LAND USE ASSESSMENT IN RESERVE LANDS: A CASE STUDY OF MBOOLE-MUYONZO TRADITIONAL LAND IN ZAMBIA

BY

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ABSTRACT

Reliable and up-to-date information about land use practices and available land resources in an area is essential for successful resource development and conservation. A land use assessment study was carried out in Mboole-Muyonzo Traditional Land,within the Tonga-Choma Reserve Land No.21 in Southern Zambia.The objectives of the study were (a) to assess current land utilisation and management, (b) to assess land use change and demographic change between 1970 and 1991,and,1969 and 1990 respectively, and (c) to estimate future land requirement in the year 2000, assuming all other factors are held constant except population growth.

Sequential aerial photography was used in assessing land use change during the study period.The study also attempted to project human population in the year 2000 using the exponential population growth model. A field survey was carried out to assess land utilisation and management and resource degradation in the area.The results of the study are: human population more than doubled in two decades with 5% annual growth,cultivated land expanded by 68.4% between 1970 and 1991, cattle stocking level was 2.4 ha/beast/year at the time of the survey (i.e.40-60% overstocking) and

available grazing land was less than half the requirement,and shortage of good arable land has forced the inhabitants to cultivate the hilly terrain resulting in all forms of soil erosion. The study also established that land shortage in the area was more as a result of the 1969 coercive displacement of people to give way for the Batoka ranch project than of rapid population growth.

Changes in land tenure structure and land distribution pattern in the province are advisable. Periodic surveillance and monitoring land utilisation on both reserve lands and state land farming areas through sequential aerial photography and sequential geographical analysis techniques is a must if the nation is to succeed in resolving the problems of land degradation in reserve lands and land idleness in state land farming areas. Relocation of some families (e.g.the 13.6% who own 44.4% of the cattle) is advisable. Initiating a land and water management project with livestock development,grazing land management,and soil-and-water conservation as major project components is strongly recommended in the area.

DECLARATION

I, MANFORD CHILUBE MULONGO, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work, and has not been submitted for a degree in any other university.

Date..8th Feb. 1993..... Signature.....

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DEDICATION

This work is dedicated to Queen Doroth, Princess Choolwe and Prince Chibi.

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1. INTRODUCTION

Zambia has depended on copper as the mainstay of the economy for a long time (Government of the Republic of Zambia/International Union for Conservation of Nature and Natural Resources (GRZ/IUCN 1985)),but copper is a finite resource. It is from the realisation of this fact that the Government is changing the emphasis in development from mining to agriculture (GRZ/IUCN 1985). The importance of agriculture in the economy cannot be over-emphasised. It is the largest employer of human labour. It also provides food and raw material to the economy.

Agriculture is a natural resource dependent industry whose survival can only be assured if the natural resource base on which it heavily depends is sustained. However,the sustenance of the agricultural resource base depends on the appropriateness, responsiveness and effectiveness of the policies that affect land resource allocation, utilisation and management (Brundtland 1987).

In Zambia,land belongs to the state. It is divided into three tenure categories for administrative purposes: viz. state land, reserve land and trust land. State land is under the control of the state. Reserve land is under the control of chiefs while trust land is the "common"(both the state and chiefs have the right to this latter land

category). Since land belongs to the state,it is the responsibility of the Government to direct land development efforts. It is also its responsibility to protect the land resources on behalf of land users by formulating appropriate policies to guide both land resources utilisation and conservation. From the time this land tenure structure came into force in Zambia, discrepancies between tenure categories have existed and widened. Not only are state land and trust land endowed with high quality resources as indicated on the erosion hazard map of Zambia (Chiti 1988), but more so on development endeavours that have often times left the reserve land on the side line. On a number of occasions development efforts have inconvenienced populations in reserve and trust land (Colson 1971 ; Njunga 1987).

Land problems in Southern Province (Fig.1) date as far back as 1926, when the colonial government introduced reserve lands for native population and crown lands for whites (Sakala 1982). This discriminatory land tenure structure led to confinement of majority of the rural population in agriculturally marginal areas (with poor soils and hilly terrain). Under this fragmentation system seven reserve lands were created in the province (Appendix I). Three out of the seven are located on the fringe of the Zambezi escarpment in part or whole.

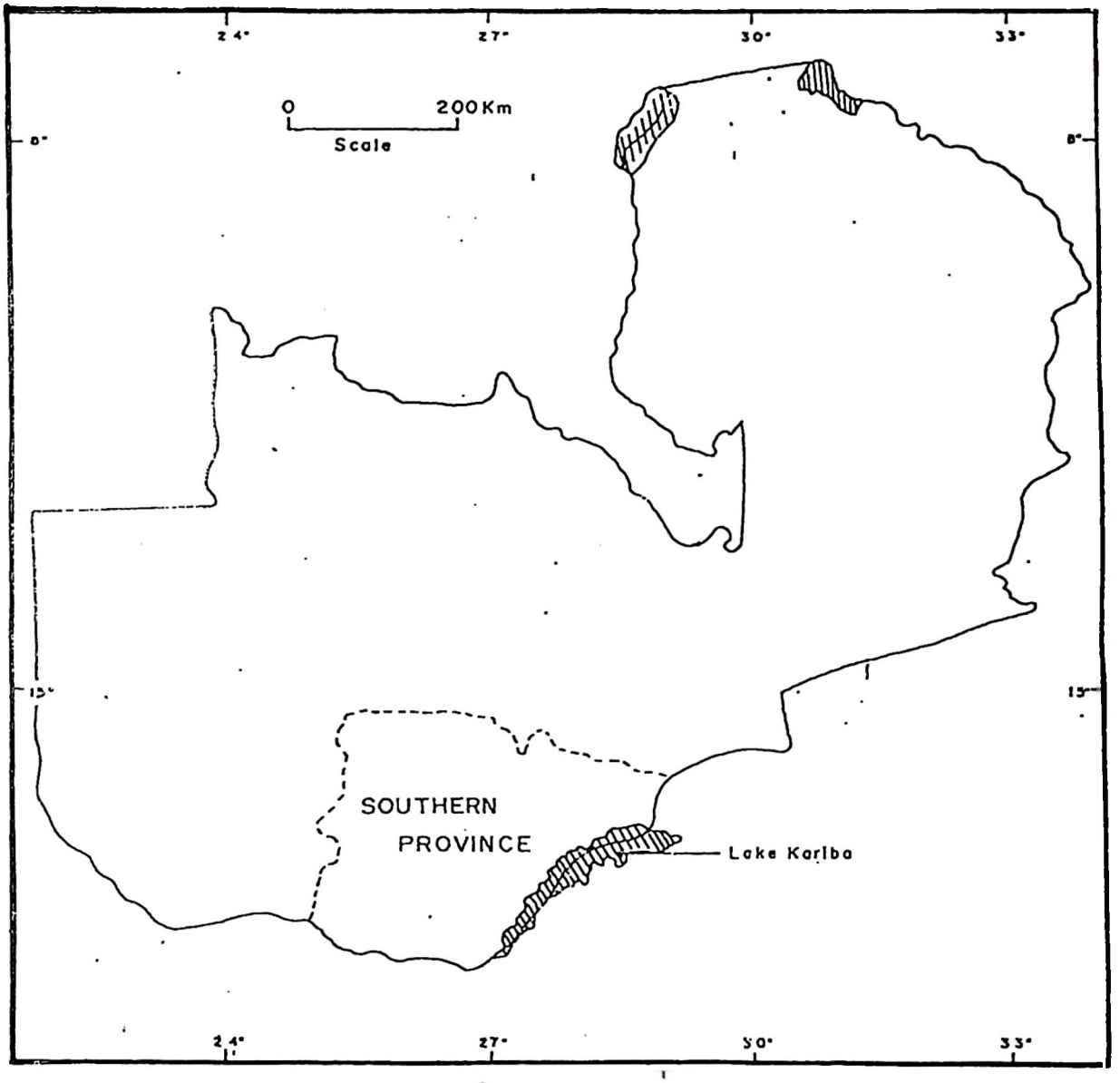

Fig.1. Location of Southern Province in Zambia.

Due to the extent of state land in the Southern Province (Appendix II), most reserve lands are overcrowded and overstocked with cattle, thereby threatening the reserve land resources (McDonnell 1975). After independence (in 1964),the land tenure structure and land distribution pattern remained as in pre-independence period, except for the change in nomenclature, where "crown land" became state land and "reserve land" became reserve and trust land. Even after independence further confinement of people in reserve lands occurred. The state ranch project saw the displacement of people from some of the present-day ranches. The recent displacement occurred in 1986, in Gwembe Valley where the "cotton growing peasants" were displaced by a multinational company (Njunga 1987). The questions one may be forced to pose are: Where do these people find a fixed or permanent abode? What are the environmental implications of these unplanned (spontaneous) movements of people?

Land use is a dynamic phenomenon, an ever changing relationship between people and the natural resources (Vink 1975 ; Mandal 1981). Human needs are diverse but land from which these needs are derived directly or indirectly is a fixed resource with capabilities and limitations for different uses and susceptible to

deterioration when used in disharmony with its capabilities.

Reliable and up-to-date information about land use practices and the available land resources is necessary in order to establish a good land development and management plan of an area (FAO 1977). Understanding of the suitability of land for various uses is essential to preventing land resources deterioration associated with misuse and over use of land.

The knowledge of the type, extent,location and quality of resources and how they are being utilised is a pre-requisite to successful resource development and conservation. It is therefore imperative to have available inventories of past, present and potential land use of a country, region, district and catchment (Department of Agriculture Zambia 1977). In this regard both the resource and activity must be monitored if they are to be maintained in a productive state (Van Riet and Cooks 1988).

With the rapid population growth, it is essential to identify, assess and report on risks of irreversible damage to natural systems and threats to the survival and well-being of the rural communities (Brundtland 1987).

Land use and demographic change analysis plays an important role in one of the greatest challenges of our time: planning the use and conservation of the earth's resources for its present and future generations.

Land use assessment (analysis) is concerned among other things, with natural resource base determination, resource potential evaluation and resource utilisation monitoring (Estes and Senger 1974; Higgins et al. 1984). Current status of land resources and changes in resources induced by the existing land use systems in reserve lands are not known. It is against this background that this research with a resource utilisation monitoring bias was initiated.

The main and general objective of the present study is to determine and analyze the rate of land resource exploitation and the implications of the existing land policy (land distribution pattern and land tenure structure) on the reserve land resources amid rapid population growth in fragile ecosystems, with a view to recommending to the Government on how it can resolve the problem of increasing number of people and livestock in the study area in particular, and reserve lands in general, in order to prevent serious resource degradation.

The specific objectives of the study are:

(a) To assess current land utilisation and management.

(b) To assess land use change and demographic change between 1970 and 1991,and,1969 and 1990 respectively.

(c) To estimate future land requirement in the year 2000, assuming all other factors are held constant, except population growth, in Mboole-Muyonzo Traditional Land.

2. LITERATURE REVIEW

Literature on land use studies and environmental change is scarce in Zambia (Mbewe 1987). Most of the studies that have been carried out do not address the issues of land use, population and land availability and resultant resource degradation.

Schultz (1974) carried out a land use study in Zambia. His work led to the production of the land use map of Zambia. The study aimed at dividing the country into different farming regions and land use systems based on a number of diagnostic variables (viz. farming system, farming tools,land tenure system etc.). The study never took account of areas that have suffered from population pressure and resource degradation. Aerial photographs and mosaics and some field check were used in data collection.

Chidumayo (1987) investigated and reviewed the status of " chitemene" shifting cultivation system in northern Zambia. Changes in soil nutrients , relationship between population density and deforestation and the survival of the chitemene cultivation system under conditions of overpopulation relative to critical population density were assessed. He found that population increase caused deforestation and resultant reduction of (a) the length

of fallow period from 25 years to 12 years, (b) the per capita woodland requirement from 1.1 ha to 0.53 ha. Chidumayo further observed that the diminishing wood resources resulted in an increase in carrying capacity (maximum number of people that a given resource can support on a sustainable basis) from 2.4 persons/km^2 to 18.7 persons/km^2. The pattern of deforestation in relation to population density was studied by examining false colour satellite imagery of 1979 and population census data of 1980.

Keech (1969) analyzed the changes in gully density in relation to changing agricultural practices and increasing population pressure in Mondaro Tribal Trust Land in Zimbabwe using sequential aerial photography and survey. He concluded that gully density increased with increase in human population.

Land use change between 1956 and 1984 was analyzed in Malta by Charlton and Beeley (1987). They found that cultivated land estimated at 17 700 ha in 1956 had fallen to 11 491 ha by 1983 (a decline of 35 per cent in 27 years).

A study on population-land relationship was carried out in Fiji by Clarke and Morrison (1987). They found that

the land in use increased by 233 per cent between 1958 and 1978, while rural population increased by only 31 per cent between 1958 and 1976. They associated the increase with the adoption of cattle raising in village agriculture.They observed that the expansion of cultivation resulted in degradation of the newly developed land on rolling to hilly terrain.

Land use changes in relation to human population changes were analyzed in the Komering basin of Indonesia by Van de Putte (1988). He found that population was the main dynamic factor and cause of change in the project area. Three population- induced changes were observed: increased number of farms, increased area under cultivation and intensive cultivation of existing land. Rate of deforestation and land use changes were assessed in the northern zone of Costa Rica by Jacobs (1990). Sequential landsat images were used in the analysis (viz. landsat MSS 1978, 1986 and 1988). He found that deforestation in some zones was progressing at an alarming rate, but there was no relationship between deforestation and soil type or geomorphology.

Tekie (1990) used sequential aerial photography to assess changes in both land use and population between 1955 and 1966 in the Nyamzue catchment of Zimbabwe. Using the

derived annual population growth rate , he estimated the amount of land required to meet the daily energy, protein and firewood needs. He further estimated the period during which the catchment would sustain its inhabitants based on the remaining unutilised land. He made recommendations on how to sustain the resources of the catchment viz. resettlement of some people and not allocating plots which are too small or too big to ensure optimal land utilisation.

Examination of land use and farming changes was done in Basilicata district in Italy by King and Killingbeek (1990). They found that population in the area declined during the period 1970 to 1982, seventy per cent of the land holdings were less than 10 ha in 1970 and 1982, the average size of holdings was 16.2 ha and 15.3 ha in 1970 and 1982, respectively and a small number of holdings was in 10-20 ha class. Data collection involved field work where observations were made and discussions with farmers were held. An 1: 25 000 base map was used in the study.

Analyses of land use change in relation to population and household growth were carried out in the fast- growth counties of United States of America between 1960 and 1980 by Vesterby and Heimlich (1991). Paired-point sampling and equal-sized sample techniques were used to

analyze land use change. They found that (a) population increased by 46% in the 1970s,(b) number of households increased by 38% in the 1970s while the increase in the 1960s was 55%, (c) the average household size decreased by 5% in the 1960s but decreased by 13% during the 1970s.

