LUCID's Land Use Change Analysis as an Approach for Investigating Biodiversity Loss and Land Degradation Project

Land Use Change Patterns and Root Causes on the Southern Slopes of Mount Kilimanjaro, Tanzania

LUCID Working Paper Number 25

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The Land Use Change, Impacts and Dynamics Project
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1. INTRODUCTION

Mount Kilimanjaro has witnessed extensive land use changes over the last 100 years or more. These changes have led not only to modification but also to conversion of land cover with serious environmental implications. Various studies on the slopes of Mount Kilimanjaro (e.g. Maro, 1974, 1988; Gamassa, 1991; Yanda and Shishira, 2001; William 2002; Soini, 2002) give evidence of replacement of forests by agriculture and settlements, severe soil erosion, disruption of water sources and drying up of rivers. The factors behind these changes are multi-faceted, but they represent the interaction between biophysical and societal processes over space and time and reflect the economic, social and political processes and the physical environment. They also reflect interdependencies among scales, from local, national and international scales.

This study was undertaken as part of a project on "Land Use Change Analysis as an Approach for Investigating Biodiversity Loss and Land Degradation", being implemented in Kenya, Tanzania and Uganda. A case study approach was adopted for the entire project to facilitate comparison of geographically different but analytically similar land use situations, taking into consideration the complex linkage and interactions between society and environment, reflecting the economic, social and political processes and the physical environment. The objective was to analyse the patterns and trends in land use change and to identify the root causes of land use change leading to changes in biodiversity and land degradation. Mount Kilimanjaro (Plate 1), specifically the southern and south - eastern slopes of the mountain, was selected as the case study site for Tanzania because of the extensive land use changes that have occurred there, particularly on the southern slopes since the 1900s. This paper describes the patterns of land use change and analyses the root causes or driving forces that underlie the changes in land use.

Plate 1. Mount Kilimanjaro showing distinct ecological zones
(Source: http://visibleerth.nasa.gov/cgi-bin/viewrecord?18663)

1.1 Conceptual and Theoretical Framework

This study applies the environmental-societal dynamics as the domain of synthesis in understanding the interaction between biophysical and societal processes. This domain refers to the way human beings impact the environment and the way the environment shapes human activities (NRC, 1997). It also refers to the way human beings perceive and respond to the changes of the environment as being caused by themselves and the way their responses again impact/change that environment.

Human activities have increasingly modified the environment over time and space. In fact, their role in environmental change overrides natural changes to ecosystems brought by climate variations of the past few thousand years (Turner, et al., 1990; Lambin et al. 2003).

These activities include cultivation in various forms, livestock grazing, settlement and construction, reserves and protected lands and timber extraction, among others. These and other land uses have cumulatively transformed land cover at the local and global scales, with significant consequences for land cover, biodiversity, soil condition and water and sediment flows (Turner, et al., 1994). These kinds of impacts are generated by modification or alterations in the attributes of cover (e.g. degradation of forest through tree cutting) and conversion of land cover involving complete change from one cover type to another (e.g. from forest to cultivated land).

The premise for this study is that multiple dimensions of drivers – socio-economic, biophysical, and land management (proximate causes)– are relevant to land use and cover change (Turner et al., 1995; Campbell and Olson 1991; Lambin et al. 2003). In this perspective, the human dynamics of land use change can be fitted to large-scale and small processes, and the variable importance of human and biophysical forces that operate at different spatial and temporal scales will be more apparent.

Land use and land cover change, and the resultant environmental change thus form a complex and interactive system linking human action to use/cover change to environmental feedbacks to their impacts and human responses. Land use patterns, driven by a variety of social, economic, political and natural processes, result in land cover changes that affect biodiversity, water, land productivity and other factors, that cumulatively affect the biosphere. As such, an understanding of current and future land use/cover dynamics and their environmental consequences requires an understanding of these dynamics at various times in the past (a historical dimension) and the diverse set of forces/processes driving these dynamics. These forces must also be put into historical and cultural contexts. According to Turner et al. (1995), cultural practices are important sources of variation in land management (proximate causes) at the level of the unit of production, and may endure over long periods of time, transcending shorter-term historical periodisation.

2.0 METHODOLOGY.

2.1 Selection of Transects

Primary data were collected in three transects, namely the Machame Transect in Western Kilimanjaro, Mbokomu Transect in Central Kilimanjaro and Rombo Transect in Eastern Kilimanjaro (Figure 1 and Figure 2). The Machame Transect began in the mountain ecological zone at a height of about 1,800 metres above sea level (S 03° 10′ 43″ and E 037° 14′ 301″). The Transect ended in Kikafu River at a place called Longoi located at 762 metres above sea level (S 03° 25′ 842″ and E 037° 17′ 876″). On the other hand, the Mbokomu Transect (Figure 3) began in the mountain ecological zone at about 1,831 metres above sea level (S 03° 25′ 842″ and E 037° 17′ 846″). The transect ended in the lowlands at a place called Mabogini located at 775 metres above sea level (S 03° 25′ 163″ and E 037° 22′ 763″. The Rombo Transect began from the highland ecological zone at Kitangaro (03^{o} 07′ 57″ and E 037° 34′ 18″) to Msaranga in the lowland ecological zone (S 03° 38′ 306″ and E 037^{o} 40′ 546″).

2.2 Data Collection Methods

A triangulation of information sources was applied to this study, as outlined in the LUCID project methodological guide (Maitima and Olson 2002). This involved a variety of methods to describe the land use patterns and change and to identify the root causes of these changes. The methods included interpretation of satellite images, household questionnaire survey and review of available literature. A historical analysis of land use and cover change since the 1950s was based on available records.

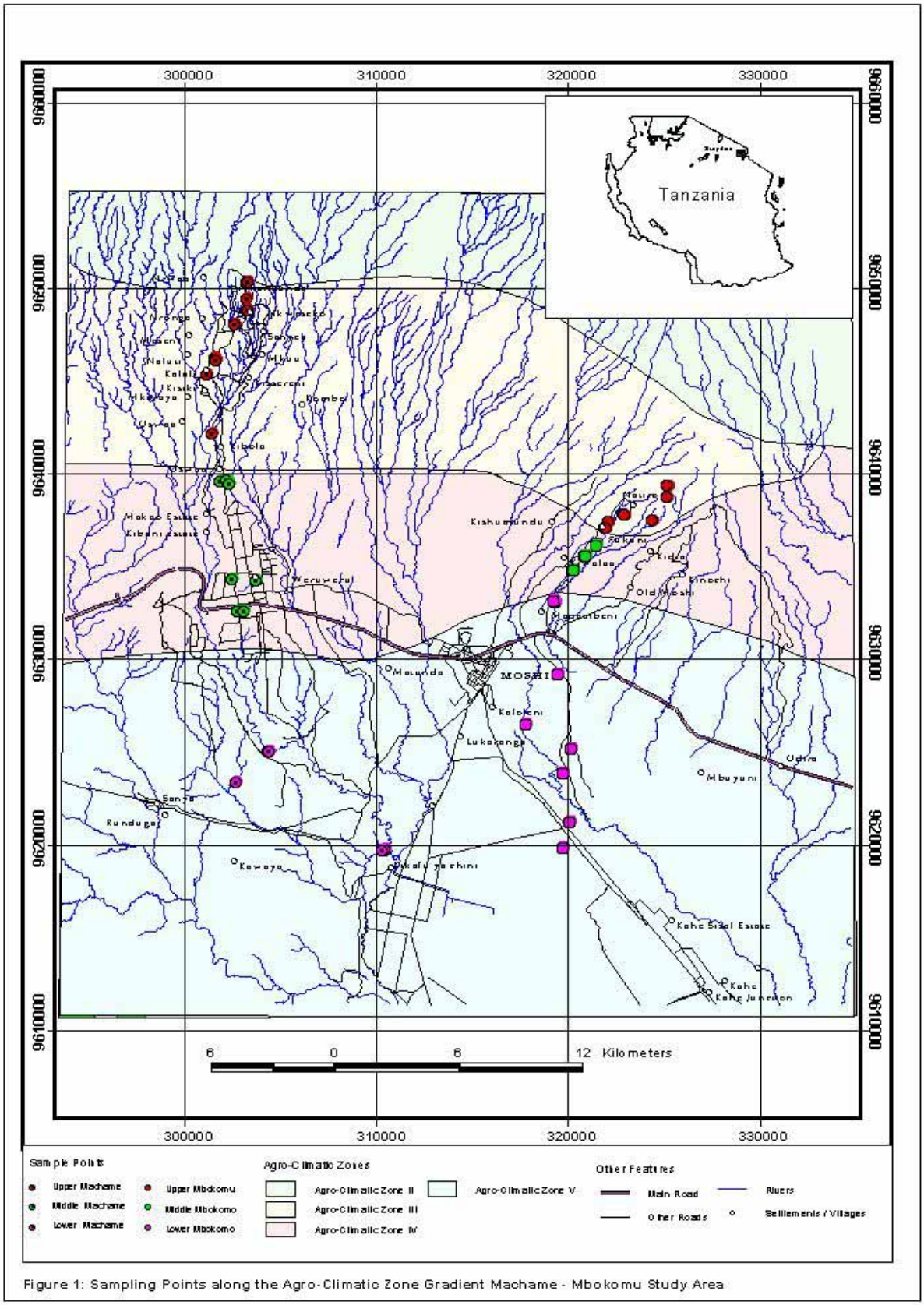


Figure 1: Sampling Points along the Agro-Climatic Zone Gradient Machame - Mbokomu Study Area

