebated the problem. Swift (1996) argues that the United Nations Conference on Desertification (UNCOD) justified increasing control by natural resources bureaucracies such as the planning of forest and wild life or national park services over the land. Thus, national governments in Africa in the 1970s used "desertification" as a crisis scenario to claim rights to stewardship over resources previously outside their control, and as a justification to maintain their authoritarian intervention in rural land use (Swift, 1996, p.86).

However, Beck (1980) citing an example of South-western Iran, argues that government control has lead to unsustainable utilisation of resources, hence, initiating the very process of 'desertification' (Beck, 1980). For example, programmes for rangeland use in Iran emphasized desertification, not social and economic problems. "While it was obvious that these programmes, if they had been successful, might have dealt with some aspects of environmental degradation and might have helped some individuals, they did not speak to the needs of whole pastoral populations" (Beck, 1980, p.259).

- **Foreign aids**

Desertification narrative was also a useful justification for calls for increased aid flow. For the aid agencies, desertification seemed in 1977 an ideal theme for their activities, since it was seen to lie largely outside the political arena (unlike poverty or birth control). As in the case of national governments, desertification provided a crisis narrative enabling aid agencies to assert rights as stake holders in the drylands (Swift, 1996).

- **Land policies**

Land policies and/or lack of such policies can be another cause of land degradation (Barrow, 1991). Existing indigenous land tenure and land use patterns in drylands have evolved in response to social structure, economic change, technical innovation, population growth and many other forces (Falloux and Mukendi, 1988).

Far from being static, indigenous tenure systems have been characterised by a remarkable ability to adapt to changing conditions. In general indigenous systems were appropriate for specific situations. For example where rainfall is unreliable in both time and space, a decentralised system of land management and an open range are most appropriate to provide pastoralists with sufficient flexibility to exploit meagre resources more efficiently (Horowtz and Murdock, 1987).

Today, conditions have changed in drylands due to population growth and increasingly, incorporation of rural economies into nation states and cash economies. Traditional tenure systems have been overlooked at all levels of decision making in development projects (Falloux and Mukendi, 1988). Nationalisation of land and other resources have alienated these resources from customary users (Toulmin, 1991). Thus, rights of farmers and herders to land in fallow and to traditional grazing territories have not been clearly defined. Moreover, formal ownership of the land by state have allowed state authorities to gain access to particular pieces of land whenever necessary, for example, carrying out settlement schemes or any development project (Toulmin, 1991).

The breakdown of traditional sytems over allocation of use rights, and government's incapacity to carry out these functions effectively, have led to lack of clarity as regards how decisions about land and water uses are taken (Toulmin, 1991). Where land and grazing rights on it is a common property resource, this lack of clarity on resource use and management has resulted in land degradation (Barrow, 1991).

Falloux and Mukendi (1988), argue that although common property resource today is under threat, it represents a very ancient land use. The problem comes when governments and donor agencies fail to fully appreciate the role of traditional production systems; and generally underestimate the strengths of local institutions (Beck, 1980). In such situations dryland farmer's and herder's control over resources is lost through central planning, land tenure reforms and other good ideas from governments, the aid agencies and outside consultants (Swift, 1996).

Without clear control, common property resources are degraded as no one is accountable for the impacts of their activities. The consequences of such actions are "increased pressure on land which leads to: overgrazed range areas; reduced fallow periods; diminished soil fertility; a deteriorated soil structure; lowered rainfall infiltration; and increased erosion" (Falloux and Mukendi, 1988, p.2). Therefore, land degradation that results from these developments cannot simply be attributed to inherent weaknesses of indigenous tenure systems (Werner, 1994).

3.5 FORMS OF LAND DEGRADATION

Productivity losses can take place in different mechanisms which are interlinked in a process known as 'desertification' (Darkoh, 1993). These processes include: soil degradation, deforestation, and loss of genetic diversity of flora and fauna. These mechanisms are not isolated; for example, reduction of vegetation cover as a result of overexploitation of land can give rise to loss of biological productivity and expose soils to water and wind erosion leading to reduction of organic matter and nutrient content (Darkoh, 1993). The process of land degradation may therefore be difficult to reverse once it gets under way, particularly if vital seeds, fungi and soil organisms are lost (Barrow, 1995). Such a loss can also alter the microclimate and structural alterations of the top soil.

3.5.1 SOIL DEGRADATION

Soil degradation can be defined as a reduction of the current and/or future capability of the soil to produce in terms of quality and quantity (Barrow, 1995). Although potentially a renewable resource, its slow rate of formation as well as mismanagement can make it a non-renewable resource.

Soil degradation can be both qualitative and quantitative (Barrow, 1995). Quantitative degradation entails loss of soil due to erosion, mass movement or solution. On the other hand, qualitative degradation embraces: decline in fertility; reduction of plant nutrients;

structural changes; changes in aeration or soil moisture content, changes in alkalinity or acidity; and changes in soil flora and fauna.

3.5.1.1 Quantitative Soil Degradation

- **Soil Erosion**

Soil erosion can be defined as the physical removal of soil materials from a given site (Barrow, 1995). Erosion therefore, changes soil characteristics which affects the fertility of the soil. Agents or causes of soil erosion can be classified into two groups: *abiotic causes* and *biotic causes* (Barrow, 1995). Of the abiotic causes, water and wind are the main agents; whereas, human activity has come to dominate the biotic causes of soil erosion, (Johnson and Lewis, 1995).

Wind erosion is most commonly a problem in seasonally dry, windy regions, with a smooth, flat terrain, whereas water erosion is more common in seasonally wet regions with a sloping or hilly or mountainous terrain. Both result in a loss of topsoil rich in humus, and lead to a decline in long-term productivity. However, in most instances these are important after abiotic activities (human, animals or insects) have removed or depleted the natural vegetation (Ponzi, 1993).

The amount of erosion that will occur in a given circumstance is determined by erosivity[6], erodibility[7], cover and management (Barrow, 1995). At various times of the year, or over a period of time, erosivity, cover and management are likely to alter. Unless there is disruption, erodibility is more likely to remain stable. If cover is removed even briefly, erosion can increase considerably (Ormerod, 1978). Ponzi (1993) argues that progressive erosion increases the magnitude of soil-related constraints to production leading to larger productivity losses.

[6] Erosivity is the capacity (potential) of precipitation to cause erosion in given circumstances such as 'aggressiveness' of climate. Erosivity is a function of intensity, duration, timing, and amount of precipitation

[7] Erodibility is the vulnerability of soil to erosion; a soil property - its liability to have particles detached and then transported away.

3.5.1.2 Qualitative Soil Degradation

- **Decline of soil Fertility and Loss of Organic Matter**

Soil fertility is a function of a wide range of factors, but the most crucial are the availability of plant nutrients and adequate moisture (Ormerod, 1978). Although the limiting effect of a lack of nutrients on productivity varies according to soil types and the degree of erosion, it has repeatedly been shown that soil nutrient losses decrease productivity levels (Ponzi, 1993). One of the ways by which soil fertility status can be assessed is to look at crop yields or for sensitive 'indicator species' which generally shows that a fertility decline is taking place (Barrow, 1995).

The loss of soil organic matter and nutrients used by plants can occur in virtually any environment, but is more dramatic in dryland regions. Loss of organic matter may result from removal of plants, overgrazing or bush-fires without the return of any material to compensate. The consequences are reduced moisture and nutrient retention, degradation of soil structure, changes in population of soil micro-organisms, that is, essentially loss of fertility.

- **Soil Structural changes and Water Holding Capacity**

Structural stability of the soil if disturbed can affect soil productivity (Barrow, 1991). Changes to the soil structure can have negative impacts on organic matter, type and amount of clay, surface water retention, soil micro-organisms and other physical and chemical aspects, all of which in turn affect the soil productivity (Ponzi, 1993). On the other hand, lack of earthworms, humus and the roots of grasses make can make soil incapable of forming and maintaining a crumb-like structure. In dry areas, the crumb structure of the soil becomes less pervious or even impervious through the formation of a crust, which reduces water infiltration and the availability of water to plants.

Ponzi (1993 citing Stocking, 1984, p.37) argues that "there is a general consensus in the literature about the pre-eminence of loss of available water capacity in explaining the link between erosion and productivity." For example, trampling by livestock can lead to compaction which eventually alters the soil's infiltration rate. Because of the resulting increased water run-off, erosion may occur (Ibrahim, 1987).

Compaction can also lead to the formation of pans[8]. Once pans or crusts develop, soil moisture recharge declines, vegetation finds it difficult to root, hence it becomes more vulnerable to drought and trees in particular vulnerable to wind damage (Ponzi, 1993). Pans can also affect drainage leading to water logging and salinity or alkalinity problems.

With the destruction in soil structure, eroded land is even more susceptible to sheet and gully erosion. Nearly every semi-arid area with cultivation or long-continued grazing, suffers to some degree from such degradation (Barrow, 1991).

3.5.2 LOSS OF VEGETATION COVER

Whatever the causes, the process of degradation generally begins with damage to vegetation cover (Barrow, 1995). It is vegetation that keeps soil in its natural state and protects it from eroding. Undisturbed by humans, soil is usually covered by a canopy of shrubs and trees, by dead and decaying leaves and harbours a number of soil flora and fauna. Without the protective cover of vegetation and the binding action of roots, soil is vulnerable to damage (Skoupy, 1993).

Whether the plant cover is disturbed by cultivation, grazing, deforestation or burning, the slow rate of natural erosion is greatly accelerated (Skoupy, 1993). Therefore, in drylands where plants often grow near their limits of environmental tolerance; even slight changes in environmental factors can lead to more bare ground, species loss and degradation (Barrow, 1995).

[8] A Pan is a hard concretionary layer formed at or beneath the soil surface.

3.6 CONCLUSION

Land degradation is the result of diverse and often complex interacting natural processes exercebated by human actions. Most often land degradation in drylands is initiated when people intentionally or unintentionally disturb existing balances of processes in the affected systems. Alterations in the existing land system to meet specific human needs often sets in motion a complex of interactions among components of the system (Johnson and Lewis, 1995). For example, overgrazing may deplete vegetation cover which may lead to a reduction in organic matter. Loss of organic matter generally leads to a reduction in retention of soil moisture and with this, a decline in vegetation cover, which in turn leads to increased soil erosion. A positive feedback can thus arise, as organic matter and moisture in soil falls, so plant cover decreases and thus renewal of organic matter in soil further declines (Darkoh, 1993).

Most of the causes of land degradation in arid and semi-arid areas have their roots in a range of economic and political parameters. National governments do not consider the ecology and socio-economic adaptations of dryland environments in their plans, and hence initiate land degradation (Beck, 1980). For example, with national plans to combat desertification, most governments did not consider the logic of existing land uses and local participation in planning. Pastoralists, for instance were blamed for causing land degradation, "structurally unable to manage the land conservatively; and their irrational attachment to livestock numbers and unwillingness to sell animals quickly led to overgrazing in fragile marginal dryland environments of the desert edge" (Swift, 1996, p.88).

The following chapter highlights the ecology and socio-economic adaptations of a Namibian semi-arid area, the Gam resettlement area. The chapter concentrates on important environmental factors of Gam that essentially form the basis for land use choice within the area.

CHAPTER FOUR

4. BIOPHYSICAL ENVIRONMENT AND LAND USE OF THE GAM RESETTLEMENT AREA

4.1 INTRODUCTION

Eastern Otjozondjupa which comprises the Gam area and Bushmanland, represents a relatively pristine and less developed area in Namibia (Environmental Information Services and EEAN, 1994). Until 1960 the region was virtually uninhabited except for the eastern part of Bushmanland where the Ju/'hoansi Bushmen have been living for thousand of years (Botelle and Rohde, 1995).

The Gam resettlement area as already defined in chapter one, has a semi-arid climate with low and variable rainfall, high evaporation rates and frequent periods of drought being the norm (National Planning Commission, 1995). Gam, like the rest of Eastern Otjozondjupa, was also sparsely populated by people and domestic stock (see Figure 4.1).

The relatively uninhabited nature is one of the major reasons that prompted the government to locate a resettlement programme in Gam (Kanyemba, pers. comm., 1997). Gam was chosen for the resettlement of the Herero of Namibian origin from Botswana by the Government of the Republic of Namibia soon after independence (Botelle and Rohde, 1995). The government's decision to assist with the repatriation of up to 4000 people and approximately 60 000 head of livestock, followed a long history of plans to resettle the Herero from Botswana (EEAN, 1994). The project started in April, 1993 and, a total of 3000 people with about 10 000 head of cattle have already arrived in Gam (Shikongo, pers. comm., 1997). The impact of the resettlement programme on traditional land use and the biophysical environment in Gam will be discussed in chapter 5.

This chapter gives a brief description of the biophysical environment of Gam prior to the resettlement programme. It reviews important biophysical components: water; soils; diversity of both animal and plant species; and how these components contribute to population distribution of both human and animals within the region. The chapter will also provide a history of land use in Gam resettlement area, a description of human activities and settlement patterns prior to the commencement of the resettlement programme.

4.2 BIOPHYSICAL COMPONENTS

Biophysical components affect human and animal population distribution in most arid and semi-arid environments such as Gam (Boserup, 1980). On the other hand, productivity of the land will determine carrying capacity[9] and subsequent land use in a given environment. Seely *et al.* (1994) argue that a healthy environment, in which ecological processes occur unhindered and in which the full components of biotic diversity occur, creates the possibility of realising the full utilisation and development potential of the area. Thus, any loss of environmental component reduces the options for development and fosters development of people on external sources of livelihoods (Brown, undated).