Land use changes were evaluated in Clarke county of Georgia (USA) for the period 1944 to 1960 using panchromatic aerial photography by Avery (1965). The principal objectives were: to determine land use classifications which could be consistently identified on 1:20 000 aerial photographs taken at 16-year interval, to measure land utilization changes using 1944 and 1960 aerial photographic coverages, and to formulate reasonable explanations for land use changes. Six land use classifications were identified. He found that all the land use categories increased except cultivated land category which decreased by 5 440 ha between 1944 and 1960, while urban land use increased by 3.4%; residential urban land use was responsible for the increase in urban land use.

Kay (1969) carried out a general assessment of problems and prospects of the land use systems in Zambia. He found that even areas with good soils had low carrying capacity. He gave examples of carrying capacities for

Eastern Province plateau (9 persons /km^2), Copperbelt Province (6.4 persons/km^2),and Northern and Luapula Provinces (1.4-3.6 persons/km^2). He concluded that due to low carrying capacities, the conditions of over-population and resource degradation may be reached even when absolute population densities remain low.

The analyses of current farming patterns and dynamics of resource utilisation were carried out in the Komering basin of Indonesia by Zabel et al.(1988).The farming systems in the watershed were described and their dynamic tendencies for change over time were assessed. Population distribution and demographic changes were examined in the study watershed.They found that (a) partial population densities ranged from 27 persons/km^2 to 67 persons/km^2 with an average density of 52 persons/km^2; (b) average annual population growth rate was 5.1% in the area while the average for country was 2.1%; (c) farming was the main activity in the area with 80% - 85% of households directly involved in agriculture; (d) population growth was the main dynamic factor responsible for the change from shifting cultivation system to permanent cultivation system; (e) average farm size was 2.4 ha; (f) average farm size decreased from 2.59 ha in 1981 to 2.52 ha in 1986; and (g) none of the interviewed people owned a plough or tractor and livestock was of minor importance.

Ruthenberg (1971) studied different farming systems in the tropics (viz. shifting cultivation ,semi-permanent cultivation, grazing systems,etc.). In his study of semi-permanent cultivation systems ,he used Sukumaland in Tanzania as a case study. The following variables were studied: cropping systems, fallow systems, crop rotation, land use intensities, soil fertility maintenance, and characteristics of animal husbandry, animal ownership,and problems of the system. He found that (a) mixed cropping was the predominant cropping system, although cash crop production led to an increase in number of pure stands; (b) fixed sequence of cropping (crop rotation) was not common; (c) fallow period ranged from six months to five years; (d) mineral fertilisers were used to improve soil fertility; (e) communal use of grazing land was customary(f) cattle ownership in Sukumaland was highly concentrated than cropland ownership(25% of the families cultivated 55% of the cropland but 25% of the families owned 80% of the cattle),and (g) due to the relatively intensive land use,maintaining soil fertility, soil erosion, and degeneration of the livestock economy were recognised as the major problems of the land use system.

Barrow (1988) assessed land utilisation and management in the semi-arid and arid lands of the Pokot and Turkana tribes in Baringo district of Kenya. The principal

objective of his study was to investigate into some of the traditional values of the Pokot and Turkana tribes which could be useful in soil and water conservation in dry areas.The study was initiated after observing deterioration of resources around settlements. In assessing existing range management and land use strategies, he found that (a) as a result of development initiatives, substantial amount of land had been cultivated; (b) livestock management (herd formation and choice of grazing land) was organised on a multi-family basis; (c) transhumant method of livestock grazing was practised by the Pokot and Turkana; and (d) human and livestock populations were on the increase resulting in over-utilisation of the physical resources.

Prescott (1972) examined over-population and overstocking in Native Areas of Matebeleland of Zimbabwe. He found that land alienation was the cause of human population and livestock congestion in the study areas. He observed soil erosion around settlements and on grazing land due to continuous livestock grazing. Pressure from livestock hooves and cultivation of stream banks were identified as the causes of stream bank erosion. He further observed that despite the increase in area of native land,the area available for each household continued to fall due to rapid increase in population. The restricted amount of

grazing land amid increased livestock population caused complete removal of vegetation cover exposing the land to climatic assault and subsequent soil erosion. Aerial photography and field survey were used in data acquistion for the study.

Kay (1972) examined the (a) origin and character of overcrowding in the Native Reserves of Eastern Zambia, (b) the role of resettlement in alleviating the problem, and (c) technological, economic and social measures designed to bring about optimum use of natural resources of marginal lands. He found that land alienation by colonial Government and rapid population growth were the causes of overcrowding and resource degradation in reserve lands. He concluded that unfavourable population-land adjustments required both movement of people and improvements in the agricultural systems.

McLeod (1990) studied levels of overgrazing in the Kgalagadi district of Botswana. He described the cattle grazing system and its associated problems in this semi-arid environment. Implications of the 1981-87 drought to the cattle economy in Kgalagadi district were enumerated.Comparisons of the cattle stocking rates in the two districts of Kgatleng and Kgalagadi were made.He found that the actual stocking rate in Kgatleng was 3.1

ha/beast in 1978,while the potential carrying capacity was 12 ha/beast.The degree of overstocking was 287%. Kgalagadi district had stocking rate of 77 ha/beast in 1978,and carrying capacity was 26 ha/beast. The degree of understocking in the district was therefore 66%. The study indicated that although Kgalagadi district was understocked, overgrazing was a real problem in localised places within the district.

Mpofu (1990) assessed the basic needs and the environment of the communal areas in the Save Catchment of Zimbabwe.In the study he looked at the interplay of social and political factors in land apportionment. He found that (a) approximately equal areas were apportioned for both white and black farming communities, although rural black population made up 80% of the total population; (b) infrastructure and credit provisions were in favour of the white farming community; (c) colonial land apportionment caused the concentration of majority of the rural black population in marginal areas with poor soils, low rainfall and reduced overall agricultural potential. The study also focused on land use patterns, changes in availability of natural resources and estimation of sustainable human population densities in the Save Catchment. Aerial photographs were used in analysing the extent of cultivated land and multi-date

aerial photography was used in assessing the rate of deforestation in the catchment.

Darkoh (1990) analysed Kenya's environment and environmental management. The study focused on (a) land availability and population, (b) land use and land categories, (c) future land requirement, (d) land use changes, (e) cultivation of marginal lands, (f) population pressures on land and environmental management. He found that Kenya's food producing potential areas had been already exploited beyond their carrying capacity; arable land for subsistence farming was in short supply resulting in expansion of cultivation into marginal lands, 75% of the population was concentrated on 20% of land; national population growth was 3.9% per annum,and national population density was 27 persons/km^2. The study indicated that Nyanza region would run out of additional land for farming by the year 1995. The overcrowding and expansion of cultivation into marginal lands were direct consequences of colonial land alienation which created a situation of land scarcity. Expansion of cultivation and alienation of land for ranching were rapidly diminishing the available grazing land thereby intensifying overstocking and overgrazing. He concluded that population growth and distribution were

the major factors linked with the problem of land degradation.

Mohamed (1985) analysed multi-temporal land use in the villages of Rukwa Region in Tanzania. The study focused on, among other things, the changes in land under agricultural production and factors responsible for changes in agricultural development trends. Aerial photographs taken in 1976 were used for the study. Different land use categories were identified and delineated on the aerial photographs. Land use categories classified were: settlement sites, plant cover or vegetation type, cultivation,swamps and surface water bodies etc. Vegetation was classified into the following categories: forest, woodland, bush and grassland. Estimates of size of each land category and human population were made for each of the study villages.

3. BACKGROUND INFORMATION OF THE STUDY AREA.

3.1 Location, extent and brief history of the study area.

The area lies between latitude 16°45'S and 16°56'S and longitude 27°15'E and 27°21'E (Fig.2), in Choma district of Southern Province. It is situated about 30km from Choma town.The western boundary of the area is Batoka-Maamba road (D775) and Batoka ranch; its northern boundary is the railway line and Batoka Boma.
Ndondi Local Forest No. 181 forms its eastern boundary, while the Simwami Munzuma National Forest No. 180 forms its southern boundary (Fig.3). The study area accommodates nine villages of Sianamaya, Bulongo, Chindolo, Chibuno, Siankandu, Siachikwela, Sichikali, Siafwakweenda and Siakachamatanga in Batoka ward.

Mboole-Muyonzo Traditional Land occupies an area of 9 200 ha within the Tonga-Choma Reserve Land No. 21 created in 1926, under the Crown and Reserve Land Act (Sakala 1982). The study area was chosen because:-

- no research of this nature has been carried out before,
- the area was not reached by the commission of inquiry into land matters in the province in 1982,

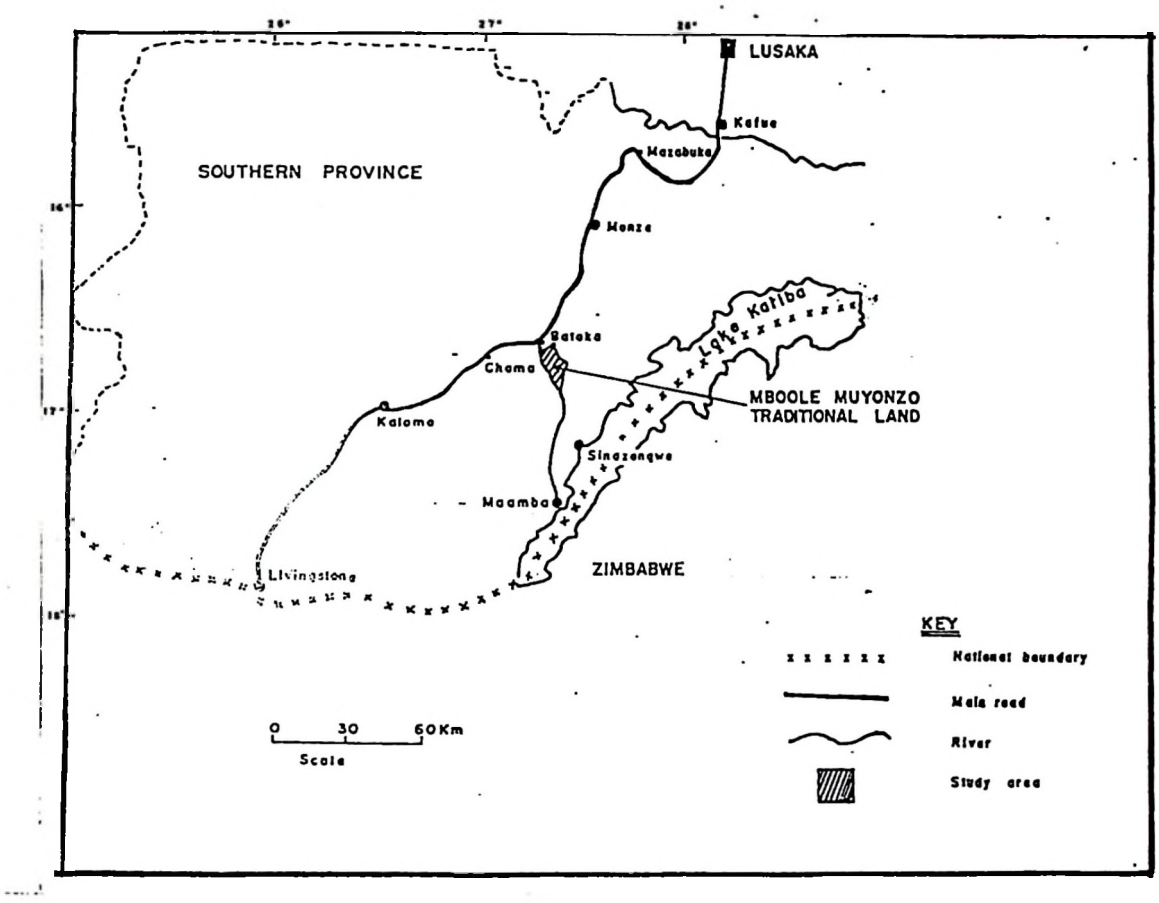

Fig.2. Location of Mboole-Muyonzo Traditional Land

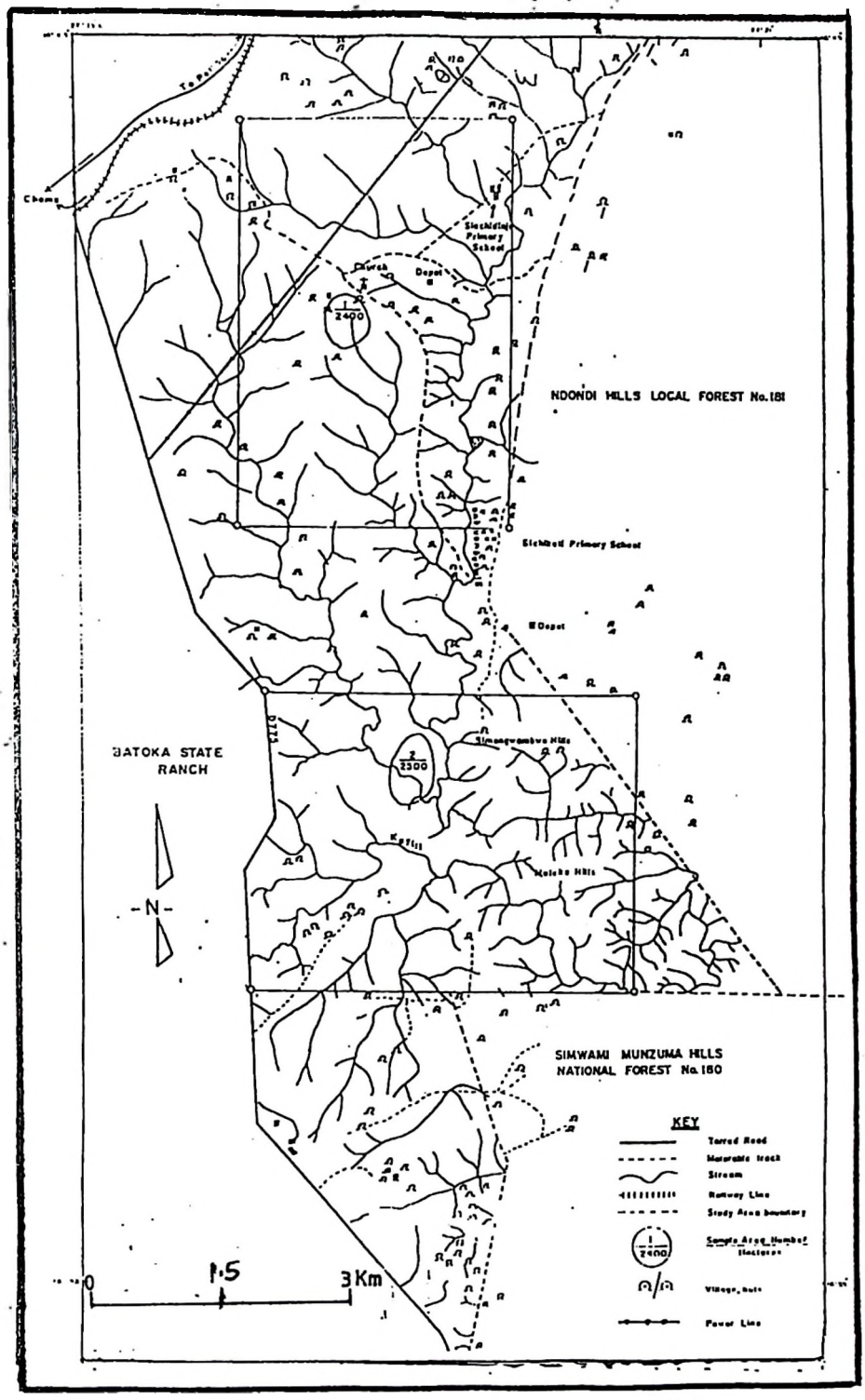

Fig.3.Settlements and Drainage in Mboole-Muyonzo Traditional Land.An extract from topographical map and 1991 aerial photography.