Figure 1.Sampling Points along the Machame-Mbokomu Agro-climatic Zone Transects

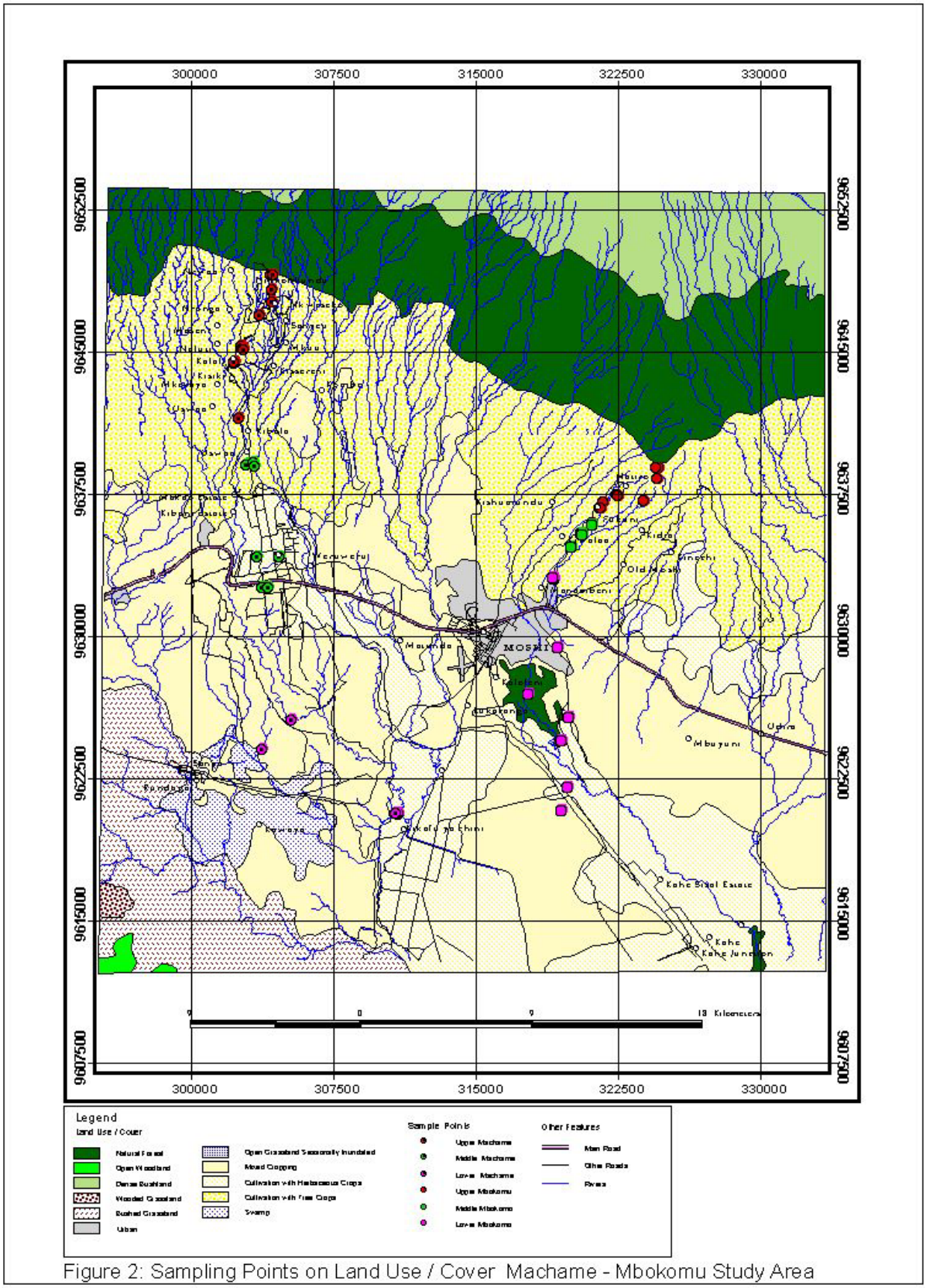


Figure 2: Sampling Points on Land Use / Cover Machame - Mbokomu Study Area

Figure 2. Sampling points on land use/cover Machame-Mbokomu transects

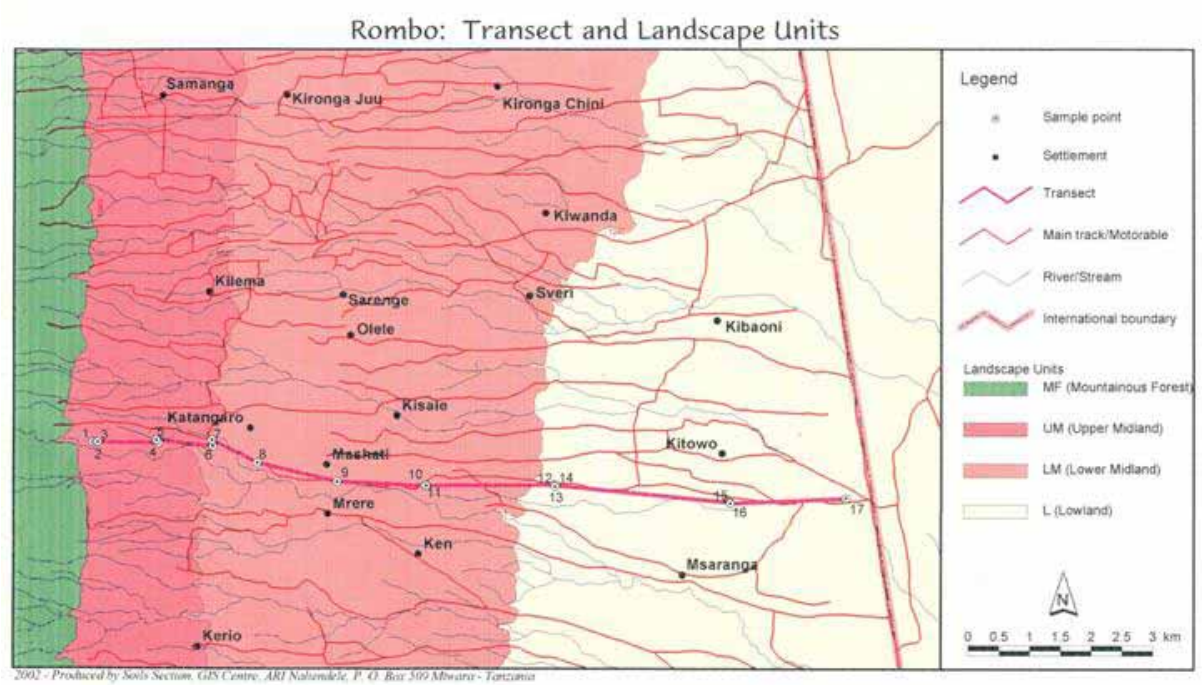


Figure 3: Sampling Points within Ecological Zones along the Rombo Transect

2.2.1 Interpretation of satellite images

An analysis of land use and cover change on the slopes of Mount Kilimanjaro was done based on the interpretation of satellite images. Four different images were obtained and used in the study. These covered the periods 1973, 1984 1999 and 2000. The 1973 and 1984 images were Landsat MSS while the 1999 and 2000 were Landsat 7 ETM+. The 1999 and 2000 images were combined to form a 1999/2000 colour composite mosaic at a scale of 1:150000.

Each image was first radiometrically and geometrically corrected and geo-referenced to Transverse Mercator geographic projection (UTM Zone 37 South Grid). Colour composite images (hard copies) were produced at the scale of 1:150000 to facilitate the visual interpretation process. After interpretation, the polygons were digitised to produce land use and cover maps, and vector maps of towns and villages were overlaid on these maps for visual referencing. Maps showing land use and cover patterns on the slopes of the Mount Kilimanjaro for the three periods were then produced at a scale of 1:250000. There were, however, some distortions resulting from cloud cover on the 1973 and 1984 images, which led to an underestimation of forest coverage for the two years. The lack of clear contrast between forest cover and cultivation with tree crops, which is basically an agroforestry system of cultivation, with coffee, banana and tree mix, also led to either overestimation or underestimation of the latter class on the 1973 and 1984 images.

Since the interest of this study was to show land use change patterns on the southern slopes of Mount Kilimanjaro, the area of interest was clipped from each of the three maps and the area coverage for each cover category determined. It was necessary to merge some of the classes in order to reduce their number and improve clarity of the maps. Thus, for example, cultivation with tree crops, mixed cropping and cultivation with herbaceous crops were merged to form one class namely mixed, herbaceous tree crop cultivation. Bushland, bushed grassland and grassland were merged to form bushland-grassland. Similarly, bushland with crop cultivation was merged with grassland with crop cultivation to form bush-grass mix with cropland.

The 1973, 1984 and 1999/2000 clipped maps were then overlaid to detect changes in land use and cover between the three time periods. The main interest was to show the extent to which

agriculture had expanded in the area at the expense of other cover classes. Therefore, only a few classes, mainly irrigated agriculture, mixed, herbaceous tree crop cultivation, bushland-grassland, bush-grass mix with cropland and sugarcane, were considered in the change detection. Change detection matrices for 1973-1984 and 1984-2000 were developed from the statistics generated from the overlaid maps to show how much area of one cover category changed to each of the other categories over the two time periods.

2.2.2 Household Socio-Economic and People's Perception Surveys

Socio-economic data were collected along the three transects by using a questionnaire, which was prepared by the LUCID project regional office and there were a few modifications made to suit the Tanzanian situation (Maitima and Olson 2002). The questionnaire captured the main economic activities of the people, land ownership and migration. The villages and households along the three transects were randomly selected but the selection closely followed the ecological zones of Mount Kilimanjaro. Besides the closed questionnaire interviews with individuals who had knowledge of the different dimensions of land use change in the study area provided additional information on the nature of land use change over time, particularly since the 1950s, causes of such changes and loss of plant species. Such key informants included owners of farms and long time residents in the area, as well as government officials.

A study of people's perceptions on the slopes Mount Kilimanjaro was conducted in two transects in April 2002. In Machame transect two villages were selected; these were Foo village in the highland ecological zone and Longoi village in the lowland ecological zone. In the case of Mbokomu transect, Korini Juu and Mandaka village were selected to represent the highland and lowland ecological zones respectively. In each village about 10 households were selected to fill the questionnaire, giving a total of 40 households. Also a number of focus group discussions were held with elderly (60-90 years), middle aged (30-59 years) and young populations (15-29 years).

3.0 LAND USE CHANGE PATTERNS

Mount Kilimanjaro is an important ecosystem that has unique resources and many opportunities for the development of its people. It has five distinct ecological zones, which can be clearly observed on Plate 1 and Figure 1. These are: the lowland zone, reaching an altitude of about 900-1000 meters; the cultivated belt (coffee-banana belt) extending up to 1700-1900 m; the montane forest zone, which includes the half mile strip along the southern edge of the forest and the Kilimanjaro Forest Reserve extending to 3500-3700 m; Heathland occurring in the alpine and sub-alpine zones at altitudes exceeding 3,500 m.a.s.l., and the alpine desert (the summit) dominated by bare rock and ice.

Over the years, major changes in land use have occurred on the southern and southeastern slopes of the mountain. The major land use changes have been the expansion of cultivation down the slopes and the replacement of natural vegetation by cultivated land. Both the lowlands and the highlands are intensively cultivated, leading to fragmentation of the bushland vegetation, which seemed to have been characteristic of the lower slopes. In the uplands, there has been encroachment on the forest for agriculture and in some areas exotic trees have replaced the indigenous trees. In the lowlands, including the plains agriculture has expanded into areas formerly used for grazing and wildlife conservation. These changes have taken place at different time scales as illustrated in the sections that follow.

3.1 A Historical Analysis of Land Use and Cover Change 1950s -1970s

Vegetation patterns on the southern slopes of Mount Kilimanjaro have been completely altered, with a large proportion of the forest, particularly towards the lower boundary, consisting of secondary vegetation. A belt of cultivated grassland and cropland has replaced

virtually the entire lower part of the montane forest belt. Much of what used to be scrub, bush and lowland forest has been converted to cropland or grassland.

Historical records indicate that much of the present day cultivated land in the highlands was initially forest. With the establishment of settlements, which started in the middle zone up to 1400 m (Iliffe, 1979), the forests were cleared for cultivation of bananas. Only useful tree species were retained in the farms while less useful species disappeared gradually (Fernandes et. al., 1984). Two different types of land use emerged, the Kihamba or home gardens where houses were built and multi-purpose trees were intercropped with food crops, mainly bananas, finger millet and beans, and the shamba land (small fields between the different vihamba) where food crops like maize, beans, yams, sweet potatoes, finger millet and grass for livestock were cultivated (Anderson, 1982). This farming system, which is an agroforestry system, was supported by a sophisticated irrigation system using traditional fallows. According to Mwasaga (1991), this cultivated belt replaced the lower montane forest belt.

With time, cultivation extended to the upper zone, an area where grazing of livestock and the collection of fodder was more extensively practiced (O'Kting'ati and Kessy, 1991). In the late 19th century, with the arrival of missionaries and early colonialists, large scale farms were opened up mainly for coffee production. Coffee was introduced in 1983 by the Catholic Mission, which led to the conversion of the upland grazing lands to large-scale coffee estates necessitating stall-feeding of cattle (Mtei, 1974). Smallholder farmers also started to grow coffee on the Kihamba, intercropping it with bananas and trees.