The majority of Namibia's population, especially the rural population, are dependent on the environment for their livelihoods (Seely *et al.*, 1994). In addition, a significant proportion of both formal and informal economic activity depends on the ecological production and integrity of the environment (National Planning Commission, 1995).

This section briefly describes the important biophysical features that determine the distribution of both fauna and flora in the context of the Gam resettlement area.

4.2.1 SOILS

The Gam resettlement area falls within a semi-arid region comprising geologically recent surficial deposits. The low moisture environment preclude to a large degree the development of mature soil profiles (Environmental Information Services and EEAN, 1994). Soils are therefore, largely unstructured and are derived from redistributed

[9] Carrying capacity is defined as the upper limit to the total number (or biomass) of any species that can be supported in a given habitat.

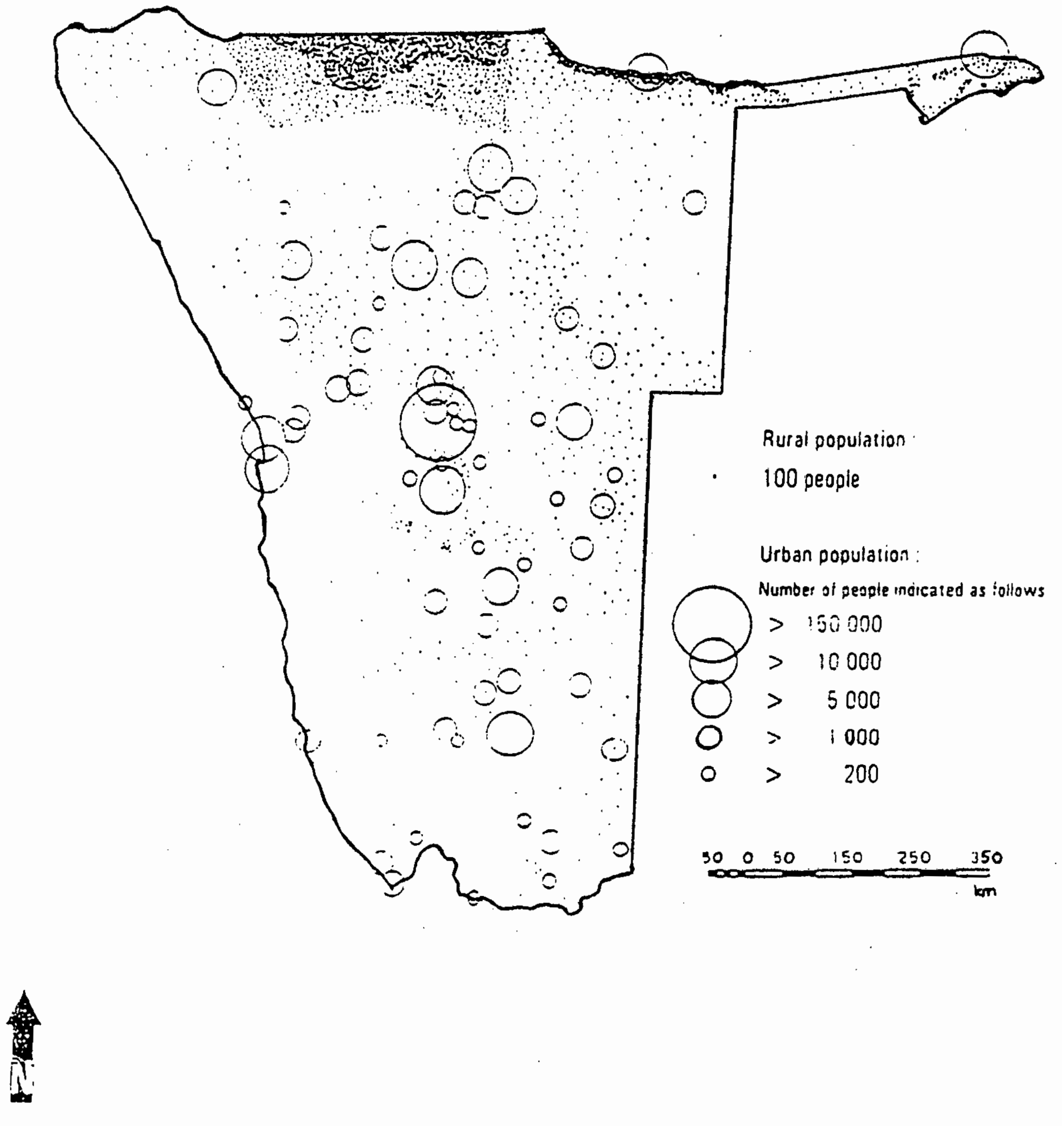

Figure 4.1 Population Distribution in Namibia (Ashley, 1995)

surficial deposits through aeolian and surface flow processes (Environmental Information Services and EEAN, 1994).

The area consists of very deep sandy soils (dunes) with patches of weakly developed sandy loams in the dry river beds of the Otjisondnjou and Danieb which run from west to east through the area towards the Okavango Delta rivers. Typical soils of the dry river beds exists on shallow shales and clays ranging from one and a half metres to several metres deep (Botelle and Rohde, 1995).

The soils in Gam are inherently poor in phosphorous, hence over-exploitation through excessive grazing or intensive cultivation can result in phosphorous deficiency leading to poor grazing quality (Kakujaha, pers. comm., 1997). In addition, poor water retaining capacity of the soil in general renders limited use of the soil for crop production (MPhil. Baseline Report, 1997).

The Ministry of Lands, Resettlement and Rehabilitation (1994) argues that lack of surface water has limited the use of the calcareous soils of higher potential for small scale arable farming in the north-western corner of Gam. Although the area lies within the Okavango Delta catchment, the higher absorption capacity of the sand prevents much surface runoff from taking place (MLRR, 1994).

Poor soil conditions and the associated vegetation types, have contributed to the temporal or seasonal utilisation of grazing in the Gam area and to the limited population of both humans and livestock.

4.2.2 GROUNDWATER

Groundwater is a very important source of water in the Otjozondjupa region as is the case with most of Namibia (National Planning Commission, 1995). In this region, apart from the occasional surface flow of the omiramba[10] there is no permanent surface water, and

[10] Omiramba is a local name for seasonal rivers; which are seldom deeply incised and consist generally of rather shallow depressions in the landscape.

most people depend on water from boreholes which exploit local groundwater sources (EEAN, 1992).

Due to the lack of perennial water and aridity, agricultural production in Otjozondjupa region relies mainly on livestock and game farming. The absence of perennial rivers and reliable groundwater places constraints on the development of settlements away from the Omuramba Omatako and the southern boundary of the area (Directorate of Extension and Engineering Services, 1994).

In Gam, all water for human and stock consumption is obtained from boreholes, at depths of approximately 150 metres and greater below the surface (Botelle and Rohde, 1995). The Department of Water Affairs (1988) ascertained that considerable groundwater sources occurs in bedrock below Kalahari beds in Otjozondjupa region. However, these resources may be limited due to difficulties in sitting of boreholes to intersect the aquifers (Directorate of Extension and Engineering Services, 1994 citing the Department of Water Affairs 1988, p.31). Therefore, although the stored reserves are believed to be considerable, low transmissivity limits the yield of the boreholes (Directorate of Extension and Engineering Services, 1994). Moreover, available resources are highly dependent on recharge which is subject to rainfall. Due to unavailability of data on the rate of extraction and recharge, there is no indication of sustainable use of groundwater resources in Gam (Botelle and Rohde, 1995).

4.2.3 BIODIVERSITY

Gam resettlement area falls within a region of particular significance for biodiversity conservation in Namibia (Ashley, 1996). The relatively undisturbed nature of the resettlement area has resulted in a natural fauna with species assemblages closely resembling those recorded in similarly undisturbed areas further north (EEAN, 1992).

The region is recognised for its richness in wildlife and the diversity and abundance of key plant resources; especially the species which are utilised by the Bushmen for food such as the morama, *Tylosema esculentum* and the mangetti nut, *Ricinodendron rautanenii*

(Botelle and Rohde, 1995). Generally, Gam forms part of the Kalahari sandveld system with the eastern part characterised by a series of pans which serve as a focal point for people and wildlife alike at various times during the year (Jones, 1996). When the pans are flooded they attract large numbers of pelicans, flamingos, and a wide variety of wading birds (Jones, 1996). Game also concentrates around the natural pans which act as breeding sites.

4.2.3.1 Vegetation

The resettlement area falls within the 'Forest Savanna and woodland', a broad transitional zone between the so called 'wet' and 'dry' savannas (Environmental Information Services and EEAN, 1994).

Acacia species dominate on the more calcareous soils north-west of Gam whilst forest savanna and open woodland dominate the rest of the area with plenty of *Terminalia sericia* (Sand Yellow Wood) and occasional occurrences of Red Serigia, *Pterocarpus angolensis* (Dolf wood) and Manghetti trees more to the West of the area (MLRR, 1994).

Most of the dry river valleys (omiramba plains) contain comparatively more fertile soils and unique vegetational combinations (Botelle and Rohde, 1995). These plains are covered with open grassland with patches of Acacia and solitary Camel thorn trees. *Dichaepetalum cymosum*[11] (Gibflaar) is endemic to the area (Environmental Information Services and EEAN, 1994). The plant is wide spread on the Kalahari sands and occurs throughout the resettlement area (Ministry of Lands, Resettlement and Rehabilitation 1994).

The occurrence of *Dichaepetalum cymosum* as well as the harsh environmental conditions and low niche separation of the Kalahari have led to a generally impoverished flora in the Gam area *per se* (Environmental Information Services and EEAN, 1994). These factors have in turn affected the quality of grazing and carrying capacity of stock in the area

[11] *Dechaepetalum cymosum* is a poisonous plant of major concern to livestock farmers in north-eastern Namibia. Small quantities of leaves are sufficient to be lethal in most domestic animals.

(Botelle and Rohde, 1995). The carrying capacity in the north eastern areas is estimated at 15 hectares per large stock unit assuming a high standard of veld and stock management (Baseline Report, 1997). However, the Ministry of Environment and Tourism (1993) has argued that for Gam, an average carrying capacity of 1:17 is required if the availability of water and occurrence of *Dichaepetalum cymosum* are also taken into consideration.

Ashley (1996) argues that although Gam has a very limited carrying capacity for livestock, it has a much higher potential carrying capacity with respect to game. Wildlife that have evolved in the area are not severely affected by the scarcity of water and *Dichaepetalum cymosum.*

Poor grazing resources and the wide spread of *Dichaepetalum cymosum* restrained the settlement of much of the resettlement area prior to the resettlement programme (Environmental Information Services and EEAN, 1994). The few settlements which existed by that time were confined to the dry river valleys where fertile soils allowed good grazing; and where no *Dichaepetalum cymosum* occurred. The occurrence of this plant and the scarcity of surface water lead to the consideration of Gam by farmers of the densely populated areas of western and southern parts of Otjozondjupa as available only for seasonal grazing (Botelle and Rohde, 1995).

4.2.3.2 Wildlife

Wildlife populations in Namibia are particularly rich in the north-east and north-west (Ashley, 1996 citing HKW Engineering, 1992). Environmental Evaluation Associates of Namibia points out that, as recently as October 1992, during the development of the Roads Master plan for the area, game was thought to represent a major land use option in Gam.

Animal species in Gam closely resemble those recorded in Bushmanland. Fauna types found in Gam area include amphibians, reptiles, birds, and mammals (Environmental Information Services and Environmental Evaluation Associates of Namibia, 1994).

Large game species such as gnu (Blouwildebeest), oryx, giraffe, kudu and eland, are found in small numbers in the Gam area. Small game present in the area include steenbok, duiker and warthog. A number of predators such as jackal, cheetah, leopard and both brown and spotted hyena are also found in Gam. Lion occasionally enter the area from the Nyae-Nyae region (Ministry of Lands, Resettlement and Rehabilitation 1994).

Degradation of habitat by clearing land for agriculture and settlements, have been reported as primary causes of biodiversity loss in Eastern Otjozondjupa (Ashley, 1996). Environmental Information Services and Environmental Evaluation Associates of Namibia (1994) speculated that some of the animal species including several Red Data species are going to be severely affected by changes in land use as a result of the resettlement programme in Gam. However it is not possible to predict the significance of the impacts as most of the habitat requirements of these species are unknown (Environmental Information Services and EEAN, 1994).

4.3 HISTORY OF LAND USE IN THE GAM AREA

Gam has been used mostly by a small population of Bushmen, who hunted and collected food on a seasonal basis (Jones, 1996). During exceptional rainfall years, livestock from more densely settled areas to the south may have been herded as far as Gam, and grazed there for several months until surface water resources dried up (Environmental Information Services and EEAN, 1994). The main land use activities of the region then, were livestock farming and utilisation of game and veldfoods. Traditional settlement were found around water points especially along the seasonal Omiramba Omatako river.

There was a sharp contrast in land use between Gam and a neighbouring area along the south-western border and the dry river bed of former East Hereroland (Botelle and Rohde, 1995). Due to availability of water, the neighbouring area has supported permanent occupation. The resultant high population densities of both humans and livestock have had a profound negative effect on the environment (Environmental Information Services and EEAN, 1994).

4.3.1 LIVESTOCK FARMING AND SETTLEMENT PATTERN

Prior to the resettlement programme, the original population of Gam was transformed from the predominantly hunter gathering society to a mix of livestock production, hunting and gathering. The changes were due to the arrival of a few Herero cattle farmers who moved into the area from the mid 1980s (Botelle and Rohde, 1995). By the late 1990s Gam was inhabited by a community of about 154 people (EEAN, 1994 citing Katjariwa, 1990).