- the area is on the fringe of the Zambezi escarpment with rolling to hilly terrain, highly susceptible to degradation under moderate population pressure, and
- the area accommodates some of the people who were displaced from the present-day Batoka ranch.

Sometime in 1969 part of the study area was declared an extension of the present-day Batoka ranch. A barbed wire fence was erected about the same year. The good grazing land was fenced and local people had little amount of land on which to graze their animals. However, before cattle could be put in the second phase of the ranch, the barbed wire fence was removed and more than 2 000 ha piece of land was once again used by the local people as grazing ground. As people increased in number the area has come under cultivation. In search of more space, other displaced farmers and their cattle found themselves in the Simongwangwa and Muleka hills.

3.2 Geology, geomorphology and drainage.

The area is underlain by pre-Cambrian basement rocks. Gneisses, schists and migmatites are the common metamorphic rocks. Schists consisting mainly of quartz and muscovite are common in the hilly parts of the area (Money 1975)

The study area is part of the degraded central plateau division and southern plateau physiographic subdivision (Williams 1975). The average elevation is 1 200 m above sea-level (a.s.l).

The study area is drained by high density dendritic stream (dambo) network from the Simongwangwa and Kayili catchments (Fig.3). Two major physiographic subdivisions are identified as:

(a) - high less dissected flat to gently sloping plateau, characterised by dendritic drainage pattern, semi- perennial and non-perennial streams with wide and shallow stream valleys (dambos). The average slopes range from 0-3% in both upper Simongwangwa and Kayili Catchments (Fig.4). The interfluves (ridges) are a series of wide and long and gently sloping surfaces with tapering ends at stream confluences.

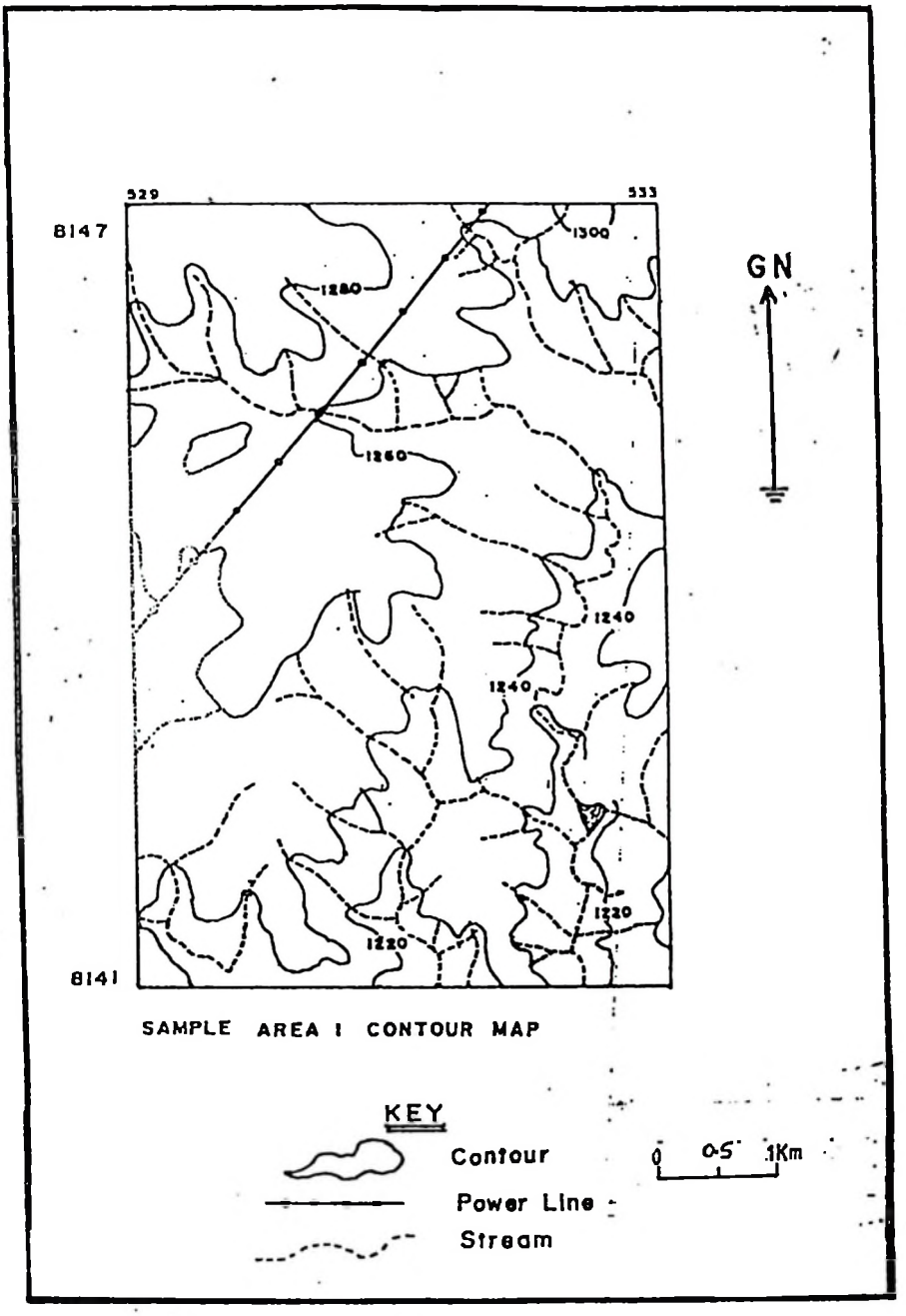

Fig.4. Contour map of Upper Simongwangwa Catchment.

Source:Topographic map 1:50 000

The interfluve spacings range from 150 m to 1 200 m, while valley widths range from 75 m to 450 m. Large and medium termite mounds are abundant in this land system. The ridge orientation is mixed (north-south, north west-south east and west-east). This system has moderate local relief amplitude. This area can support intensive agricultural activities where soils are good. Apparently, it offers the highest potential for grazing, both in winter and summer;

(b) - the highly dissected, rolling to hilly plateau merging with the escarpment terrain. The area is characterised by very high stream density of dendritic and trellis pattern in both lower Simongwangwa and Kayili catchments. Local relief amplitude is approximately 152 m. The stream valleys are incised, narrow, deep and steep sided. West-east ridge orientation is dominant. Slopes range from 8% to more than 12% (Fig.5).

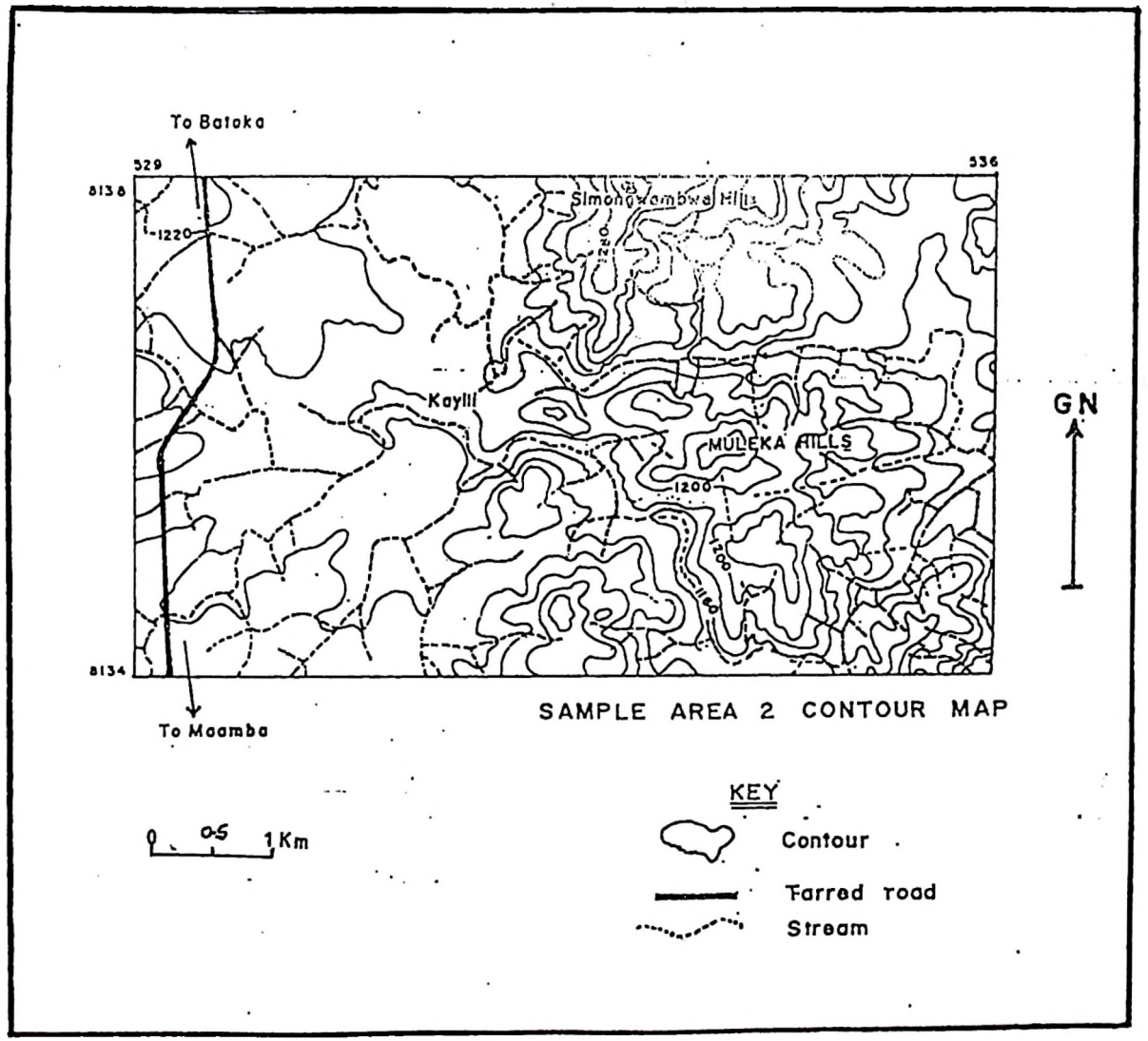

Fig.5.Contour Map of Middle Kayili Catchment.

Source: Topographic map 1:50 000

3.3 Climate

3.3.1 Agro-ecological zonation

The study area is situated in the agro-ecological region IIa and zone 4-es (east-south) Choma (Fig.6). It is characterised by the growing period of 100 to 110 days in an average year and drought during the growing season is in the range of 30-40 days (Veldkamp 1987). These variables were determined at 70% probability.

3.3.2 Rainfall

Zambia experiences tropical climate (Cwa) according to Koppen classification (Griffiths 1972), with a long dry season and a short wet season. The length of the rainy season and the quantity of rainfall decreases from north to south. Rainfall variability decreases from south to north. Dry spells are longer in the south than in the north.

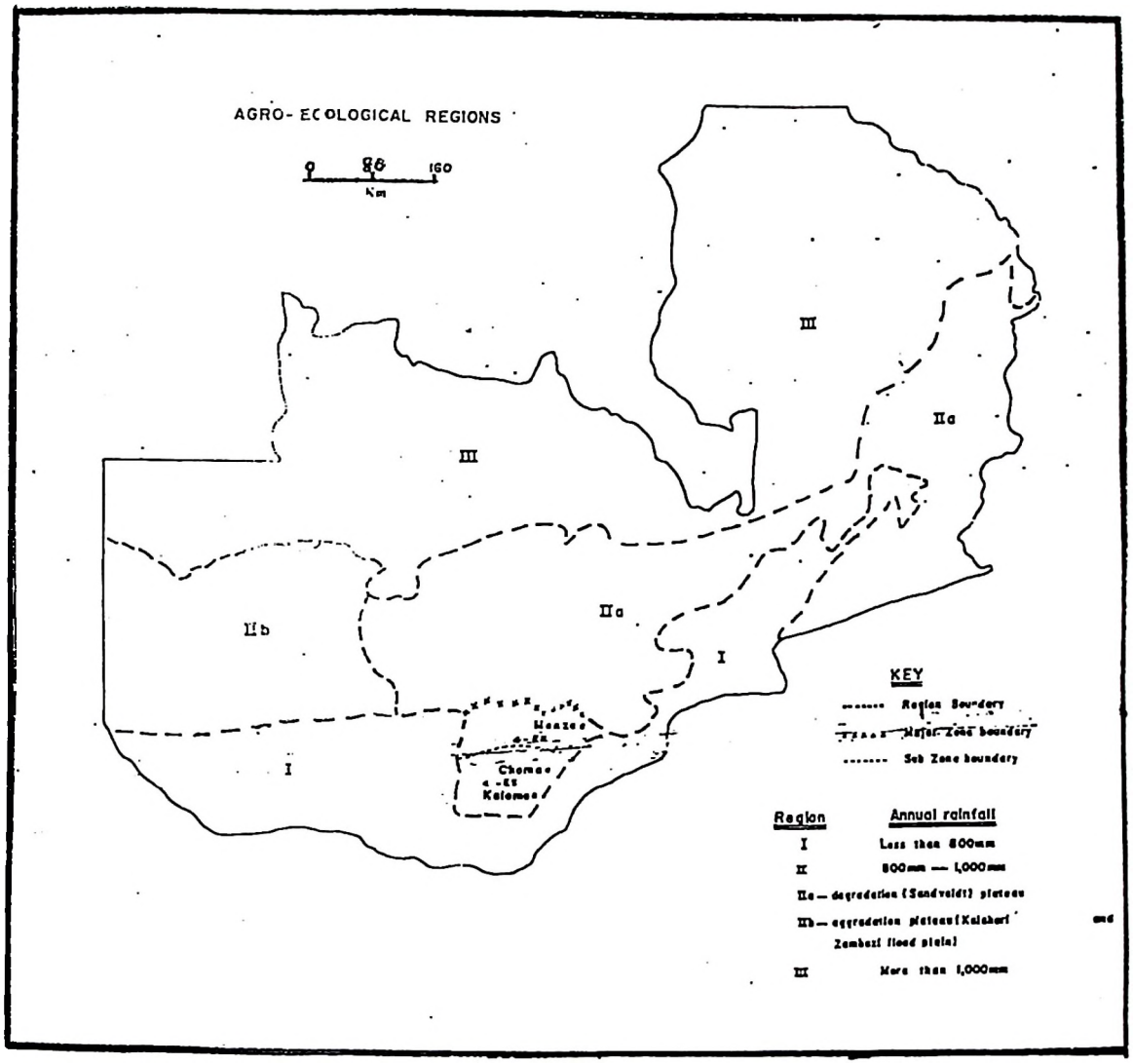

Fig.6. Agroecological Regions in Zambia
(Veldkamp,1987)

The study area receives mean annual rainfall ranging from 750-900 mm with an average of 825 mm per annum (Veldkamp 1987). Rainfall has been erratic during the last ten years (1980-1989) and droughts have been causing crop failure and cattle deaths in the study area. The rainy season is from October/November to March/April and is of mono-modal type with December/January as the peak rainy months. Evapotranspiration is generally high during most part of the year with highest values during the period from October-March. Figure 7 shows monthly rainfall and evapotranspiration patterns in Choma station.