With the emergence of the Kihamba system and the introduction of coffee, many indigenous trees were replaced with exotic tree species, such as *Grevillea robusta, Eucalyptus, Persea Americana*, which were planted for various purposes, such as timber, shade, fruit and animal fodder. *Eucalyptus* was mainly planted for fuelwood supply and poles. Some indigenous species, such as *Albizia schimperiana* and *Newtonia buchananii* were, purposely retained in the farms for soil conservation. These are leguminous plants, which add nutrients to the soil.

According to Soini (2002a) the expansion of coffee production led to the conversion of the grazing areas in the uplands, which necessitated stall-feeding. Some of the small fields (shambas) where food crops were grown and *Dracaena* groves, areas set aside for burials and sacrifices were also converted to home gardens. Agriculture and settlement increasingly spread to steep river valleys and down the slopes to the lowlands, with cultivation of food crops being pushed to the lower slopes. The lower slopes that bordered settled areas and the plains were mostly covered by woodland and bushland (Holland, 1996). The Chiefs allocated lowland plots (shambas) to upland farmers from the 1940s to 1960s so that a farmer would have a kihamba (home garden) in the upland for coffee/banana production and a shamba in the lower slopes/lowlands for food crop production (Maro, 1974). More coffee estates were established in woodland and bushland zones in the upper lowlands (Soini, 2002a).

The major crops grown in the lowlands were maize, beans, finger millet and vegetables. Cotton was also being produced in some areas as a cash crop on a smallholder basis. In the dry low-lying areas (with rainfall less than 700mm), pastoralism was the main land use type, practiced mainly by the Maasai herdsmen.

Thus by 1950s, the slopes of Mount Kilimanjaro were already settled and intensively cultivated. This is also confirmed by socio-economic survey, which revealed that majority of the people (about 94%) who acquired land between 1950 and 2001 acquired land that was already under cultivation. According to Maro (1974), there were two steps in the intensification of land use. The first step was when the fertile highlands were converted to home gardens and small fields of food crops, followed later by establishment of large-scale coffee estates. The second step was when part of food crop production was moved to the lower slopes.

By 1961, there was still space in the home garden area for small fields of sweet potatoes, other vegetables and small patches of grazing lands (Soini, 2002a). With increased population, however, the small fields were converted to Kihamba. Thus over time, the upper slopes became more uniformly covered by home gardens while in the lowlands, more bush land was opened up for food production. Soini (2002a,b) observed that there had been expansion of cultivation to more and more marginal land down the southern slopes of the mountain since the 1960s, as well as extreme fragmentation of natural bushland vegetation and appearance and expansion of settlements. Thus by 1965, for example, areas of induced vegetation brought about by cultivation and grazing through the removal of the original vegetation were found nearly all around the mountain from 760m to 1820m (Greenway, 1965). Since then, there had been a lot of encroachment on the grazing areas by agriculture particularly by people who were migrating from the densely populated highland areas. This led to expansion of areas under agriculture and a decrease in grazing areas. Near the rivers, irrigated agriculture (small-scale) for crops such as rice and vegetables became common.

3.2 Patterns of land use and cover change 1973-2000

As observed by Soini (2002a), there has been continuity of land use on the mountain in time and space. The two types of land use, the home gardens (cultivation with tree crops) and shamba (mainly with mixed cropping), have remained a characteristic way of Chagga farming until today. Consequently, the general trend of land use as can be depicted from the 1973, 1984 and 2000 land use and cover maps (Figure 4) and Table 1 has been the expansion and intensification (measured by percentage of land under cultivation) of cultivation, particularly in the lowlands. It is evident from the maps that mixed, herbaceous and tree crop cultivation has expanded at the expense of natural vegetation. In 1973, about 54% of the land in the study area was under some form of cultivation, with 48.5% being under mixed, herbaceous and tree crop cultivation. By 1984 and 2000 the area under cultivation had expanded to 62% and 63% respectively, with the area under mixed, herbaceous and tree crop cultivation being 53% and 57%, respectively.

Data in Table 1 reveal that mixed, herbaceous and tree crop cultivation increased by 8.8% between 1973 and 1984 and by 8.3% between 1984 and 2000. Overall, there was a general increase of this cover category of 17.8% between 1973 and 2000. The rate of increase may seem to be small compared to other use and cover classes. This is because three different land use classes have been combined to form this category, which has obscured the differences in land use change among them. The three classes are cultivation with tree crops characteristic of the uplands, which does not seem to have changed much over the two time periods as shall be explained later, mixed cropping, and cultivation with herbaceous crops both characteristic of the lowlands. Much change seems to have taken place in the latter two categories.

Use/cover type	Coverage in Hectares			Cover change					
				1973-1984		1984-2000		1973-2000	
	1973	1984	2000	Ha	%	Ha	%	Ha	%
Natural forest	16461.4	30059.6	32086.9	+13598.2	+82.6	+2027.3	+6.7	+15625.5	+94.9
Degraded forest (forest clearing/regeneration)	1374.3	37.9	1993.7	-1336.4	-97.2	+1955.8	+5160.4	+619.4	+45.1
Bushland-Grassland	27779.4	18637.1	16797.6	-9142.3	-32.9	-1839.5	-9.9	-10981.8	-39.5
High Altitude Grasses	2322.3	4570.1	2462.9	+2247.8	+96.8	-2107.2	-46.1	+140.6	+6.0
Bush-Grass Mix with Cropland	5442.1	9032.3	3789.1	+3068	+56.4	-4721	-55.5	-1653	-30.4
Mixed Herbaceous Tree Crop Cultivation	73730.6	80230.4	86865.9	+6499.8	+8.8	+6635.5	+8.3	+13135.3	+17.8
Irrigation (herbaceous crops)	366.3	1915.7	2330.6	+1549.4	+422.9	+414.9	+21.6	+1964.3	+536.2
Plantation (Sugarcane)	0.0	1470.0	1747.4	+1470.0	+100.0	277.4	18.9	+1747.4	+100
Swamps/Marsh Either Permanent or Seasonal	2021.3	2230.6	1138.2	+209.3	+10.3	-1092.4	-48.9	-883.1	-43.7
Swamps/Marsh with Cultivation	2112.6	1060.4	1029.6	-1052.2	-30.8	-30.8	-2.9	-1083	-51.3
Urban Areas	245.0	564.1	1552.9	+319.1	+130.2	+988.8	+175.3	+1307.9	+533.8
Airfields	31.4	45.9	78.8	+14.5	+46.2	+32.9	+71.7	+47.4	+150.9
Cloud cover	19975.8	2008.4	0.0	-17967.4	-89.9	-2008.4	-100.0	-19975.8	-100
TOTAL	**151862.5**	**151862.5**	**151873.9**						

*Underestimate due to cloud cover

Table 1. Area Coverage and Change of Land Use/Cover Types 1973-2000
Note: Clouds covered much forested area in 1973 so the apparent increase in forested Ha is not due to land use/ cover change.

Much of the cultivation, particularly mixed cultivation and cultivation of herbaceous crops, seems to have extended to the lowlands and plains (Figure 5) where a decline of bushland-grassland can be observed from the maps. There has been a general decline of bushland-grassland from 27,779.4 ha in 1973 to 16797.6 ha in 2000, a decrease of 39.5% (Table 1). A similar pattern can be observed between 1973 and 1984, with a decrease of 32.9%. Soini (2002a) observed that while the upper slopes became more uniformly covered by home gardens (cultivation with tree crops) since the 1980s, more bushland was being converted to agricultural land for food production in the lowlands.

A greater part of the Bushland-grassland vegetation (about 9198 ha) was converted to mixed, herbaceous tree crop cultivation between 1973 and 1984 (Table 2a) compared to 6915.9 ha between 1984 and 2000 (Table 2b). These results correspond to the observation made by Soini (2002a) that more bushland was opened up for food production by 1982 in response to increased population pressure on the upper slopes. Today patches of bushland vegetation remain only on top of volcanic hills or in areas not suitable for cultivation because of shallow soils.

Most of the bushland-grassland areas were used as grazing lands by the Maasai pastoralists. This implies that expansion of agriculture into these areas has been at the expense of grazing land, which has been reduced significantly over the years as depicted from the bushland-grassland decline. The expansion of agriculture into the traditional grazing areas has also been a major source of conflict between farmers and pastoralists.

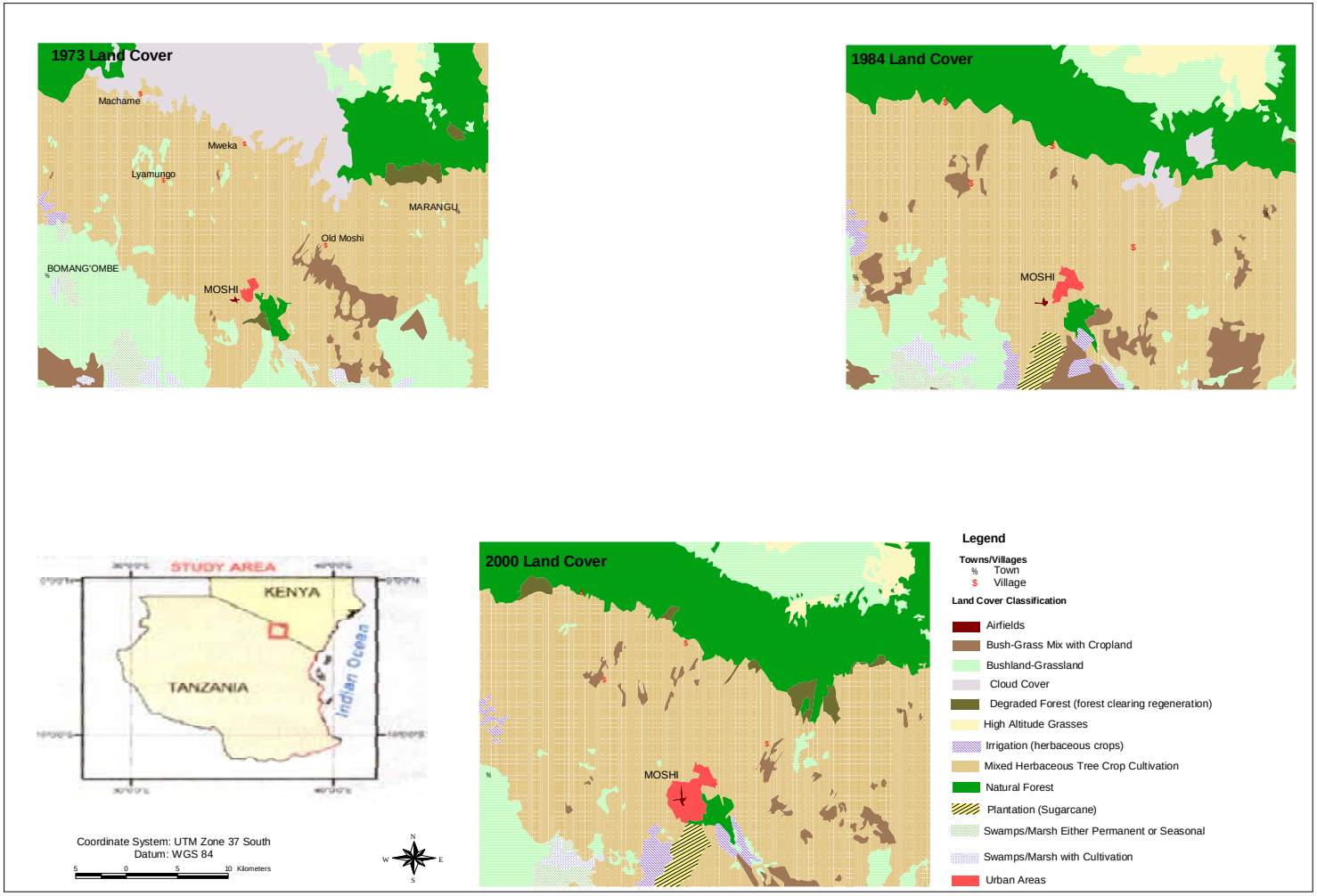


Figure 4. Land Use and Cover Change on the Southern Slopes of Mt. Kilimanjaro 1973-2000