The Herero farmers settled near the old Gam spring where settlement location depended on the availability of water. The farmers utilised a few isolated boreholes which were developed in the vicinity of Gam, along a linear east-south-east geological feature immediately to the south (the Gam lineament). It was established by then that groundwater was scarce in the area, and very difficult to locate (Inter-Consult, 1996).

Grazing of cattle as well as goats, donkey and horses was the primary farming activity in Gam and the surrounding areas. Traditionally the Herero pastoralists followed a nomadic way of life with their large herds of cattle (Malan, 1995). However, in Gam the nomadic movements were more restricted due to changes in the availability of water and grazing.

Herero farmers coped with the problem of water scarcity and grazing by practising seasonal grazing or transhumance (Hines, *et al.,* 1995). This practise involved movable cattle posts, whereby cattle were moved to temporary grazing posts away from the settlements but always returned after a few months when gazing conditions had improved (Environmental Information Services and EEAN, 1994).

The above discussion shows that water is an important driving force affecting land use and cultural processes in Gam. The rhythm of agriculture and hence other activities are dominated by the seasonal water availability. Homestead are situated to take advantage of the aquifer. Grazing patterns of cattle are also determined by the availability of drinking water. Thus water can be defined as the ultimate limiting factor for grazing potential in Gam, and determines whether any animals can exist for more than a few months at any particular place (Environmental Information Services and EEAN, 1994).

4.4 CONCLUSION

Eastern Otjozondjupa accommodates a small population, within a relatively diverse natural environment. The region is endowed with relatively abundant natural resources including wildlife and plant species, some of which are used as sources of food. The Gam resettlement programme therefore, fall within a region of particular significance for biodiversity conservation in Namibia.

Environmental Information Services and Environmental Evaluation Associates of Namibia (1994) speculate that, some of the animal species including several Red Data species are going to be severely affected by changes in land use as a result of the resettlement programme in Gam. However it is not possible to predict the significance of the impacts as most of the habitat requirements of these species are unknown.

The main constraints in developing the potential of the region's natural resources are as follows:

- Historically, the absence of surface water has isolated the Bushman population from outsiders, and large tracts of land remain uninhabited. The water retaining capacity of the soil in general is very poor, and therefore only limited use can be made of the surface water resources. Consequently, the habitation of the Eastern Otjozondjupa is solely dependent on borehole water supply. Notwithstanding that the stored reserves are believed to be considerable, however, low transmissivity limits the yield of the boreholes. Moreover, available resources are highly dependent on recharge subject to the rainfall.

- Rainfall is low and highly variable, placing serious constraints on rainfed crop production. The lack of perennial water and aridity in general has meant that agricultural production in Otjozondjupa region is dependent mainly on livestock and game farming.

- The carrying capacity is influenced by the availability of water and the occurrence of *Dichaepetalum cymosum*. Although much of the region has a very limited carrying capacity for livestock, it has a much higher potential carrying capacity with respect to game that has evolved in the area and is not severely affected by water availability and the occurrence of *Dichaepetalum cymosum* (Ashley, 1996).

This chapter has indicated that seasonal availability of water is a major controlling factor for land use and settlement patterns in Gam. Seasonality, therefore is an important driving force of biological and cultural processes in the region. The availability of grazing as far as Gam is concerned is secondary to the availability of drinking water.

Imposing permanent land uses in a semi-arid area like Gam could lead to intensive exploitation of the biophysical environment and in turn lead to unsustainabe use and ultimate degradation of the resources. The impacts of changing land use on the environment will be examined in the following chapter. The focus will be on the impacts of the Gam resettlement programme and the provision of boreholes which have enabled availability of new grazing lands.

CHAPTER FIVE

5. HUMAN IMPACTS IN THE GAM RESETTLEMENT AREA

5.1 INTRODUCTION

The population of the Gam resettlement area is mainly composed of Herero speaking people. Traditionally, the Herero community is considered to be the most affluent group of Namibia's communal farmers in terms of livestock. The Hereros are pastoralists and cattle form a very important source of wealth (Malan, 1995). Therefore, with the arrival of the Herero in Gam, changes in the methods of land use and the rural economy in general were more likely. Besides, the introduction of permanent livestock farming into a potentially vulnerable environment leads to changes in utilisation of resources. The changes might be due to intensification of traditional land use owing to population increase as well as growing concentrations of people in settlements with secure water resources.

This chapter examines specific aspects of the environmental impacts of the Gam resettlement programme with particular attention to boreholes (see Figure 5.1) and changes occurring around them. The chapter centres on land use changes as a result of providing boreholes to tap groundwater reserves in a semi-arid area devoid of surface water. Information collected from field observations and interviews will be used in the chapter as a bases for examining changes in soils, groundwater and vegetation as indicators of degradation occurring around boreholes within the resettlement area. The discussion will also highlight the implications of this localised degradation for biological diversity and sustainable resource use within the area.

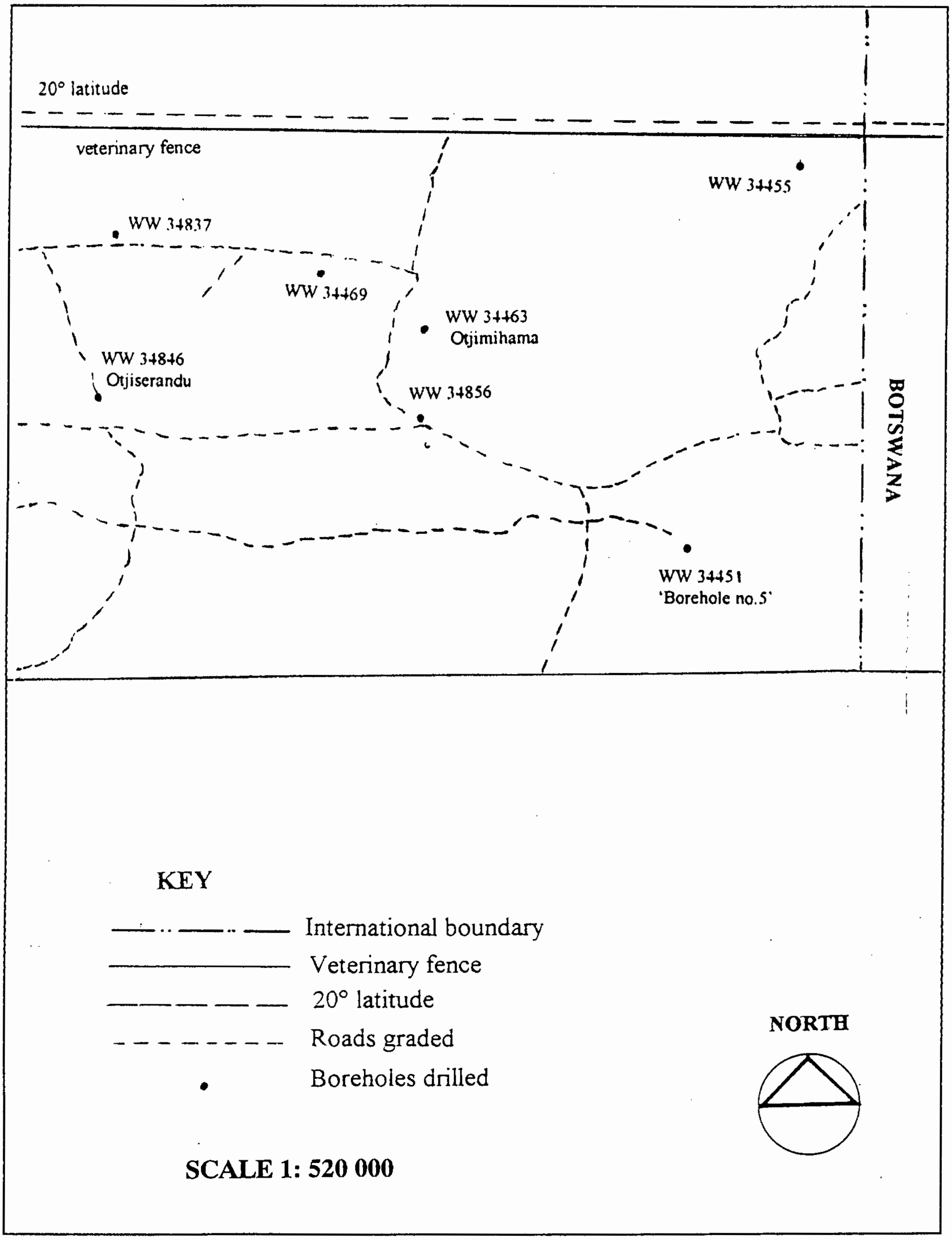

Figure 5.1: Location of the Boreholes in the Study Area in the Gam Resettlement Area.

5.2 EVALUATION OF HUMAN IMPACTS ON THE ENVIRONMENT IN THE GAM RESETTLEMENT AREA

This section provides an evaluation of human impacts on the biophysical and socio-economic environment in the Gam area. The discussion will concentrate on evaluating evidence of degradation on the biophysical component including: groundwater; soils; and vegetation as observed during the study (MPhil. Baseline Report, 1997). In addition, habitat deterioration will form a basis for evaluation of human impacts on wildlife in the Gam area. Evaluation of human impacts on the socio-economic environment will address land use, including grazing patterns, rangeland management and carrying capacity.

5.2.1 SOIL DEGRADATION

The Gam resettlement area like the rest of the Kalahari surface has extremely low relief and is dominated by aeolian sand with a low nutrient status (Perkin and Thomas, 1993 citing Thomas and Shaw, 1991). Despite the absence of perennial and even seasonal water courses in this area, these soils support mixed savanna vegetation, and had long been seen as an untapped potential grazing resource (Perkin and Thomas, 1993). However, with the resettlement programme in Gam, changes in soils properties have occurred affecting the ability of the soils to support vegetation. Some of these changes and their causative factors are discussed in this section.

5.2.1.1 Soil Erosion

Generically the Kalahari soils are fragile, sandy to sand-loam with poorly developed structures (EEAN, 1994). The finer components within the coarse sand textured soils are more prone to erosion both by wind and water. However, Mainguet (1989) argues that wind erosion is the main process of degradation in arid and semi-arid ecological areas when rainfall is less than 300 - 400 mm/year. The most favourable conditions for soil erosion are: low and sparsely distributed rainfall; sandy soils with poorly developed structure and deficient in organic matter, and flat and open topography. As indicated in Table 5.1, the soil characteristics and the topography of the Gam resettlement area render the area vulnerable to wind erosion. Such soils can be easily eroded due to poorly developed structure as well as a lack of binding clay particles.

Table 5.1: Soil Characteristics in the Study Area (MPhil. Baseline Report, 1997)

	Soil Components				
Locality Names	**Relief**	**Surface Stoniness**	**Form of Soil Surface**	**Soil Texture**	**Evidence of Erosion**
'Borehole number 5'	Flat land	Stoniless	Heavily trampled. Low compaction.	Loam	Water: splash erosion
Otjimihama	Flat land	Stoniless	Heavily trampled Medium compaction.	Loam	Water erosion: rills; denuded top soil.
Otjiserandu	Flat land	Stoniless	Heavily trampled; highly compacted; crust formation	Loam (in the vicinity of borehole); elsewhere, sandy.	Water erosion: loss of top soil.

Despite signs of splash erosion at 'borehole number 5' (Plate 5.1), evidence of serious water erosion was however, absent, even during the wet season when the study was done. This suggests that runoff is entirely negated by the low relative relief and high infiltration capacities of the Kalahari sand. Environmental Evaluation Associates of Namibia (1994) argue that erodibilty of the soil is however, based on resistance to erosion derived from a complex range of physical (texture and structure) and chemical variables. Therefore, it is the variables which influence the detachment of soil particles and their transport.

Plate 5.1: Vegetation characteristics at 'Borehole number 5'

As observed in Gam, the unconsolidated nature of the Kalahari soils makes the area prone to splash erosion. This process is important in the removal of top soil in arid and semi-arid regions receiving high intensity rainfall (Ormerod, 1978). Given the high intensity rainfall, the extent to which erosion occurs depends upon the type of soil, the gradient, the land use and vegetation. Thus it is minimal on flat land, forest and rich pasture land, but whenever these conditions are not available, such as in deforested areas and overgrazed rangelands, splash erosion can cause total removal of top soil (Ormerod, 1978). The total loss of vegetation observed within a 10 metres radius from the boreholes (see Plate 5.2) has left the exposed soils without protection and more susceptible to splash erosion.

Soil erosion, linked to the removal of ground cover due to livestock pressure, has been intrinsically treated as a negative outcome of intensive grazing in drylands. In study area, erosion hazards in the vicinity of the boreholes were exacerbated by large numbers of animals using the boreholes on a permanent basis. The observable negative impacts caused by animals around the boreholes include trampling and overgrazing with complete loss of vegetation cover close to the boreholes. It is these locations which ought to be susceptible to increased soil erosion; be it by splash erosion or wind erosion during the dry windy season.

Plate 5.2: Complete loss of vegetation cover around the borehole at Otjiserandu.

5.2.1.2 Soil Compaction

Soils around the boreholes in the study area were found to be heavily trampled (Table 5.1) However, due to the unstructured nature of the aeolian sand deposits of the Kalahari Systems, soil compaction at all sites was not notable except for Otjiserandu (MPhil. Baseline Report, 1997).

Ponzi (1993) argues that the removal of plant cover together with trampling may result in soil compaction thus affecting soil properties. Compaction for instance, may change soil structure with negative effects on its capacity to hold water. This can lead into other soil degradation processes such as soil erosion (Seely *et al.,* 1994). Soil compaction mainly results from trampling through overgrazing; and because overgrazing basically occurs with overstocking, trampling is an important aspect of soil degradation (Seely *et al.*, 1994). This aspect was observed around the areas surrounding the three boreholes within the study area in Gam (Plate 5.3). Trampling was more prominent within 10 metres distance from the boreholes where soils were mainly composed of finer particles.

