Economic Policy Reforms and Meso-Scale Rural Market Changes in Zimbabwe

The Case of Shamva District

Edited by
LOUIS MASUKO

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Chapter 3

ENVIRONMENTAL ISSUES AND LAND-USE IN THE SHAMVA DISTRICT: A STUDY OF THE IMPACT OF SOCIO-ECONOMIC ACTIVITIES ON THE NATURAL ENVIRONMENT

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SECTION I: INTRODUCTION

1.1 STUDY FRAMEWORK

This chapter partly addresses the relationship between land-use and the natural environment in the small-scale farming sector under a climate of macro-economic liberalization. This theme covers two interrelated aspects of land and natural resources management, namely, the use and products of their management, and the changing land tenure systems. There are two main areas of focus in this theme:

(i) The relationship between land-use/cover and the physical environment, and

(ii) The changing nature of land and natural resource markets and systems of land tenure and administration.

1.2 AIM AND OBJECTIVES

1.2.1 Aim

Within this broad theme/framework the basic objective of this chapter is to relate socio-economic change and activities to environmental conditions. It is argued that environmental conditions are true reflections of socio-economic activity. It should, therefore, be imperative that environmental issues be rigorously analysed. Furthermore, wherever possible, emphasis was on changes that have occurred in the past five years since the inception of ESAP.

1.2.2 Objectives

This chapter has three major aims:

1. to map out the status of the natural vegetation and other land-uses/cover in the communal and resettlement lands of the Shamva Rural District,
2. to assess the importance of soil and vegetation conservation within this area, and
3. to estimate the degree of land-use conflict in communal lands using aerial photo analysis.

1.3 HYPOTHESIS

The basic hypothesis is that soil and vegetation degradation in communal lands is largely due to conflict between physiographic patterns and land-use. The corollary will be that land degradation in communal lands is caused by lack of knowledge about environmental issues.

1.4 RESEARCH INSTRUMENTS AND METHODS

Although this chapter is largely an attempt to map out the relationships between land cover and erosion potential, ancillary information was required to explain some of the patterns that were observed during the mapping exercise. This ancillary information was largely related to socio-economic activities and their impact on the natural environment, particularly vegetation and soils. However, such information was analysed in greater detail by other members of the research team.

1.4.1 Analysis of Socio-economic Activities and the Natural Environment

Primary data was collected through a household survey. Such a survey was seen as appropriate since it is the locals that are the fundamental decision makers over land-use patterns and environmental management. The survey was meant to provide information on the interrelations between land-use, agricultural practices and the natural environment, i.e., grazing lands, woodlands, soils and water resources. The survey utilised a questionnaire and will be followed soon by in-depth focused group discussions. Four hundred and sixty-eight households were included in the sample, accounting for approximately 10% of the population.

The questionnaire covered eight major parameters:

1. Socio-economic and demographic background of each sampled household.
2. Land tenure issues and migration.
3. Economic labour activities.
4. Transport and marketing.
5. Non-farm activities.
6. Energy and the environment.
7. Organizational affiliation.
8. Demographic patterns.

Secondary data was derived from published maps (hydrological, geology, vegetation, etc.), institutions involved in environmental issues such as the Meteorological Office, Agritex, MLGRUD, etc. Of particular importance were AGRITEX reports and officials who have the mandate for sustainable environmental management in small-scale farming areas.

1.4.2 Erosion Hazard Mapping

The steepness of the slope was seen to be the main control variables in assessing erosion hazard under natural conditions. Steepness is also often related to possible erosional processes and the development of particular erosional features. The hazard maps were created by mapping physiographic units. These are mesoscale physical features normally defined by average gradient and height above sea level. Under natural conditions their development is controlled by climate, lithology and vegetation cover. They are the major controls of degradational and depositional processes through their influence on run-off, aspect, pedological processes and vegetation cover.

Either deliberately or unwittingly, human activities have responded to the physiographic patterns. Through studies of the relations between land-use and physiography in different cultural and climatic regions, it is now accepted that environmental degradation is usually a result of conflict between physiography and land-use, particularly in marginal areas. The table below summarises the framework within which erosion hazard assessment was done for the Shamva District.

Table 1.1: Relations between land-use and physiography

Physiographic Unit	Mean Slope	Erosional Processes	Erosion Risk
Steep Slopes/ Summits	>10%	Soil slip, rilling, slope wash, landslides	Usually stable. High risk when disturbed
Foothills/ Footslopes	6–10%	Piping, gullying, slopewash	Moderate to high
Alluvial/ Colluvial Plains	2–6%	Rilling, piping, sheetwash	Moderate to minimal
Alluvial Terraces and Floodplains	0–2%	Headward erosion, deposition, stripping	High risk particularly close to stream banks

1.4.3 The Vegetation Land-use/Cover Mapping

Vegetation cover is probably the most important factor affecting erosion in Zimbabwe. Land-uses related to farming and other activities has generally affected the status of vegetation in many parts of Zimbabwe causing serious environmental problems. It will be suggested here that land-use planning and vegetation utilisation should take cognisance of the overall influence of the physiography of the landscape. Aspects of land status, such as soil fertility, erodibility, ground water, etc., tend to vary with physiographic position in the landscape. If this is accepted in land-use planning it would go a long way in avoiding undesirable conflicts that would lead to erosion and other environmental problems.

Aerial photographs were the primary source of land-use and vegetation cover data for the District. In this chapter we divided vegetation and land-use into seven categories which were used in mapping from aerial photographs. This followed after ground truthing of the tones and textures shown on the aerial photos. The seven categories were:

1. **Cultivation**
   a) open
   b) agroforestry
   c) horticulture
   d) abandoned
   e) with sparse trees
2. **Forest**
   a) indigenous
   b) plantation
3. **Woodland**
   a) dense savanna
   b) open savanna
4. **Bushland**
   a) dense
   b) open
5. **Grassland**
   a) open
   b) savanna
   c) bushy
6. **Wetland**
   a) grassy
   b) bushy
   c) cultivated
   d) miombo
7. Others
   a) gulleys
   b) streams/rivers
   c) bare ground
   d) roads
   e) badlands
   f) riparian vegetation

SECTION II: BACKGROUND TO SHAMVA RURAL DISTRICT

In this section the aim is to present a basic guideline to the Shamva environmen The information has been synthesized from a variety of secondary sources.

2.0 PHYSICAL BACKGROUND

2.0.1 GEOLOGY

The area between Bindura and Shamva towns is underlain by Early Precambrian metasediments of the Shamvaian System or Group. This area is flanked to the north and south by rocks of the same age called the Bulawayan System and is composed of andesitic and dacitic metavolcanics. Within this matrix are found basaltic metavolcanic rocks with intercalated metasediments. Within this southern part of the district are found several veneers of younger rocks (Late Jurassic) which are mainly dolerites and gabbros. These are associated with the Great Dyke Group.

The northern part of the district is still poorly mapped but similar formations as those in the south are expected. Madziwa Mine is actually located on gabbros of the Great Dyke Group. The dominant complexes in this area appear to be gneisses and dolerites.

On the northern boundary of the district are isolated outcrops of serpentinite, pyroxenites and ultramafic complexes of the Great Dyke Group; but these are well localised.

Most of the rocks found in this district are of economic importance, particularly those of the Great Dyke Group. Dolerites and gabbros are often associated with minerals such as copper, nickel, magnesite and monumental stone. Serpentine and ultramafic complexes contain asbestos, chromite, nickel, talc and platinum.

The early Precambrian formations found in the southern part of the district are a potential source of a variety of minerals including gold, silver, copper, zinc, tin, limestone, lithium, emeralds, uranium, feldspar, tungsten, manganese, arsenic, antimony, pyrite, lead, tantalum, iron ore, etc (Source: Zimbabwe Geological Map 1:1 000 000, 1991).

2.0.2 SOILS

Soils in this region are largely kaolinitic. They tend to follow the geological pattern. The southern part is covered by the Fersialitic Group and these are moderately shallow to moderately deep reddish-brown to greyish-brown, relatively silty loams over reddish-brown to yellowish-brown similar clays. The latter are frequently mottled (leached) but the soils are not markedly hydromorphic, i.e., they are highly permeable. These are formed on argillaceous sediments.

The northern part of the district, particularly around Bradley Institute, has a more varied soil pattern with east-west belts of Para-ferralitic Group soils. These are mainly sandy soils that have some essentially ferralitic characteristics, but which are not ferrallitic *sensu stricto*. They are moderately deep to deep, greyish-brown, coarse grained sands over pale loamy sands and similar sandy loams over yellowish-red sandy loams or, occasionally, sandy clays. Reserves of weatherable minerals are appreciable. Base saturations range from about 30 to

60%. They are derived from granitic rocks. This group is also mixed with fersiallitic soils that are moderately shallow, greyish-brown, coarse grained sands throughout the profile. Within the area there are also some pockets of moderately deep to deep, reddish-brown granular clays. These also occur in the southern part of the district.

Notes

a) Kaolinitic soils are moderately to strongly leached soils. The clay fractions are composed mainly of kaolinite together with appreciable amounts of free sesquioxides of iron and aluminium.

b) The Fersialitic Group are soils with appreciable reserves of weatherable materials; base saturation over 50%, usually between 60 to 80%. Clay fractions contain some 2:1 lattice minerals.

c) The Paraferallitic Group are mainly sandy soils that have some ferrallitic characteristics, but which are not ferrallitic.

2.0.3 VEGETATION

There are two dominant vegetation types in the Shamva Rural District:

a) Tree Savanna: Found in the southern part of the district and is composed of the following species:
   - *Pterocapus angolensis*
   - *Pericopsis*
   - *Acacia spp.*
   - *Combretum*

b) Savanna Woodlands: Found in the northern part of the district and is composed of:
   - *Brachystegia boehmii*
   - *B. Allenii*
   - *Julbernadia globiflora*

In the northern part of the district there are isolated pockets of savanna woodlands composed of *Brachystegia spiciformis* and *Julbernadia globiflora*. (**Source**: Wild H.: Vegetation Map of Rhodesia — Ministry of Agriculture, Rhodesia — 1:2 500 000).