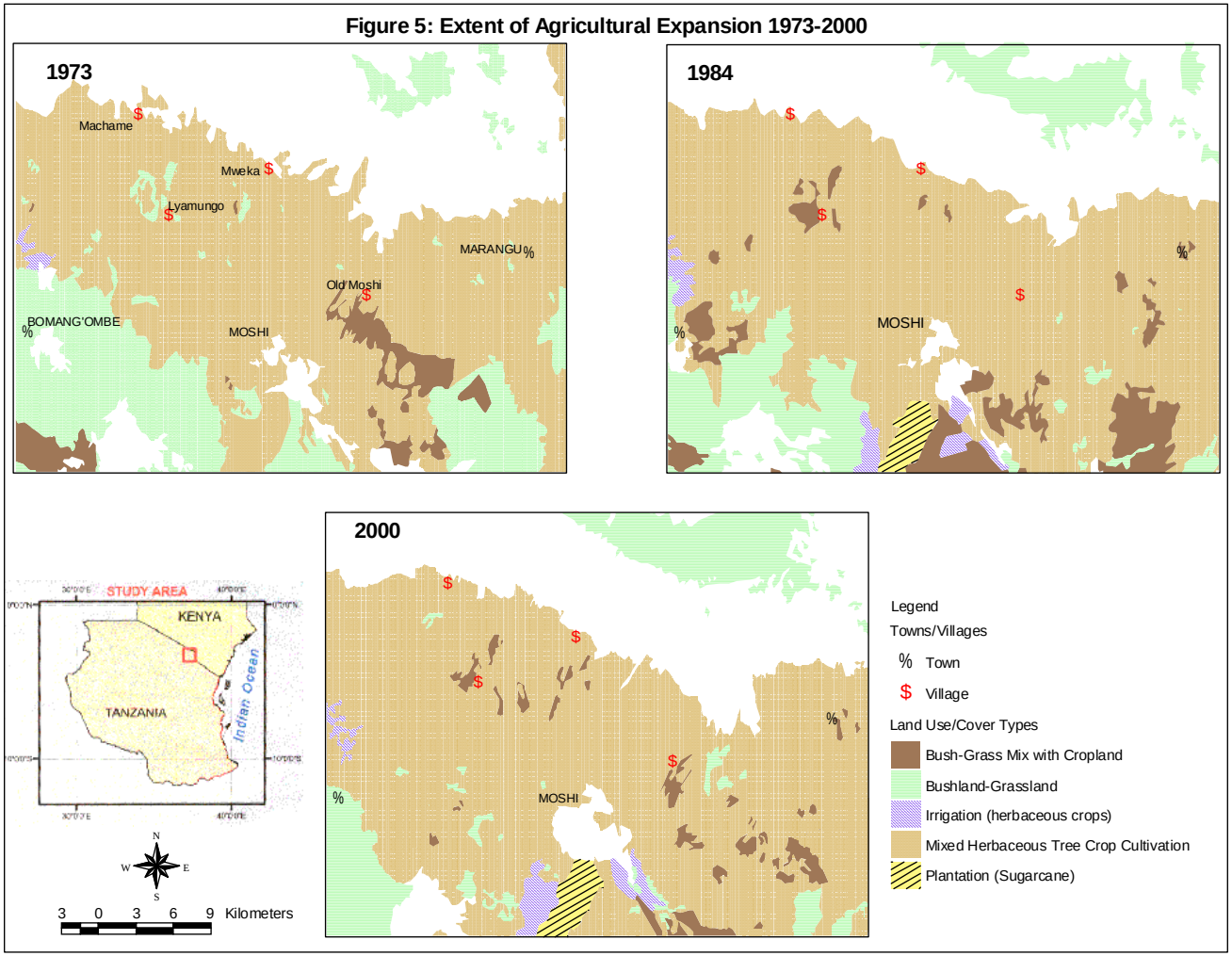


Figure 5. Extent of Agricultural Expansion 1973-2000

Table 2a. Land Use and Cover Change Detection Matrix 1973-1984

		Land use/Cover in 1984 (ha)				
		B-G	**B-G C**	**MHTC**	**IA**	**PSG**
Land Use/Cover in 1973 (ha)	**B-G**	10368.0	4713.2	9198.7	1168.6	87.5
	B-G C	963.3	864.1	3164.3	0.0	0.0
	MHTC	828.0	0.0	64177.9	480.0	1382.6
	IA	0.0	0.0	263.4	102.8	0.0
	PSG	0.0	0.0	0.0	0.0	0.0

Note: B-G – Bushland-Grassland, B-G C - Bush-Grass Mix with Crops, MHTC – Mixed Herbaceous, Tree crop Cultivation, IA - Irrigated Agriculture, PSG – Plantation (sugarcane)

Table 2b. Land Use and Cover Change Detection Matrix 1984-2000

		Land use/Cover in 2000 (ha)				
		B-G	**B-G C**	**MHTC**	**IA**	**PSG**
Land Use/Cover in 1984 (ha)	**B-G**	9286.9	229.5	6915.9	0.1	
	B-G C	1483.4	776.2	6072.4	194.9	374.6
	MHTC	1795.7	2606.8	71039.1	1069.8	186.8
	IA	26.7	1130.5	0.0	756.1	0.1
	PSG	0.4	0.0	83.5	202.9	1182.7

Note: B-G – Bushland-Grassland, B-G C - Bush-Grass Mix with Crops, MHTC – Mixed Herbaceous, Tree crop Cultivation, IA - Irrigated Agriculture, PSG – Plantation (sugarcane)

Much of mixed cropping and cultivation with herbaceous crops is rainfed and is often supplemented by the traditional irrigation system because of inadequate rainfall. The main characteristic feature of agriculture in the lowlands as observed also by Sevaldsen (1997) is the dominance of food crops over cash crops, with maize being the most important crop followed by beans. These two crops are intercropped under the mixed cropping system. Other crops include sunflower, finger millet, groundnuts, banana, cassava, sweet potato and vegetables like tomatoes, onions, cabbage, spinach and eggplant. Most of these crops are cultivated by the inter-cropping system along the maize production. Cotton, which is sometimes mixed with maize, beans and sweet potatoes, has for as long time been the main cash crop in this zone, but it is now being replaced by tomatoes and other vegetables. Rice is the main crop in cultivation with herbaceous crops. The crop is grown under irrigation. Very few trees are found in the shambas in the lowlands compared to the uplands.

The bush-grass mix with cropland increased by 56.4% between 1973 and 1984 but decreased by 55.5% between 1984 and 2000. The increase in the earlier period is due to the conversion of 4713.2 ha of bushland-grassland to bush-grass mix with cropland while its decrease in the latter period may be explained by the conversion of 6072.4ha to mixed, herbaceous and tree crop cultivation. Yanda and Shishira (2001) observed that bushland with scattered cultivation increased by 265% between 1952 and 1982 while grassland with scattered cultivation increased by 1,189% in the same area.

Irrigated agriculture increased by 422.9% between 1973 and 1984 and by 21.6% between 1984 and 2000. This could be attributed to the preliminary irrigation schemes that were initiated in the area by the Japanese between 1975 and 1977 and later the Lower Moshi Agricultural Development project that was commenced in the area in the early 1980s to support irrigated agriculture in the lowlands within the lower Moshi area. Generally, an increase of 536.2% from 366.25 ha in 1973 to 2330.6ha in 2000 can be observed from Table 1. The main crops grown are rice, maize, onions, tomatoes and other vegetables. A number of smallholder irrigation schemes have been constructed in the lowlands, the largest scheme being the Lower Moshi Irrigation Scheme constructed by the Japanese in the early 1980s. There is also a privately owned large-scale sugar cane plantation in the lower Moshi area covering an area of about 1747 ha on the clipped map in the year 2000, as well as floriculture estates within the middle zone, most of which have replaced coffee.

Although the maps and statistics show an increase in irrigated agriculture, in practice there has been a decline in irrigation over the recent past. This is mainly attributed to scarcity of water for irrigation because of the increased demand and extraction. In the Lower Moshi Irrigation project area, for example, rice cultivation covers only 1100ha out of the 2300ha supposed to be under irrigation. Currently, each growing season can only support 200-300ha instead of the foreseen 600ha due to water shortage. A study by Sevaldsen (1994) in Makuyuni ward also reported of water scarcity as being the major constraint for most farmers who practised irrigation.

In the uplands, not much expansion of agriculture can be observed. This may be due to scarcity of land. Much of the land in the upper and middle zones is so fragmented that there is no further room for expansion. According to Soini (2002a) most open spaces had been taken by 1982 for building new home gardens. Today, even these home gardens have become so fragmented that they are now too small to sustain a family. The average size of holdings ranges between 0.5ha to 2 ha, with some households having less than 0.25 ha (Oyan, 2000). This zone is characterised by a belt of intensive cultivation, with the natural vegetation having been replaced with coffee, bananas and exotic tree species.

According to Soini (2002b), the home garden area on the upper slopes has not expanded downwards since the 1960s. However, many changes have been experienced in the area. Because of land scarcity and the limited opportunity to expand agriculture in the upper and middle zones, farmers have opted to diversify their crop production. Thus cropping patterns have changed over time. Many homesteads have vegetable gardens in their immediate surroundings, with such crops as cabbage, tomatoes, onions, eggplant and sweet pepper.

As observed by Sevaldsen (1997), the increased importance of vegetables has been noted all over the Kilimanjaro region. The increased demand for vegetables grown on Kilimanjaro is believed to have increased since independence with the expansion of a wage-paid labour force with limited access to land (Grove, 1993). In recent years, particularly since the 1980s, vegetables are seen to provide a higher and stable income than coffee, which for a very long time has been a major cash crop in the area. In response to this, some farmers have uprooted their coffee trees and planted vegetables and horticultural crops like tomatoes and onions. In some areas, previous large coffee estates have been planted with flowers, which are grown mainly for the export market. Some of these estates have now been converted to maize farms.

Diversification of crops has also occurred in middle and lower slopes where tomatoes and other vegetables have replaced cotton as a major cash crop. Because of the drastic drop of the price of cotton since the 1980s, many people especially in Makuyuni ward turned to the production of coffee (Sevaldsen, 1997). But due to the increased scarcity of water and the fact that many people did not have the required shady environment to make the coffee trees thrive, many farmers have been forced to turn to new crops such as tomatoes, other vegetables and

sunflower. Since the mid-1980s, tomatoes have gained significance as a cash crop and have even become the number one cash crop for people in Makuyuni ward (Sevaldsen, 1997). However, because of the perishability of the crop and the limited market as many people have become involved in the production of the crop, the prices are no longer favourable, although they are still much better than the coffee and cotton prices. Also increasingly, a number of people are becoming involved in off-farm activities as a livelihood strategy because of difficulties in agriculture caused water shortage for irrigation and scarcity of land.