Plate 5.3: Trampling around the borehole at Otjiserandu

Soil compaction may result in lower organic matter and reduced infiltration with less water available to plants (Ponzi, 1993). Moreover, a hard or crust surface which is formed from compaction and reduced infiltration, as seen in Otjiserandu, limits root development. In such a situation, the establishment of most plant species in the long run will be limited, thus making the area more susceptible to erosion (EEAN, 1994).

5.2.1.3 Soil Texture and Water Holding Capacity

Soil texture at the three boreholes within the study area ranged from loam to sand (see Table 5.1) (MPhil. Baseline Report, 1997). Naturally, sandy soils have a very low water-holding capacity, but by the same token virtually all of the water that enters them is available to plants (Walker, 1993). In arid regions such as Gam, sand soils, though infertile, provide a more favourable soil moisture regime when compared to clay soils, which despite a high water holding capacity have a high wilting capacity. Although sand soils are low in nutrients, they enable plants and woody plants in particular, to develop larger root systems to exploit the full volume of soil (Walker, 1993 citing Rutherford, 1982).

Smith (1992) argues that the condition of the soil, particularly the permeability or capacity for infiltration of rain water is very important. Soils which allow deep penetration of water will be important for tree maintenance. Infiltration on the other hand, will be greater if there is a reasonable plant cover to break the rainfall and to allow penetration of water. The slower the infiltration rate the more available water becomes to the plants.

In the Gam resettlement area, overgrazing has led to degradation of vegetation cover around boreholes and the surrounding rangelands which in turn has affected the availability of soil water necessary for plant maintenance. In addition, trampling has led to soil compaction, particularly in the vicinity of boreholes, slowing the rate of water percolation. Trampling loosens the top soil composed of organic matter and humus. When this material is eroded away a hard crust is left on the top soil. This hinders water percolation (Kambatuku, 1994). Surface crusting observed in Otjiserandu was an indication that water from previous rains took some time to percolate. Smith (1992) argues that an appreciable amount of water which is left standing on the surface by compacted soils may be lost through evaporation, hence very little or none gets down to the plant roots. It is therefore even more difficult for seeds to germinate in encrusted and dry soil (Kambatuku, 1994).

5.2.1.4 Loss of Organic Content

The Kalahari soils are known to have extremely low nutrient and organic contents under natural conditions, implying that the recovery of vegetation after disturbance is likely to be slow (Perkin and Thomas, 1993). The study area in the Gam resettlement programme, as already mentioned, falls into this fragile ecosystem in which accumulation of organic matter is a very slow process.

Exploitation under such circumstances is advantageous only in the short-term and a total disadvantage in the long term on the impoverished land. Overgrazing has caused total removal of vegetation around the boreholes in the Gam resettlement area in such a way that nothing is left on the ground for organic matter to accumulate upon and support associated micro-organisms and restore fertility.

Carroll and Meffe (1994) argue that nutrient cycles such as carbon, nitrogen and phosphorous are essentially determined by biological, especially microbial and higher plant activities. Therefore, activities that impair microbial processes such as loss of vegetation and organic matter, limit the availability of plant nutrients necessary for primary productivity.

Ormerod (1978) argues that the fragility of the Kalahari soils means that if vegetation is removed after the rains have ceased, the ground will remain unprotected from wind erosion during the long dry season and from high intensity rainfall when the dry season finally breaks. Since soils in the Gam area are largely devoid of clay, stable organic matter has little or no opportunity to build up. This has serious implication for soil fertility and plant growth. In the absence of organic matter the chances of seed germination are also minimal.

5.2.2 GROUNDWATER

Inter-Consult (1996) pointed out that ground water is scarce in the Gam resettlement area and very difficult to locate. With the regional water table level in the Gam area being approximately 90 metres and aquifers occurring mainly in bedrock structures, development is rather difficult and expensive (Directorate of Extension and Engineering Services, 1994). Accordingly the Ministry of Land Resettlement and Rehabilitation (1994) argues that groundwater exploration in the resettlement area has historically, met with limited success due to ground conditions as illustrated by a reported borehole success rate of 20 - 30 %. However, the Directorate of Extension and Engineering Services (1994) argues that despite the reported success rate, boreholes which have been drilled in the Gam area, are generally poor yielding.

The three boreholes within the study area were all installed with diesel pumps and water was reported to be sufficent both for livestock and domestic use. None of the people interviewed gave a clear picture regarding boreholes yield. However, at Otjimihama, it was reported that an additional pipe had been installed in the hole since its original installation so as to tap water at a deeper level (Kahaku, pers. comm., 1997; MPhil. Baseline Report, 1997). This implies that the pumping depth had dropped due to recession of the water table.

The main complaint as regards boreholes in the study area was related to maintenance. There were no technicians nor trained borehole caretaker stationed in the resettlement area. Moreover, the Ministry of Lands, Resettlement and Rehabilitation, which is responsible for the boreholes in the resettlement area, lacked expertise and had to rely on the technicians from the Department of Water Affairs based in the Tsumkwe. This caused long delays and exacerbated damage on the land around the neighbouring boreholes where people had to herd their animals each day for drinking (Mungenje, pers. comm., 1997).

Whitlow (1988) argues that the effects of overgrazing are both ecological and hydrological. In the case of Gam, overgrazing exacerbates the problem of water availability in an area where water is naturally scarce. Loss of vegetation cover observed around the boreholes in the Gam area indicated that the infiltration of rain water was hindered. This was clearly indicated at Otjiserandu where surface crusting was observed. The decreasing infiltration on bare areas around the boreholes in Gam implies that the chances of aquifer recharge from rain water are greatly reduced.

The additional water pipe in the borehole at Otjimihama to extend the pumping depth, would appear to indicate that water table levels are dropping. Thus if the rate of drawing continues to exceed the rate of recharge the borehole will have to be deepened within four years (MPhil. Baseline Report, 1997). This further implies that more costs would be incurred and hydrologically the pumping rate is depleting the water aquifers.

Naturally, the absence of surface water flow and the ubiquitous deep sandy soils resulting in rapid infiltration of rainfall into the surface sands affects aquifer recharge. In areas where the Kalahari cover exceeds several metres most of this water will be lost through evapo-transpiration during the dry season. It is unlikely that any direct recharge from the local rains or indirect recharge from riverbeds occurs, and secondary aquifers probably rely solely on very slow flow through bedrock fracture systems for replenishment (Inter-Consult, 1996). Therefore if the rate and extent of degradation in the Gam resettlement area continues unchecked, the slow flow of aquifer recharge would be greatly hindered.

5.2.3 VEGETATION DEGRADATION

Overgrazing has been identified as the primary cause of degradation around the boreholes and surrounding rangelands in the resettlement area in Gam (MPhil. Baseline Report, 1997). Vegetation around the three boreholes visited showed a similar patterns of degradation, the most conspicuous being complete loss of vegetation cover within 10 metres from boreholes (Table 5.2). The composition, quality and quantity of both tree and grass species changed considerably the closer one approached the central point of livestock activities, the boreholes.

Each borehole was surrounded by a patch of highly grazed, bare land followed by almost concentric rings of lower grazing intensities at a distance from it (see Figure 5.2). Prior to the installation of the boreholes and the resettlement programme, vegetation around the areas presently occupied by boreholes resembled the rest of the area in density and composition (Stander; Berriman; Kahaku, pers. comm., 1997) (Plate 5.5). The current changes were said to be the consequence of overgrazing and trampling from livestock drinking at the boreholes daily (Figures 5.2, 5.4 and Plate 5.2). The changes were extreme within 10 metres radius from the boreholes with total destruction of all the vegetation.

Browsing on trees and shrubs was heavier near the boreholes, in particular on the lower branches of *Acacia* trees. Browsing intensity was more pronounced at Otjimihama and Otjiserandu where grasses around the boreholes were completely overgrazed (Plate 5.6). Unpalatable bushes such as *Catophractes alexandrii* were observed about 500 metres from the boreholes. Horowitz and Salem-Murdock (1987) argue that with the exhaustion of the grass, browsing becomes increasingly important as the dry season progresses in drylands. Although such browsing is potentially beneficial for the spread of plants, as the seeds are transported in a rich manure environment, when they are ingested unripe the chances for germination are reduced. Overgrazing therefore, further affects natural regeneration of important fodder sources such as *Acacia* species in the Gam area.

Table 5.2: A Summary of Vegetation Description in the Study Area (MPhil. Baseline Report, 1997)

Locality Name	**Vegetation Description - 600 m From the Borehole**				
	0 - 10 m distance	**20 - 100 m distance**	**200 - 400 m distance**	**400 - 600 m distance**	**Browse/Graze Pressure**
'Borehole number 5'	No vegetation	Short annuals, in low density Scattered perennials. Few bushes.	Annuals, high density. Fewer trees. Scattered perennials.	Trees dominating. Tall annuals.	Low
Otjimihama	No vegetation	Wild pumpkin dominating. Scattered annuals. Big *Teminalia* trees. *Acacia* trees	Wild pumpkin dominant. Annuals in medium density. Scattered shrubs.	Scattered big trees dominating. More shrubs. Denser annuals. *C. alexandri*	High
Otjiserandu	No vegetation	Short scattered annuals.	Annual in low density. wild pumpkin.	Scattered shrubs. Both tree and grass in low densities. Scattered D. cymosum.	High

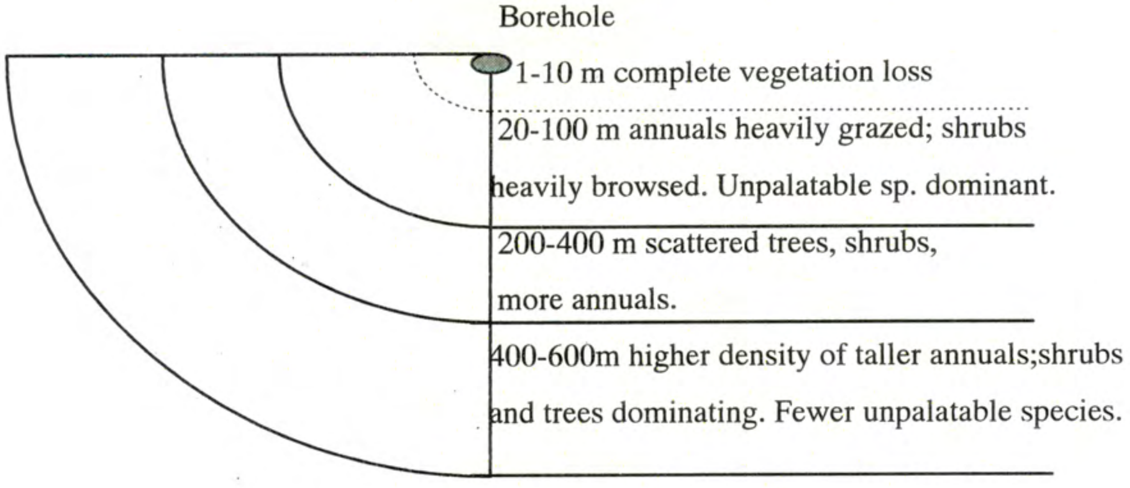

Figure 5.2: Schematic Diagram of Vegetation Change From a Borehole (Adapted from Perkin and Thomas, 1993)

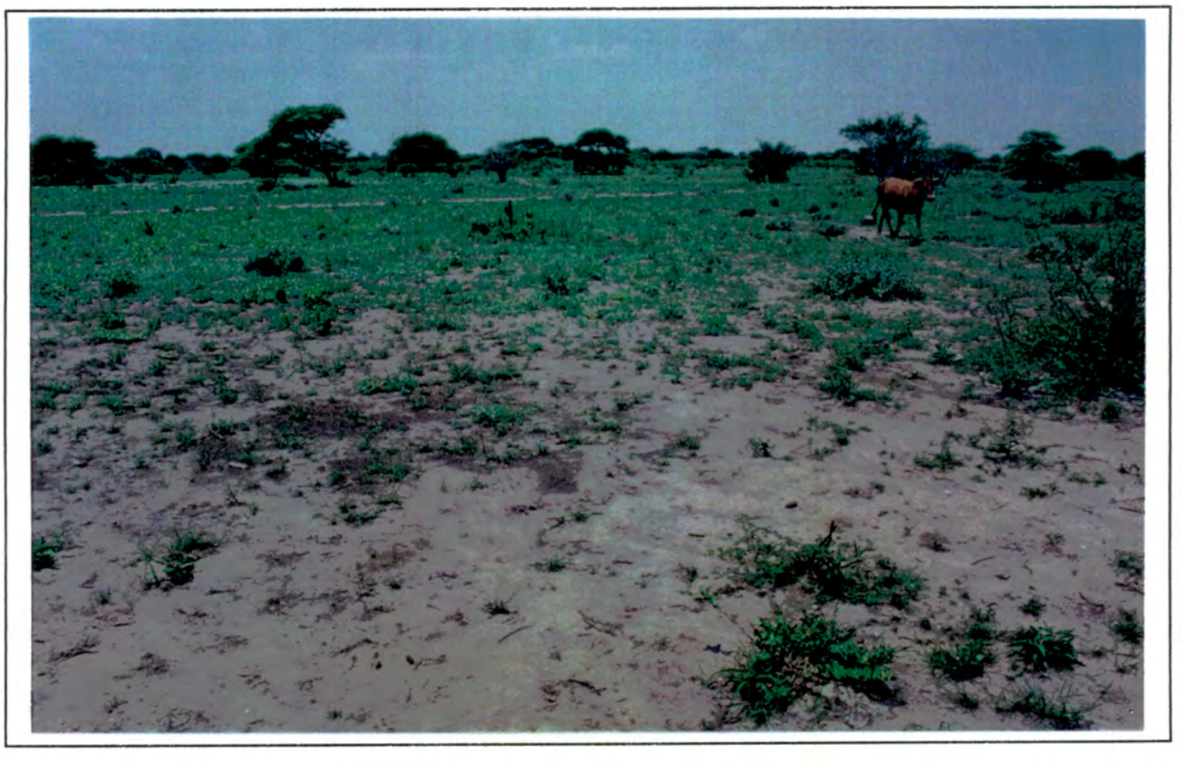

Plate 5.4: Different grazing intensities from the borehole at Otjiserandu

Overgrazing and trampling are the two main activities contributing to vegetation degradation in drylands (Manshard and Ruddle, 1981). Although these processes take place simultaneously, trampling seems to cause more damage than overgrazing. Kambatuku (1994) argues that animals whether grazing, browsing or going for water, cause serious damage by uprooting shallow rooted grasses, trampling and pounding the soil with their hooves. Trampling not only clears the less stable vegetation cover leaving the woody species behind, but it also makes the soil difficult for the roots of many palatable species to penetrate (Kambatuku, 1994).