The whole of the Shamva rural district could be considered to be composed of medium to dense woodlands, particularly in the south, with much open woodland in the north. Open land, grassland and woodland dominate in the north. In relative terms the area may be considered well endowed in vegetation resources, a factor that may be attributed to the soils, topography and climate of the area. In the higher altitude areas to the north, pockets of indigenous forest may be observed.

A comparison of the pre-independence map and the 1986–88 Landsat data shows that the northern part of the district has undergone severe degradation with most of the savanna woodland being turned into open woodland and grassland. The greater part of this zone has been turned into grassland or farmland, leading to severe soil erosion over the greater part of the communal lands.

2.0.4 NATURAL FARMING REGIONS

At least three natural farming regions are found in this district — IIa, IIb and III.

a) **Region IIa:** Occurs in the north-western part of the district — an intensive farming region. Rainfall is confined to summer and is relatively high (750–1000 mm). An average of at least 18 rainy pentads per season and normally enjoys reliable conditions, rarely experiencing severe dry spells in summer. Suited to intensive systems of farming based on crops and/or livestock production.

b) **Region IIb:** Cuts across the district as a north-south belt through the centre of the district. Has an average of 16–18 pentads per season and is subject to either more severe dry spells during the rainy season or to the occurrence of relatively short rainy seasons. In either event, crop yields will be affected in certain years, but not sufficiently frequently to change the overall utilisation from intensive farming systems.

c) **Region III:** Occurs in the eastern portion of the district in the Mufurudzi and Madziwa Mine area. Suitable for semi-intensive farming. Rainfall is moderate (650–800 mm). High temperatures affect the effectiveness of the infrequent but heavy storms. The area receives an average of 14–16 pentads per year. The area is also subject to fairly severe mid-season dry spells and therefore is marginal for crops such as maize, tobacco and cotton; or for enterprises based on both livestock and/or wildlife and cash-crop production. Soils have high moisture potential.

SECTION II: REVIEW OF THE CHAPTER THEME

3.1 ISSUES AND CONCEPTS OF LAND-USE AND ENVIRONMENTAL CHANGE

3.1.1 INTRODUCTION

The phenomenon of natural resource appraisal has been of great concern for decades. Studies that have been carried out have better focused upon actual and or, potential supply of resource supply and availability. Natural resources that will be discussed here will primarily focus on soils and vegetation.

Utilisation of these land resources is only possible after having established a comprehensive land-use inventory to determine the magnitude of capital stocks or assets that are available.

This concern solicits for the need for land information which act as a basis for planning, development and control of land resources (Harsson, 1991). Continuous expansion in terms of production causes pressure on scarce natural resources. Similar pressures on these resources have also stemmed from unabated population growth. Land, being in one way or another the basic source of most material wealth, is of crucial importance and consequently, will require management of supply. The purpose is to be able to maintain control on the land resources and being able to effectively achieve full utilisation of these finite scarce resources. (Agenda 21,1992). For example, it is easy to identify unsuitable land uses with drought, famine, serious erosion among others, as possible consequences.

At the same time appropriate land uses may also be mismanaged because of unsuitable agrarian patterns that are accompanied by outdated tenure systems with inadequate protection of tenure rights. On another note, forests, minerals, etc., may be exposed to excessive and uncontrolled exploitation with resultant soil conservation problems and shortages of fuel wood. An effective land use system creates a good basis for establishing a Land Information System (LIS). A Land Information System forms a tool for legal, administrative and economic decision-making and an aid for planning and development. The LIS consists of on the one hand, a database containing spatially referenced land-related data for a defined area, and on the other hand, procedures and techniques for the systematic collection, updating, processing and distribution of the data.

Land use practices have a major impact on the natural vegetation and soil status. Sound land-use planning is an aid to environmental planning and management. It helps as an aid to decision-making, better formulation of development action and acts as an instrument to achieve sustainable development of the environment (Glasson, Therivel and Chadwick, 1994). In conclusion, land-use planning and environmental impact assessment have a significant role to play towards achieving sustainable development.

3.1.2 LAND-USE PLANNING

This is primarily a process of determining land-use and creating a resource inventory. There is also need to determine resource capability or potential in the process of land-use planning. Land-use planing seeks to determine the present condition of land, identify and understand reasons for the state of the existing trends and finally assist in planning for future land-use purposes. Finally, land-use planning helps in classifying land categories for purposes of ensuring adequate utilisation of that land.

Secondly, land-use planning is necessary in assessing land capability ,i.e., resource potential and capability. The inventorying of resource use or capability is necessary in order to have natural resource information which is needed to make decisions as far as resource potential and capability is concerned. The inventory of resource use or capability has serious implications for decision-making concerning future allocation of resources (Mitchell, 1979). As a tool, they help decision makers and planners to investigate present and future use of the land.

3.1.3 ENVIRONMENTAL CHANGE

Human activities and actions have frequently triggered a chain of events which impoverished the environment. There is need to establish protective and precautionary measures that minimise environmental degradation. Environmental Impact Assessment (EIA) is therefore necessary as a tool to check against man's actions on the environment. Its purpose is to protect both the physical and socio-economic environments. Lack of protection of the physical environment could have adverse effects on, for example, the atmospheric composition, water resources, soil and climate. The purpose of both environmental protection and land-use planning is strongly linked. The link allows us to identify natural resources and utilise those resources without necessarily damaging the environment. Changes in vegetation composition and distribution can trigger serious environmental changes.

3.1.4 ISSUES ON LAND USE AND THE ENVIRONMENT

There are a number of issues that need to be addressed if effective land-use planning and environmental management is to be achieved and these are:

- Establishment of policy instruments and strategies that ensure effective land-use planning and environmental management tools are in place before any development activities can take place.
- Establishment of institutional arrangements that focus upon the rules or constraints that shape the management process. This should emphasise on the interaction of legal, administrative, financial, political and or, other historical customs and values.
- Establishment of enforcement mechanisms or strategies that ensure proper use of land and other natural resources without necessarily imposing a penalty to the environment and present and future generations.
- Establishment of strategies that should be followed first before any land or natural resources can be utilised.
- Establishment of monitoring and evaluation strategies that should be put in place to ensure that these natural resources are adequately utilised.

3.2 OVERVIEW OF LAND-USE CHANGE, CONFLICT AND THE ENVIRONMENT IN ZIMBABWE — A HISTORICAL PERSPECTIVE

Since 1990 the manner in which rural lands are utilised and organised has changed dramatically. During the early years of colonialism the whole country was partitioned into three principal zones of land-use which were based on

a) race
b) agricultural potential, and
c) other economic value (e.g., presence of minerals, wildlife, etc.).

These considerations led to the establishment of a number of broad rural land-use classes:

1. White, privately owned commercial farming areas;
2. African communal farming areas; and
3. Crown and State lands.

In those early colonial days the Tribal Trust Lands (TTLs) were not aimed to be economically viable units. They were to serve as labour reserves for the white dominated economic sectors such as commercial agriculture, mining and the urban industrial sector. It became quite clear early on that the TTLs had excessive populations which could not be incorporated into the mainstream colonial economy and also that these areas were located in fragile marginal zones which could not sustain peasant subsistence. Frail attempts were made then to minimise environmental damage without addressing the whole problem of land pressure.

Legislative enactments were promulgated which fostered a deep paradox between TTL tenure systems and land-use on one hand and the natural environment on the other. It took over 70 years for the colonial government to realise that the TTL system could never sustain good environmental management because of the severe population pressure and high population growth rates.

As mentioned above, token measures were taken to ameliorate the problems. These included the Native Land Husbandry Act, The Tribal Trustlands Act, etc. These were meant to control land-use; to limit environmental degradation by controlling the size of African livestock herds, and restricting access to some resources such as woodlands, wildlife and water.

Alongside these socio-political developments there was a growing interest from a number of researchers. Initially their primary aim was to rationalize the newly established land division and classification system. This theme was pursued into the 1940s when it became apparent that there was need to avert land degradation in the TTLs. The aim was now to commercialize African agriculture at most, or at least to achieve adequate subsistence levels. The implementation was spearheaded by conservation and agricultural extension services, private companies involved in manufacturing crop seeds and fertilizers, and state controlled marketing monopolies such as the CMB, TMB, CSC and GMB.

These policies of limited land redistribution with emphasis on the commercialization of the communal farming sector through diversification into market farming have continued into the post-independence era. Initially this was due to the shortage of resettlement land under the willing buyer-willing seller arrangements grudgingly agreed to at the Lancaster House Agreement that ushered Zimbabwean independence. Today, various interest groups still lobby for transforming communal farming practices, particularly since the inception of ESAP.

The aim is to follow the land-use changes that have occurred in the LSCF sector, particularly since 1990. The changes include the introduction of export commodities such as ostriches, wildlife ranching, beef, horticultural products and tobacco. Communal farmers are being encouraged to adopt similar adjustments in order to take advantage of the 'improved' agricultural marketing and pricing systems.

Such a development may not be easy to envisage or achieve with the current disparities in land ownership between LSCFs, CLs and resettlement areas. One problem lies in that the Government of Zimbabwe (GOZ) has not actively promoted the theme of diversification to communal farmers. Thus the competitiveness of communal farmers under the envisaged new order is severely compromised. Most efforts aimed at reforming agricultural policies and practices have traditionally been aimed at the LSCF sector. The support of governments, bilateral agencies and financiers has also been traditionally aimed at this sector. This marginalisation of the communal sector is an obstacle to the production of surpluses and commercialization of this sector, even in a climate of economic liberalization.

The argument does not suggest that the small-scale sector has not seen some adjustments in cropping and land-use in the past. The early attempts by pre-independence governments saw the introduction of cash crops such as cotton, sunflower, soyabeans, etc. Today this sector dominates on the cotton export market and domestic maize production. In recent years the GOZ, with the support of agro-industries, some LSCFs and their representative organisations, have continued to foster diversification of small-scale peasant agriculture. These efforts have seen the introduction of market crops such as tobacco, tea, sugar and horticultural products.

These limited changes have, however, led to an increased awareness of the need for improved land conservation in CLs. The main policy instruments that have recently gained popularity in some rural areas include reforestation through both community-based and individual woodlots to limit the degradation of natural woodlands in the CLs. Other measures are related to soil conservation and controlled grazing rights and sites. However, such efforts continue to be stifled by the small individual landholdings found in communal lands.