Although it has been difficult to interpret the changes in forest cover because of cloud cover on the 1973 and 1984 maps, there is evidence of some forest loss in the south- eastern and eastern parts of the forest. This is reflected in an increase in patches of degraded forest characterized by forest clearings and regeneration particularly along the edges of the half-mile strip. In 1973, the degraded forest covered 1,374.3 ha but by 2000 it had increased to 1993.7 ha. Some of the forest areas have been converted to cultivation, the dominant land use pattern in the highlands being cultivation with tree crops. Lamprey et al. (1991) also reported of forest loss in the south - eastern part of the forest reserve from encroaching agriculture between 1958 and 1987. According to Fernandez et al. (1984), the Chagga home gardens covered about 1200 km^2 by the 1980s. Crops grown in this zone include coffee, bananas, fruit and exotic trees. Other crops include maize, beans, cabbage, potatoes, carrots and taro.

A study by Yanda and Shishira (2001) on the southern slopes of Mount Kilimanjaro revealed that the area coverage of the natural forest had decreased by about 41 km^2 between 1952 and 1982. Some areas that were under natural forest are now under cultivation or degraded types of vegetation. The most affected areas are the edges of the forest reserve, particularly the half-mile forest strip, which have been seriously affected by timber harvesting by big companies and different forms of encroachment. A belt of cultivated grassland and cropland has replaced virtually the entire lower part of the montane forest belt, pushing the boundary of the forest to 1800 meters. Similar observations were made by (William 2002) who reported that forest cover in the Half mile strip on the southern slopes of Mt. Kilimanjaro declined from 194.41 km^2 in 1952 to 155.8 km^2 in 1982.

Similar changes have been observed on the western and north - western parts of the mountain. Major changes were observed in the plantations with much of the plantation being turned into the shamba system where vegetables and maize were being grown. Settlement areas also increased at the expense of bushland and bushed grassland, particularly around Olmolog and Lerangwa villages. According to Chapuis et al. (2001), West Kilimanjaro went through major changes during the last 40 years, although the coffee-banana belt, the most highly populated land use area is non-existent there. The first major change was a conversion of the Maasai grazing areas to cultivation with large estates of wheat. This was followed in the 1970s by increase of small-scale cultivation with herbaceous crops in former grazing areas.

4.0 ROOT CAUSES AND THEIR EFFECTS ON LAND USE AND SOIL MANAGEMENT

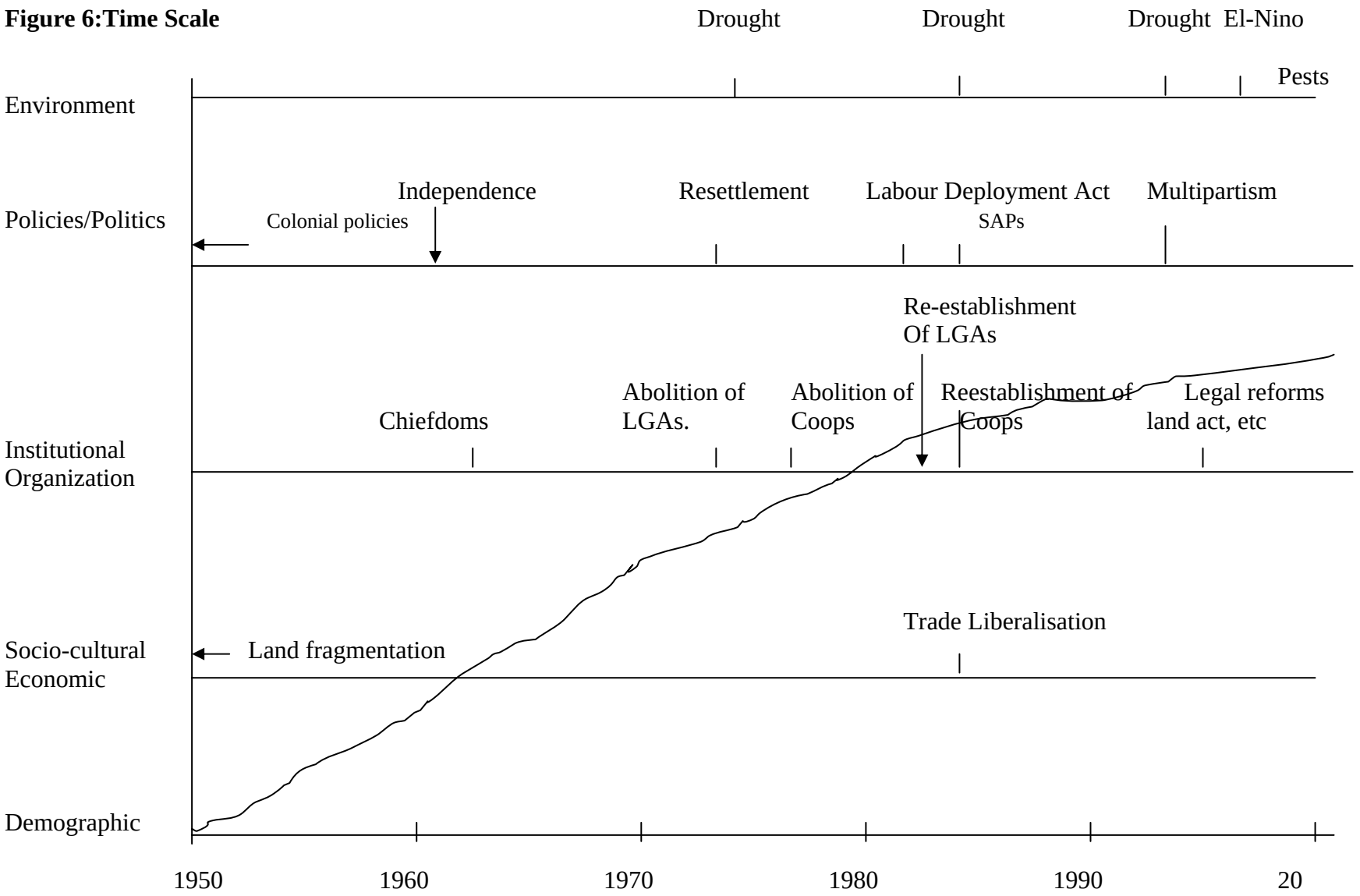
The root causes of the land use and cover changes that have taken place on the southern slopes of Mount Kilimanjaro as described in the previous section are many and are multi-faceted. They include demographic factors, colonial and post-independence government policies, institutional factors, legislation, as well as socio-cultural, economic and environmental factors. All these factors represent the interaction between biophysical and societal processes over space and time and reflect the economic, social and political processes and the physical environment. They also reflect interdependencies among scales, from local, national and international scales. These factors have operated in the study area at different time periods since the 1950s as illustrated in Figure 6 (figure adapted from Campbell 1998).

4.1 Demographic factors

The settlement of people on the slopes of Mount Kilimanjaro began several centuries ago when people of Bushmen type covered nearly the whole mountain. The Bushmen were displaced by the Chagga who originated from the northeast, probably from among the Kamba on the slopes of Mount Kenya or the Maasai who were scattered in semi-arid areas of East Africa. The Chagga were attracted to the slopes of Mount Kilimanjaro because of its good climate and fertile land for cultivation (Stahl, 1965). Despite the fact that demographically the human population occupied the slopes of Mount Kilimanjaro for the last 2,000 years it appears a dramatic change in population dynamics occurred during the last 60 years (Maro, 1975; Mbonile, 1999). A number of reasons explain these rapid population dynamics:

- The introduction of traditional irrigation systems enabled the farmers to grow crops throughout the year and increase the productivity of staple foods like bananas.
- A change in the cropping system with the introduction of coffee as a cash crop. The money obtained from selling coffee enabled the population on the slopes of Mount Kilimanjaro to purchase food from neighbouring regions and countries.
- The increase of population mobility between the lowlands and the highlands increased the area that could be cultivated. Resources such as grass and crop residues were carried to the highlands by farmers who used them to enrich the highland soil by making compost and by applying manure from livestock fed on the lowland resources.
- The introduction and spread of health facilities began during the colonial period. Both the missionaries and the government introduced many medical facilities from local to regional levels. This reduced mortality rates, especially among infants.
- Despite the fact that the slopes of Mount Kilimanjaro are a leading source of out-migrants, the region was and is still a major region of in-migration particularly to areas with large plantations such as the Tanganyika Planting Company, and to urban centres such as Moshi Municipal and small towns like Boma la Ngombe and Himo.

Figure 6:Time Scale



- Human fertility rates on the slopes of Mount Kilimanjaro have been declining from a Total Fertility Rate of about 7.9 in 1967, to about 6.2 in 1988, and finally to about 5.8 in l999. Nevertheless, the rates are still very high when compared to countries in the developed world where Total Fertility Rates have declined to 1.2 per woman.

As indicated by Msuya (1995) these high fertility levels persist in the midst of declining mortality rates. In fact the child mortality rate declined from about 152 in 1978 to about 98 in 1999 (DHS, 1991/9992, TRCHS, 1999). Due to the young population structure, the population will continue to grow for several decades to come (ECA, 2001). As indicated in Table 3 the population on the slopes of Mount Kilimanjaro increased from about 267,700 in 1948, to about 840,000 in 1988, and to about 1,053,204 in 2002.

Table 3: Population on the Southern Slopes of Mount Kilimanjaro by District

Year	Districts				Mount Kilimanjaro
	Hai	Moshi Rural	Moshi Urban	Rombo	
1948	-	-	-	-	267,700
1957	-	-	-	-	365,000
1967	116,974	242,075	29,423	114,615	503,087
1978	172,444	312,041	52,066	157,715	694,246
1988	200,136	342,553	96,838	200,859	840,386
2002	259,958	402,431	144,336	246,479	1,053,204

Sources: Population Censuses 1948, 1957, 1967, 1988 and 2002

These population dynamics have produced an overall growth rate ranging between 1.9 % and 4.5% for the region (Table 4). This rapid population growth rate results in the population doubling every twenty years. Because of the rapid population growth, population density has become very high especially in the highlands. This has led to increased pressure on natural resources resulting in a scarcity and fragmentation of land and out-migration into the lowlands. There are also high rates of migration to urban areas. The high population growth in Mt. Kilimanjaro has been slightly reduced by the heavy out-migration to other regions in Tanzania and to abroad (Mbonile, 1999).

Generally, this interpretation of the census data is supported by data obtained in the household survey conducted in December 2001 to January 2002 (Machame and Mbokomu transects) and September 2002 (Rombo transect). The information on the place of birth and residence in the three transects indicates that 84.8% of the husbands who have the right to inherit the land were born in their current villages of domicile. Others were born outside the village but within their districts (9.3%) and about 3.7% were born within the same region. Those who were born in other regions were only 2% (Figure 7). The low proportion of in-migrants from other regions reflects the difficulty of in-migrants have in accessing land because tradition and culture limit land sales. The major reasons given for in-migration include seeking land for cultivation and habitation. Others followed their parents or husbands to new places of residence.