Plate 5.5: A relatively undisturbed area near Nama Pan in Bushmanland

Examination of grass species composition in the studied areas showed that perennial species were more degraded than annuals. In Gam, apart from a few perennials, mostly *Panicum* species at 'borehole number 5' where grazing pressure was relatively low, and dry tufts observed around Otjimihama, no perennials were seen during the transect walks. Ludwig (1985) argues that in natural situations despite the highly seasonal patterns of precipitation, annuals and perennials both survive in dry environments each using their own tactics. Natural plant populations have evolved numerous tactics to capitalise on this unpredictable timing of precipitation (Ludwig, 1985). Drought evaders or annuals have a high net photosynthesis rate when soil moisture is available, but evade drought conditions by forming seeds. In contrast, drought endurers or perennials have intrinsic lower rates of net photosynthesis, but can maintain a low level of photosynthesis even in dry soils.

Plate 5.6: Browsing intensity at Otjimihama

Bosch (1988) argues that the degradation process in the semi-arid grasslands of southern Africa is mainly characterised by changes in the ratio between palatable and unpalatable species. Species composition with the largest palatable component occurs where there are light to moderate grazing conditions. By contrast, more severe grazing leads to an increase in unpalatable species. The changes in the ratio of palatable and unpalatable species was observed around the boreholes in Gam where more unpalatable species were found in those areas with severe degradation.

At Otjimihama, for instance, most of the vegetation observed immediately after the layer of complete degradation, consisted of unpalatable plant species, such as the Wild Pumpkin (Figure 5.2). *Sida cordifolia* was among unpalatable plants which were also found in higher densities from about 20 metres from the borehole. This species was among the prominent indigenous, invasive species which were hardly observed in the rangelands away from the boreholes (Kahaku, pers. comm., 1997).

At 600 metres distance form the borehole, the poisonous plant, *Dichaepetalum cymosum* (gifblaar) was found in lower densities in some places such as Otjiserandu. The plant was found in high densities in severely degraded areas. Basically it is a deep rooted stolon and turns green in the late dry season, thus attracting livestock when most of the surrounding vegetation is dry (Homann and Seiffert, 1996). This plant was reported to be a big problem on sand soils and has killed many cattle in Otjiserandu (Christopher, Pers. Comm., 1997).

Further deterioration due to severe overgrazing in the long term leads to the encroachment of shrubs. Ashley (1996) argues that lost productivity of rangeland in Namibia is most tangible in areas of bush encroachment, where diverse and palatable grass species have been replaced with unpalatable bush. In the resettlement area, encroachment of unpalatable shrubs, such as *Catophractus alexandri* (omukarawize) was observed within the study area. Although donkeys occasionally feed on them, they were reported to be amongst the unpalatable invasive shrubs in the Gam resettlement area, (Kahaku, pers. comm., 1997).

Vegetation is the key to prevention of most forms of degradation. Belshaw *et al.*, (1994) argue that if all soils were continually covered by forest or ground cover, there would be no detachment, transport and net loss of organic matter. However, most land uses make this practically impossible.

Vegetation degradation observed around the boreholes in the Gam resettlement area increases the risk of land degradation through processes such as soil erosion, loss of soil fertility and organic matter from compaction, impaired infiltration, reduction of soil moisture and surface capping. Moreover, re-establishment of perennials and palatable species as well as soil organisms is hindered. Bosch (1988) argues that a change in vegetation is also associated with further degradation of the habitat.

5.2.4 HABITAT DEGRADATION

The direct impact of livestock farming on wildlife habitat is mainly through competition for food and water, which is most acute at water sources, in arid areas and in drought years (Bosch, 1988). Ashley (1996) however, argues that it is the indirect impacts through human disturbance which are more important, and these include: clearance of bush for crop production; felling of trees for construction; the conversion of seasonal grazing areas to permanent settlements; and other related activities which lead to degradation or loss of habitat.

Agriculture, including both livestock and crops, is the main habitat displacing activity in Namibia. A report by Environmental Evaluation Associates of Namibia (1992) argues that, as a result of agriculture and settlements, wildlife such as Hartebeest, Kudu, Duiker, Steenbok; and vermin such as wild dogs, jackals, hyenas, leopards and wildcats, have almost completely disappeared or been confined to the uninhabited present eastern Otjozondjupa, (EEAN, 1992).

The increase in human and livestock population in the Gam area, however, has lead to a decrease in number of both large game species as well as carnivores in the region. It was reported that large game were illegally hunted by Herero people who have resettled from Botswana (Stander, pers. comm., 1997). On the other hand, predators such as lions, leopards, wild dogs, spotted hyena and cheetahs are also being killed especially when they attack livestock (Stander, pers. comm., 1997). For example, it was learnt that a leopard was killed a few days before the study visit at 'borehole number 5' (Kahaku, pers. comm., 1997).

Environmental Information Services and Environmental Evaluation Associates of Namibia (1994 citing HKW Engineering, 1992) argue that as recently as October 1992, during the development of the Roads Master plan for the Gam area, the repatriation of the people was not considered possible and game was thought to represent a major land use option for the area. However, despite all the concerns, the Gam district was eventually chosen as the most viable area for resettlement because of its vastness, and its virtually uninhabited nature (MLRR, 1994).

Notwithstanding its uninhabited state, the ecology of Gam, like any arid and semi-arid land, can deteriorate quickly if misused. Scoones (1993) argues that in many dryland areas, the utilisation of wildlife resources may be capable of producing higher yields than could be obtained by concentrating on domestic animals. Despite the fact that there was no data to substantiate the number of animals lost as a result of the resettlement programme in Gam, "it can be clearly stated that Gam as a 'habitat' is lost" (Stander, pers. comm., 1997). The present habitat destruction may lead to changes in species number and composition which will in turn lead to more loss of biological diversity.

5.2.5 SOCIO-ECONOMIC CONDITIONS, GRAZING AND RANGELAND MANAGEMENT

The principle economic activity of the Herero settlers in Gam is extensive livestock farming. Whereas cattle plays an important role in the social and economic status, small numbers of sheep and goats are kept on a subsistence scale (Kozonguizi, 1995). Like the rest of pastoral societies, livestock production of the Herero is influenced to a certain extent by socio-cultural factors, particularly herd size and composition. McMaster (1990) argues, that traditionally, pastoralists in dry areas kept as many cattle as possible; but one tactical response to prolonged pressure on vegetation was to keep more sheep and goats, and fewer cattle.

Transhumance, as mentioned in chapter four, was a strategy traditionally used by the Herero community residing in Gam prior to the resettlement programme; although this movement was constrained to a lesser extent by the presence of a plant poisonous to cattle, *Dichaepetalum cymosum* (Kozonguizi, 1995). Mobility was designed to obtain the minimum resources, such as pasture and water for the domestic herds (Hines, *et al.*, 1995).

However, with the establishment of a resettlement area and provision of boreholes in the Gam area, the transhumant movements have been limited. The transition to sedentary patterns of land use, by limiting movement has promoted livestock concentration around watering points in Gam, leading to localised destruction of rangelands. Prior to the resettlement programme, traditional nomadic grazing methods closely resembled those of 'wild grazing animals' (Smith, 1992), and until borehole interventions distorted the original patterns, they were on the whole well adapted to the ecology of the semi-arid zones, such as Gam.

5.2.5.1 Grazing Patterns

The growth of human and livestock populations and a secure water supply has been instrumental in the extension of pastoral activities in Gam. This has led to profound impacts in terms of sustainable resource use and land productivity of the area. Since animals use boreholes as permanent water points, the land around such boreholes experiences continual degradation.

Livestock grazing in the study area are primarily cattle, goats, donkeys, horses and a few sheep. The animals are grazed in an open extensive system. Large livestock like cattle, donkey and horses are left to roam freely over the area and only returned to a central point for water (MPhil. Baseline Report, 1997). During the investigation period, each borehole had a year-round diesel pump supplying water to a drinking trough, and close to the trough was a fenced kraal for keeping the animals when drinking water.

5.2.5.2 Rangeland Management and Carrying Capacity

Rangeland management practices such as rotational grazing was not practised in Gam. It was learnt that the Ministry of Lands, Resettlement and Rehabilitation was responsible for controlling livestock number and administering rotational utilisation of the boreholes in order to avoid overgrazing (Shikongo, pers. comm., 1997). However due to fact that most of the settlers were still in temporally settlements (in the Gam receiving camp) and more were still arriving, it was difficult to control livestock numbers (Shikongo, pers. comm., 1997). The traditional transhumant mobility had been attempted by establishing movable cattle post around some boreholes away from the main settlement. However, some farmers have chosen to settle permanently around the cattle posts. For example, 'borehole number 5' was essentially established away from the main settlement so as to ease pressure on grazing, but has turned out to be a permanent settlement.

Lack of rangeland management and the resulting range degradation in Gam was characterised by three main factors. Firstly, lack of proper structures for monitoring cattle numbers or families using a particular borehole. Secondly, since most families were not yet settled and some were still coming in, it was difficult to settle people around one specific borehole. In addition extended family culture hindered the efforts at assigning new-comers on different boreholes as they preferred to join their relatives (Shikongo, pers. comm., 1997). Thirdly, emergencies during borehole breakdowns which were followed by long delays, necessitated herders taking their cattle to any neighbouring boreholes. Therefore it was irrational to restrict livestock to one borehole.

Carrying capacity of the area has been estimated as 1:15 (1 Large Stock Unit per 15 ha.), implying that each borehole will accommodate 300 Large Livestock Units (MLRR, 1994). According to the Agricultural Extension Officer responsible for the area, however, this estimation does not hold on the ground as there are more animals than required per borehole (Kakujaha, pers. comm., 1997). Except for Otjiserandu where grazing is limited by *Dichaepetalum cymosum*, more than 300 cattle were found to be using one borehole during the study (MPhil. Baseline Report, 1997). A summary of stocking levels obtained from farmers is shown in Table 5.3.

Impacts of the herd size on grazing were far from exclusively negative, with the widespread occurrence of the palatable annuals under high herbivory use pressure within 50 m from the boreholes. The level of environmental damage was assumed to be in part related to stocking levels and to the length of the use. The commencement dates were obtained from borehole users, though it was not possible to get from the farmers the actual number of animals using a particular borehole at a particular period.

Table 5.3: Stocking Levels of the Boreholes in the Study Area in Gam (MPhil. Baseline Report, 1997)

Locality	Borehole Number	Number of Animals	Number of Households
'Borehole Number 5'	WW 34451	600 cattle; more than 1000 goats	7
Otjimihama	WW 34463	About 2000 animals	10
Otjiserandu	WW 34846	300 cattle	16

Walker (1993) argues that although some of the degradation of rangelands can be attributed to deliberate overgrazing in order to make quick profit, by far the majority of rangelands degradation lies in a lack of understanding of how rangelands work. When considering the impact livestock have on the environment it is necessary for planners to examine the details of habitat use patterns before assuming carrying capacity of the land.

Assessments of carrying capacity that do not assess the complex spatial use of vegetation resources and of a diverse range of habitat types scattered across the landscape can give a distorted picture. In the case of Gam, it seems that the assessment of carrying capacity underestimated the effects of the *Dichaepetalum cymosum* on pasture availability. The occurrence of this plant has inhibited farmers' willingness to settle around some borehole with consequent overstocking in areas with lower densities of the plant such as Otjimihama (see Table 5.3).

The problem arising from mismanagement of livestock in Gam has become increasingly serious as the number of people with livestock has increased. Kozonguizi (1995) argues that population pressure, combined with lack of appropriate management of livestock, is the major environmental problem in Gam. Other problems are derived from inappropriate land use management, these include: overgrazing; overstocking around boreholes; and lack of active management such as, herding, rotational grazing, adaptive management strategies based upon variable rainfall and grazing availability.

5.2.5.3 Loss of Livelihoods

Apart from land use changes, the resettlement programme in Gam has also affected the resident communities in the area. As mentioned in chapter four the Bushmen initially utilized the various habitats in the Gam area for their livelihoods. Botelle and Rohde (1995) argue that the social economy of the Bushmen populations has inherent strengths which are continually ignored, these being the relatively equal access to natural resources, and a more diversified and sustainable system of natural resource use. As far as Bushmen are concerned, losing control of the land and natural resources in the Gam area means a loss not only of a subsistence economy, but also the possibility of playing an equal role in developing a mixed economy (Botelle and Rohde, 1995).