Sustainable environmental management remains seriously threatened by the need for survival and productive farming land in CLs. Severe degradation can be observed in communal farmlands, grazing lands, streambanks and woodlands. Riparian waters and resources are now threatened by the advent of alluvial gold panning along rivers.

It is suggested here that policies that are specific to communal land-use change be promulgated now. At present the communal farming sector's development efforts are being stifled by the heavy dependence on the LSCF sector and the overall influence of the latter on policy making, marketing organisations and financiers. The dependence is manifest through providing labour to the LSCFs and subcontracting agreements between the two parties. In the contracts the small farmers receive seed and/or other inputs from the large farmers who then buy the produce for processing and marketing (Moyo, 1995).

Another stifling factor to diversification is the lack of irrigation infrastructure in communal lands. Only in the last five years has there been a noticeable development of medium-sized dams in communal lands. At present only about 1% of irrigation schemes are located in communal areas.

The most noticeable land-use change in CLs has been achieved through the CAMPFIRE programme. This is based on the commercialization of wildlife and their habitats for financial gain to the locals. Thus rural populations can now actively participate in the lucrative tourism industry with active state support. Such a development should lead to improved environmental conservation in CLs.

SECTION IV: LAND-USE, LAND COVER AND PHYSIOGRAPHY

4.1 PHYSIOGRAPHIC CHARACTERISTICS AND LAND-USE OF SELECTED WARDS

The major physiographic characteristics that were measured were related to the mean slope of physiographic units, their respective areal extents and the associated land-uses. As noted in the Introduction, these different units are associated with particular erosional processes and forms. Chihuri, Mufurudzi and Sanye South Resettlement Wards will be used as case studies since we were able to obtain detailed physiographic and land-use/cover information for these areas.

Note: This section should be read in conjunction with the enclosed erosion potential and vegetation and land-use/vegetation maps for Chihuri, Sanye South Resettlement Scheme and Mufurudzi Wards. Also refer to section 2.6 for the land-use/cover codes.

4.1.1 LAND-USE AND PHYSIOGRAPHIC PATTERNS IN CHIHURI WARD

Chihuri Ward is situated in relatively gentle terrain with only 4% of the area classified as steep slopes and summits. Even these are also relatively gentle averaging a steepness of 20%. About 77% of the area forms colluvial and alluvial plains which the units usually associated with cultivation. The area also possesses fairly extensive alluvial terraces and floodplains, occupying about 9% of the area (Refer to Table 4.1).

Within the steep slope and summit units the observed land cover types are savanna and bushy grassland with the former being more dominant. Tree cover is heavily depleted. However, the fairly low gradient naturally reduces the erosion potential. There was little evidence of accelerated soil erosion in this unit. (Refer to Table 4.2 and the enclosed erosion potential and land-use cover maps of Chihuri Ward).

TABLE 4.1: Chihuri Ward: Physiographic characteristics (Total area = +/- 6350 ha)

Physiographic Unit	Mean Slope (%)	Area (ha)	% Area
Steep slopes/Summits	20	254	4
Footslopes/Foothills	10	635	10
Alluvial/ Colluvial Plains	4.5	4 889.5	77
Alluvial Terraces and Floodplains	1	571.5	9

TABLE 4.2: Physiography and land-use in Chihuri Ward

Physiographic Unit	Observed Land-use Cover	% Area
Steep slopes/Summits	5c, 5b	4
Foothills/Footslopes	5b,7e, 1d, 1a, 3b	10
Alluvial/Colluvial Plains	5b, 1d, 1a, 3b, 6a, 7e, 3a, 1c,7a	77
Alluvial terraces and Floodplains	5c, 1a, 4a, 1a, 7f,7a	9

(**Source:** 1990 Aerial Photographs)

The foothill and footslope units also occupy a relatively small portion of this ward (10%). As noted above, cultivated lands are normally found on alluvial and colluvial plains, but large portions of these foothills/footslope units are under cultivation. Consequently this is an area in which we can expect excessive pressure on grazing lands. Land-uses within these units are quite diverse and include savanna grasslands, open cultivation, abandoned fields, savanna woodlands and some badlands. The dominant uses are open cultivation and savanna grassland.

The alluvial and colluvial plains are the dominant units within this ward. Very little of these are not under cultivation. These units have multiple uses including open cultivation, abandoned fields, horticulture, savanna woodlands and grassy wetlands. However, gullies are evident in this zone. Only about 5% of this zone are under some form of 'natural' vegetation. Thus vegetation clearance has reached extreme proportions in this ward.

The alluvial terraces and floodplain units, occupying a relatively large area (9%) when compared to the other wards, are under multiple use as well. The observed land-use/cover types include open cultivation, dense bushland, shrubland and bushy grassland. These uses vary in dominance from village to village within this zone. However, we observed signs of accelerated erosion including gullies and badlands. These are related to cattle tracks in most cases. However, riparian vegetation still exists along some water courses, indicating fairly low levels of vegetation degradation.

4.1.2 LAND-USE AND PHYSIOGRAPHIC PATTERNS IN MUFURUDZI WARD

This is also an area of fairly low relief but is very rugged. Steep slope and summit areas occupy only 0.2% of the area. Unlike in Chihuri and Sanye South, the foothills and summit areas are spread randomly over the area and cover about 23% of the land area (see Table 4.3 and the enclosed erosion potential map of Mupfurudzi Ward). The cultivable lands (colluvial and alluvial plains) cover about 75% of the area. The riverine zone (alluvial terraces and floodplains) occupy only 2% of the area, showing the youthfulness (low order) of rivers flowing here.

The steep slope and summit units are dominated by open savanna woodland and bushy grassland. The foothills and footslopes, once again, have multiple and often conflicting land-uses. These include open cultivation, agroforestry, abandoned fields, dense savanna woodland, open bushland, bushy grassland and badlands (see Table 4.4 and the enclosed land-use/cover map of Mupfurudzi Ward). The dominant land-uses/covers include open cultivation, open savanna woodland and savanna grassland.

TABLE 4.3: Mupfurudzi Ward: Physiographic characteristics (Total area = +/- 4 150 ha)

Physiographic Unit	Mean Slope (%)	Area (ha)	% Area
Steep slopes and Summits	25	8.3	0.2
Foothills and Footslopes	10	954.5	23
Alluvial and Colluvial Plains	4	104.5	74.8
Alluvial terraces and floodplains	2	83	2

TABLE 4.4: Physiography and land-use in Mupfurudzi Ward

Physiographic Unit	Observed Land-use Cover	% Area
Steep slopes and summits	3b, 5c	0.2
Foothills and footslopes	1a, 1b, 1d, 1e, 3b, 5b, 5c, 7e	23
Alluvial and colluvial plains	1a, 1d, 1e, 3a, 4b, 5c, 7e	74.8
Alluvial terraces and floodplains	1a, 1c, 4a, 5b, 5c, [illegible], 7f	2

The rivers are also under threat from various uses. These include open cultivation and horticulture. Also observable are uses/covers such as dense bushland, savanna and bushy grassland, bushy wetlands and riparian vegetation. Dense bushland, bushy grassland and savanna grassland are dominant in this zone.

4.1.3 LAND-USE AND PHYSIOGRAPHIC PATTERNS IN SANYE SOUTH RESETTLEMENT WARD

This is a fairly small area (3 300 hectares) and the source materials (aerial photos) cover a period before it became a resettlement scheme (1986). It is composed of fairly rugged terrain units. About 50% of the area is composed of steep slopes, hill summits, footslopes and foothills. Only 45% of the area appears suitable for cultivation. Riparian zones are also limited (5%) (see Table 4.5 and the enclosed erosion potential map of Sanye South Resettlement Ward). However, besides the steep slope and summit units which are covered solely by dense bushland, the area accommodates various land uses.

The footslope and foothill units accommodate uses such as open cultivation, abandoned fields, dense savanna woodland, dense bushland, savanna and bushy grassland and wetlands. Badlands are quite extensive in this zone. The dominant cover types are savanna and bushy grasslands.

TABLE 4.5: Sanye South Resettlement Ward: Physiographic characteristics (Total Area = 3 300 ha)

Physiographic Unit	Mean Slope (%)	Area (Ha)	% Area
Steep slopes and summits	25	660	20
Foothills and footslopes	17	990	30
Alluvial and colluvial plains	3.5	1 485	45
Alluvial terraces and floodplains	1.5	165	5

The arable zones are limited in areal extent but also have diverse uses and land covers. These include open cultivation, open savanna woodland, dense bushland, open and bushy grasslands, and grassy and bushy wetlands. Badlands also exist within this small area. The dominant land-uses are open cultivation, savanna grassland and miombo wetlands.

The alluvial terrace and floodplain units, whilst accounting for only 5% of the area, are also quite diverse in land cover types. These include dense savanna woodland, savanna grassland, bushy wetlands and miombo wetlands. But degradation is also evident in the form of badlands and cultivated wetlands.

TABLE 4.6: Physiography and land-use in Sanye South Resettlement Scheme

Physiographic Unit	Observed Land-use Cover	% Area
Steep slopes and summits	4a	20
Footslopes and foothills	1a, 1d, 1e, 3a, 4a, 5b, 5c, 6b, 6c, 7e	30
Alluvial and Colluvial plains	1a, 3b, 4a, 5a, 5b, 6d, 7e	45
Alluvial terraces and floodplains	3a, 5b, 6b, 6c, 6d, 7e	5

4.2 RESULTS

Correlation of physiographic and land-use/cover in parts of the Shamva District has shown that cultivation and other human activities are prevalent in almost all physiographic units, although with different intensities. Of major concern is the prevalence of cultivation practices in the footslopes and foothill areas. As noted earlier such areas have been associated with medium to high erosion risk. These are areas prone to piping, gullying and slopewash, even under undisturbed (natural) conditions.

Another problem observed in this zone relates to the density of footpaths and cattle tracks within this zone. The problem was noted particularly in the northeastern part of Chihuri Ward. Given the climatic characteristics of the area, such tracks easily turn into gullies at the onset of the rain season. These areas are used primarily for grazing, but increasingly they are being settled, cultivated and stripped of vegetation.