Table 4: District Population Growth Rates of Mount Kilimanjaro 1948-2002

District	1948-1957	1957-1967	1967-1978	1978-1988	1988-2002
Hai	-	-	4.2.	1.5	1.9
Moshi (Rural)	-	-	2.5	1.0	1.2
Moshi (Urban	-	-	7.0	8.5	2.9
Rombo	-	-	3.4	2.6	1.5
Mt. Kilimanjaro	3.5	3.2	2.9	1.9	1.6

Source: Computed from 1948, 1957, 1967, 1978, 1988 and 2002 Census

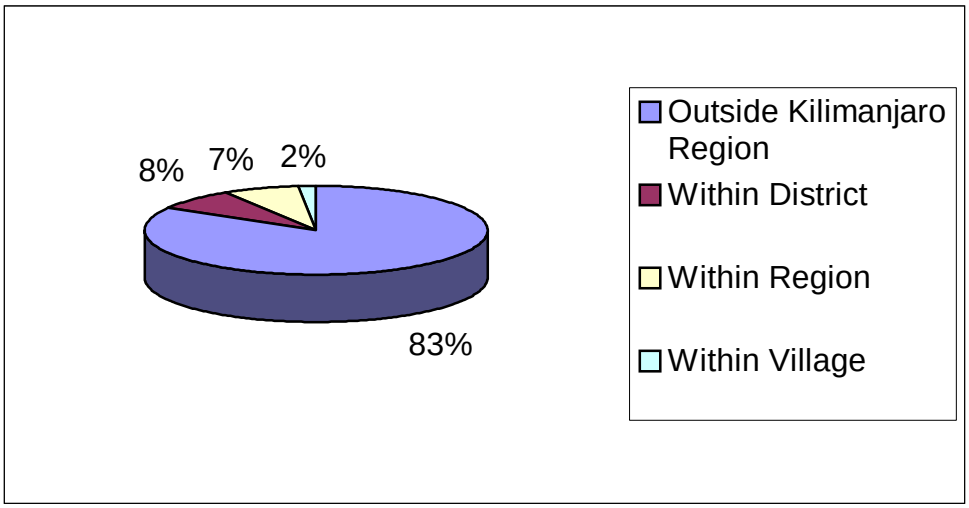


Figure 7: Place of Birth of Heads of Households

Nonetheless, there are major differences in in-migration between the lowlands and the highlands. As indicated in Table 5, out of a total of 48 in-migrants, 40 were living in lowland villages like Kimashuku (13 in-migrants), Mandaka (16 in-migrants) and Longoi (10 in-migrants). Only 6 migrated into the highlands.

An indication of high out-migration from the Kilimanjaro region is that of the 235 surveyed households, 113 had sons aged above 20 years who lived off farm. The number of such sons varied per household and ranged from 1 to 5 per household. In addition, out of those 113 households, the place of residence of the first son living off-farm was as follows: 3 lived within the village, 10 within the district, 9 within Kilimanjaro region and 91 lived outside the region. The destination of three quarters of those living outside Kilimanjaro region was Dar es Salaam and Arusha, the major commercial centres in the country. The major occupations of the sons who had moved with the region include petty trade and being guides/porters of tourists. This young population exploits the rich tourist industry in the northern circuit of the country, which include Mount Kilimanjaro and National Parks like Arusha, Serengeti, Manyara, Ngorogoro and Tarangire.

Table 5: Distribution of In-migrant Husbands by Zone and Village

ZONE	Village	No of in-migrants	Percent
HIGHLANDS	Foo	0	0.0
	Wari	1	2.2
	Tema	0	0.0
	Korioni Juu	1	2.2
	Katangara	1	
Sub-Total		**3**	**6.3**
MIDDLE	Uduru	1	2.2
	Nshara	0	0.0
	Korini Kusini	3	6.7
	Kisale	1	
Sub-Total		**5**	**10.4**
LOWLANDS	Kimashuku	13	28.9
	Mandaka	16	35.6
	Longoi	10	22.2
	Msaranga	1	2.2
Sub-Total		**40**	**83.3**
TOTAL		**48**	**100.0**

The departure of this young population has affected labour availability at the household level, and has influenced farm management. The increase of absentee farmers in the region has led to poor farm management or abandonment of farms leading to changes in the biodiversity of the farms (Mbonile 2003). This is mainly the result of leaving older adults to attend to the farm. Only a few households, especially in the lowlands, utilize part-time farm workers.

4.2 Government Policies

The current situation on Mt. Kilimanjaro is to a certain extent a reflection of past colonial policies, particularly land policies that led to the land alienation and gazettement of forest reserves such as Kilimanjaro and Rau. The local communities were thus denied access to resources in the forest reserves. In Western Kilimanjaro, land was alienated for large-scale wheat farms and ranches reducing land available to the local population for cultivation and grazing. This situation has been aggravated by post independence policies that led, for example, to the gazettement of Kilimanjaro National Park (KINAPA) and the establishment of exotic forest plantations in Rongai and West Kilimanjaro that replaced indigenous forests.

Due to high population density in the Kilimanjaro highlands, there was no place for the establishment of Ujamaa villages. Therefore, the government made an attempt to reduce pressure by resettling some of the population to less densely populated areas such as Rukwa and Morogoro regions. In the lowlands, however, Ujamaa villages were established between the pastoral and other communities. This greatly affected wildlife corridors and natural vegetation as it involved clearance of vegetation for settlement and agriculture. In 1983, the Government enacted the Labour Deployment Act, which led to the resettlement of the urban unemployed into the lowlands.

Also important are the agricultural policies that have influenced land use on Mount Kilimanjaro. For example, in 1983 an agricultural policy was introduced to avert the food crisis facing the country then. The standard of living of the farmers was to be raised by using modern methods of agriculture and animal husbandry. This policy influenced land use on the slopes of Mount Kilimanjaro through the expansion of cultivated land especially in the lowlands. During this period, various traditional cash crops like coffee and sisal were abandoned in favour of annual crops like maize and vegetables.

The Tanzanian government's energy policy focussed on oil exploration and developing hydropower and ignored firewood and charcoal, the main energy source used by people. The high prices of petrol products and electricity have resulted in dependence on firewood and

charcoal, endangering some of the most common three species on the slopes of Mount Kilimanjaro such as *mijohoro.*

The government's mining policy has also had a big impact on the biodiversity of Mount Kilimanjaro because large- scale and small-scale mining have been destructive of the environment. The major mining activity on the slopes of Mount Kilimanjaro is the extraction of salt and sodium carbonate in the semi-arid lowlands. Other minerals heavily extracted are the volcanic products of pumice and volcanic rocks. Miners neatly cut them into bricks and they are used extensively in the building industry (Bagachwa, et. al. 1995). These mining activities have been responsible for the loss of native vegetation and degradation of the land in the affected areas. Where the volcanic rock is extracted, for example, large open pits are left leaving the areas a wasteland.

The industrial policy has also influenced land use and biodiversity on Mount Kilimanjaro. Moshi town, a regional centre, was earmarked in 1969 as one of the country's growth poles. Many industries were then established including the tool and machinery industry, sack factories, soft drinks factories, and breweries. These industries provided employment to the population in Kilimanjaro and so reduced the number of people who directly depend on the extraction of natural resources. However, some evolved into important sources of pollution, particularly water pollution. The pollution affected major water sources for the region such as the Njoro Springs. Large rivers including the Rau, Weruweru, and Kikuletwa were threatened by liquid pollution and solid waste materials produced by the major settlements along their banks.

4.3 Institutional factors

4.3.1 Abolition of chiefdoms

During the colonial period, the custodians of natural resources were chiefs, the traditional rulers. The establishment of *indirect rule* in 1926 by the British Colonial Government sanctioned the nomination of several traditional rulers. This role was strengthened by the African Chiefs' Ordinance of 1953. The first post-independence amendment of local government was made in 1962, amending the Local Authority Ordinance of 1953. This amendment abolished the chiefs' roles and functions completely and left them powerless over control of natural resources; they were then only concerned only with traditional issues. As a whole, government bureaucrats and party authorities have replaced the chiefs who had been custodians of natural resources for several centuries, leaving control of natural resources in the hands of non-stakeholders (Oyugi, 1998).

On Mt. Kilimanjaro, the abolition of chiefdoms changed completely the structure of local government and land tenure. The local chiefs, called *mangi*, had been extremely powerful in protecting the scarce land resources. The protection of natural resources was then left in the hands of local governments that were manned by people who were not indigenous to that locality. The control of local government by distant authorities made possible the gazettement of several protected areas and some sacred areas that preserved natural resources (Mniwasa & Shauri, 2001).

4.3.2 Abolition of Local Government

Local government as an administrative system has experienced a troubled history in Tanzania. On several occasions, the government has attempted to either decentralize or centralize the local government (Mniwasa & Shauri, 2001). The first attempt to centralize the local government occurred during the colonial period when independent local institutions were put under colonial rule, so were administered by the colonial local government system. However, this approach was terminated in 1969 by the post-independence government. The second attempt occurred in 1984 after the failure of structural decentralization that began in 1972 (Mukandala, 1998).

In 1926, a British governor named Cameroon established indirect rule that led to the colonial bureaucracy pretending to give power to the indigenous people to control their localities. During the last eight years of the British Administration, there was an attempt to democratise the local government system in Tanganyika by introducing the local Government Ordinance (Cap 333) of 1953. This ordinance replaced the Native Authority Ordinance (Cap 72) of 1926 (Max 1991:24). In 1962, the post independence government did not abolish the local government structure but integrated it into the government and the ruling party by revising the Local Government Ordinance.

A decentralization process occurred between 1972-1982 when the government reorganized the administration to give more power in decision-making and participation to the regional and district authorities *(madaraka mikoani*). The Parliament enacted the Decentralisation Government Administration (Interim Provisions) Act of 1972 abolishing local government authorities and replacing them by larger bodies called District Development Councils. Since there was then no control of natural resources at local level, the period can be described as the most chaotic period in the history of natural conservation in the country. It was during this period that several areas that had been conserved by the colonial government (including Kilimanjaro Forest Reserve) were invaded. The whole process led to the near disappearance of some forest reserves in the country. The marketing of plant species such as bamboo, used to maintain water sources and catchment areas, led to their depletion in several catchments. This was also the period of rapid expansion of cultivation into natural vegetation and into sacred wetlands. Since the Act weakened the power of local people, there was an invasion of pastoral land by farming populations. The areas that suffered most by this type of invasion were the semi-arid areas that were formally considered marginal for agriculture (Mniwasa & Shauri, 2001; Mbonile, 2002)

Additional changes in policy that impacted local government and natural resources conservation took place between 1983-1998. In 1982, the local governments were re-established to enhance the decentralization of government administration. A number of local government acts were enacted including:

1. Local Government (District Authorities) Act No. 7 of 1982.
2. Local Government (Urban Authorities) Act No. 8 of 1982.
3. Local Government Finance Act No. 9 of 1982.
4. Local Government Services Act No. 10 of 1982.
5. Local Government Negotiating Machinery Act No. 11 of 1982.
6. Decentralization of Government Administration (Interim Provisions)(Amendment) Act No. 12 of 1982.

In 1984, Act No. 15 was enacted which constitutionally sanctioned the existence of local government authorities and affected their conservation of natural resources in the country. The process of changing the powers of the local government continued through to 1997 when the Regional Administration Act of 1997 moved power from the regions to the district. Through this act the local governments became the providers of social services and goods. They were permitted to work with other organizations located within their respective areas such as Non-governmental Organizations (NGOs) (Mniwasa & Shauri, 2001).