3.3.3 Temperature

The maximum monthly temperature is as high as 32°c in the month of October. Figure 8 shows monthly temperature variations in Choma station. Mean minimum monthly temperature (°c) ranges are: 4-7, 8-12 and 16-17 for the periods May to July, August to October and December to February, respectively. Mean maximum monthly temperature ranges are: 23-26,28-32 and 26-27 for the periods May to July, August to October and December to February, respectively (Veldkamp 1987).

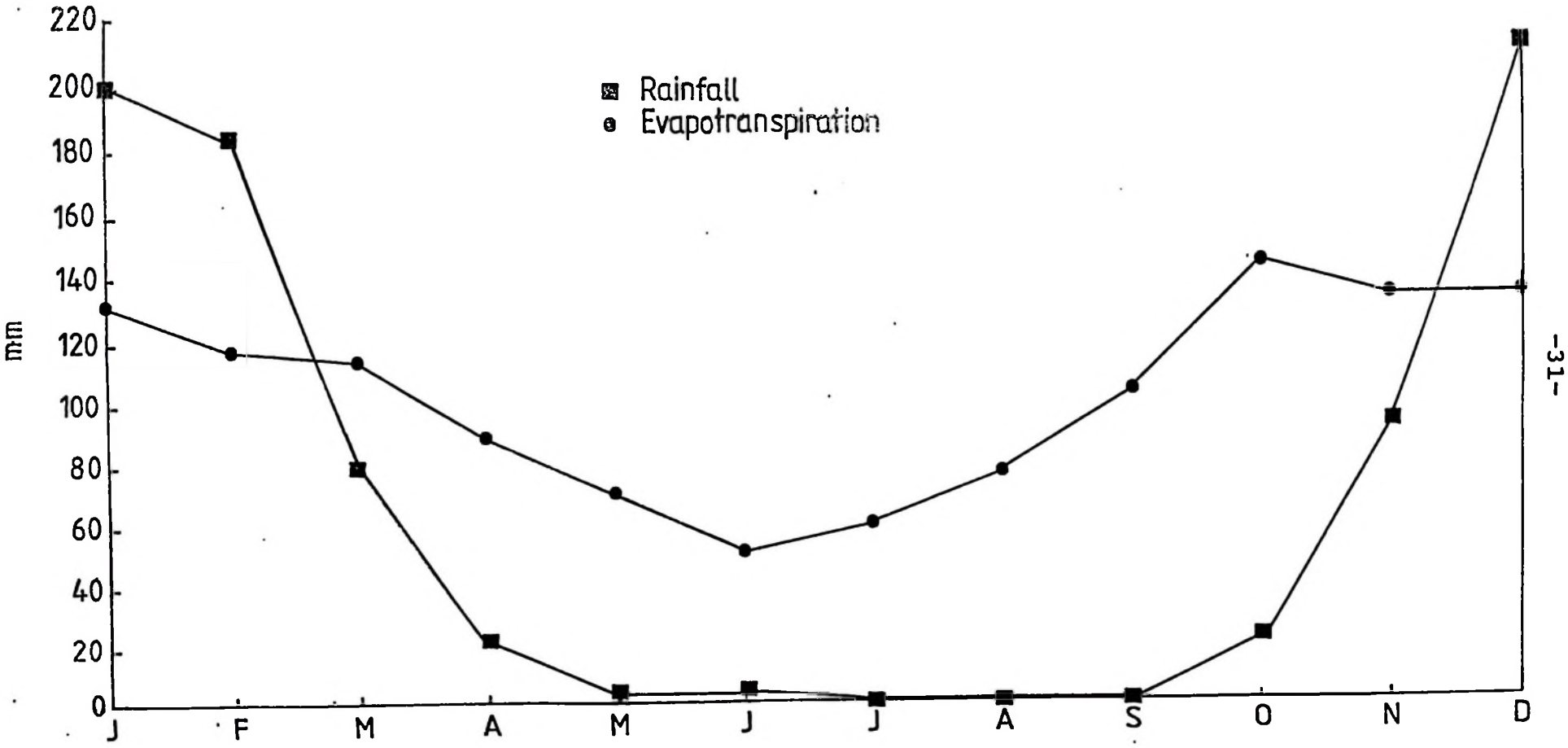

Fig.7. Monthly rainfall and evapotranspiration pattern in Choma station (FAO,1984).

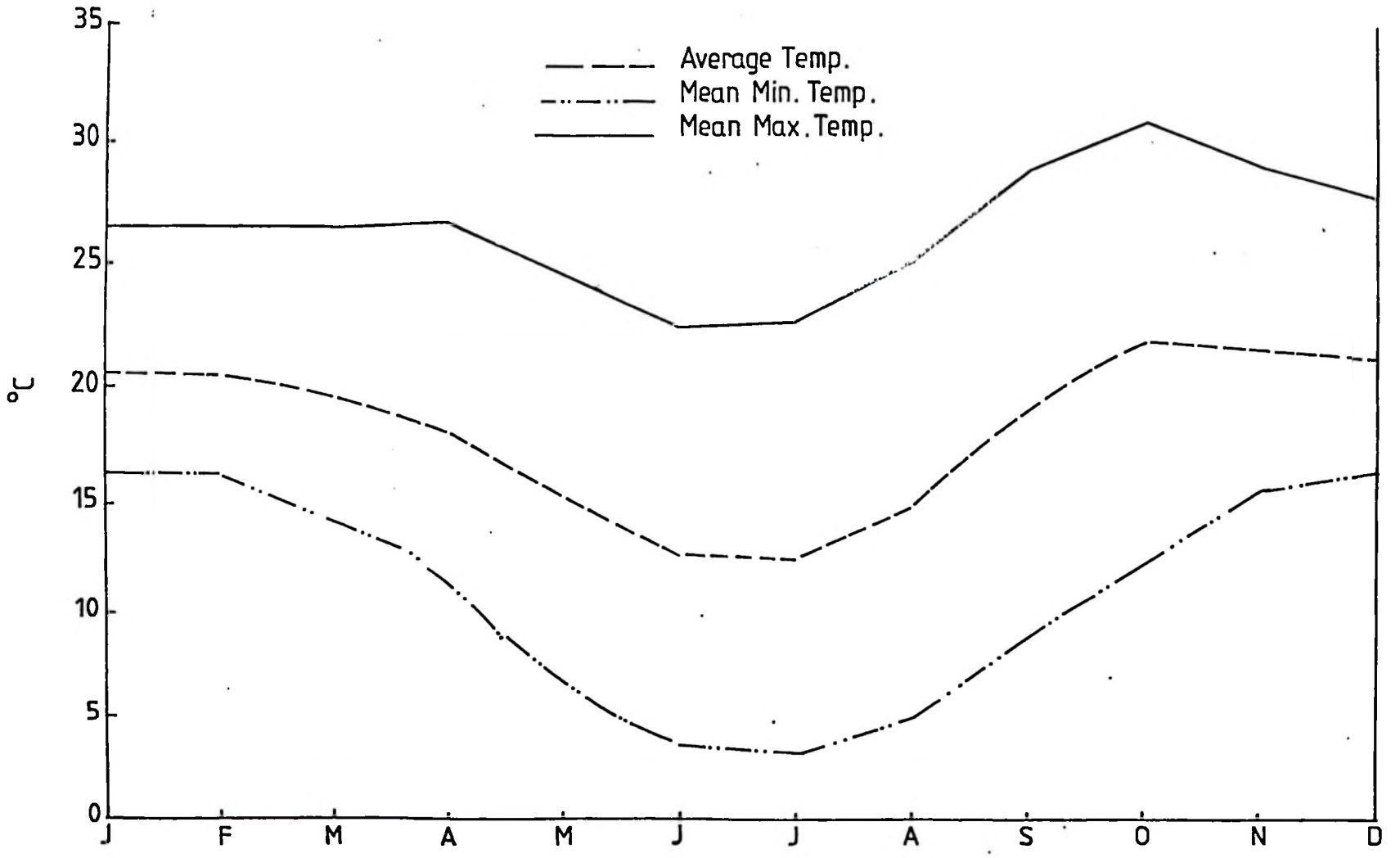

Fig.8. Temperature patterns in Choma station (FAO, 1984).

3.4 Vegetation and Land Use

The vegetation in the study area falls into the escarpment Miombo Woodland (Huckabay 1975), characterized by open woodland with grass undergrowth. The dominant tree genera are Brachystegia, Julbernardia and Isoberlinia. Vegetation falls into three categories based on tree-grass compositions (Fig.9). Grassland (Rg) is associated with saucer shaped stream valleys called dambos. The vegetation is predominantly grass with scattered bushes. The grassland vegetation category accounts for 14% of the land cover in the study area. It is this vegetation type which gives the area high potential for livestock grazing. The area covered by this vegetation type is not suitable for arable farming due to temporary wetness during the rainy season.

Another vegetation category is the open woodland (Fo) with mixed vegetation types (trees, bushes and grass). The common tree species are the Julbernardia paniculata locally known as" Muumba" growing on the sandy loam soils of the upper and middle catchments. This vegetation category accounts for 64% of the land surface in the study area.

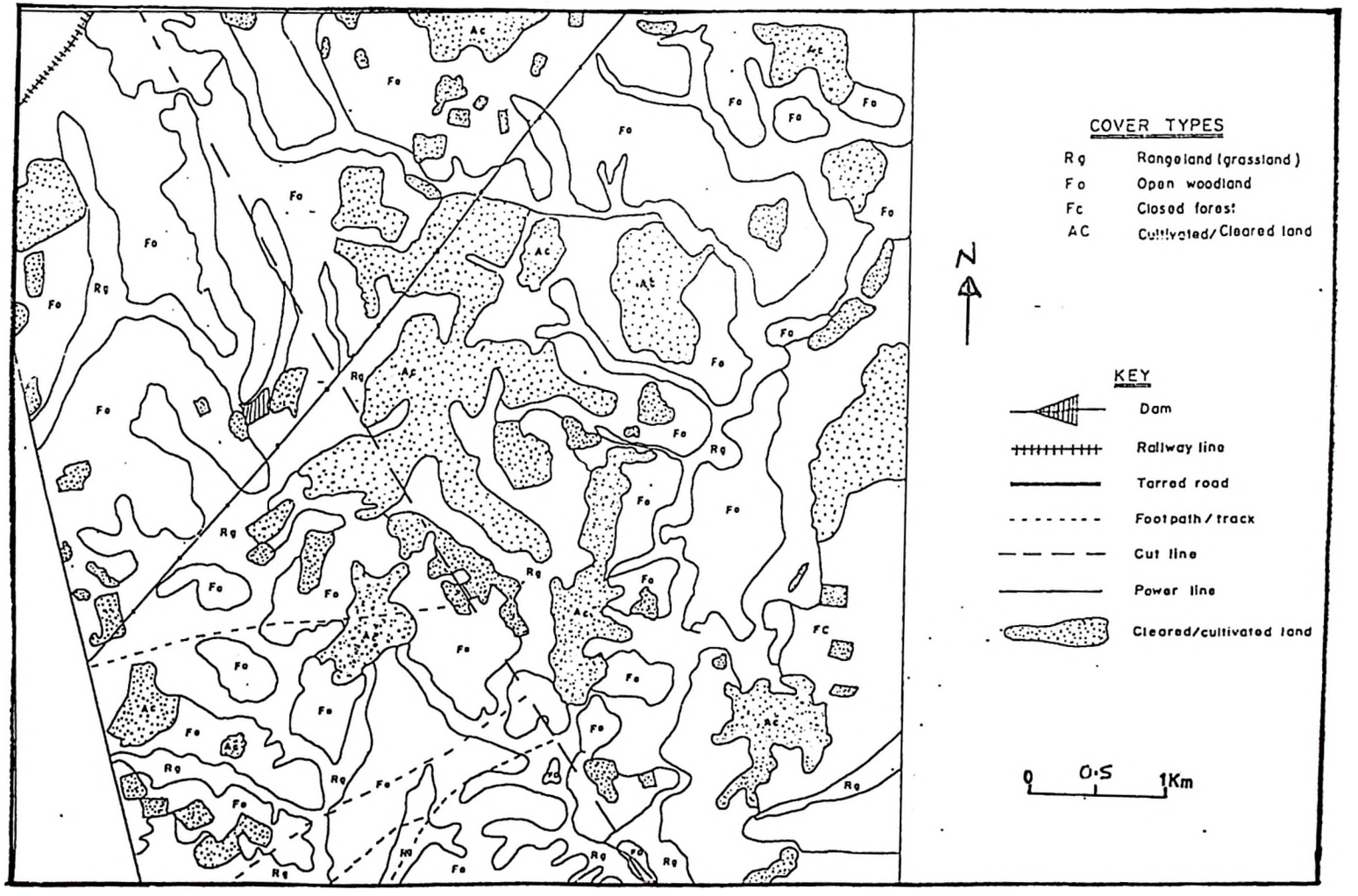

Fig.9. Land Use/Land Cover of Upper Simongwangwa catchment.
(Aerial photography 1970)

The third vegetation category is the closed woodland (Fc) with evergreen trees of the Brachystegia longifolia (locally known as " Mubombo") species and Uapaca kirkiana locally known as " Musuku" species growing on hilly terrain. Tall trees are found on hill summits and hillsides. Short grass under-growth is also common in this category. This vegetation type accounts for 22% of the land surface in the study area.