The alluvial and colluvial plains, the major soil formation zones, are heavily utilised in almost all the wards surveyed. Chihuri Ward, in particular, has barely any significant natural vegetation stands within this zone. Stream bank cultivation is prevalent in this area. The result is the observed high density of gullying close to streams. On the 1990 aerial photos, there is very little evidence of the existence of soil conservation measures in this area. There are no contours in the fields and also the natural vegetation was totally stripped.

The only observable vegetation that exists in this area is found on the hill summits and along rivers where it exists in thin strips. Whilst it is documented that in the past this area was covered by pockets of woodlands and savanna tree, what is generally seen now are open grasslands and shrublands. However, wetlands have continued to exist along tributaries of the major streams. Most of these, though, have lost their natural vegetation cover. What is of concern, however, is the prevalence of bushland over most uncultivated lands.

4.3 DISCUSSION OF RESULTS

Through aerial photo analysis we can safely conclude that soil and vegetation degradation are prevalent in all physiographic units with relatively less impact on steep slopes and hill summits. In some stretches the floodplains and alluvial terraces are still covered by riparian vegetation. However, siltation is quite evident along most of the larger perennial rivers. The questionnaire sought to clarify some of these findings from the stakeholders themselves.

In most communal lands the foothills and footslope units are reserved for pastoral use, although photo analysis showed that activities such as cultivation have encroached into these zones. Almost 60% of the population has no designated grazing lands and has problems with access to pasture. The most pressing problem appears to be grazing space and pasture quality. Therefore the gully and hill erosion evident in the footslope and foothill zones may be due to overgrazing.

Natural resource degradation could also be caused by population increase through immigration from surrounding areas. In the past five years the majority of the people have seen their landholdings affected by the migration of people into and out of their villages. Many (52% of the population) were affected through new immigrants. A fairly large number (19%) saw their farmlands reduced through this immigration process. Obviously this increases the pressure on land and is a recipe for continued, if not accelerated, clearance of vegetation and settlement in marginal areas. Such land-use conflicts will cause continued resource depletion.

Furthermore, about 45% of the respondents claim to have insufficient land for cultivation. The main immediate cause of land shortage appears to be fragmentation among relatives. About 40% of the population has access to less than four acres of land when the average household size is about six members. Only about 4% has more than 12 acres.

The land pressure due to livestock numbers and human population will also have a negative effect on vegetation composition and distribution. Different requirements for timber such as woodfuel and construction timber, lead to selective exploitation of particular plant species. Consequently biodiversity is reduced under increased population pressure. This was borne out in the photo analysis where most physiographic units were covered by very few woody species and these were mostly shrublands or grasslands. 'Mature' woodlands could only be seen on some steep slopes and hill summits.

Within settled areas species diversity is similarly affected, but even worse affected is the distribution. In all the three wards that were analysed, only about 10% of the alluvial and colluvial plains are covered by some form of 'natural' vegetation. With the advent of communal woodlots the situation may improve, but their present worth requires further assessment.

Today 95% of the population relies on shrublands and woodlands for fuel. Only about a third of the sample population rarely or never runs short of firewood. The majority are increasingly having problems of collecting firewood. The most commonly cited issues relate to the depletion of woodlands near to homesteads. Thus people now have to walk long distances to collect firewood. Consequently no area can be saved from the axe. The most popular sources of fuelwood are any area outside the cultivated lands. State woodlands and forests and surrounding commercial farming areas are increasingly coming under threat from communal settlers.

Degradation of natural resources can also arise from misconceived perceptions about the state of the natural environment by the stakeholders. In this chapter we were interested in the level at which people value the soils in their fields and whether they have recently observed any degradation effects. Surprisingly, only about 27% of the population felt that their cultivated lands are either in a poor state or unfit for agriculture. The majority appear satisfied with the state of their farmlands although they accept that the acreage is generally insufficient. This apparent satisfaction needs further investigation as serious erosion is evident in fairly extensive cultivated lands.

Equally surprising is the fact that almost 75% of the population claim to maintain contour ridges on their farms to prevent erosion. In Chihuri Ward there is very little evidence of contour ridging. However, this may be due to the relatively extensive alluvial and colluvial plains of low gradient in that ward. The situation may be different in the other wards.

The rivers and riverside areas are not being spared from human activities either. Elsewhere in the research project, evidence of extensive gold panning was observed along and within rivers. Streambank cultivation is also extensive in all the wards which were analysed. From the questionnaire survey, the alluvial terraces and floodplains are also used for farming and pasture. These zones, as noted earlier, are highly prone to gully erosion and siltation. Rivers are inherently sensitive to environmental change and human interference. Their reaction to adverse external inputs can be devastating as witnessed in the Save River Catchment. As will be suggested later, the Water Act needs to designate even lower order streams as protected areas than at present where a few high order rivers such as the Zambezi, Limpopo, Gwai, etc. are listed. This is an area where intervention is of paramount importance.

Therefore, the conflicts between land-use and the natural environment are due to various causes. Amongst these are overgrazing, overdependence on woodlands for fuel and construction by an ever-increasing population, and misconceived perceptions about the nature of resource conservation. However, a great deal of conservation work is being done in communal lands but there are some insurmountable pressures that will continue to erode any gains made. The solution, then, may lie outside the efforts of local inhabitants.

SECTION V: RECOMMENDATIONS

The findings made about the status of the natural environment in Shamva Rural District clearly call for intervention if continued land degradation is to be averted. This can be achieved at various levels ranging from local initiative to local government, NGOs and central government. Most of the environmental problems highlighted in this chapter can be directly related to poor land-use planning by both the local population and the planning agencies. As noted in Section II, there are also other causes such as the historical context of communal lands, externalities such as droughts and macro-economics, etc.

5.1 LOCAL LEVEL INTERVENTION

It has become common knowledge that land degradation problems in Africa have become so widespread and severe that any solution to them excluding consultation with and involvement of the rural population is unrealistic. Rural populations have been seen to have the capability to evaluate a project and its innovative propositions and to decide whether or not to integrate new kinds of behaviour into their system of relations and activities.

In this regard, it is suggested that environmental issues be tackled with the participation of local inhabitants. The questionnaire survey showed that this is already happening in Shamva in dealing with gully formation and the development of woodlots. However, it appears there is diminished interest from villagers which may stem from the conflict between traditional and political authority over environmental issues. Without undermining the authority of either one of these, politically independent environmental organs should spearhead environmental activities so as not to alienate some members of a different political orientation.

It is now widely held that traditional conservation systems were largely effected through the declaration of certain lands as sacred. Such areas included mountains, hills, forests and woodlands, and certain wildlife and plant species. Nowadays there is little awareness of such traditions. About 67% of the sample population have never heard of any 'sacred' areas which may not be reached nor exploited without consultation with the traditional authorities such as chiefs and spirit mediums. Such awareness may need to be reawakened by resolving the role of traditional authority and that of political parties.

The questionnaire survey found that most rural folk are aware of the need for natural resource conservation but there are various obstacles that make conservation difficult. For example, most respondents were prepared to discuss issues related to woodlands and soil conservation, but aspects related to wildlife, grazing lands, mineral extraction and water use caused some discomfort or uncertainty. Thus the locals are not in a position to be totally responsible for integrated environmental conservation. There is a great need for intervention and/or participation by expert planning agencies.

5.2 INTERVENTION BY PLANNING AGENCIES AND NGOS

Land-use planners should accept the environmental and socio-economic context of local communal farmers. Most communal land-uses cannot be dissociated from each other. There are always important interactions between communal land-uses such as pastoral, crop cultivation and forestry. Thus environmental management at the village level should be integrated into a framework that incorporates local level accountability for vegetation and soil management.

This approach has been referred to as 'Integrated Village Land Management' (P. Laban, 1995). Planners have to realise that communal land can be classified into two distinct 'use zones': a silvo-pastoral zone which is reserved for pastoral use only and an agro-silvo-pastoral zone where cultivation dominates. However, these are dynamic in both a temporal and spatial sense. Thus an appreciation of the local perceptions about these two use zones is always important in land-use planning.

This chapter has also highlighted the conflicts that exist in the communal lands between land-use and physiography. The result is a high degree of land degradation due to farming in marginal areas such as foothills, footslopes and streambanks. It is suggested that land-use planning should commence only after land capability classification of which physiographic analysis is only one component. This will expose areas where erosion is likely to occur through mismanagement and areas where erosion occurs through misuse. In the first case, erosion can be reduced to a tolerable level by suitable conservation practices. In the latter case, erosion control is expensive and difficult, if not impossible, e.g., along streams and on steep slopes.

Aerial photo analysis in the three wards of Chihuri, Sanye South Resettlement and Mufure has clearly shown the existence of widespread erosion in both pastoral and cultivated lands. We have attributed this to the conflict between land-use and the physiographic nature of the landscape. This does not mean that if the conflict were resolved then the erosion problem would go away. Neither would the extensive planting of trees. What is required are long term strategies of conservation with well defined priorities. There are also other conservation techniques that can be considered such as agronomic measures which utilise the role of vegetation in preventing soil erosion; soil management measures which are concerned with ways of preparing the soil to make it more resistant to erosion; and mechanical methods which are usually expensive but long lasting, e.g., terracing and windbreaks. Thus the communal woodlot can be both sources of timber as well as act as windbreaks.

It should also be observed that soil degradation is often not a general phenomenon that affects all households uniformly. Its relative importance depends to a large extent on the distribution of (intrinsic) soil fertility and the means to conserve it. Social stratification can lead to certain groups gaining control over the more fertile land forcing others to use more marginal land and consequently failing to conserve the soil. This was borne out in the questionnaire survey. Only 2.5% of the sample population in communal lands possesses more than 16 acres of land and it appears these occupy the more stable lands on colluvial and alluvial plains. But the differentiation is not seen only in land ownership but also livestock ownership, road access, water access, productivity, ability to conserve the soil, etc. Therefore planners should take cognisance of social differentiation.

With this in mind, planning agencies have to tackle the problem of excessive streambank cultivation, wetland cultivation and extraction of minerals from river beds and banks. For the sake of survival of the riparian ecology, a hard line is necessary if such ecosystems are to continue to exist. In brief, no mining activities along rivers! If any agricultural activities are to occur along river banks, they should be well planned. Rivers should be regarded as recreational areas and sources of water only.