5.3 EXPLANATION OF LAND DEGRADATION IN THE GAM RESETTLEMENT AREA.

The explanation of the problem of land degradation in a specific case may seem straightforward, but in actual fact is usually quite complex (Belshaw, *et al.*, 1994). Apart from physical processes, as elaborated on in chapter three, there are a wide range of human factors which contribute to land degradation. Darkoh (1993) suggests that explanations for land degradation must be sought in the political economy of the societies in question. Thus the phenomenon of land degradation is a societal rather than a physical problem. Belshaw *et al.* (1994 citing Blaikie and Brookfield, 1987), suggest a chain of explanation for the process of land degradation at a specific site (Figure 5.3).

Darkoh (1993) also comments on this chain of explanation of land degradation which links a series of ever-widening frames of reference. The chain moves away from attempts at location-based explanation of physical symptoms towards an examination first of local; then national: and finally international, political economy-based explanations (Darkoh, 1993).

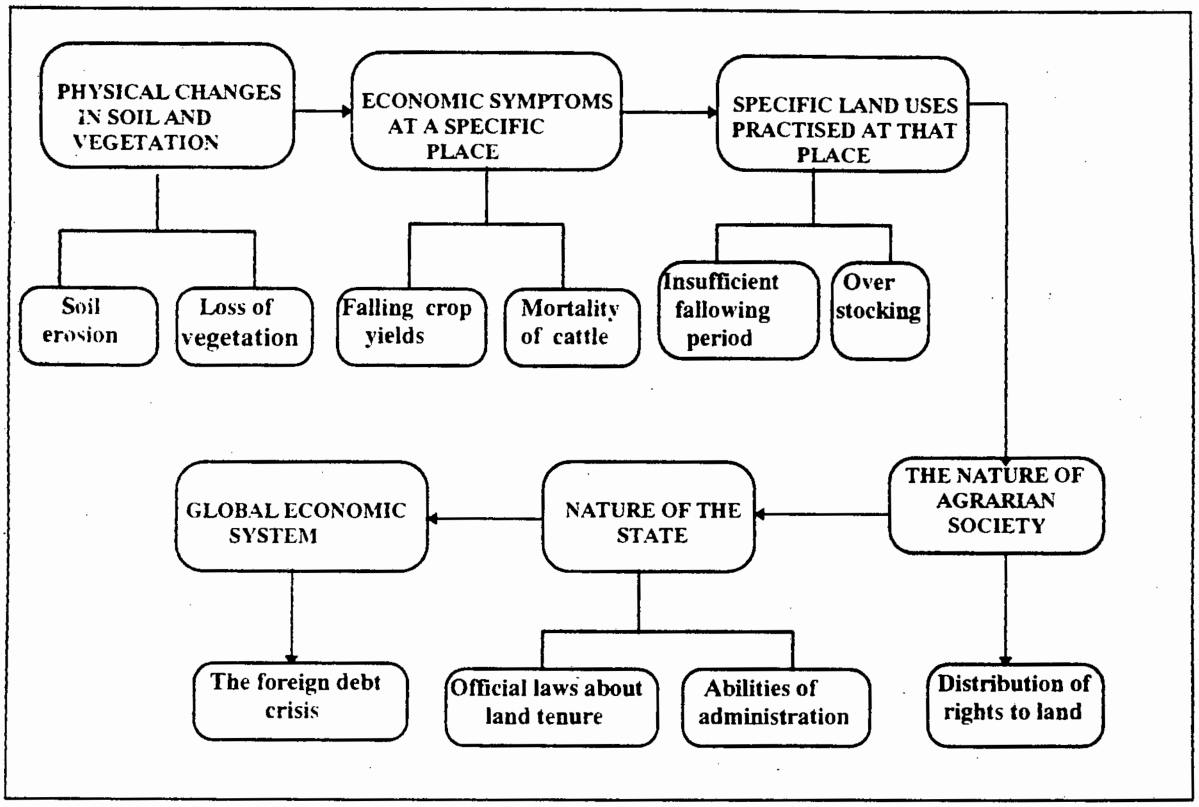

Figure 5.3: Explanation of Causes of Land Degradation: "Chain of Explanation" (Adapted from Blaikie and Brookfield, 1987)

The explanations for land degradation in Gam are linked in a similar chain of cause and effects which will be elaborated on in this section. The section will examine the political, and socio-economic factors in Namibia contributing to land degradation in the Gam resettlement area as already described in the previous sections of this chapter.

5.3.1 POLITICAL AND ADMINISTRATION SYSTEM

In most countries in Africa, there has been a tendency to address land degradation problem by simply tackling symptoms rather than addressing the fundamental problems Darkoh (1993). This approach has been viewed as a "conventional" or "technocratic" approach merely seeking a technical solution, thereby excluding the social economic system as a causal element (Darkoh, 1993 citing Baker 1981, p.1). Commenting on various studies of land degradation, Darkoh (1993 citing Barker, 1981, p.1) argues further that "if we step back one pace and pull the policy and decision-making system itself into the array of variables, then the environmental problem denotes itself into a set of symptoms malaise within the broader issue of the political economy."

Dewdney (1996) argues that in Namibia, many policies have not ensured sustainable use and have promoted land degradation. This section highlights some of those policies in Namibia which are of particular relevance to the problem of land degradation in Gam. These will include policies addressing: resettlement; water supply ; and communal land.

5.3.1.1 Resettlement and Land Degradation

There is no single, overall resettlement policy document in Namibia (Dewdney, 1996). However, it is Government policy that resettlement projects should be self-sustaining after a 3-5 year period (Dewdney, 1996). According to the National Development Plan 1, resettlement policy prioritises three groups. First, returnees who have no land and no job; second, demobilised ex-servicemen and their dependants who have no land or no job; and the third group, small scale livestock farmers with maximum of 15 head of cattle and 90 head of small stock (National Planning Commission, 1995). In high rainfall areas, settlers are typically involved in subsistence crop production whereas in drier areas such as Gam, livestock farming predominates (Dewdney, 1996).

The Gam resettlement Programme was established on the initiative of the government with its timing greatly influenced by political expedience (EEAN, 1994). As a result of the political objectives, appropriate government intervention in the implementation of the programme was affected. The manner in which the resettlement programme was established has led to localised degradation particularly around borehole and some settlements within the area. Some of the factors which might have contributed to land degradation problems in the Gam resettlement area are discussed below:

- **Planning and Selection of site**

A lack of detailed and comprehensive planning has been cited as a major factor behind poor performance and land degradation of most settlement projects (Oberai, 1988). Planning of the Gam resettlement was treated as if it was a separate issue rather than an integral part of the land use planning process within the Otjozondjupa region (Dewdney, 1996; Shumba, pers. comm., 1996). The resettlement programme was therefore characterised by: lack of policy guidelines for regional development and agriculture in particular; reactive, crisis management approach; lack of policy guidelines for appropriate land use planning and sustainable use of natural resources; lack of acknowledgement of environmental constraints in the area and the dependency syndrome due to lack of policy guidelines and erratic institutional support (EEAN, 1992).

One of the most crucial aspects of planning is selection of a suitable site. As far as selection of a site is concerned, the physical aspects and environmental conditions in general must be appropriate (Oberai, 1988). Essentially, ecological and socio-economic baseline surveys ought to be conducted to ascertain suitability of a site for intended land use and management plans. The Gam resettlement programme was not preceded by serious, comprehensive, in-depth ecological, economic and social feasibility studies. Commissioning of the studies was done after the resettlement programme was already under way (EEAN, 1994; Bottelle and Rohde, 1995). However, as far as site suitability is concerned, the Gam resettlement programme is considered to be a highly ambitious project in a marginal area (Dewdney, 1996).

The main reason cited with regard to the lack an appropriate planning before the implementation of the Gam resettlement programme was time constraints behind "intense internal and international political and social pressures to expedite the project implementation without delay" (MLRR, 1994, p.24). Oberai (1988), giving examples of settlement projects in Somalia and Ethiopia, argues that settlements which are established in a period of national emergency tend to suffer from lack of planning. For example, the resettlement scheme at Dujuma in Somalia where "things were done in a quick manner, and ambitious and unrealistic goals were set to be achieved in a very short time. After five years, the project had be abandoned because of the salinity of the soil" (Oberai, 1988, p.29).

Settlement schemes in many countries have failed where ecological and socio-economic considerations have not been properly understood. Oberai (1988) argues that it is futile to settle people on land that does not provide them with enough elasticity to allow for changes in population number or variations in rainfall and which do not fulfil livelihood requirements.

- **Administration**

Good management and administration are important for achieving the objectives of a resettlement programme. Oberai (1988) argues that it is essential for the organisation or department entrusted with the implementation to be able to harness the help and assistance of other government departments.

In the case of the Gam resettlement programme, the Ministry of Lands, Resettlement and Rehabilitation was tasked as the co-ordinating and resettlement management ministry. To facilitate effective co-ordination of all the line ministries, an Inter-ministerial Technical Committee for the Repatriation of Hereros was established. This committee has been responsible for co-ordinating repatriation activities, *inter alia* the location, possible entry points and the assessment of potential resettlement areas (MLRR, 1994).

However, the line ministries responsible for the implementation of the resettlement programme were not well co-ordinated, hence lack of commitment. Other factors also contributed to inadequate involvement of some line Ministries, and these included: lack of involvement from the beginning, (hence they felt like they were forced to do what did not necessarily coincide with their own priorities); clashes of interests and/or priorities between those who favoured conservation, opposing on principle those in favour of development; and concern about the scale of costs involved in the resettlement programme (MLRR, 1994).

The weakness in the co-ordination of government departments involved in the resettlement programme was observed in Gam during the study. As already mentioned, the Ministry of Lands, Resettlement and Rehabilitation was in charge of managerial tasks at the settlement. However, the Ministry could not solve some of the issues emerging from the settlers which were beyond the Ministry's capabilities. A good example to illustrate this is the issue of borehole maintenance. Amongst the three boreholes in the study are, only 'borehole number 5' was found to be in good operating condition (MPhil. Baseline Report, 1997). The other two had mechanical problems and it was reported that technicians from the Department of Water Affairs usually take time to fix the broken boreholes since they have their own departmental duties to attend to (Shikongo, pers. comm., 1997). Such delays, as already mentioned, exacerbated land degradation around functioning boreholes. In addition, people were not given relevant training to foster sustainable use of local resources such as boreholes maintenance. This partly added to a tendency for regarding boreholes as government property and a consequent lack of motivation for sustainable use (MPhil. Baseline Report, 1997).

Community development programmes, veterinary services as well as health services seemed to be inadequate. For example farmers at Otjiserandu complained about the long distance they have to travel to Tsumkwe to buy drugs for livestock due to a lack of extension officers stationed within the area (Christopher pers. comm., 1997). Lack of health education partly contributed to ill-health; for instance at Otjimihama where the borehole had no separate tap for human consumption hence people had to draw water form the livestock trough (MPhil. Baseline Report, 1997).

Oberai (1988) argues that to be successful, resettlement operations require a transfer of responsibilities from the government to the settlers themselves. Otherwise a dangerous dependency may rise with negative effects on the resources. Action should be taken from the outset to prepare for the transfer of management responsibilities to the settlers. If the government overcomes the tendency to retain decision-making and managerial functions and encourage the emergence of recognised community leaders, this will stimulate local initiatives and greatly facilitate the transfer of responsibilities.

Government-sponsored settlements, as currently structured, appear to have major disadvantages. The erroneous and incomplete preliminary natural resource surveys and lack of participation of the beneficiaries, have been almost universal shortcomings of the directed projects (Oberai, 1988).

5.3.1.2 Water Supply and Land Degradation

The overwhelming majority of Namibia's citizens derive their livelihood directly from the environment through various agricultural uses (Jacobson *et al.*, 1995). Environmental productivity on the other hand, depends primarily on the availability of water. However, the 'environment' is not specifically recognised as a consumer of water in the national policy on Water Supply and Sanitation (WASP) (Jacobson *et al.*, 1995). Priority for water allocation by the government of Namibia as given in the present policy is for domestic purposes (including livestock watering for both subsistence and commercial farming) and for economic activities (Dewdney, 1996).

Jacobson *et al.*, (1995) argue that because livestock is listed as a first priority, so too must the production of livestock forage which also consumes water. However, as a result of environmental water needs not being listed, the value of this resource is not considered, leading to its degradation. The exclusion of the environment as a priority use of water in the Water Policy in Namibia, has led to water provision being considered as an engineering rather than a social problem (EEAN, 1992). In Gam, water was supplied in reactive response to the resettlement emergency despite well established knowledge that water is scarce in the area. EEAN (1992) argue that water supplied in response to crises is used to promote short-term political ends and not promote sustainable development (EEAN, 1994). Moreover, water supply in the resettlement area did not involve the targeted beneficiaries in the planning. This has contributed to a lack of strategy for borehole uses and management amongst the settlers.

Perkins and Thomas (1993) argue that in recent years, the supply of water through the introduction of artificial water points into the Kalahari within Botswana as well as the southern Kalahari within South Africa, has led to the rapid degradation of huge areas. The use of boreholes allow livestock to stay all year-round in areas formerly grazed only during the rains when seasonal pans held water. Namibia is no exception; where not correctly planned and managed, provision of drinking water has contributed to massive land degradation in recent years as animals gather around water holes and overgraze the area.

Although boreholes have enabled resettlement to take place in Gam, they have also promoted land degradation in the area (Kavaa, 1995; MPhil. Baseline Report, 1997). Boreholes have attracted large numbers of livestock which concentrate around them on a daily bases; as a result local overgrazing has occurred. Notwithstanding that livestock concentration around boreholes was more intense in dry seasons (Kahaku, pers. comm., 1997); it was observed that degradation was very prominent around the boreholes even in a wet season (MPhil. Baseline Report, 1997).