3.5 Soils

Deep to moderately deep sandy loams are found in the ridges of the upper catchments (of less dissected high plateau or land System a). Moderately shallow to shallow sandy clay loams are found on the high, dissected, rolling to hilly terrain or land system b. The soils on the hill slopes are generally shallow and rocky, with a plough layer of less than 10 cm in some places. Surface features limiting arable farming are: surface gravel (G) (common on the ridges of the upper catchment), rock outcrops (R), shallow soils (s), erosion (e),steep slope (S) and temporal wetness(w) (associated with stream courses).

4. MATERIALS AND METHODS.

4.1 Materials.

The following materials were used in this study:

- topographic map (1: 50 000),
- thematic maps (viz. vegetation, geology, climatic and landform),
- aerial photographs taken in 1970 and 1991 at scale of 1:30 000,
- mirror stereoscope and mechanical pantograph for map reduction.

4.2 Methods.

Aerial photographs and thematic maps are well known tools used in studying land use and natural resources (Fox 1986). This research is no exception. Different methods were used in data acquistion for this study.

4.2.1 Pre-field operation.

Data generation and source material assembling stage involved making lists of:

(1) data to be collected to answer specific research objectives falling into four categories (viz. land, land use, demography and others),

(2) data source materials (viz. maps, aerial photographs reports and publications).

(3) modes of data collection (viz. literature search, aerial photo-interpretation, calculations, observations and measurements, inquiries and interviews), and assembling of all data source materials.

In assessing land use and demographic changes the following data were collected: total cleared/cultivated land in 1970 extracted and determined from 1970 aerial photographs, total cleared/ cultivated land in 1991 extracted and determined from 1991 aerial photographs, the change in cleared/cultivated land between 1970 and 1991 was calculated, number of people, number of households and average size of households for 1969 and 1990 were collected from Central Statistical Office (CSO) in Lusaka,the change in number of people, households and size of households were calculated, average size of land holdings were determined from 1970 and 1991 aerial photographs and inquiry from the local people.

In assessing current land utilisation and management the following data were collected: major land use categories and activities,types of crops grown, production orientation, size of land holdings, configuration of land holdings, land tenure systems, source of power for farm

operations, farm transport types, cultivation practices and implements, average distance to fields, cropping system, level of material inputs, tillage types and techniques, crop residue management, grazing land management, soil conservation measures on cultivated land,water availability and supply and constraints to existing land use. These data were collected from the area through observations and interviewing the local people using an informal questionnaire (a checklist of information required in the study).

For estimating future land requirement the following parameters were determined: average size of households for the year 1990, annual population growth rate derived from 1969 and 1990 population figures, average size of land holdings (1991), and projected population figure for the year 2 000 using the exponential population growth model (Haggett 1983), that is,

$N_t = N_o e^n$

where N_t = population at time t,

N_o = population at time o,

r = annual population growth rate,

t = time of projection,

e = 2.71828 the base of natural or Napierian logarithm.

The problems of estimations are associated with answering the questions in specific terms concerning the future situations. However, the uncertainities are with the answers in specific figures and not with the general direction of change. The following questions pose some difficulties in estimating future land requirement and demand:

1. How fast will the population grow in the area?
2. What proportion of people will be in the area during the projection period?
3. How much land will additional people need?

The population projection and land requirement estimates are based on the following assumptions:

1. Annual population growth rate derived from past population census data (1969 and 1990) and the average size of households for 1990 to remain constant during the projection period.
2. The average size of land holdings for 1991, to remain constant during the projection period.
3. No new farming technological innovations are envisaged in the area during the period of projection.
4. Immigration is equal to emigration, giving a net migration of zero in the area during the

projection period.

4.2.2 Modes of data collection.

All the demographic data were extracted from population census reports. An 1: 50 000 topographic map was used:

- to provide the basic topography of the area,
- as a basis for choosing the two sample areas and for calculating average slopes.

Aerial photo-interpretation (API) was carried out to extract spatial, qualitative and quantitative data. Photo mosaics of the area were made using aerial photographs taken in 1970 and 1991 at the scale of 1: 30 000. Delineation of the land use/ land cover categories (Fig.9) was the entry point to the process of aerial photo-interpretation. The aerial photo-interpretation was based on a number of interpretation elements and characteristics. The interpretation elements used in this study were spectral, spatial, temporal and associated features. The interpretation characteristics employed are tone, shape, size, pattern, season, crop calender and features such as footpaths and tracks associated with settlements (Dent and Young 1981; Lillesand and Kiefer 1987). Man made features such as roads, footpaths/tracks and settlement sites were delineated visually (without

using the stereoscope). Delineation of landforms and areas which have suffered from erosion was done using a stereoscope. Collating data on landform types and land cover (vegetation types) gave a good fit (viz.dambos are associated with grassland (Rg), ridges with open woodland (Fo) and hill summits, hillslopes and footslopes with closed woodland (Fc)). Zoning of the study area into two land systems was based on topography, drainage pattern and vegetation types.A transparent overlay was used when delineating cultivated land on 1970 and 1991 aerial photo mosaics and the total size of cultivated land was determined using the grid square method of area measurement (Dickinson 1979).

4.2.3 Field data collection.

Selection of sample areas (1 and 2) was based on differences in land systems as identified on the topographic map and on aerial photographs. Selection of observation sites for the assessment of land use changes,land utilisation and management, and resource degradation was based on the land use/ land cover categories inferred from aerial photographs and verified in the field. To assess land use change, two approaches were used:

1. Purposive paired- point sample technique was used to assess the change in size of cultivated land on hilly terrain;
2. Equal- sized area technique was used to assess the gross land use change in the whole study area during the study period (Vesterby and Heimlich 1991).

Land utilisation and management data were collected from selected household heads, representing the two land systems and small and large holdings through inquiries and interviews using an informal questionnaire. Data on land resources degradation were collected through observations in the field. Details of aerial photographs consulted and used in the study are given in Appendix IV.

5. RESULTS AND DISCUSSION.

5.1 Land use changes for the period 1970 - 1991.

Cultivated land expansion trends are given in Table 1. Figures 10 and 11 show the spatial distribution of cultivated land in 1970 and 1991, respectively. The amount of cultivated land increased by 68.4% between 1970 and 1991. The rate of change was increasing between the two decades. There was an increase of 258.9 ha (23.4%) between 1970 and 1980, while the increase between 1980 and 1991 was 499.2 ha (36.5%).

Table 1. Cultivated land expansion in Mboole-Muyonzo Traditional Land (1970- 1991).

Year	Cumulative cultivated land(ha)	Percent of total land
1970	1 108.1[1]	12.0
1980	1 367.0[2]	14.9
1991	1 866.2[3]	20.3

Source: 1.Determined from 1970 aerial photographs.
2.Determined from 1984 map based on 1980 aerial photographs.
3.Determined from 1991 aerial photographs.

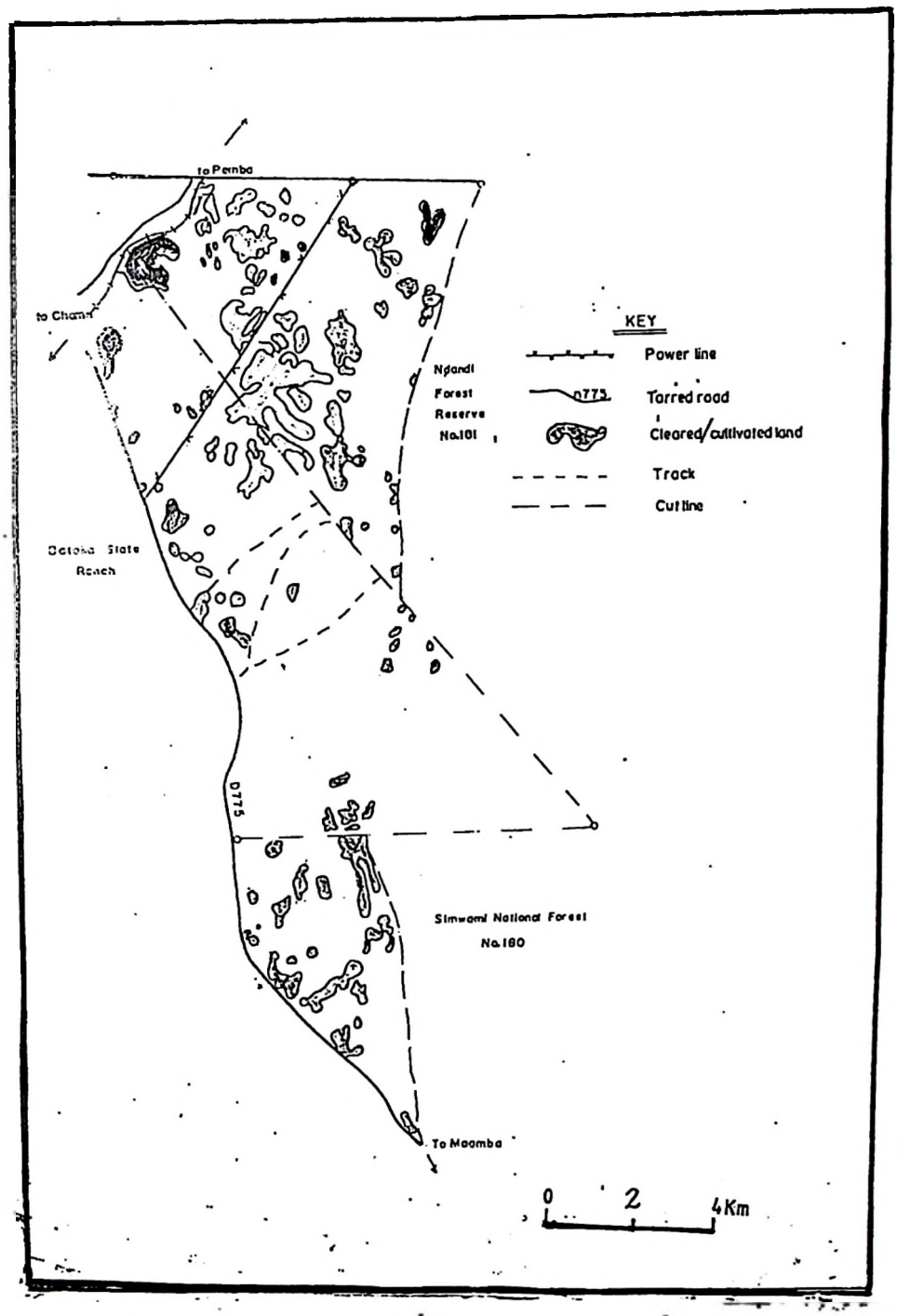

Fig.10. Cultivated/Cleared Land 1970

Source: Aerial photography 1970

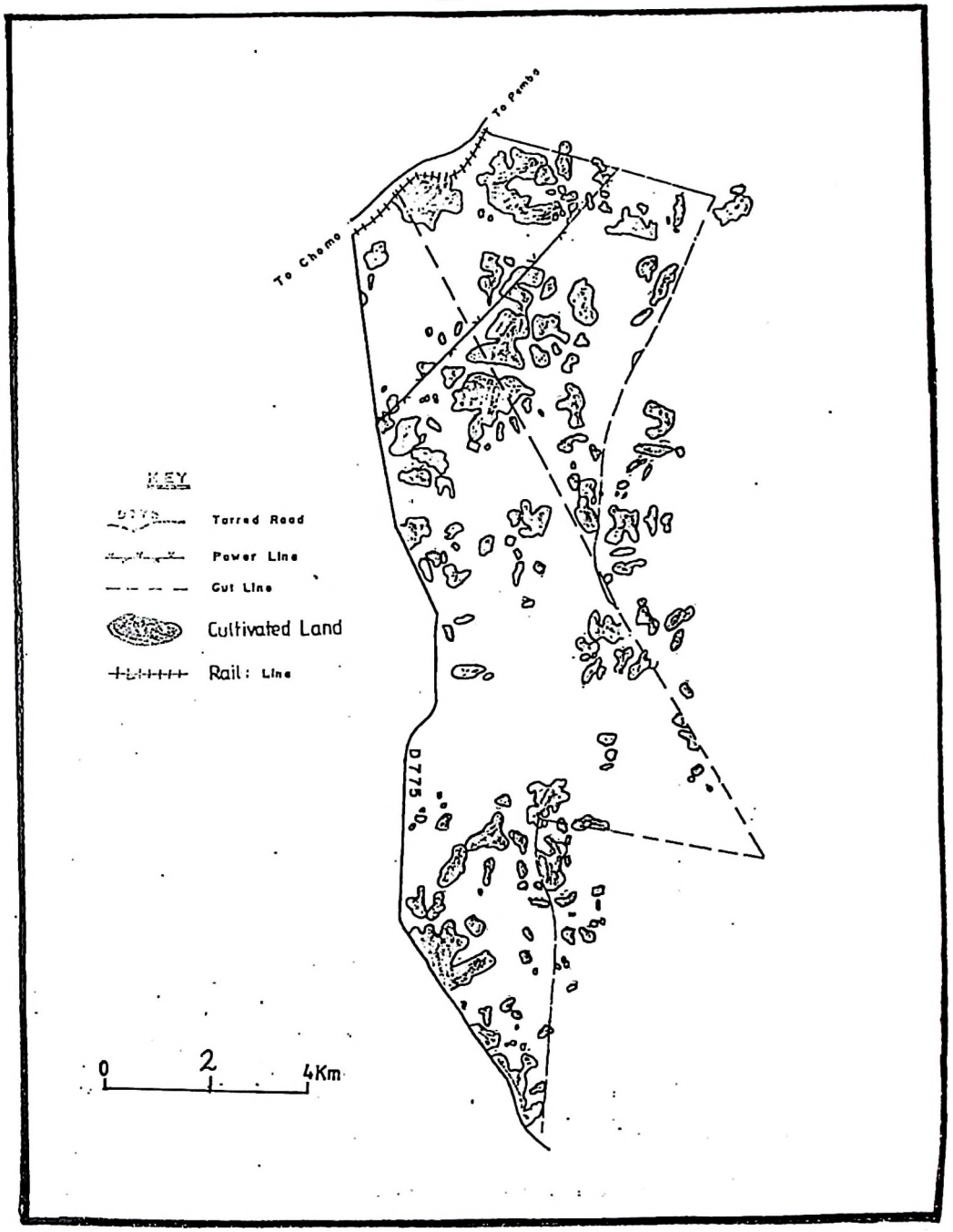

Fig.11. Cultivated/Cleared Land 1991.
Source: Aerial photography 1991

The average size of land holdings increased by 2.8 ha (57%) between 1970 and 1991 (Table 2). The increase in amount of cultivated land during the study period is attributed to the increase in human population and the introduction of some technological packages such as improved seed varieties (hybrid seed),inorganic fertilisers and improved tillage implements in the early 1970s.This was established from the inquiry made with the local people.