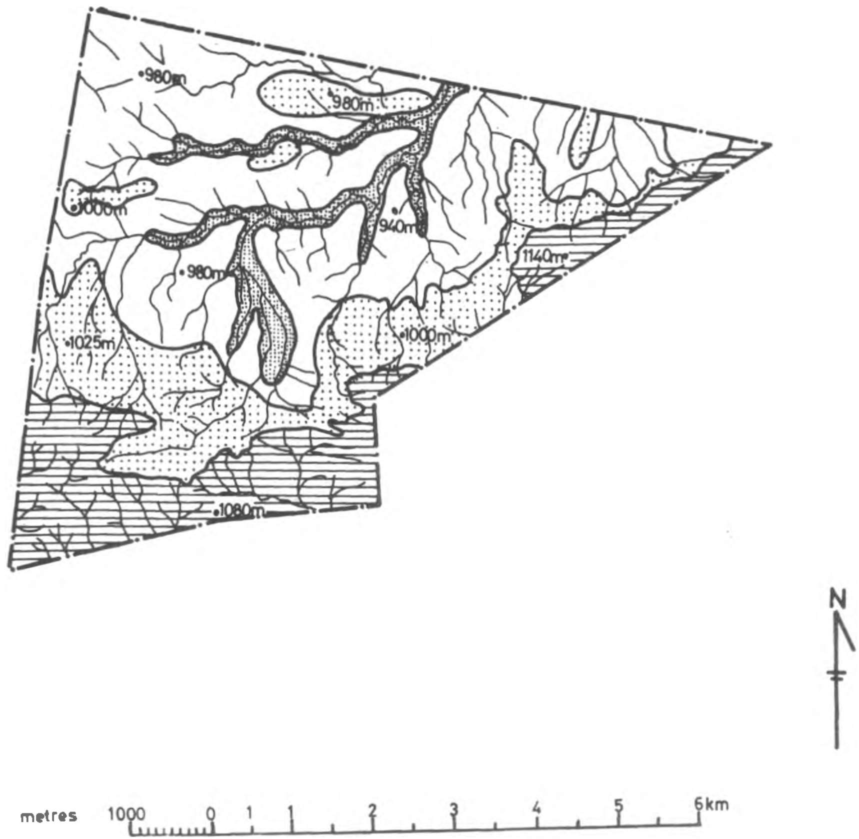
5.3 INTERVENTION BY CENTRAL GOVERNMENT

Government should understand that communal farmers in many parts of Africa do not have the will to accept responsibility for managing the natural resources within their landholdings. This has been attributed to the lack of guarantees of rights and economic interest in natural resource use. Villagers feel responsible for their natural resources only when they can exert control over such resources. This has been amply demonstrated in the CAMPFIRE Programme. Villagers need to have rights, knowledge and the means to exercise control over resources in order to be motivated into conservation.

There is also need for accountability at all levels including local government and NGOs. Accountability here implies the promotion and application of appropriate policy instruments. This entails proper institutional setting, political commitment and the translation of political and socio-economic priorities into national and local government budgets.

Government legislation should not unnecessarily reduce the authority of traditional authority. Lack of certainty in land ownership and classification causes communal farmers to feel unaccountable for the preservation of natural vegetation and other resources on their holdings. The survey found that the locals, for different unknown reasons, prefer that particular authorities control the utilisation of certain resources. On soil conservation most locals preferred AGRITEX (52%) and VIDCO/Councillors (26%). On vegetation most were aware of the role of VIDCOs, the Forestry Commission, the Natural Resources Board, and the Police. So it is up to Government to empower the relevant local authorities to govern and conserve particular resources as the locals see fit.

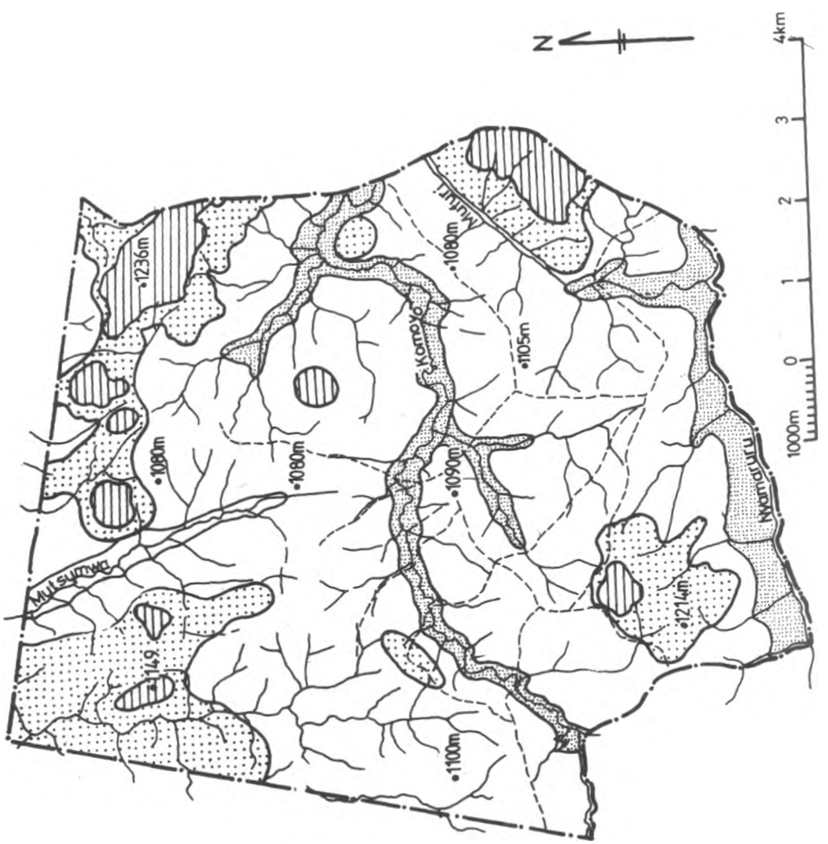
Map 1: Physiography and Erosion Potential — Sanye Resettlement, Shamva District



PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES(AND FORMS)	EROSION RISK
Steep Slopes/Hills and Summits	25%	soil slip, rilling, slopewash, rock falls (rills, thin soils, stony ground, bare rock)	Minimal risk when vegetated but high risk when disturbed.
Foot hills/Foot slopes	17%	piping, gullying (gulleys, badlands, bare rock, gravelly)	Very high risk due to undulating terrain. Avoid intensive usage.
Alluvial/Colluvial Lowlands/Plains	3.5%	rilling, gullying, sheetwash (rills, gulleys, badlands, gulley heads)	Moderate risk. Controlled by landuse and conservation efforts.
Alluvial Terraces and Floodplains	1.5%	headward erosion, deposition (collapse walls, gulleys, sedimentation	High risk near terrace edges and streambanks.

(Source: Stereoplotted from Aerial Photography dated August 1978 by the Surveyor General, ZIMBABWE)

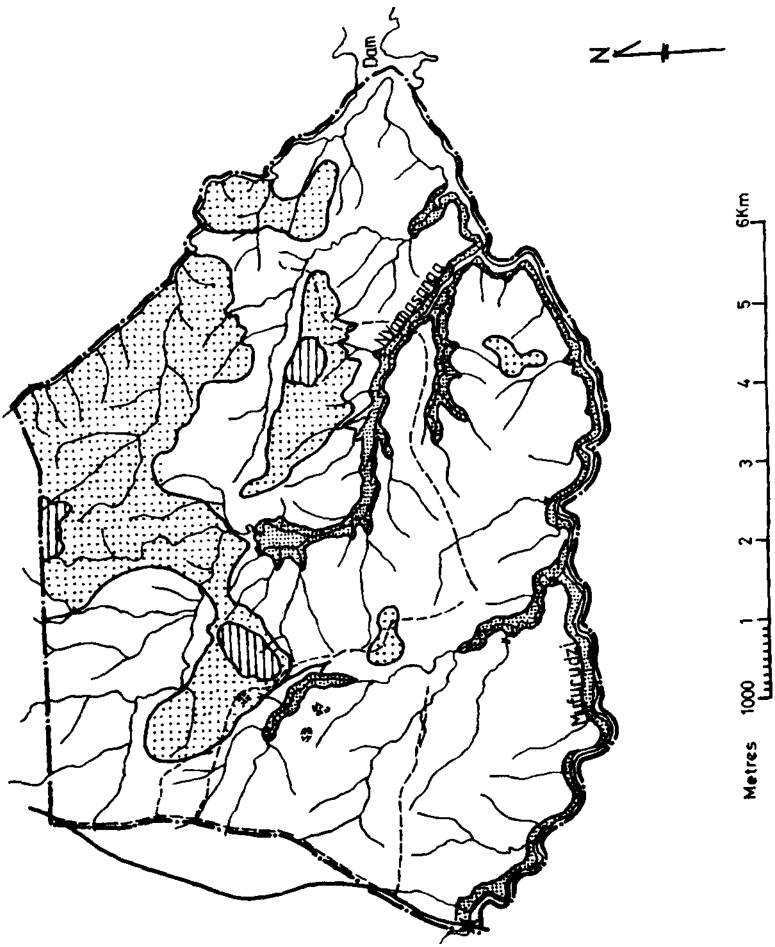
Map 2: Physiography and Erosion Potential — Chihuri Ward, Shamva District



PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES	EROSION RISK
Steep Slopes / Hill Slopes Summits	20%	soil slip, rilling, trampling (rills, thin soils, stony ground)	Minimal risk when vegetated but high risk when disturbed.
Foothills / Foot slopes	10%	piping, gullying, slopewash (gulleys, badlands, stony ground)	High due to steep undulating terrain.
Alluvial / Colluvial Plains	4.5%	rilling, piping, sheetwash (rills, gulleys, gulley heads)	Moderate to minimal. Depends on landuse and soil conservation.
Alluvial Terraces and Floodplains.	1%	headward erosion, deposition (eroding banks, siltation)	High risk along streambanks.