The Land Act No 6 of 1999, amending the Local Government (District Authority) Act of 1982, established three standing committees that greatly affected environmental management. One is the Economic Affairs, Works and Environment Committee that is directly involved in sustainable management of natural resources. In urban areas, a standing committee of Urban Planning and Environment was established that made the conservation and environmental management measures paramount in urban planning (Hala, 1999; Kironde & Ngware, 2000). As a whole, the recent amendments to local government authority have put a strong emphasis on local communities participating in environment management (Mniwasa & Shauri, 2001).

To attain sustainable development, regions like Kilimanjaro need to balance accelerated economic growth with efficient management of the environment. It is also important to develop a sustainable framework for the utilization of natural resources (Liviga, 1999).

4.3.3 Abolition of Co-operatives

Another institutional policy change that influenced the utilisation of resources on Mount Kilimanjaro was the abolition of parastatal co-operative unions. In the Kilimanjaro region, co-operatives had been driving forces of development. The first one was established in 1923, followed by the Kilimanjaro Native Co-operative Union in 1932. In 1976, their abolition led to the fluctuation of cash crop prices because there was no authority to monitor and level the world market effectively. The authorities that replaced the co-operative unions were detached from the farmers, the stakeholders. The abolition greatly affected coffee production in Kilimanjaro because farmers could no longer buy chemical inputs and coffee became infected by pests and diseases like the Coffee Berry Disease (CBD).

In the 1980's, the decline led to farmers uprooting coffee and substituting it with crops like maize and vegetables that would provide them money within a short period. The re-establishment of co-operative unions in 1984 occurred when the economy of the country was in deep recession. By then, the co-operative unions had lost most of their assets. They were forced to establish a new infrastructure and could not concentrated on the well being of the farmers. To compound the problem, the re-establishment of the co-operative unions coincided with trade liberalisation, which allowed private dealers to compete with co-operatives. Most farmers opted for the private market that paid the money promptly, but they then had no security of supply of inputs like fertilisers and pesticides. Many farmers abandoned their coffee farms and the coffee trees turned into bushes (Maddox et al., 1996; Mbonile, 1999; Ponte, 1997).

4.4 Environmental Legislation

Tanzanian laws that pertain to environment may be grouped into four main categories: land laws; natural resources and conservation areas laws; pollution-related legislations; and overall environmental management legislations (LEAT, 2000). Legal reforms on these have been carried out in Tanzania since the colonial period. Before the arrival of the Germans in 1885, individual families or clans owned land in Tanganyika, and traditional chiefs had power over land and natural resources. In 1895 when the powers of the Germans had firmly been established in the country, they confiscated all the land and declared it public property. One of the major conditions of this confiscation was that it did not allow the transfer or lease of land by the native population without the approval of the German government (Stahl, 1965). Later the British introduced the *Land Act of 1923* which repeated the same process started by the Germans of putting land ownership under the Government but with a slight modification of recognizing land ownership by natives through customary law.

The post-independence government made some amendments, particularly the long-term land lease system. For quite a long period, smallholders held the land almost entirely under customary tenure or deemed right of occupancy. The first act immediately after independence was the *Free Titles (Conversion) Act of 1963*. This was followed by the *Government Leaseholds (Conversion of Occupancy) Act of 1969*. Nonetheless, land ownership is one of the major causes of conflict in the past few decades in rural and urban areas despite the right of occupancy of land.

The establishment of Ujamaa Villages in the 1970s is one of the most important land reforms in the post independence period. The passing of the *Village Act of 1975* led to the grouping of villages into Ujamaa villages. The land use in these registered villages became a mixture of individual tenure and communal plots or block farm. Since the land in these registered villages was usually not allocated due to its agricultural potential, the result was often severe land degradation and deforestation. Deforestation occurred because people settled in new

areas and required allot of building materials. In the Mount Kilimanjaro region, however, the high population densities restricted development of the villagization programme to a very few areas in the lowlands such as Kahe, Longoi and Mandaka.

In Western Kilimanjaro, the nationalisation of private land by the *Land Acquisition Act, 1967* did, however have a large impact. By using this act, thousands of acres were acquired by the government. Most of the land was given to national institutions such as the National Food Corporation, and other land was distributed to communities living in the vicinity of these plantations. Due to a lack of commitment and resources, however, the former cultivable land was allowed to revert to grassland and bush. To a certain extent this allowed pastoralists to graze freely in these plantations. Nonetheless, in some of the plantations it created severe conflicts between the collapsing governmental institutions and the pastoralists, and some cattle were impounded. The same type of conflict was observed between farmers who had been owners of the land, and the plantations. After the trade liberalization policy was enacted, the former owners returned and attempted to evicted squatter farmers; but they then learned that the Ujamaa Land Act of 1975 gave the squatters this land.

As stated above, the *1982 Local Government Act* consolidated *the 1975 Village Act* by giving power to the Village Council in all land matters, including the allocation of land for communal and individual use. However, the system had no written guarantee of rights over land ownership and ownership could be terminated at the will of the government. Hence the tenure system was not conducive to capital investment. However, as stated by Bagachwa et al. (1995) this weakness was somewhat removed by the Agricultural Policy of 1983. This attempted to reduce this insecurity by establishing a system under which villages were allocated land under 999 year leases with the power to sub-lease any part of their land to individuals, enterprises or institutions for shorter periods of 33 to 99 years. The problem with this land lease was that the land could not be sold, and it ignored the traditional land use rights of grazing and access to water, essential in semi-arid and arid areas. This omission led to the expansion of cultivation into marginal land becoming a source of conflict between agriculturalists and pastoralists.

In 1992 the *Regulation of Land Tenure (Establishment Villages) Act No 22* virtually extinguished all customary rights to village land incorporated between 1970 and 1977 (the Ujamaa Villages). This registration also terminated legislation under which customary rights were being claimed. The *Land Act 1999* maintained the system of having all land be public land with the President of the country the ultimate trustee. This Act moved one step further by granting the *right of occupancy* of any person who has been granted land through either customary tenure or other means. The transfer of land was placed under the jurisdiction of the Village Council. The village land may be transferred to general land in accordance with the provision of the *Village Land Act of 1975*. Furthermore, it defined what is reserved land by including a number of ordinances that established forests, national parks, public recreation grounds and conservation areas. Besides this, it included the declaration of hazardous lands, which include mangrove swamps, and coral reefs, wetlands and offshore islands, land designated as hazardous e.g. for dumping waste materials, land on slopes and other land which is deemed as hazardous when it is being developed.

To summarize, a number of acts have been enacted to control land tenure in Tanzania. These include the Freehold Titles of 1963, the Land Acquisition Act, 1967, the Government Leaseholds (Conversion to Rights of Occupancy) Act of 1969, the Village and Ujamaa Villages (Registration, Designation and Administration) Act of 1975, and the Local Government (District Authorities) Act of 1982 and the Land Act of 1999. In one way or another all these legalisations have had a major impact on land use/cover on the slopes of Mount Kilimanjaro.

4.5 Social/cultural factors

The southern slopes of Mount Kilimanjaro are among the most densely populated areas in the country (300 people per Km^2). This high population density has led to continued land fragmentation. As defined by Kadigi and Mbiha (2000) land fragmentation is the process whereby a larger holding is divided among several heirs leading into smaller units without necessarily increasing field dispersion per household. Sometimes this process is equated to farm fragmentation that refers to the possession by a farmer of many dispersed parcels of land rather than one consolidated holding.

In general, land fragmentation is not an issue only of the population in Mount Kilimanjaro; it was a common agrarian structure in many Western Europe before consolidation of farms in the 19^{th} century (McPherson, 1982). The determinants or root causes of land fragmentation vary from one place to another. Nonetheless, in most agro-pastoralists communities the major underlying cause is rapid population growth (Maro, 1975). In the case of Mount Kilimanjaro, land fragmentation was accompanied by land intensification until it reached a stage of super-population pressure (Boserup, 1965). When this super-population pressure was reached the Chagga were forced to scatter their farms by establishing new farms in the lowlands where annual crops like maize and beans were grown to supplement the food produced in the highlands like bananas and cocoyams (Mbonile, 1999). Another driving force that led to land fragmentation in Mount Kilimanjaro is the land tenure system. The traditional land inheritance system intensified land fragmentation simply because every household has a cardinal responsibility of distributing land to every male child. Furthermore, due to recent changes in marriage dynamics it is also supposed to be distributed to daughters who are not married. Also after the death of parents it is the last son who is supposed to inherit the land close to the homestead.

In terms of land acquisition or access to land, the survey confirmed that land is essential for the livelihood of rural households. Each household on the slopes of Mt. Kilimanjaro has a *kihamba* that includes the homestead and adjacent farmlands. However, some households have other plots of land away from the homestead within and outside their villages. The survey further reveals that the size of plots of homesteads and adjacent farmland ranged from 0.12 ha (0.3 acres) to 9 ha (22 acres), giving a mean of 0.7 ha (1.8 acres) per household. A very small part of the land is used for the homestead and the rest is farmland, with the mean size of cropland being 0.6 ha (1.7 acres). Also, as observed above, the majority of households acquired their plots through inheritance from parents (82.6%) (Table 6 & Figure 8). Others inherited the land through other means such as from clan (6.4%), or from the grandfather or husband (1%). A small proportion acquired plots of land through a free offer from the village government (2.7%) and about 7.3% of the households had acquired plots through buying and renting. Moreover, according to Chagga traditions a *kihamba*, regarded as the heart of livelihood of the homestead, is rarely sold.

ZONE	Village	Means of Acquiring Land				TOTAL
		Bought/Rented	Inherited from parents	Other means of inheritance	by Government	
HIGHLANDS	Foo	1	34	5	1	41
	Wari	2	22	0	0	24
	Tema	0	40	1	0	41
	Korini Juu	0	28	0	0	28
Sub-Total		**3**	**124**	**6**	**1**	**134**
MIDDLE	Uduru	1	16	1	0	18
	Nshara	1	17	0	0	18
	Korini Kusini	2	12	0	1	15
Sub-Total		**4**	**45**	**1**	**1**	**51**
LOWLANDS	Kimashuku	4	16	0	0	20
	Longoi	5	8	0	2	15
	Mandaka	4	8	0	2	14
Sub-Total		**13**	**32**	**0**	**4**	**49**
TOTAL		**20**	**201**	**8**	**6**	**235**

Table 6: Means of Acquiring the Plot of Land in the Homestead and Adjacent Farmlands

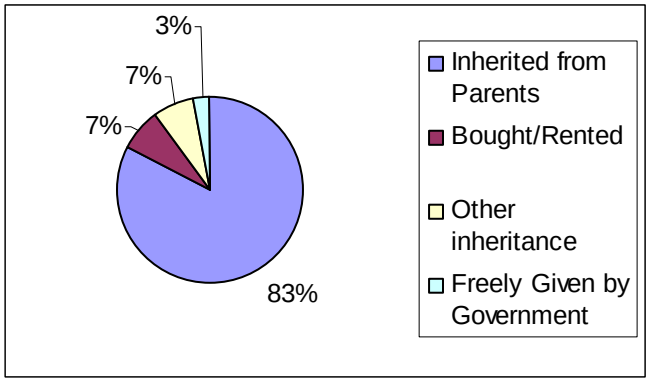


Figure 8: Means of Acquiring Plots for Homesteads and Adjacent Farmlands

Nonetheless, a large proportion of plots acquired through market transaction were in the lowlands. This is because the lowlands have been receiving migrants from both the upper parts of Kilimanjaro and other areas of Tanzania. There is literally no indication of acquisition of land through the market in the uplands of Kilimanjaro. As stated above this strongly suggests that traditions and customs related to land tenure are still very strong and important in land transactions. Generally, land is still considered to belong to the clan and so it is not supposed to be sold—this is a major limitation to any future land consolidation or increase in land purchasing. Since land is not transferable, it is also not accepted as collateral.