Table 2. Land use changes in Mboole- Muyonzo Traditional Land between 1970 and 1991

Year	Average size of holdings (ha)	Cum. cultivated land (ha)	Grazing & other uses (ha)
1970	4.9	1 108.1	8 091.9
1980	-	1 367.0	7 833.0
1991	7.7	1 866.2	7 333.8

Source: Ibid.

Cum.= Cumulative

5.2 Demographic changes in Mboole- Muyonzo Traditional Land for the period 1969 and 1990.

When the technological package was introduced in the area in the early 1970s, more land was opened up and this meant more family labour was required. This led to the increase in number of polygamous households between 1970 and 1991 (Table 3). In Bulongo village (familiar to the researcher), 17.6% of the households were polygamous in 1970.

Table 3. Changes in marital status in Bulongo village for the period 1970 and 1991

No. of wives per man	Frequency		Percentage of total number of sample households	
	1970	1991	1970	1991
1	14	27	82.4	67.5
2	3	10	17.6	25.0
4	-	1	-	2.5
5	-	2	-	5.0

Source: Results of inquiry from local people, survey 1991.

However, the polygamous households increased to 32.5% by 1991 in the same village. The human population in the study area increased by 104.8% between 1969 and 1990 (Table 4). This gives an annual growth rate of 5% which is much higher than the national annual growth rate of 3.7% (CSO 1990). Looking at population in terms of the number of households (most important demographic variable in agricultural land demand), there was an increase of 34% in the number of households during the study period. The size of households increased from 5.3 persons in 1969 to 6.5 persons in 1990 (CSO 1975 and 1990).

Table 4. Demographic change in Mboole-Muyonzo Traditional Land (1969 to 1990).

Year	Average HH size	No.of HHs	Pop.	Percent change HHs	Pop.
1969	5.3	252	1 338	-	-
1990	6.5	339	2 740	34.5	104.8

Source: Central Statistical Office (CSO) 1969 and 1990 population censuses.

HHs = Households, Pop. = Population

5.3 Spatial population distribution.

Within the study area, the population density increased from 14.5 persons/km^2 in 1969 to 30 persons/km^2 in 1990 giving a 106.3% rise (determined from 1969 and 1990 censuses of human population and the size of the study area). However, the population density is not uniform in the area as indicated in Table 5. The partial densities are highest in the northern part of the study area near the railway line, where densities range from 27 persons/km^2 to 63 persons/km^2. The southern part of the study area has population density of 24 persons/km^2. The lowest population density is 10.7 persons/km^2 (compared to the national average of 10.6 persons/km^2) in the area which was at one time declared an extension of the Batoka ranch. It is this portion of land which still has the potential to absorb the population although at the expense of grazing land.

Table 5. Partial population densities in the study area.

CSA[1]	SEA[2]	Pop.	Area (km^2)	Pop. density (persons/km^2)
077	01	333	31.0	10.7
077	02	292	13.0	22.5
078	01	491	18.0	27.3
078	02	472	7.4	63.4
086	01	435	18.0	24.2

Source: Determined from census of population field map and report of 1990 (CSO, 1990).

1. Census supervisory area.
2. Standard enumeration area.

5.4 Land distribution in 1970 and 1991.

There were changes also in the pattern of cropland distribution and ownership during the study period (Table 6). In the 1960s (including 1970), 64.3% of the households in the sample had holdings less than 5 ha In the 1970s and 1980s (including 1991), 55.5% of the households in the sample had holdings between 5 and 8 ha.

Table 6. Land distribution (size of holdings) in Mboole-Muyonzo Traditional Land (1970 and 1991).

Class (ha)	No. of households		Percent household	
	1970	1991	1970	1991
2 -4.99	9	5	64.3	27.8
5 -7.99	2	10	14.3	55.5
> 7.99	3	3	21.4	16.7
Total	14	18	100.0	100.0

Source: 1970 and 1991 aerial photography and inquiry from the local people during field survey 1991.

Comparing land distribution patterns between the study area (reserve land) and the state land farming area (Ngwezi settlement scheme) (Table 7) reveals some discrepancies between the two land tenure categories. The smallest farm unit in the scheme is 61 ha, while the average is 78 ha. If the study area were to be subdivided and equally allocated to the households in 1969, each household would have got only 36.5 ha. However, if the demarcation was to be done in 1990, each household would have got only 27 ha. Implications of the inequitable land distribution pattern as shown in Table 6 versus Table 7 is that while the farmer on state land farming area with 61 ha may keep a maximum of 13 cattle at the recommended and sustainable stocking level of 4 ha/head and still retain 10 ha for arable cropping, the farmer in the study area (reserve land) may keep only 5 cattle after retaining 7 ha for arable cropping.

Table 7. Land distribution on state land farming areas: An example of Ngwezi settlement scheme in Mazabuka district.

Scheme block	Size(ha)	Hectarage per household	No.of households
1	2 379	61	39
2/A	2 533	70	36
3/B	2 528	148	17
4/C	1 209	67	18

Source: From McDonnell (1975)

5.5 Cattle population and stocking levels.

Cattle population in the study area was estimated at 3 827 heads at the time of the survey (Table 8).

Table 8. Cattle population in the study area.

Name of dip tank	No.of cattle
Siakachamatanga	2 810
Mulundano	1 017
Total	3 827

Source: Dipping records 1991, personal contact with dip tank supervisors.

The grazing land availability and seasonal cattle stocking levels are given in Table 9. In winter (dry season), it is assumed that cattle can graze anywhere within the area. However, it must be noted that the stocking level during this season is purely for roaming, since not all the 9 200 ha are grazed. An allowance should be given for areas where there are buildings and other infrastructure and water. The stocking level in summer (rainy season) is based on the fact that about 1 300 ha of dambo network is temporarily wet and

therefore not available for grazing. In view of this, an adjustment can be made on the summer stocking level. In the absence of data on wetness and dryness behaviour of the dambos , a range of stocking levels can be suggested viz.1.6 ha/beast -1.9 ha/beast). The stocking level in summer is slightly higher and that of winter is slightly lower than that shown in Table 9, in line with the preceding discussion. Looking at Tables 9 and 10, the level of pressure on land resources can be established. Whereas the cattle stocking level in the study area (reserve land) range from 1.6 ha/ beast to 2.4 ha/ beast as indicated in Table 9, the recommended stocking level ranges from 4 to 6 ha/ beast year $^{-1}$, for the same type of pasture or grazing land quality (Table 10).

Table 9. Grazing land availability and seasonal cattle stocking level (1991).

Season	Size of grazing land (ha)	Stocking level (ha/beast)
Winter	9 200.0	2.4
Summer	6 033.8	1.6

Table 10. Pasture management level and recommended cattle stocking levels.

Management	Stocking level (ha/beast yr $^{-1}$)
Poor untreated grass, continous grazing during dry season.	4 - 6
Planted grass, fenced grazing land.	3.2
Improved pasture, with legumes and supplimentary feed.	1.2

Source: From Jeanes (1986)

The difference in stocking levels between the actual and the recommended rate is an index of overstocking. Overstocking in the area ranges from 40% to 60%. This has resulted in overgrazing. The effects of overgrazing are the deterioration of the physical environment such as complete removal of vegetative cover and compaction of some patches of land which lead to soil erosion. The eroded soil causes shallowing of water bodies through siltation.

Kondoa Eroded Area in Dodoma region of central Tanzania is a good example of what man can do to the land reources on which he depends for livelihood viz. gullied hills and sand heaps in streams (Kerkhof 1990). In 1979, when livestock destocking exercise started the cattle stocking level was 1.4 ha/ beast in the area. Even after 19 years (from 1973-1991) of HADO (Hifadhi Ardhi Dodoma i.e. Soil conservation in Dodoma) project in Kondoa district, the land is not completely healed. Although the problem was known as early as 1968, the appropriate action was only undertaken 10 years later. Prevention is indeed better and cheaper than cure. Due to the inequitable land distribution pattern and differences in land tenure structure, some areas are being over-exploited while others are being under-exploited in Zambia.

Table 11 proves the validity of this assertion. Comparing the cattle stocking levels between state land farming areas and the study area (reserve land), one discovers big disparities. The ratio of cattle stocking level in state land farming areas to that in study area (reserve land) is 8 : 1, and yet statistics show that more than 60% of the grain and 90% of cattle in Zambia come from reserve and trust land (GRZ/IUCN 1985 ; CSO 1989). With these production results, how sustainable are the reserve

land development efforts amid rapid human and livestock population growth?

Table 11. Cattle stocking levels in the study area, province and state land farming areas.

Area	Stocking level (ha/beast yr^{-1})
Study area	2.4[1]
State land areas	20.0[2]
Provincial (average)	8.0[3]

Source: 1. Field survey results 1991
2. Chiti et al. 1989
3. Chiti et al. 1989

5.6 Cattle-and-cropland ownership.

Cattle ownership in the study area is more concentrated than cropland ownership (Table 6 versus Table 12). While 16.7% of the households cultivated a holding greater than 8 ha in 1991 (Table 6), 13.6 and 38.6% of the households owned 44.4 and 10.8% of the cattle respectively (Table 12).

Table 12. Cattle ownership in part of the study area 1991.

No.of cattle	No. of H/holds	Percent	No. of cattle owned by this group	Percent
1-5	34	38.6	110	10.8
6-10	25	28.4	205	20.2
11-15	11	12.5	143	14.1
16-20	6	6.8	107	10.5
> 20	12	13.6	452	44.4
Total	88	100.0	1 017	100.0

Source: Mulundano dip tank, dipping records 1991.

5.7 Land utilisation and management in Mboole-Muyonzo Traditional Land.

5.7.1 Land use system

The study area falls in the maize/cattle mixed farming system (Schultz 1974). Maize is a staple food crop and therefore grown on all holdings. Other crops grown in the area but on a very small scale are groundnuts, cotton, sunflower and sweet potatoes. Crops are grown to satisfy

home consumption with some households selling the surplus.

Although the area falls into the semi-permanent farming system according to Schultz (1974), the cultivation intensity factor (R) calculated for the opened up and cultivated land shows that there is permanent and continuous cultivation in the area (Ruthenberg 1971; Dent and Young 1981).The period of continuous cultivation (C) ranges from 5 to 6 years and the period of fallow (F) ranges from 1 to 2 years .

$$R = C/(C+F)$$

Using the range of values for C and F above, the R factor ranges from 0.75 to 0.83. The dominant cropping pattern is sole cropping (i.e.one crop or variety of crop grown on a given field in one or more years). Very little crop rotation is practised in the area although sunflower, groundnuts, sweet potatoes and cotton occasionally alternate with maize. Soil fertility is maintained by the application of inorganic fertilizers. Several tillage operations are carried out before and after seed germination (clean cultivation). Table 13 shows the tillage operations and associated tillage tools. Contour ploughing is being practised in the area on steep sloping land. However, the ridges formed are too small to effectively contain the overland flow due to soil depth

limitation. Crop residue is left in the field after harvesting and animals are allowed to roam in the harvested fields for about four months. Whatever residue is left when animals are withdrawn is collected into heaps and burnt before the onset of the rain.

Table 13. Tillage operations and tools.

Tillage operation	Tillage tools
Land preparation	Mouldboard plough
Planting	Mouldboard plough, cultivator and/or harrow
Weeding and bassal dressing fertiliser application	Mouldboard plough or cultivator
Weeding and top dressing fertiliser application	Mouldboard plough or ridgers plough
Weeding (field cleaning)	Hand hoes and sickles

Source: Field survey results December 1991.

Agriculture in the area is characterised by scattered, sometimes non-contiguous fields, unfenced and undemarcated communal grazing land usually located haphazardly and intermingling with cultivated land. Most holdings are small (Table 6).

Homesteads in some cases are clustered into small villages away from the cultivated areas. Other homesteads are scattered and located close to the cropland. There are two forms of land tenure in the area: privately owned and family operated cultivated pieces of land, and communally owned grazing land. The right to private land ownership is granted through land clearing. There are no restrictions on when and where one can clear the bush to create a plot for crop production.

The consequence of this laissez faire approach to land resources utilisation is the shrinking of the " commons". As human population increases in the area, more and more of the once communal tracts of land are turned into private tenure (Anderson and Hill 1968). Privatization of the " commons" is one of the signs of resource inadequacy in an area where resource utilisation is uncoordinated.

Ox- drawn implements are used for most farm operations. All households employ draught animals for ploughing. The most popular means of transport in the area is the ox-drawn sledge. All households in the area use sledges for transporting firewood, water, harvested crop and farming inputs. While every household has at least one sledge, the number of ox-drawn carts is very small. In one village of forty households, there were only five ox-drawn carts.This accounts for only 5% of cart ownership.

5.7.2 Livestock grazing and grazing land management.

The farming system is characterised by the interaction between crop production and livestock keeping. Although other small livestock (goats and pigs) are kept, cattle is the most important. There are five reasons for keeping cattle :

- It is a guarantee against the risk of crop failure (especially in this area where rainfall is erratic).
- It is a source of meat and milk to supplement and complement the maize meal.
- Cattle serve very important social functions (payment of bride price).
- Provision of manure for cultivated fields and animal traction power for ox-plough cultivation and transport. Cattle ownership

ranges from one head to 66 heads per household with 12 heads as the average.

Communal use of grazing land is customary, and periodic grazing occurs even on privately owned fields after harvesting the crop. In winter animals are allowed to roam in the fields during the day but are brought back to the village kraals every evening. In summer when cultivated fields are under crop, animals are driven every day to some distant places away from the village and are brought back to the village kraals every evening. Continuous grazing is practised in the area. Since grazing land is communal there are no land improvements taking place. Land users can only be motivated to carry out land improvements on a piece of land if they are certain that their children and grandchildren will live on it as long as they live. There must be a feeling that the land belongs to them and not to everybody.

5.7.3 Water availability and supply.

Water for both human and livestock consumption is from the streams. However, the availability of water is intermittent. During the dry season (from about July to November) the area experiences serious water shortage despite the dense stream network. Most of the streams do not hold water for a long period due to among other

factors, steep nature of the land. Cattle are driven long distances (about 6Km) to water. The underground water potential is not very clear, although some dambos indicate some potential, by shallow wells (less than 3m deep) yielding substantial quantities of water during the dry season. There are two old earth dams in the northern part of the study area. However, their lifespan is being threatened by siltation.