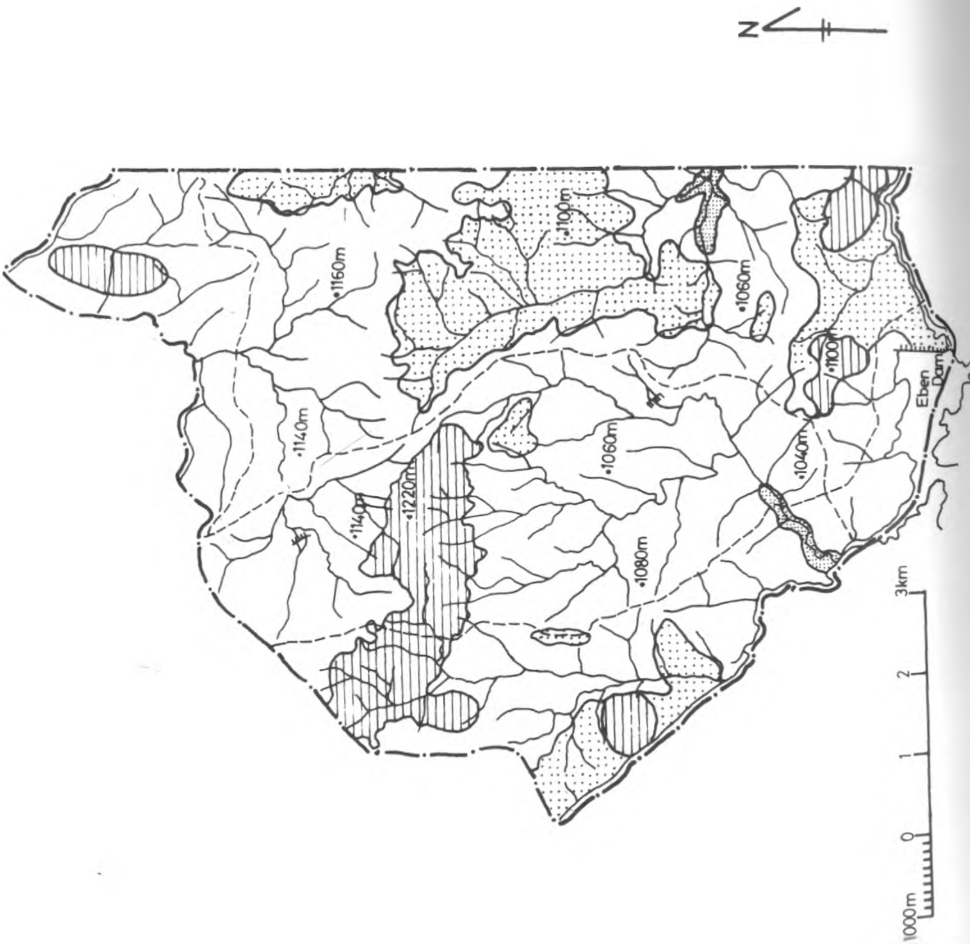
(Source: Manually plotted from Air Photography dated 1977 by the Surveyor General, Zimbabwe)

Map 3: Physiography and Erosion Potential — Chidembo Ward, Shamva District



PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES	EROSION RISK
STEEP SLOPES/HILL SLOPES AND SUMMITS	20%	soil slip, rilling, mass wasting (rills, thin soils, bare rock)	Moderate risk under natural conditions.
FOOTHILLS AND FOOT SLOPES	10%	piping, gullying, slopewash (terracettes, gulleys, gravels)	High due to steep undulating terrain.
ALLUVIAL/COLLUVIAL LOWLANDS/PLAINS	4%	rilling, piping, sheetwash (rills, gulleys, gulley heads)	Moderate to minimal. Depends on landuse practices.
ALLUVIAL TERRACES AND FLOODPLAINS	1%	headward erosion, deposition (bank collapse, sedimentation)	High risk along streambanks and terrace edges.

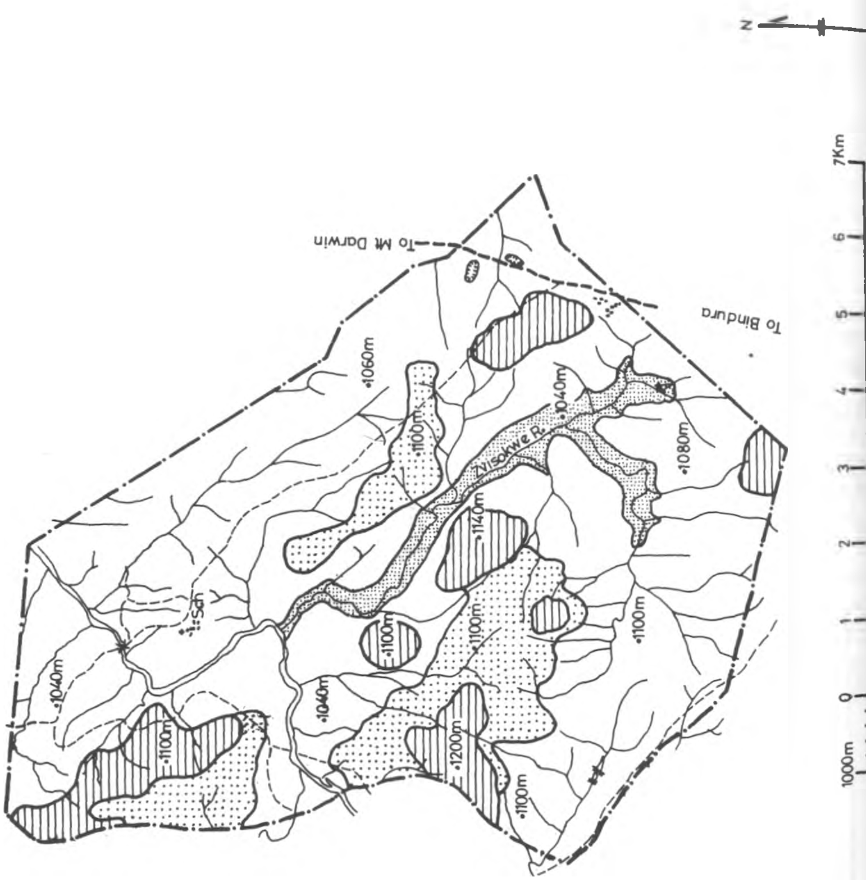
(Source: Stereoplotter from Air Photography dated August, 1982, by the Surveyor General, Zimbabwe)



Map 4: Physiography and Erosion Potential — Nyamaropa Ward, Shamva District

PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES &(FORMS)	EROSION RISK
Steep Slopes/Hills Summits	22%	soil slip, rilling and avalanches (terracettes, rills, thin soils, bare rock)	Minimal risk where vegetated. Unstable for farming/buildings
Foothills / Foot slopes	13%	piping, gullying (gulleys, badlands)	High risk due to steep undulating terrain. Avoid cultivation.
Alluvial/Colluvial lowlands or Pediments	4%	rilling, piping, gullying, sheetwash (rills, gulleys, badlands, gulley heads)	Moderate to minimal. Depends on landuse practices.
Alluvial Terraces, Floodplains	2%	headward erosion, slumping deposition (collapse walls, gulleys, sedimentation)	High risk near terrace edges and streambanks.

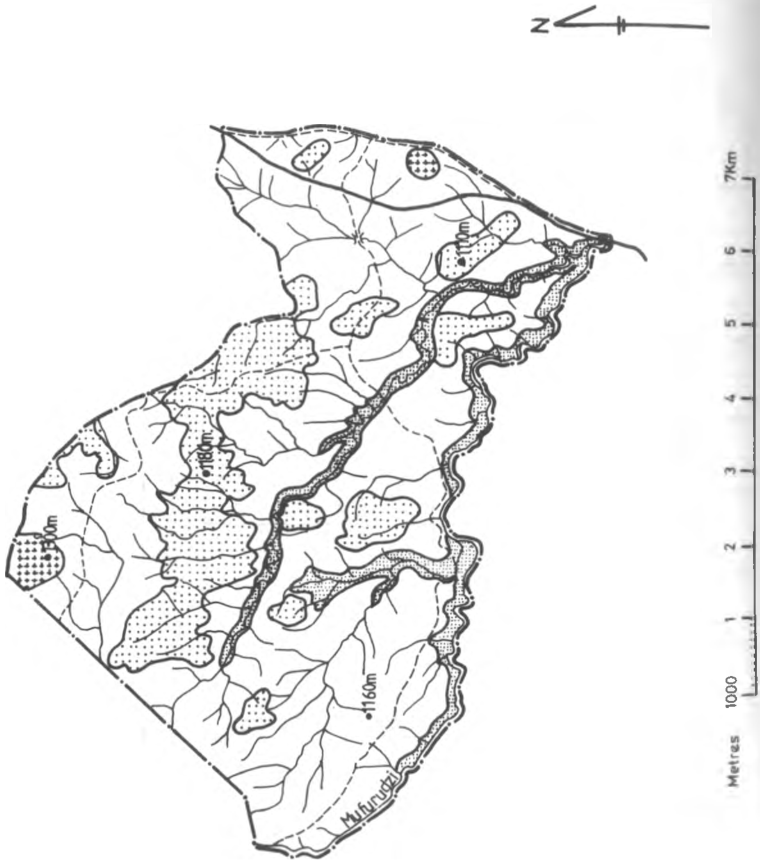
(Source: Stereoplotter from Aeridl Photography dated August 1978 by the Surveyor General, Zimbabwe)



Map 5: Physiography and Erosion Potential — Mupfure Ward, Shamva District

PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES	EROSION RISK
STEEP SLOPES / HILL SLOPES AND SUMMITS	27%	soil slip, mass wasting, rilling, (rills, thin soils, bare rock, wash)	moderate risk under natural conditions.
FOOTHILLS AND FOOT SLOPES	12%	piping, gullying, slopewash (terracettes, gulleys, stoney ground)	high risk due to steep undulating terrain & loose debris.
ALLUVIAL / COLLUVIAL LOWLANDS / PLAINS	3%	rilling, piping, sheetwash (rills, gulleys, gulley heads)	moderate to minimal. Depends on landuse practices & conservation.
ALLUVIAL TERRACES AND FLOODPLAINS	0.8%	headward erosion, deposition (bank collapse, sedimentation)	high risk along streambanks and terrace edges.