As mentioned in chapter four, prior to the resettlement programme, animals were able to graze the abundant pastures during the rain season when surface water was adequate. With the provision of boreholes and the increase in livestock population in Gam, that access today has been limited as the boreholes have taken on greater importance and are the principle points of animal congregation with severe degradation around them (Perkins and Thomas 1993).

Environmental Evaluation Associates of Namibia (1994) argue that boreholes and a sudden rise in livestock population in Gam area would negatively affect the ecology of the area. "This will increase pressure on the fragile ecosystem which is unlikely to be able to cope with all the 50,000 additional cattle" (EEAN, 1994). Visible impact of overgrazing on the environment were already profound around boreholes and settlements in the resettlement area (EEAN, 1994; MPhil. Baseline Report, 1997). By contrast, in the vicinity of dams, where water is only available during part of the year, the impact of overgrazing is less critical. Experience from other areas within the region shows that degradation is more likely where water is permanently available. For example, the severe destruction of the natural vegetation and soils along the western boundary of the Omuramba Omatako river. Equally noticeable in the former Hereroland, is an encroachment by bushes, locally known as "Swarthaak" (EEAN, 1994).

Boreholes can be an appropriate solution to meeting surface water needs. If mismanaged, however, they can lead to severe environmental impacts (Perkins and Thomas, 1993). In nomadic land use systems, both pastorals and wildlife move about in a dry area such as Gam, in search of water and forage. The introduction of boreholes in Gam, however, has allowed the activity of people and livestock to become uncoupled from surface water availability (Jacobson *et al.*, 1995) (Figure 5.4). With water availability no longer limiting livestock numbers, the surrounding vegetation has become the limiting resource. As a result, vegetation cover has become degraded or completely eliminated around the borehole (MPhil. Baseline Report, 1997) (Figure 5.5).

Naveh (1992) argues that most of the changes brought about in dryland, pastoral areas, for example provision of water points, attempt to transform well adapted pastoral land use economies into 'modern' (settled) ones. However, most of these changes lack the understanding and appreciation of the in-built resilience and the true nature of the mutual adaptation and co-evolution of land use and the physical and biotic features of their landscapes. In Gam for instance, prior to borehole introduction, management systems, prolonged drought periods and unreliable rainfall distribution, and a lack of water and nutritious food in critical periods controlled the number of livestock and their movements. Together with grazing and burning practices which were well adapted to local conditions, these acted as combined natural and cultural protection and regulation functions, within a closed negative feedback loop with human population they also ensured the long-term productivity of the pastoral dryland ecosystems. In this way catastrophic droughts could be overcome and a dynamic flow of equilibrium was established between the abiotic, biological and human landscape elements (Figure 5.4).

Naveh (1992) argues that this flow of equilibrium has been distorted by uncontrolled inputs of scientific and technological information and its positive, run-away feedback couplings with increased flow of energy and material. In East Africa, Southern Africa and the Sahel, for instance, most of the natural as well as cultural negative feedbacks have been removed by the provision of water in the critical periods. However, most attempts have failed to replace these regulative feedbacks by the introduction of new, cultural regulative feedbacks of rational resources, livestock and population management. This has resulted in a vicious cycle of landscape deterioration and population explosion (Figure 5.5) (Naveh, 1992).

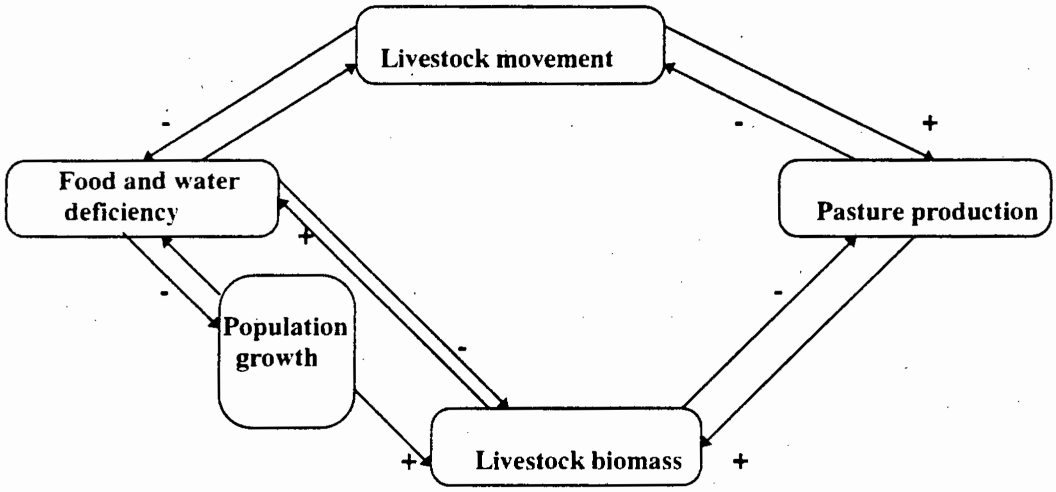

Figure 5.4: The feedback regulation of pasture and livestock production and human population in a semi-arid landscape (adapted from Naveh, 1992).

Because water is a critical factor limiting the survival of organisms living in arid regions, any change in availability of water will in turn change the environment. Herein lies the root of all environmental problems associated with water supply development in arid lands (Jacobson *et al.*, 1994). At the same time, if the borehole pumping rate is in excess of recharge, the water table will drop, and water availability for tree growth or a farmer's well will be reduced or exhausted. Therefore, there is a need for government water policies to consider the environment and the organisms it support amongst the priority users of water.

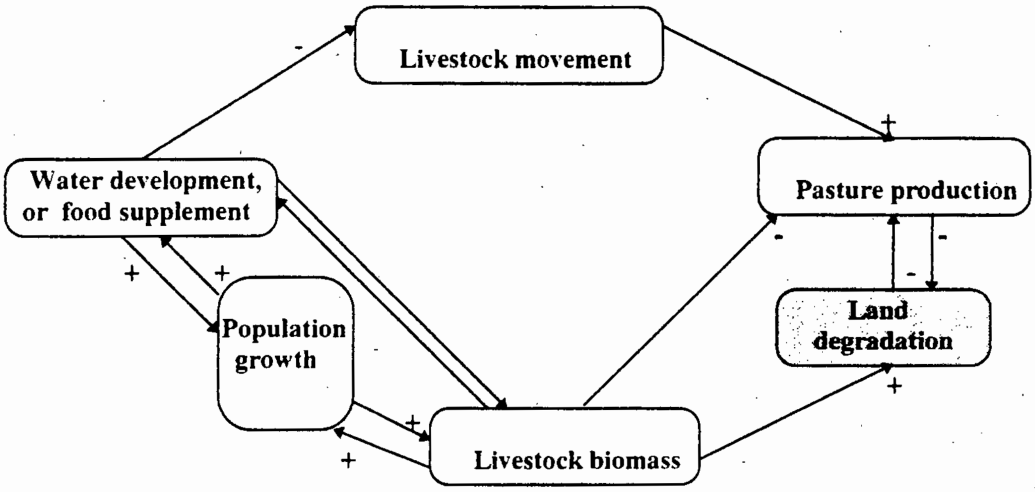

Figure 5.5: The disruption of the feedback regulation of a semi-arid landscape by water and food supplement (adapted from Naveh, 1992).

5.3.1.3 Communal Land Tenure and Land Degradation

In most parts of the developing world there are often gross discrepancies between formal and effective land tenure systems in the rural areas (Horwitz and Salem-Murdock, 1987). In Namibia all communal land is owned by the state and currently there is no comprehensive policy document on land allocation or natural resource use (Dewdney, 1996). Prior to independence, allocation of land in communal areas was regulated by a series of 'traditional authorities' or second tier authorities set up by the South African government (Rohde, 1994). However, upon independence, the laws regulating these authorities were repealed and traditional authorities no longer have the power and ability to effectively administer land tenure (Dewdney, 1996). This means that rural communities do not have secure, exclusive tenure over land and the natural resources on it (Dewdney, 1996).

Lack of a Communal Land Bill makes the legal status of land allocation in communal areas unclear (Dewdney, 1996). In practice, access to most grazing land is regulated by local principles of tenure. Permanent grazing land is held in common and is broadly available to all farmers in the village. More precisely, the land is grazed by those who have firm rights of access to local water points. However, this does not mean that strangers are denied occasional access to water, but regular access is allocated to those who habitually graze the area (Rohde, 1994).

Government policies of nationalisation of land in many developing countries promote unsustainable land use (Belshaw, *et al.*, 1994). Government ownership of the land leads to the breakdown of traditional power structures that should control pasture management. For example, a study of rangeland nationalization in nothern Iran showed that it reduced the pastoralist's sense of ecological responsibility and removed an element of personal investment, which resulted in environmental damage (Beck, 1980). This also contributes to changing community values and expectations. Traditional authorities have in former times managed communal grazing areas amongst the Herero, which indeed was the task of a village headman (Kozonguizi, 1995). With Government owning the land, the tribal authority in Gam has been limited to tasks of representing community interests to the officials of the Ministry of Land Resettlement and Rehabilitation (Shikongo; Mungenje pers. comm., 1997).

Most of the communal land in Namibia, such as Gam, is only suitable for extensive production (Ashley, 1996). Communities have user rights over the land, but not ownership of the land resources. In the Gam resettlement area, communal use of land and the associated resources is on a free-for-all basis (Kozonguizi, 1995). Belshaw *et al.* (1991) argue that without secure tenure, sustainable land use is not perceived to benefit the individual farmer. Individual improvements to the land management are discouraged by communal, free-for-all use. The same attitude applies to government-supplied improvements such as boreholes which are seen as public property with no one responsible for maintenance.

Belshaw *et al.* (1991) suggests that where a government has acquired more land than it can manage itself, which is the case of many developing countries today, devolution to more effective owners, (those who have to live off the land) should be considered. Contrary to the perceived wisdom, "such local people often have a far more long-term view of the need for environmental protection than does the state with its frequent changes of local officials if not of national-level leaders and policies" (Belshaw *et al.*, 1991). In Gam, farmers expressed concern about issues such as, degradation around the boreholes, borehole breakages and rangeland deterioration. Since the resources were regarded as government properties, farmers had no plans to change the situation (Mungenje; Christopher, pers. comm., 1997).

Smith (1992) giving an example of the Maasai and the Iraqw pastoral groups in Tanzania, argues that pastoral people view their territory from a series of loci, such as water-holes, and certain pasture areas. In so doing, they define rights and privileges of land use and how the space is used and the relationship with their neighbours' land use. Herding groups have exploitation zones that are fixed within boarding limits and that tend to become known as their territories. In West Africa, for instance, the marginal nature of the grassland zone is such that a high degree of fluidity in access to resources must remain open (Smith, 1992).

A study done in Eastern Otjozondjupa by the Directorate of survey (1994) prior to the arrival of the settlers in Gam revealed that the problem of land was seen as serious or very serious and an awareness of the existing overgrazing and land degradation could be noted. When the key informants were asked whether they would welcome Botswana Namibians, it was stated that the available grazing was not enough in particular in times of drought and consequently more respondents preferred to welcome them back without livestock than with livestock.

Tiffen (1991) argues that in the large majority of cases, farmers in the rural areas are interested in maintaining the long-term productivity of the land, or in protecting a watering point for their livestock, because they wish it to remain capable of supporting them and their children. However, good management is connected to security and authority. Farmers cannot protect the land when they do not have land rights. Normally, degradation is less of a problem when a specific body of people have rights to use a specific area of land (Tiffen, 1991). It is also well known that the worst problems of degradation may occur on land that is not individually owned.

Where traditional rights of communal land have been superseded by national laws declaring such land state property, rural natural resource management declines. Beck (1981 citing Katouzian, 1978, p.367) comments that "what actually happens in practice, is not nationalisation in that sense, but expropriation and exclusion; by removing an element of personal investment, which results in environmental damage". Tiffen (1991) argues that currently, tenure systems in developing countries betray a mixture of open access regimes, particularly around public boreholes, and more demarcated regimes where certain herders have been able to maintain some rights to control access to water and hence surrounding pasture lands.

Oberai (1988) argues that a land tenure system defines rights and obligations with respect to acquisition and use of land in agricultural areas. The ideal land tenure system therefore, is one that provides adequate incentives to produce, to adopt improved technologies and to invest (Oberai, 1988). In most cases, land settlement projects incorporate a wide array of tenure systems reflecting both local customs and the project objectives. To avoid confusion and ensure sustainable utilisation of land and the resources, settlers need to be made aware of their rights and obligations and the government must have the necessary enforcement authority (Tiffen, 1991).

One major problem facing sustainability of settlement programmes is that many governments do not have a consistent well thought out, long-term settlement policy that looks ahead to problems of adjustment and of integrating these settlements in regional plans (Oberai, 1988). In many countries there is a tendency to put a major effort into the initial settlement and to fail to plan for settlers' long term requirements.

5.4 CONCLUSION

Overgrazing is argueably the major cause of desertification world-wide. In Gam, like in other semi-arid areas, the ability of herds to range widely and freely is essential. Plants are adapted to being eaten by sparsely scattered, grazing mammals which move in response to the erratic rainfall common to these regions. In situations where grazing and water resources are scattered and seasonal, such movements can be an effective strategy for long-term exploitation of the range. Pastoralists who formerly lived or utilised resources in the Gam area copied this natural system. They moved their small groups of domestic animals in response to food and water availability. Such regular stock movement prevented overgrazing of the fragile plant cover.