5.7.4 Problems of mixed land use system under traditional land tenure.

The consequence of communal grazing and private ownership of cattle is what is known as cattle cycles (Ruthenberg 1971). While not deviating much from Ruthenberg's cattle cycles, in this study an illustration of the land use cycles in a mixed land use system is given (Fig.12). In the Figure: xt1, xt2 and xt3 are sizes of available grazing land at different times, yt1, yt2 and yt3 are sizes of cultivated land at different times and zt1, zt2, zt3 and zt4 are human and livestock populations at different times (in years). The changes in size of cultivated and grazing land are caused by the changes in human and livestock population (cause and effect scenario). Due to the uncoordinated nature of resource utilisation under communal land tenure, the amount of land held in communal ownership decreases with the

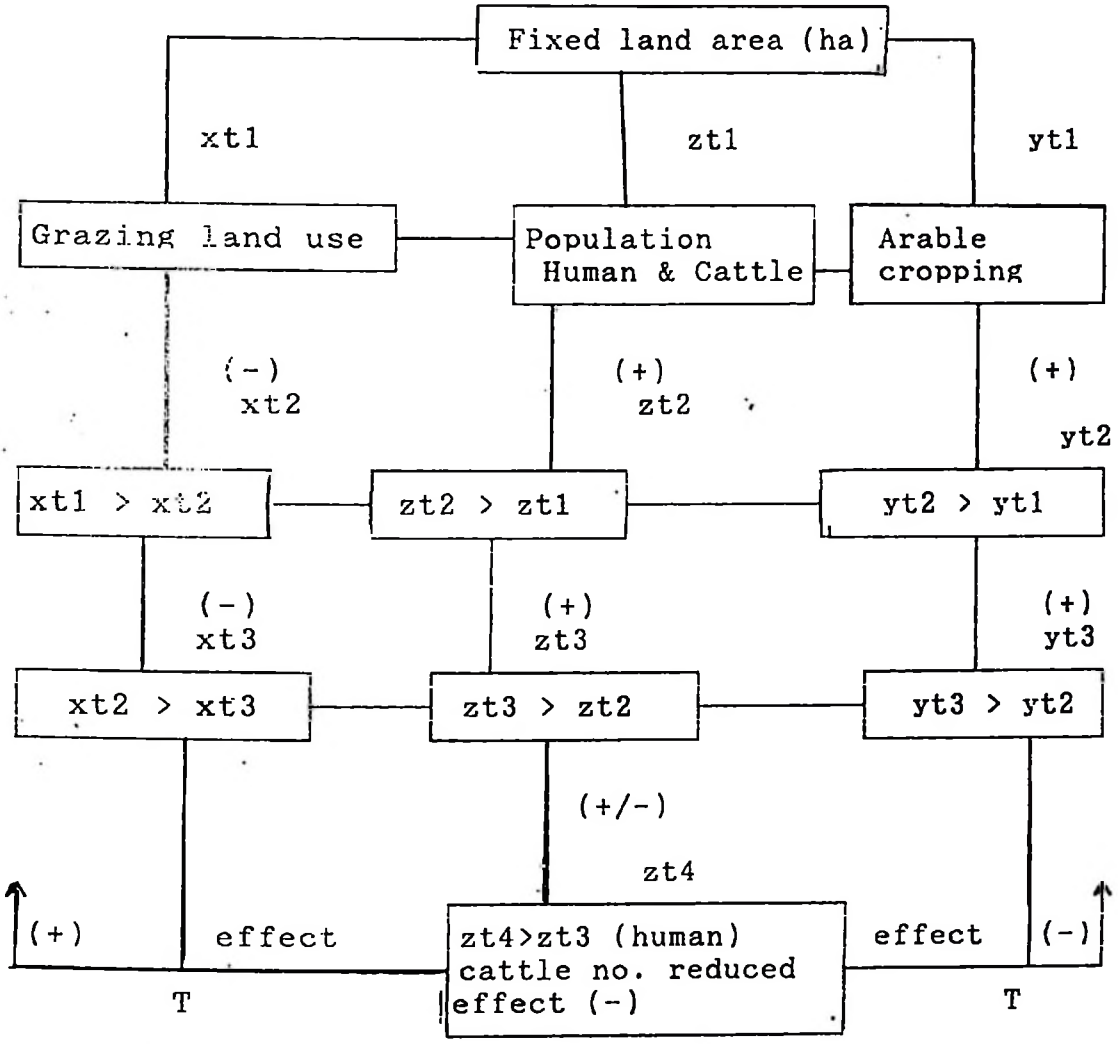

Fig.12. Cycles in Mixed Land Use System under traditional land tenure

increase in human population in time and space (Table 2 and Figs.10 and 11). At zt1 the initial human population will determine the livestock population which also influences the size of cultivated (yt1) and grazing land (xt1). At level zt2 there will be more people (+) than at zt1.

The effects are (1) an increase in number of livestock kept, presumably the additional numbers are from additional households,and (2) an increase in amount of cultivated land (+). Due to the finite nature of the land resource, an increase in cultivated land (+) results in a decrease in amount of grazing land (-) at each stage in the figure. The effect of the decrease in amount of grazing land amid increasing livestock population is overstocking which is the major cause of resource degradation through overgrazing in traditional lands.

At level xt3, grazing land is degraded due to increased grazing pressure coupled with any climatic swing such as lack of rainfall (drought). The inability of the grazing land to provide food leads to large numbers of livestock falling out (zt4). This level is the end of one cycle and beginning of another (turning point (T)).

The livestock stocking level at which this turning point occurs is the critical stocking level. The resilience of the resource base and the frequency of the climatic swings influence the length of the cycle. The cycle is longer if the physical resource base has high resilience and climatic swings are not common.

In the study area, the cycle which had been progressing for almost two decades , reached its turning point in 1986 when a large number of cattle died (personal interview with local people 1991). No past cattle records were available to ascertain the cattle stocking level at which this cycle ended and another one started in the area. At the time of the survey, scars of cumulative grazing pressure were still visible in the area (viz. a network of eroded cattle tracks, bare and compacted patches of land etc.)

5.8 Status of resource degradation in Mboole-Muyonzo Traditional Land.

Resource degradation is a process or state where the productive potential or capacity of a resource is lowered (Blaike and Brookfield 1986). The study area is divided into three erosion hazard classes (Chiti 1988) as shown in Figure 13. Forest depletion associated with clearing for cultivation is on the increase in the area.

Cultivation on hilly terrain increased by 119.4% between 1970 and 1991. The effects of forest clearing, especially on hilly terrain are detrimental to the physical and social environments, by exposure of the land surface to climatic assault and loss of some much-needed forest products, such as poles for building purposes.

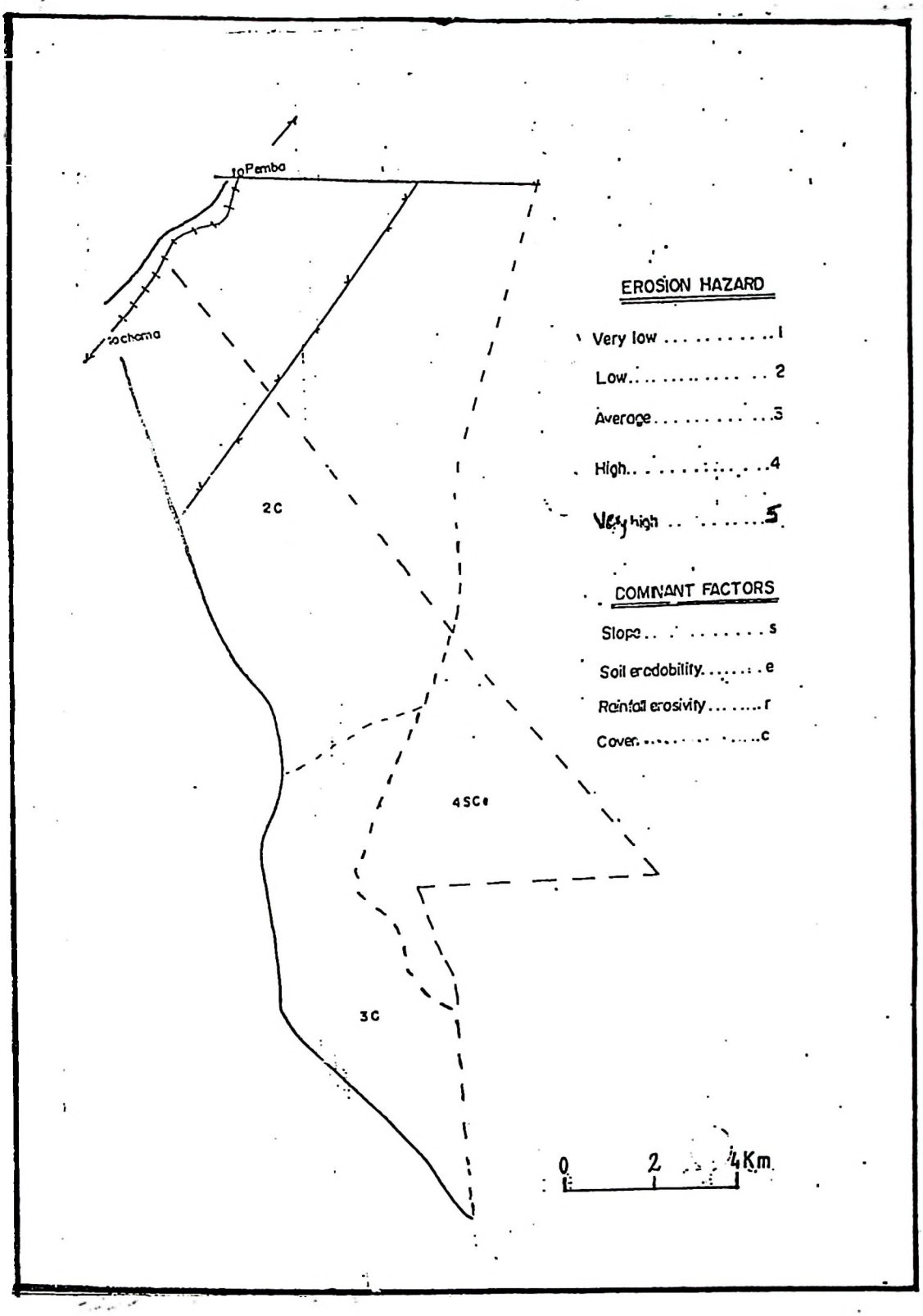

Fig.13. Erosion hazard map of Mboole - Muyonzo Traditional Land (Chiti, 1988)

As all the tracts of land near the settlements are cleared of their vegetation , long distances (about 8Km) have to be covered to collect poles for building purposes using sledges. The sledges are the main cause of soil erosion on footpaths and tracks in the area. Figure 14 shows the footpath/track network in part of the study area.

Available qualitative evidence indicates that accelerated soil erosion is a serious problem with physical, social and economic consequences. Soil erosion is known to be a product of two factors: erosivity and erodibility related to climate and soil, respectively.

However, the ultimate cause of soil erosion is the way land is being used. Therefore, the causes of land degradation in general and soil erosion in particular are land use specific. Soil erosion and land use changes are strongly related. Soil erosion accelerates quickly whenever land is misused (not used according to its capabilities) (Morgan 1986).

Soil erosion is serious on steep sloping land under cultivation (Fig.14, Obs 4,5 and 6). Most of the fields have been cut into segments by small gullies which are non- erasable by ploughing.

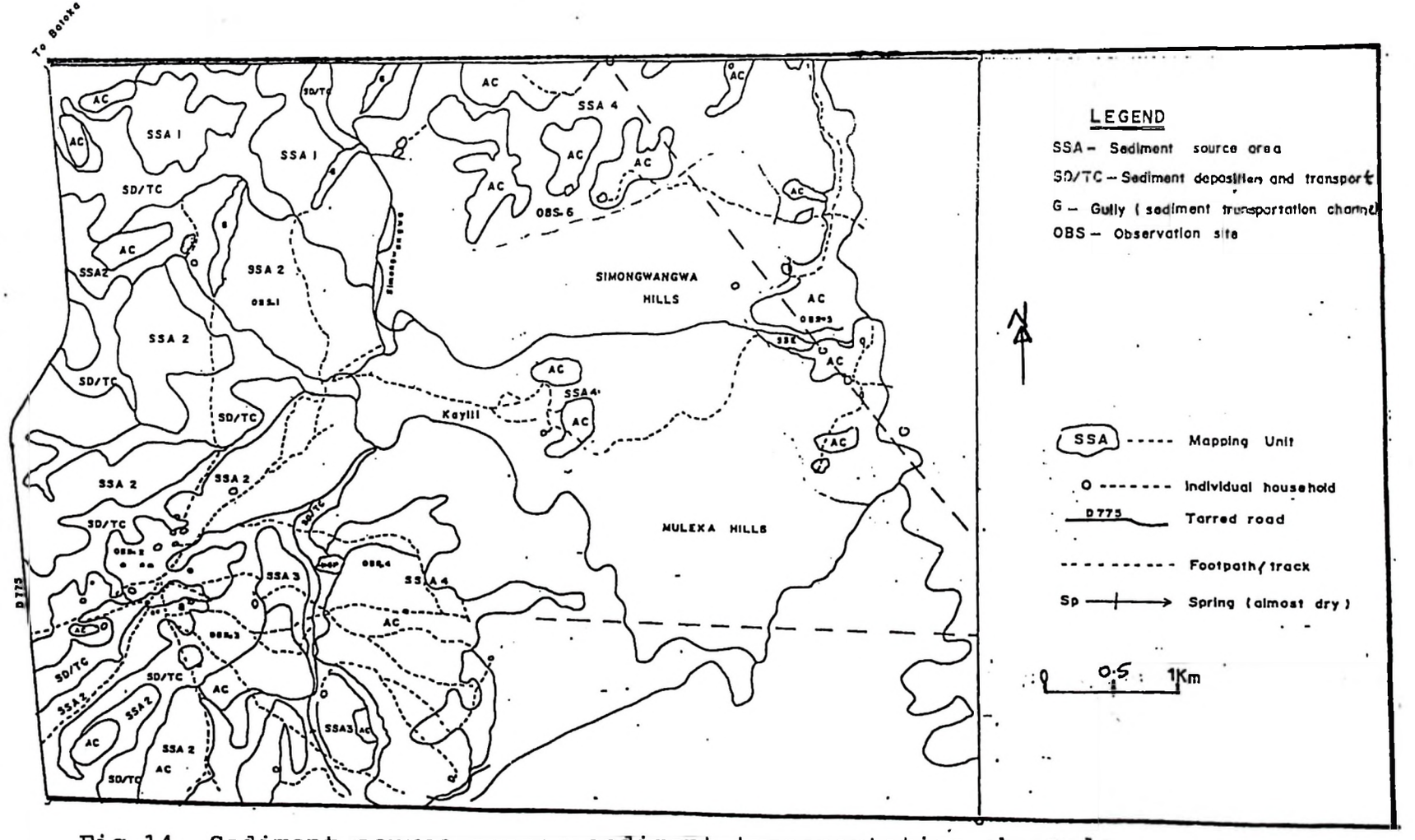

Fig.14. Sediment source-areas, sediment transportation channels, gullies, footpaths/tracks and homesteads in part of the study area (Aerial photography 1991)

Soil erosion on cultivated hilly terrain is aggravated by the inappropriate cropping pattern, tillage type and cropping sequence, among other management aspects. Due to the economic pressure (to produce for sale), the farming system on the hilly terrain is not in conformity with the capability of the land. Continuous and clean cultivation of one row crop (maize) causes not only soil erosion but also loss of soil fertility. although inorganic fertilisesr are used to replenish soil fertility, their effectiveness is negligible due to their being lost through surface runoff.