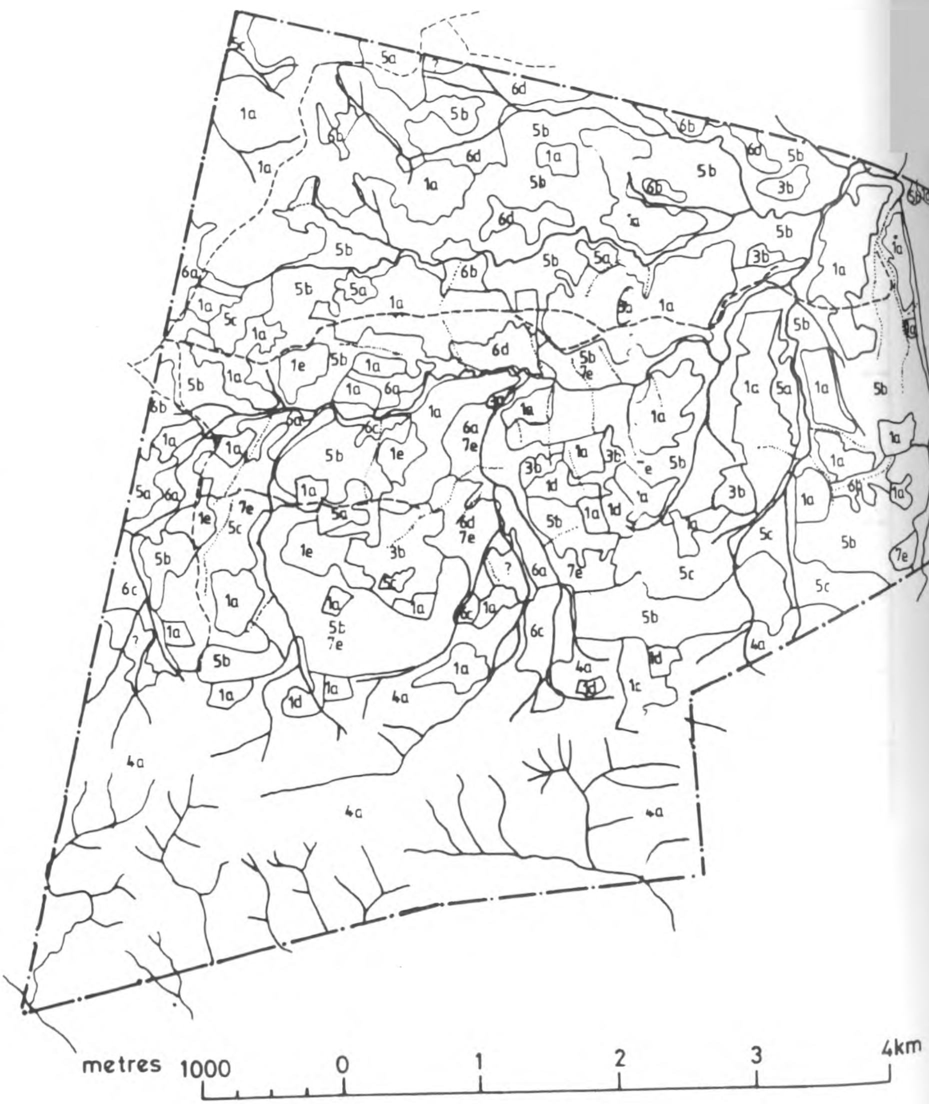
(Source: Stereoplotted from Air Photography dated August 1982 by the Surveyor General, ZIMBABWE)



Map 6: Physiography and Erosion Potential — Mupfurudzi Ward, Shamva District

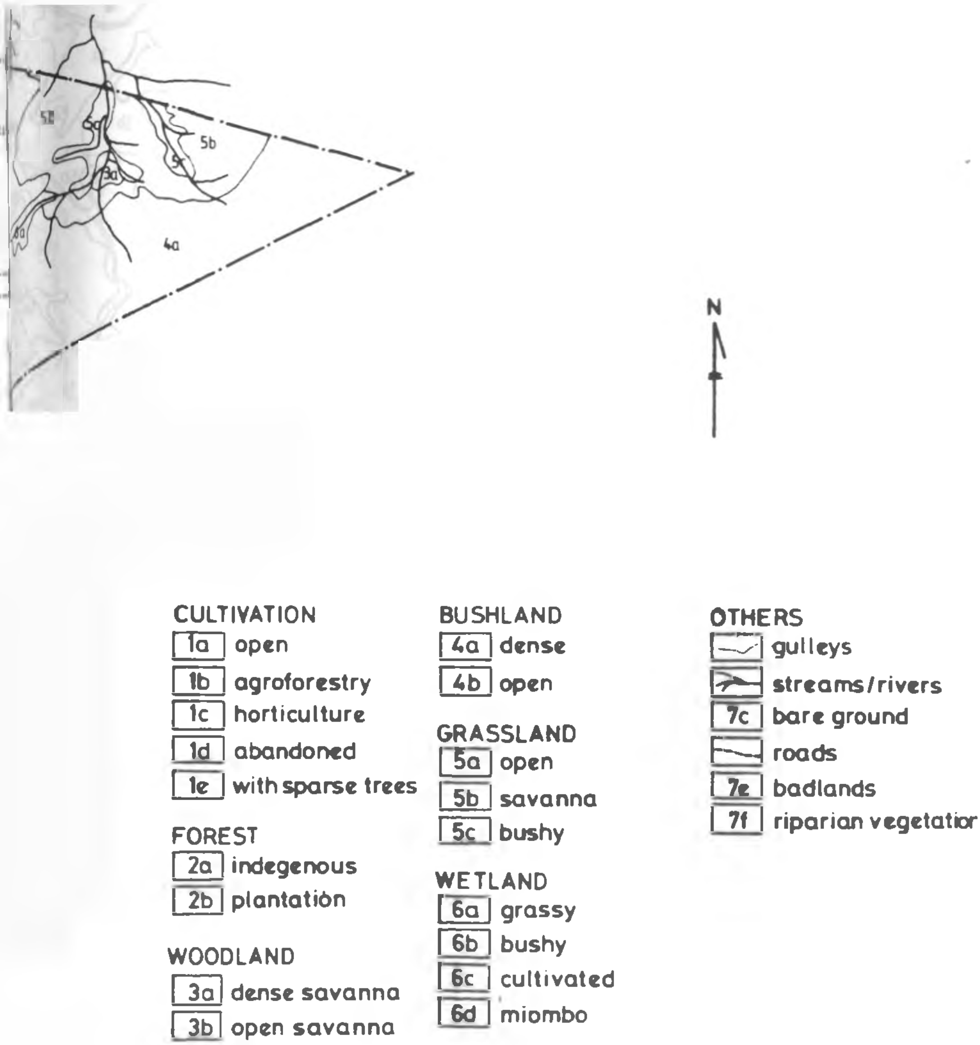
PHYSIOGRAPHIC UNIT	MEAN SLOPE	EROSIONAL PROCESSES	EROSION RISK
STEEP-SLOPES / HILL SLOPES, SUMMITS	25%	soil slip, rilling, rock slumping (rills, thin soils, stony ground)	Moderate risk under natural conditions.
FOOTHILLS, FOOT SLOPES	10%	piping, gullying, slopewash (gulleys, badlands, gravelly)	High risk due to steep undulating terrain.
ALLUVIAL / COLLUVIAL LOWLANDS / PLAINS	4%	rilling, gulling, sheetwash (rills, gullies, stony ground	Moderate risk. Dependent on landuse and conservation efforts.
ALLUVIAL TERRACES AND FLOODPLAINS	2%	headward erosion, slumping (collapse walls, gulleys, deposits)	High risk near terrace edges and streambanks.

(Source: Stereoplotter from Air Photography dated August 1982 by the Surveyor General, Zimbabwe)