The resettlement programme in Gam has resulted in a sudden population increase of people and livestock with permanent settlements located around the newly drilled borehole. The increase in the number of people with large herds of livestock has led to a sudden change of land use with negative impacts on the environment. Excessive and inappropriate grazing and other management factors have contributed to changes in the environment especially around boreholes and some settlements. In some rangeland areas, changes in the composition of grasses, particularly the loss of more palatable perennials, has occurred. Localised denudation of grass cover is quite prominent, particularly around boreholes and settlements in the resettlement area.

It is frequently pointed out that areas such as the Kalahari, and indeed much of the Sahel, are completely flat and therefore not susceptible to soil erosion in the accepted sense. Nevertheless, when the vegetation cover is removed degradation does occur. Loss of plant cover exacerbates other degradation processes such as soil erosion, loss of seed-banks, reduced infiltration rates, loss of fertility and further environmental disruption.

The Government of Namibia decided to locate the resettlement programme in Gam based on the fact that the area was seen to be uninhabited. Although the area supported hunter-gatherers and traditional pastoral herding activities; it was assumed that the area was available as a grazing resource (EEAN, 1994). However, planning for the Gam resettlement programme made no attempt to understand the whole ecosystem. This is substantiated by lack of an environmental assessment prior to the commencement of the resettlement. Consequently, the resettlement programme in Gam and the subsequent drilling of boreholes have disturbed the traditional transhumance patterns, leading to land degradation in the area.

The ecology of Gam as with other arid and semi-arid lands, can deteriorate quickly if misused. Generally land use systems in the Gam area have changed form pastoralism to sedentary, non-rotational farming. Thus the resilience through the mechanism of human and animal migration has been impaired. The provision of water has tempted the people to change their former transhumant mobility.

The main problem in the Gam area is water scarcity. Although water deficit in itself is no reason to consider an ecosystem such as Gam to be fragile, it sets limits and rules for agriculture. These rules have not been kept since the resettlement programme was established in Gam and this change has resulted in ecological damage.

Despite estimates based on grazing potential, water is the ultimate limiting factor in the area and determines whether any animals can survive for more than a few months at any particular place. Once reliance is placed upon grazing in one particular area in the Kalahari on a long-term basis, a necessity in a system that relies on the boreholes all the year round, rangeland degradation becomes a reality even at recommended stocking rates. The resultant degradation leads to the eradication of the most palatable grass species and ultimately to bush encroachment. The main causes are the reduced distances which livestock now roam, and the heavy concentration of humans and animals around new boreholes.

The local inhabitants are well aware of the environmental problems associated with the present system of livestock management in Gam. This is partly due to the rapidity with which changes are taking place and because of the obvious nature, such as loss of vegetation cover around boreholes, over-browsing of woody vegetation near boreholes and settlements, and the presence of invasive herbaceous unpalatable species.

It is clear that one of the factors causing degradation of the rangeland in Gam is overstocking based on the resources available; and the reasons for this have both political and social origins. In this instance, the social role and importance of livestock "wealth" to the Herero farmer should not be underestimated.

It has been noted that there has been a general tendency to attribute the causes of land degradation "simplistically or mechanistically" to either physical factors such as soil erosion or human factors such as overgrazing and overcultivation. While these factors are real, and do give rise to land degradation, the tendency has been to simply accept them *per se* and not to question the historical, social and institutional factors behind them.

The failure by planners and managers to correctly relate cause and effect has been cited as a primary cause of land degradation in drylands such as Gam. Rangeland degradation, for instance, depends on how livestock are managed, and not only the numbers. Therefore incentives that encourage the keeping of livestock need not necessarily aggravate unsustainable use, if they encourage good management. But livestock incentives such as permanent water points often aggravate mismanagement and rarely encourage more sustainable management.

This chapter has also highlighted the importance of secure tenure and indigenous knowledge in preserving the social and ecological viability of customary systems of resource management. Without security of tenure in the Gam resettlement area, the incentive and opportunity to manage renewable natural resources in a sustainable manner is significantly reduced. The current pattern of developments in the Gam area are seen as resulting not only in ecological devastation but also in unclarified property rights; unsustainable utilisation of boreholes, and displacement and loss of livelihood for the former resident communities such as the Bushmen. Indeed, the current land use system threatens the very culture and way of life of entire communities.

Inappropriate management of natural resources in the Gam resettlement area is due to:

- a rapid population increase that has failed to make appropriate adjustments in their management of the resources base upon which they and their livestock depend;
- the absence of long-term land use plans and strategies for the region which has resulted in the lack of co-ordination and poor government and institutional support including reactive water supply interventions;
- a land tenure system that permits free access to communal resources and no accountability for their use; and

- an inadequate information base and extension service.

With the repealing of traditional institutions there have been varying, but generally declining degrees of common property resource management through traditional institutions. The formal ownership and management of water and pasture by the state have led to greater problems of controlling access and use of these resources in Gam. Local communities have no legal power to decide and enforce decisions about rights of access to local resources. Moreover, there is no state-provided system to ensure sustainable use of the resources.

CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

This dissertation has identified a number of interrelated human factors which contribute to land degradation by exacerbating the natural processes of land degradation in drylands. It has argued that loss of productive land through various forms of degradation is the result of a complex set of often interacting economic, social, demographic forces and policy objectives; as well as topographical and climatic factors. The main focus of the dissertation however, was to examine the Namibia's Government decision on a resettlement programme in Gam; and to evaluate the impacts of the resettlement on the ecology and socio-economic adaptations in Gam.

The dissertation has particularly indicated that inappropriate land use, emanating frequently from development or policy objectives, is the basic cause of land degradation in arid and semi-arid environments. Most national governments do not consider the ecology and socio-economic adaptations of drylands in their policies and plans, hence contributing to the initiation of land degradation. Although most of the human actions emerging from such policy objectives generally aim at gaining high productivity, they tend to overexploit arid environments by exceeding the limits to productivity thus leading to rapid land degradation.

Natural conditions in the semi-arid Gam area entails a certain degree of susceptibility to ecological hazards. Indigenous land uses have proved to be essentially compatible with the natural resources constraints of the Gam area. Recent population changes have led to the excessive use of these resources, on the one hand, and to the implementation of land use methods that have initiated land degradation particularly around boreholes. It is apparent that the current land use systems and the associated livestock management practices are not compatible with the semi-arid environment of the region and consequently not sustainable.

Emerging from the discussion and conclusions drawn from the evaluation of human impacts on the environment in chapter five, the following recommendations are suggested:

♦ Strategic Environmental Assessment

In order to address the problem of land degradation, an integration of biophysical and socio-economic understanding with policy, planning, macro-economics, population dynamics and other framework conditions to produce an overall understanding of the process at ground level is required. In achieving this end, the Government of Namibia must take cognisance of the environmental implication of decisions taken at strategic stages of policy, plan and programme formulation, (this may apply to other national governments in arid and semi-arid regions). Therefore:

- Programmes for environmental protection must become integral parts of policies and overall development strategies.

- The role of resettlement policy needs to be reconsidered and become more focused. Specific attention should be paid to the constraints of the environment and to co-ordination and crucial interactions between government sectors in order to ensure viability of the resettlements.

- Policies which set priorities for water usage must take a more realistic view of the environment as a primary resource upon which the agricultural sector depends. In the case of Gam, it is recommended that future development of the area should be undertaken in the light of careful monitoring and use of the underground water reserves in order to ensure sustained livestock production in the area.

♦ Holistic land use planning

In order to avoid over-exploitation of natural resources, an integrated long-term national land use planning system must be developed. Regional and local land use strategies such as resettlement programmes and borehole provision should be informed and subjected to this planning. To achieve this end the following should be undertaken:

- There is an urgent need for planners and administrators to understand the effects of economics and political decisions made either by countries or organisations, both giving and in receipt of aid, which may well have adverse ecological effects.

- Efforts should be made to achieve an understanding of pastoral resource systems particularly in terms of their attitudes and perceptions. Attempts should be made to break the link between pastoralists and their dependence on external inputs such as permanent water points. The dynamics of nomadic grazing must be studied to determine the optimum techniques of production without overgrazing.

- The contribution of local communities in decision making and planning should not be overlooked. Local knowledge not only holds the key to historic capabilities of the land, but also indicates if there were strategies developed by past peoples to exploit the land that modern land users may be unaware of, and which might prove valuable.

◆ **Land tenure**

In order to achieve sustainable use of natural resources, policies and programmes should enhance the livelihood security of local communities, *inter alia*, through recognition of their customary rights over natural resources. The success of such efforts is critically dependent upon their ability to strengthen the technical, organisational and managerial capabilities of rural communities and organisations.

- Necessary measures, including land rights laws, must be issued to regulate the rights of certain segments of the population or communities to use grazing areas, so as to encourage appropriate management and to protect the rights of local users. Where there is ambiguity over user rights such as in the Gam area, pastures are often recklessly exploited to the extent of complete destruction. However, the tenure regime should be determined by the nature of the farming system. Extensive subsistence regimes require maximum mobility and significant cattle numbers. It is irrational to impose an intensive system on areas with high variability in rainfall and/or large numbers of subsistence farmers.

♦ Appropriate rangeland management

If land degradation is to be halted in arid and semi-arid regions, then governments must make a positive commitment to the importance of pastoral nomadism. Efforts should be made to encourage mobility and maintain full utilisation of the rangeland (Perkins and Thomas, 1993). However, it is not suggested that traditional practices are perfect; they can cause damage, but experience has shown that improved understanding of pastoralists makes land use practices more sustainable (Brockington and Homewood, 1996).

- Management practices should be based on flexible, adaptive management strategies (reducing and increasing the animals present on the range as conditions vary). The increased migration of cattle (or its possibility) will increase the ecological carrying capacity of the rangeland. A critical issue for range management thus becomes the maintenance of habitat patchiness to ensure the resilience of the system. Hence, migration should be helped rather than hindered, with obvious ramifications for the drilling of unplanned water points.

- To solve the problem of overgrazing in the Gam area, it is recommended that the first steps be to control the number of grazing animals to conform to the carrying capacity of the land. The problem would partly be solved if an even distribution of animals on all available pasture were achieved. This could be promoted by a more even distribution of watering points, encouragement of nomadism and transhumance, and the rotational use of boreholes so as to control grazing activities.

- Rangeland management should also imitate or recreate natural conditions. Wild animals graze selectively (grazers and browsers), move about constantly and do little damage to vegetation. The presence of a great number of species results in a relatively uniform use of the range, as they have preferences for different plants. The negative feedback in the system is also an important factor that leads to long-term resource use and sustainable stocking rates. While the settler adaptation to the Gam environment would be problematic given the history of resource constraints cited in chapter four, the indigenous land use systems nonetheless offer the only realistic basis on which ecologically sound management can ultimately be generated. Traditional methods such as the migration of livestock over extensive areas are seen as making more optimal use of environments in constant flux such as Namibia's (Werner, 1994).

- **Regular monitoring and evaluation of human impacts**

A monitoring system for evaluating the impacts of human activities on the biophysical and socio-economic environment should be developed. In order to be effective, monitoring should be integrated with awareness or education as regards sustainable utilisation and management of resources (such as borehole maintenance and rangeland management and carrying capacity). This can be achieved through effective extension services, with extension officers stationed within targeted communities.

In summary this dissertation has argued that the Namibia's government decision on a resettlement programme in Gam, was a political decision which did not take into account the area's ecological components and the socio-economic adaptation. The most serious repercussion of the resettlement and the subsequent developments has been increased pressure on natural resources, with negative impacts on the environment. Factors underlying the problem of land degradation in Gam, as in the rest of drylands include: lack of political will; lack of participation by the people; lack of regular monitoring; lack of suitable mechanisms for instruction in the appropriate land use practices; lack of close supervision and control of grazing; introduction of technology without regard for all factors in the environment; lack of tenure policies; and failure of governments to make land degradation a priority issue.

Land degradation process therefore, require very careful description from physical and biological viewpoints, and may be accelerated or reversed by social programmes (Whitney, 1987). High priority should be given to the assessment of the ecological capacity of the area to withstand exploitation. This will give governments and aid organisations a clear indication of the limits to which they can press development without causing ecological degradation.

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PERSONAL COMMUNICATIONS

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APPENDIX 1

COMPONENTS EMPLOYED IN THE DESCRIPTION OF SOILS

- **Relief:** Within the radius of 100 m including the relation of the site to the main drainage lines, whether the topography was flat or hilly.

- **Surface stoniness**: Description of lithology, size, shape, and abundance of surface stones. Terms for stone abundance was based on Gardiner and Dackombe (1993 adapted from Hodgson, 1974):

Term	Abundance (%)	Alternative term for use when standard terms are awkward in context
Stoniless	< 1	
Very slightly stony	1 - 5	few stones
Slightly stony	6 - 15	common stones
Moderately stony	16 - 35	many stones
Very stony	36 - 37	abundant stones
Extremely stony	> 70	extremely abundant stones

- **Form of soil surface :** Lightly, moderately or heavily trampled/compacted.
- **Soil texture:** Description was done in the field based on a sample set of tests for determining the class of soil texture based on Gardiner and Dackombe (1993 adapted from Shaw 1928).

Sandy : Loose and single grained. Individual grains can be readily seen and felt. When squeezed dry it will fall apart when pressure is released. When moist it will form a cast which crumbles when touched.

Sandy loam: A sand loam contains much sand but has enough silt and clay to make it somewhat coherent. Individual sand grains can be seen and felt.

Squeezed when dry, it will form a cast which readily falls apart but when moist a cast can be formed which will bear careful handling without breaking.

Loam: An even mixture of different grades of sand, silt and clay. Has somewhat gritty feel, yet it is fairly smooth and slightly plastic. Squeezed when dry, it forms a cast which will bear careful handling

- **Signs of erosion:** evidence of flooding, soil erosion by wind and water.