Much of the sediments choking the streams and other water bodies originate from the cultivated areas in the hills. Land degradation and soil erosion in particular,is not only a problem of cultivated areas,but occurs in all land use categories.

Land resource degradation is observed around settlements too (Fig.14, Obs 1). Due to the nature of cattle husbandry in the area (section 5.7.3) constant trampling by both cattle and other livestock coupled with the use of sledges as a means of transport are identified as the main causes of land resource degradation around settlements and along footpaths and tracks. Comparing the two sets of aerial photographs for 1970 and 1991,there

was a great increase in footpath density (the ratio of the total footpath length(l) to area (km^2). It is through this dense network of footpaths/tracks that sediments from the grazing land,settlements and some cultivated land are channelled into the streams and other water bodies causing siltation which in turn causes deterioration in water quality and quantity. Soil erosion on grazing land is caused by continuous cattle trampling under the non- rotational grazing system. Due to continuous grazing, soil compaction occurs on the grazing land. The effect of soil compaction is reduced infiltration capacity of the soil resulting in an increase in surface runoff. As the detached soil is transported by surface runoff a type of erosion called sheet erosion occurs. Sheet and splash erosion are common on the grazing land in the area. These types of erosion are identified by the exposure of tree roots,crusting surface, formation of splash pedestals and soil mounds protected by vegetation.

Stream bank erosion is another form of resource degradation in the area. Most of the gullies are along the streams. The cause of stream bank erosion is not very clear. In some cases, it is caused by cattle licking sweet soils on termite mounds located on stream banks. However, the major cause of stream bank erosion are the

high and flash stream flows associated with increased runoff. Stream bank erosion near the settlement areas is associated with footpaths crossing the streams (Fig.14, Obs 3). Another cause of stream bank erosion is the excavation of stabilising sands along the streams causing the formation of knickpoints (steps) wherever the excavation has been done along the stream. The knick-points rejuvenate the stream flow velocity resulting in scouring of the stream banks on ripple sections (bends of the stream). All gullies apart from those along streams are found along footpaths/tracks going up and down slopes.

Effects of soil erosion are felt not only in the areas where soil is removed by agents of erosion, but also in areas down slope where land is covered with sediments. One of the visible and serious consequences of soil erosion is the silting of one of the once perennial streams and the drying of the springs at the footslopes of the hills.For the first time in 21 years, the beds of some of the once deep stream water ponds got exposed.The shallowing and ultimate drying of water bodies have adverse effects on acquatic life, especially fish. Different fish species inhabit water bodies of different depth ranges. Any change in the quality of a habitat can

lead to extinction of some species.

5.9 Estimating future land requirement.

5.9.1 Factors influencing demand for land.

The demand for agricultural land is determined by ,among other factors, the total number of agricultural households and the size of land holdings per household in an area (Clawson et al.1968; de Meijere et al. 1988).

5.9.2 Population projection for the year 2000.

An exponential population growth model is used to project human population in the year 2000 (Haggett 1983) as indicated in section 4.2.1. Using the population figure of 2 740 for 1990 and annual population growth rate of 5% derived from 1969 and 1990 census data, the projected population after ten years can be calculated by inserting the figures mentioned above in the formula below:

$$N_t = N_o e^{rt} \text{ ----------(1)}$$

Where N_t = population at time t,

N_o = population at time o,

r = annual population growth rate,

t = time of projection,

e = 2.71828 the base of natural or Naperian logarithm.

The projected human population will be 4 517 people in the year 2000. Using the average household size of 6.5 for 1990, there will be 695 households in the area in the year 2000.

5.9.3 Estimating future arable land requirement.

Using the average size of households of 6.5 persons for 1990 and projected population figure of 4,517 people in the year 2000,the number of agricultural households can be determined by inserting the figures above in the arithmetical expression (2) below:

A = Total population/ Size of households----------(2)

where A = number of households.The number of households is expected to be 695 in the year 2000.

Since projections and estimates always start from a given (known or assumed) present position (Clawson et al.1968) and proceeding on the basis of assumptions, calculating the future arable land requirement will be based on the 1990 and 1991 demographic and land use data in line with the set of assumptions in section 4.2.1. The number of households was 339 in 1990, average size of holdings was 7.7 ha and actual cultivated land was 1 866.2 ha in 1991.

The size of cultivated land in the year 2000 can be estimated indirectly by using the figures above in the arithmetical expressions 3 and 4 below:

$L_c * A = C_T$ ---------- (3).

This is a theoretical expression where L_c = average size of land holdings (ha), A = total number of households and C_T = theoretical size of cultivated land.

$L_c * A = C_T \pm X\ (C_T) = C_A$ ---------- (4).

This is a calibration expression, where L_c = average size of land holdings (ha), A = number of households, C_T = theoretical size of cultivated land, C_A = actual size of cultivated land and $\pm$ X = correction factor expressed as percentage. The correction factor X is positive when the theoretical size of cultivated land is less than the actual (as determined from maps, aerial photographs or field measurements) and vice versa.

Using expression 3 and the number of households (339) in 1990 and the average size of land holdings (7.7 ha) in 1991, the theoretical size of cultivated land in 1991 can be determined. C_T was 2 610.3 ha while C_A was 1,866.2 ha in 1991. The difference between the two is 744.1 ha (28.5%). Considering that the same average size of land holdings (7.7 ha) is used together with 694 households for the year 2000 to estimate future arable land requirement in the year 2000, 28.5% or 0.285 is used as

a correction factor in expression 4. It is estimated that 3 820.8 ha will be cultivated by the turn of this century. Considering that the 3 820.8 ha is cumulative cultivated land in the year 2000,this means that additional households will require 1 954.6 ha. Inspite of the high demand for arable land, the area does not have any unutilised arable land. Currently, some of the inhabitants cultivate steep sloping land. Due to cultivation of steep sloping land,soil erosion and siltation of streams have occurred in the area.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study reveals that human population has more than doubled in two decades and is expected to exceed 4 500 people by the turn of this century. As a finite world can support only a finite population (Hardin 1968),the area is experiencing land shortage although the overall population density is moderate.

Signs of land pressure are evident and intensive cultivation of land cannot counter the increase in demand for land as at now. Cattle stocking levels are far much below the recommended and sustainable levels,thereby threatening the communal grazing land which is less than half of the requirement.

Cultivation on topographically marginal land has been increasing and will continue to increase with increase in human population in the area. Soil erosion and resultant siltation of streams have already occurred and will worsen by the turn of the century if no measures are taken to redress the situation. The study area has suffered from both the colonial and post-colonial land alienation and coercive displacement policies.It is probably now that the nation needs land policies that are flexible to adjust to the changing conditions and

responsive to responsible demands resulting from changing needs of society. It would be absurd for anyone to imagine the persistence of the land tenure structure and distribution pattern that evolved at a time of relative land abundance amid rapid population growth. The correct diagnosis of a problem is essential for appropriate treatment (Doyle 1991). The causes of land shortage and resource degradation are known, but appropriate preventive and curative measures must be taken if the nation is to achieve sustainable land resources development.

How can Zambia achieve the goals of sustainable agricultural development and provision of the basic needs to all the people of Zambia,both present and future generations as outlined in the national conservation strategy (NCS) amid inequitable land distribution pattern and inequitable land tenure structure?

Successful environmental management requires that the subsistence needs of the rural poor are met. In order to protect the remaining and rehabilitate the degraded reserve lands,there is an urgent need to identify highly fragile areas (with low resource endowment but carrying large number of people) in the country, understand the

existing land use systems,and assess their problems and potentials.

The study area's land problems are more as a result of the coercive displacement of the people from the most suitable land for cultivation and forcing them to make a living through cultivation of steep slopes and grazing animals on reduced amount of land, than of rapid increase in population.The Government through the Ministry of Agriculture,Food and Fisheries;Ministry of lands; and Ministry of Environment and Natural Resources should recognise the important contribution the people in reserve lands are making to the national economy, by ensuring that all have access to productive land resources. This demands change in land tenure structure, land distribution pattern and land administration.

6.2 Recommendations

6.2.1 General recommendations

It would be unwise to extrapolate the results from this study as they are to other reserve lands. However, it would also be unreasonable to assume that population-land problems common in the study area are non-existent in other reserve lands. In view of this, the following general recommendations can be made:-

(a) Re-definition of the land tenure categories and tenure system is advisable. This will require an evaluation of the performance of all the land development projects currently being undertaken on trust land.

(b) To reduce the problems of overcrowding and associated resource degradation caused largely by the current inequitable land distribution pattern and depression of agricultural production caused by land under- utilisation, the Government should consider putting a maximum limit on the size of land individuals and institutions can acquire. All farms exceeding the maximum limit and are not fully utilised should be subdivided and allocated to the needy.

(c) Periodic surveillance and monitoring of land utilisation on both reserve land and state land farming areas using remote sensing techniques is a must if the nation is to succeed in preventing serious resource degradation in the reserve lands and land idleness in the state land farming areas.

(d) Change in agricultural land administration is advisable (for instance it is inappropriate for District Councils to deal with matters relating to agricultural land allocation).

6.2.2 Recommendations specific to the study area.

According to Kay (1972) displacements and resettlements are two methods of population-land adjustments. Displacement of people from one area may lead to overpopulation in another area where the displaced people find themselves, and resettlement of people from overpopulated areas reduces the pressure exerted on the resource base. In view of the discussion above, the following are recommended:-

(a) relocation of some families from the area (especially the 13.6% which own 44.4% of the cattle) is advisable. The tracts of land which were identified by the Commission of Inquiry into land matters in the Southern Province in 1982 can be used for this purpose;

(b) in order to minimize the problem of water availability and supply for both human and livestock populations, soil erosion on grazing land, stream banks and on cropland, cattle overstocking and privatization of the communally owned land as populations increase, it is advisable to initiate a land and water management project in the area with the following components:-

- Water conservation (construction of small earth dams across some streams), this can raise the water table in the area in the long run,
- Soil conservation (control of soil erosion on currently cultivated and grazing land, and

reclaiming the abandoned land through afforestation),

- Livestock development and grazing land management (planning and demarcation of grazing zones to prevent further privatization of the "commons", placement of watering points and dip tanks on grazing land, monitoring cattle stocking levels through regular surveys in the area), and

(c) Due to land shortage and its associated problems in the area, there is a great need to evaluate the performance of the Batoka Ranch Project as an economically and socially viable enterprise so that the Government may consider surrendering some of the Batoka ranch paddocks to the local people to be used as group grazing zones.

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8. APPENDICES

Appendix I. Reserve Lands in Southern Province

District(s)	Reserve Land	No.
Mazabuka/Gwembe/Monze	Tonga-Magoye	20
Mazabuka/Gwembe	Tonga-Sigongo	19
Choma/Gwembe/Kalomo	Tonga-Choma	21
Monze/Choma/Kalomo/		
Namwala	IIa-Tonga	22
Kalomo	Nkoya	23
Kalomo	Toka	24
Kalomo	Baleya	25

Source: Sakala, 1982

Appendix II. Land fragmentation and human population in Southern Province (1980).

Land category	Area (ha)	Percent of total land	Pop.	Percent of total pop.
State land	1 096 635	13	186 083	27
Reserve/Trust	2 055 787	24	500 386	73
National parks	885 937	10.4		
Protected forests	650 000	7.6		
G. M.As.	2 839 924	33.3		
Kafue FP.	1 000 000	11.7		
Total	8 524 283	100	686 469	100

Source: Sakala,1982

FP = Flood Plain

G.M.As. = Game Management Areas.

Appendix III. Climatic data for Choma station (1984)

Month	Rainfall (mm)	Evapo-transp. (mm)	Average Temp. (°c)	Mean Min. Temp. (°c)	Mean Max. Temp. (°c)
Jan.	200	132	20.6	16.2	26.5
Feb.	185	118	20.5	16.2	26.5
March	80	116	19.8	14.2	26.6
April	23	90	18.5	11.6	26.7
May	6	72	15.2	6.6	24.8
June	6	53	12.8	3.7	22.6
July	0	61	12.5	3.2	22.7
August	0	79	15.0	5.0	25.2
September	1	115	19.1	9.1	29.0
October	22	145	22.0	12.7	31.1
November	93	135	21.7	15.7	29.0
December	209	135	21.0	16.5	27.5

Source: FAO,1984

Appendix IV. Aerial photographs consulted and used in the study: Contracts 70/1A, Lusaka-Livingstone (June-July) and ZA91/1, Southern Province (May-June); 1:30 000.

Year	Run No.	Photo Nos.
1970	35	5364, 5365, 5366
"	36	5499, 5500, 5501
"	37	5632, 5633, 5634
"	38	5765, 5766, 5767
"	39	5885, 5886, 5887
1991	26	73, 74, 75
"	27	78, 79, 80
"	28	80, 81, 82
"	29	79, 80, 81
"	30B	08, 09, 10

Source: Survey Department, Air photo Library, Lusaka.

Appendix V. Human population changes in traditional lands of Choma district (1969-1980).

Name of tribal chief	Population 1969	1980	Percentage change
Mapanza	23 696	32 497	+37
Moyo	7 301	7 112	-2.6
Macha	7 254	5 498	-24.2
Singani	19 413	25 104	+29.3
Siamaundu	14 708	21 743	+47.8

Source: Sakala, 1982

Appendix VI. Structure of farm sector: Zambia 1989.

Number of farms by province.

Province	Small scale	Emergent	Commercial	Institutional
Central	38 737	6 268	736	220
Copperbelt	25 911	760	184	247
Eastern	195 838	24 272	315	334
Luapula	89 871	338	15	290
Lusaka	22 488	1 137	163	94
Northern	75 478	5 380	91	41
N/Western	41 150	260	22	514
Southern	64 145	22 977	1 417	534
Western	47 914	2 656	39	197
Total	601 532	64 048	2 982	2 841

Source: Ministry of Agriculture,1990.

Small scale farms: < 5 ha cultivated

Emergent farms: 5-20 ha cultivated

Commercial farms: > 20 ha cultivated

Institutional farms: not privately owned