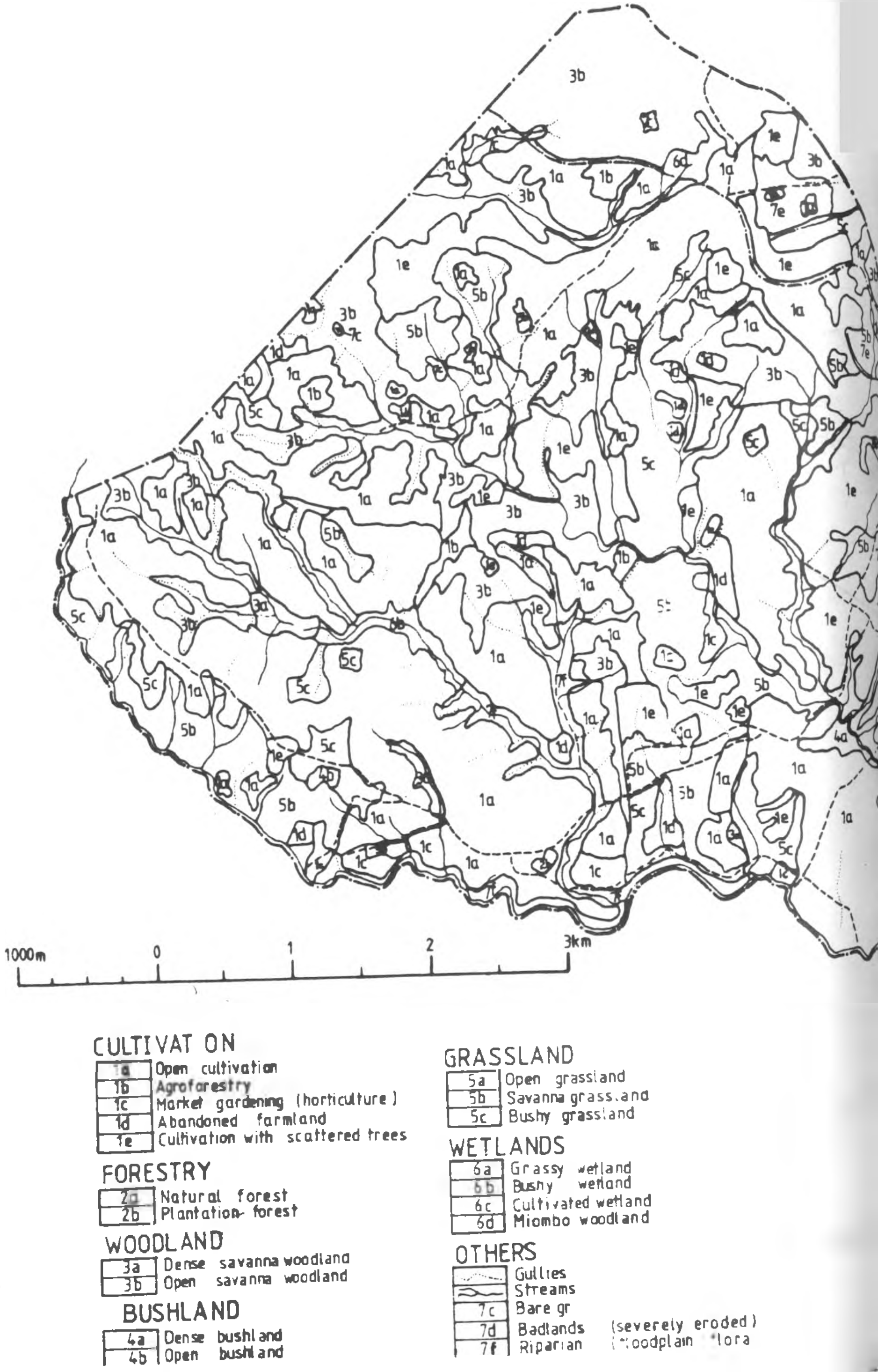


(Source: Stereoplotted from Air Photography date

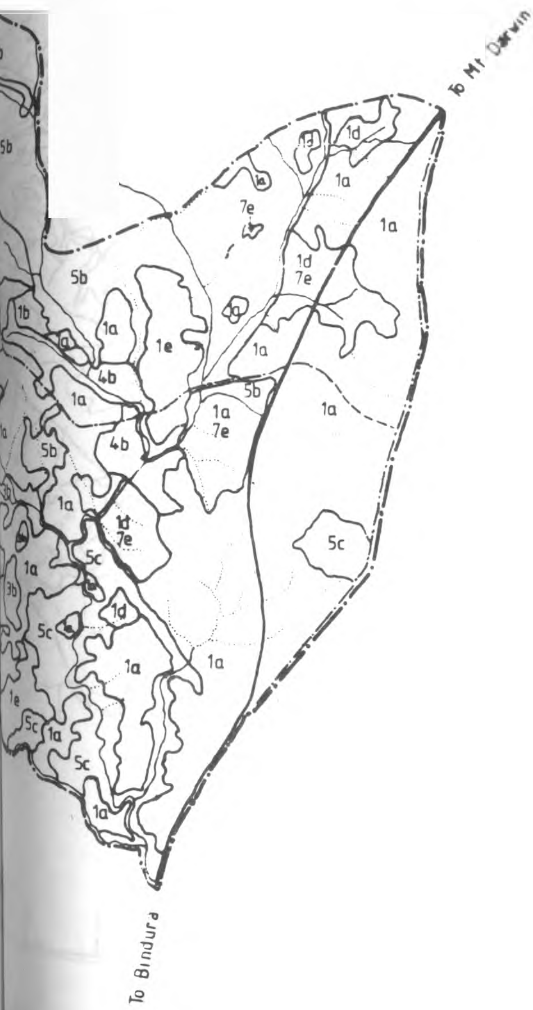
Map 7: Land-use and Vegetation — Sanye South Resettlement Ward, Shamva District



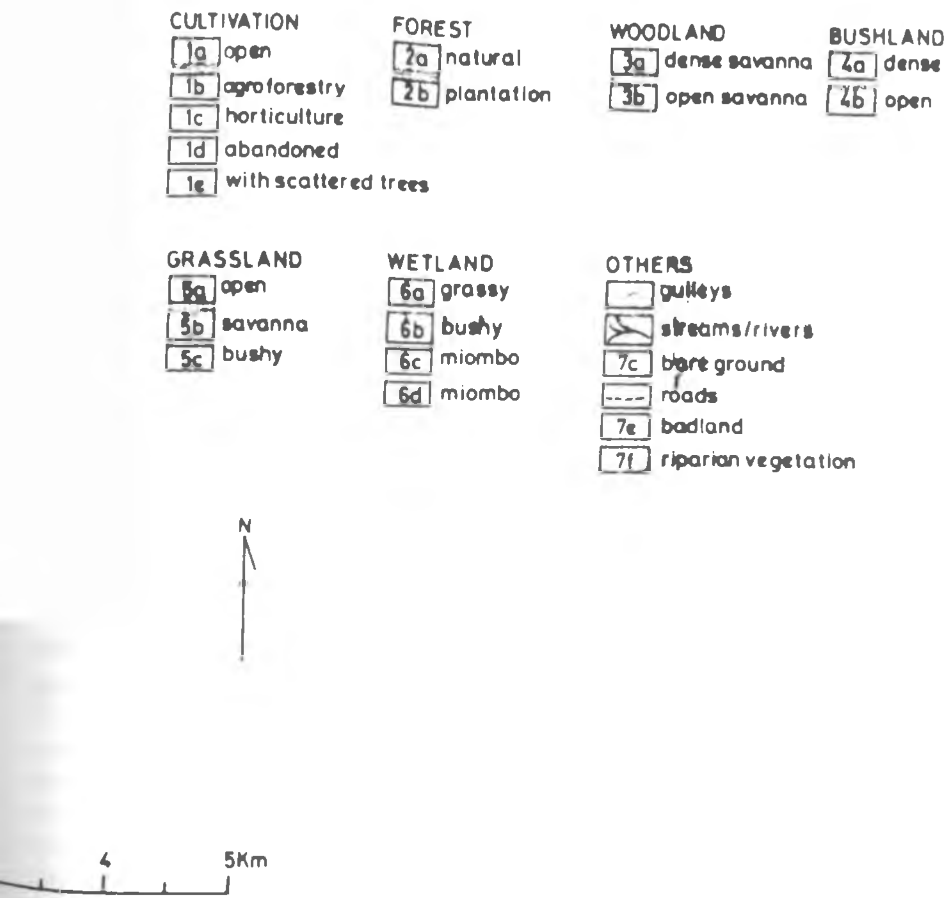
: Surveyor General, Zimbabwe)



Map 8: Land-use and Vegetation — Mupfurudzi Ward, Shamva District


To Mt Darwin
To Bindura
1d
1a
7e
1d
7e
1a
5b
1b
1a
1e
1a
4b
5b
1a
1a
7e
1a
5b
4b
1a
1d
7e
5c
5c
1a
1d
5c
1a
1a
5c
1a
5c
1a

Map 9: Land-use and Vegetation — Chihuri Ward, Shamva District


CULTIVATION
1a open
1b agroforestry
1c horticulture
1d abandoned
1e with scattered trees
FOREST
2a natural
2b plantation
WOODLAND
3a dense savanna
3b open savanna
BUSHLAND
4a dense
4b open
GRASSLAND
5a open
5b savanna
5c bushy
WETLAND
6a grassy
6b bushy
6c miombo
6d miombo
OTHERS
gulleys
streams/rivers
7c bare ground
roads
7e badland
7f riparian vegetation
N
4
5Km

BIBLIOGRAPHY

Bremer H. (1994): "Soils in tropical geomorphology". *Zeitschrift fur Geomophologie*, 38 (3), 257–265.

Cousins B *et al* (1990): The Dynamics of Social Differentiation in the Communal Lands of Zimbabwe. (UZ., CASS, Harare).

DuToit R.F. *et al* (1984): Wood Usage and Tree Planting in Zimbabwe's Communal Lands: Report for the Forestry Commission of Zimbabwe and the World Bank.

Elwell H.A. and Stocking M.A. (1976): "Vegetal cover to estimate soil erosion hazard in Rhodesia". *Geoderma*, 15, 61–70.

Elwell H.A. and Wendellar F.E. (1977): "To initiate a vegetal data bank for soil loss estimation." Department of Conservation and Extension, *Research Bulletin* 23, Harare, Zimbabwe.

Garg P.K. and Harrison A.R. (1992): "Land degradation and risk analysis in Southeastern Spain: a GIS approach". *Catena*, 19 (5), 411–425.

Justice C.O. (Ed.) 1986: "Monitoring the grasslands of semi-arid Africa using NOAA-AVHRR data." *International Journal of Remote Sensing*, 7 (11), 1383–1622.

Kelly R.D. and Walker B.H. (1976): "The effects of different forms of land-use on the ecology of a semi-arid region in southeastern Rhodesia." *Journal of Ecology*, 64 (2), 553–576.

Mandaza I. (Ed. 1987): *The Political Economy of Transition in Zimbabwe*, CODESRIA, Dakar.

Moore D.S. (1993) "Contesting terrain in Zimbabwe's Eastern Highlands: Political ecology, ethnography and peasant resource struggles." *Economic Geography*, 69 (4), 380–401.

Morgan R. (1986): *Soil Erosion and Conservation*. Longman, Harlow.

Moyo S. and Skalnes T. (1990): "Zimbabwe's land reform and development strategy: State autonomy, class bias and economic rationality." ZIDS Research Paper Series No. 3, Harare.

Stocking M.A. and Elwell H.A. (1973): "Soil erosion hazard in Rhodesia". *Rhodesia Agricultural Journal*, 70, 93–101.

Stocking M.A. (1972): "Relief analysis and soil erosion in Rhodesia using multivariate techniques". *Zeits. fur Geomorph.*, N.F., 16, 432–443.

Stomgaard P. (1985): "Biomass estimation equations for miombo woodland, Zambia." *Agroforestry Systems*, 3 (1), 3–13.

Wentworth C.K. (1930): "A simplified method of determining the average slope of land surfaces". *American Journal of Science*, Ser. 5, 20.

Mitchell, B (1979), *Geography and Resource Analysis*, Longman.

Glasson, J *et al* (1994), *Introduction to Environmental Impact Assessment*, UCL Press Limited.

Larsson, G. (1991), *Land Registration and Cadastrial Systems*, Longman.

UNDP, (1992), Agenda 21: Programme of Action for Sustainable Development on Environment and Development.