As an indication of how land acquisition is a dynamic process, households have been acquiring land by various means since the colonial period and this is continuing during the post independence period. Nonetheless, it appears most households acquired plots through inheritance between 1981-2001 (46.4%). However, a further analysis by agro-ecological zones shows that the lowlands had a greater proportion of households that acquired the land more recently (Table 7).

ZONE	Village	Period when Land was Acquired						
		<1950	1951-60	1961-70	1971-80	1981-90	1991-2001	**Total**
HIGH-LANDS	Foo	5	3	6	8	6	6	34
	Wari	2	5	5	4	4	5	25
	Tema	4	8	5	2	7	3	29
	Korini Juu	1	0	3	3	4	5	16
	Katangara	4	6	6	7	5	3	31
Sub-Total		**16**	**22**	**25**	**24**	**26**	**22**	**135**
MIDDLE	Uduru	0	4	2	4	5	3	18
	Nshara	0	4	1	5	3	3	16
	Korini Kusini	3	1	1	4	1	2	12
	Kisale	4	4	3	3	3	3	20
Sub-Total		**7**	**13**	**7**	**16**	**12**	**11**	**66**
LOW-LANDS	Kimashuku	0	1	0	3	6	8	18
	Longoi	1	1	2	1	4	5	14
	Mandaka	1	1	3	3	5	4	17
	Msaranga/ Mahorosha	0	0	2	2	1	0	5
Sub-Total		**2**	**3**	**7**	**9**	**16**	**17**	**54**
TOTAL		**25**	**38**	**39**	**49**	**54**	**50**	**255**
Percent		**9.8**	**14.9**	**15.3**	**19.2**	**21.2**	**19.6**	**100.0**

Table 7: Period when Plots of Land were Acquired by Zone and Villages

The survey also revealed that most farmers in Mount Kilimanjaro do not have formal title deeds for the land they own and use. The lack of title deeds in most households has important implications for land management in Mount Kilimanjaro. In-depth discussions with the people shows that the lack of title deeds makes farmers fail to show collateral when borrowing money, which could have allowed them to improve their land. The response to the question on who owns land indicated that more than in 90% of the households, the owners were the husbands, only 6.5% of the plots were owned by wives (especially widows), and the rest were owned by other persons.

A further investigation on land acquisition shows that the majority of the households acquired the plots of land when they were already cropped (Table 8). This supports the view that on the slopes of Mount Kilimanjaro, cropped land is passed on by parents to their sons through inheritance. In terms of biodiversity, a greater proportion of households in Mbokomu transect acquired the land under forest, while in the lowlands a significant proportion of households acquired *open* land.

The other socio-cultural factor which influences land use in Kilimanjaro is the protection of shrine (sacred) land. All areas with shrines have been protected and this has allowed the growth of natural vegetation and medicinal plants. Another positive move that indirectly influences land use in Kilimanjaro is the pursuit of formal education. The Chagga have invested allot in the education of their children and this has enabled them to penetrate the informal sector and hold high positions in government and non-governmental organisations. Others have managed to establish large business enterprises. Using their education and wealth accumulated in various places, they have established environmental non-governmental organisations whose main aim is to conserve the natural resources in the place of origin. They have also managed to provide resources and advice to communities so they can practice afforestation in order to control land degradation and preserve water resources.

Table 8: Use of Plots at the Time of Acquisition by Zone and Village

Transect	Village	Forest	Grazing	Bush	Crops	Open land	Trees	Residence & farm	TOTAL
MACHAME	Foo	1	1	0	37	1	0	0	40
	Wari	0	1	0	23	0	0	0	23
	Uduru	0	0	0	18	0	0	0	18
	Nshara	1	0	4	13	0	0	0	18
	Kimashuku	0	0	3	9	6	0	0	18
	Longoi	4	0	3	2	5	0	0	14
MBOKOMU	Tema	2	0	4	34	1	0	0	41
	Korini Juu	3	0	2	23	0	0	0	28
	Korini Kusini	2	0	2	8	2	0	0	14
	Mandaka	3	0	4	4	7	1	0	19
ROMBO	Katangara	5	3	9	16	0	1	1	34
	Kisale	1	0	2	18	0	0	0	21
	Mahorosha/ Msaranga	0	0	1	6	0	0	0	7
TOTAL		22	5	34	211	22	2	1	296

4.6 Economic factors

4.6.1 International Economic Factors

In the mid-1980s, the Structural Adjustment Programmes (SAPS) were introduced which led to the liberalisation of markets, removal of subsidies on inputs, price reforms, and institutional reforms. These have had significant impact on land use and resource management practices (Msambichaka et. al. 1995). As observed by Bagachwa and Limbu (1995) the economic reforms under the auspices of SAPS may have variable environmental impacts. Some of these impacts have been positive, while others have had negative repercussions. In Kilimanjaro region, where much of the income depends on the international trade of coffee, minerals and timber, the fluctuation of foreign currency exchange rates have resulted in negative terms of trade and lower local commodity prices. As such it pushed small farmers to the marginal lowlands to offset the effects of lower prices of highland commodities.

Furthermore, in the Kilimanjaro region it led to crop substitution. The changes in local agricultural prices resulting from the world market prices have been detrimental to perennial tree crops like coffee. The tree crop of coffee was substituted by annual crops including tomatoes, maize and beans that leave the soil susceptible to erosion (Msambichaka, et. al, 1995)

The other environmental impact of SAPs is related to the reduction in subsidies for farm inputs (fertilisers, pesticides and farm equipment). In the case of Kilimanjaro the removal of subsidies on fertilisers made the farmers resort to traditional system of extensive agriculture, which led to high rates of deforestation (Bagachwa & Limbu, 1995). Also as observed by Maddox et al. (1996) and Mbonile (2000) the removal of subsidies of veterinary inputs reduced the ability of the local communities' access to these inputs. This led to decimation or a big decrease in livestock populations following out-breaks of diseases such as rinderpest. In turn this has forced the pastoralists to diversify their livelihood systems by growing crops, further squeezing the grazing towards more fragile land, and to migrating to other regions in the country.

4.6.2 Local Economic Factors

The survey confirmed the fact that the main occupation of the people in Kilimanjaro is crop farming (86.3%). Other occupations include business/trade, masonry, carpentry, mechanics and in services such as health and education. On the other hand, livestock keeping was a secondary occupation for 69.8% of the households. The primary occupation of wives was crop farming (92.2%) and livestock keeping was their secondary occupation. However,

despite the growing literature on the de-agrarianization in Sub-Saharan Africa, the pace of this process on the slopes of Mount Kilimanjaro is a bit slow simply because most young people would like to establish business outside of the Kilimanjaro region. Besides business/trade, very few households were engaged in masonry, carpentry and tailoring.

The major food and cash crops include coffee, bananas, maize, vegetables, rice and beans. Whereas coffee, bananas and vegetables are dominant cash crops in the highlands, maize and beans are the major cash crops in the lowlands. In areas where water is available for irrigation such as Mandaka village the dominant cash crop is rice. The predominance of coffee as a cash crop has declined in recent years simply because vegetables and other non-traditional cash crops like maize, beans and rice have increased their economic role in the region. In fact only 44% households indicated that coffee was the first cash crop (Table 9). Those that indicated that maize was their first cash crop was 23.2%, followed by 16.2% that indicated that bananas was their first cash crop. Meanwhile, 8.9% indicated that vegetables were their first cash crop. Only 3.9% indicated that rice was their first cash crop.

Table 9: Major Cash Crops of the Area

Cash Crop	No of Households	Percent
Coffee	114	44.0
Maize	60	23.2
Bananas	42	16.2
Vegetables	23	8.9
Rice	10	3.9
Fruits	4	1.5
Groundnuts	4	1.5
Sorghum and millet	1	0.4
Beans	1	0.4
Total	**259**	**100.0**

The key food crops are bananas and maize. 61.1% of the households indicated that bananas was their major food crop and 32.6% of the households indicated that maize was their main cash crop. 74.3% of the households produced sufficient food in the normal year. However, despite the fact that Mount Kilimanjaro is among the major food- producing region in the country, food insecurity is very common in many households (25.6%). As indicated by Table 10, food insecurity is found in all agro-ecological zones. Nonetheless, food insecurity seems to be more common in some of the highly degraded villages like Korini Kusini in the Mbokomu transect and Foo in the Machame transect.

However, it is important to note that some of the current economic conditions being faced by people on Mount Kilimanjaro are strongly linked to the economic history of the country and region. Since the drought of 1974 and the inflation of prices linked to the rise in oil prices, the Kilimanjaro region has been facing severe economic conditions. The slopes of Mount Kilimanjaro were also highly affected by the break up of the East Africa Community in 1977 and the Iddi Amin War in 1978/1979. Since it borders Kenya and is on the route for goods being transported to Uganda, the region was highly affected by these incidences. These economic problems made the economy of the region and the country grow negatively or at an extremely slow pace particularly between 1982 and 1984. The economic slump continued with the removal of subsidies on agricultural inputs in 1982 that lead to some crops such as maize facing stiff foreign competition from Kenya. The problem greatly affected the major maize growing areas of Iringa, Mbeya, Rukwa and Ruvuma. The removal of subsidies on agricultural inputs resulted in the cost of producing a kilogram of coffee being more than what was fetched on the world market. This led to a change in the cropping systems of the people.

Table 10: Proportion of Households that Produce Insufficient Food in a Normal Year

ZONE	Village	No of Households	Households with Food Insecurity	Percent
HIGHLANDS	Foo	40	11	27.5
	Wari	24	2	8.3
	Tema	41	4	9.7
	Korini Juu	28	5	17.8
	Katangara	35	19	54.3
MIDDLE	Uduru	18	2	12.5
	Nshara	18	3	16.7
	Korini Kusini	15	6	40.0
	Kisale	21	15	71.4
LOWLANDS	Kimashuku	0	0	0.0
	Longoi	14	1	7.1
	Mandaka	19	3	15.8
	Mahorosha / Msaranga	7	5	71.4

As stated above, the importance of coffee for the income of the people in Kilimanjaro declined. The failure of coffee to meet the needs of the people continued to the 21st century. People in Kilimanjaro said during discussions that the production of coffee has declined due to falling prices, but also because they fear cancer of the throat from agricultural chemicals that most old people with coffee plantations have died from. Coffee as cash crop has fallen out of favour by the young generations who have already converted to maize and vegetable growing. The young generations are also very interested in non-farming activities like business, which appears to improve the income and status of the people within a very short period. Further discussions with people on the transects show that the young generations are not interested in establishing their businesses in Moshi Municipal because they believe that there is strong competition and that the circulation of money is very small, and that this has led to strong out-migration from Mount Kilimanjaro. They would like to invest in the region by using capital earned from other places.

4.7 Environmental Factors

Over the past few decades, environmental protection has emerged from the point of obscurity to one of the most important issues of our time. Generally, at regional, national and international forums the primary aim of environmental protection is to achieve sustainable development. This theme is a follow up of the Rio Declaration on Development and Environment, the Tanzania National Environment Action Plan (NEAP) and the Tanzania National Conservation Strategy for Sustainable Development (LEAT, 2000).

As one of the major catchments and ecological zones of Tanzania, Mount Kilimanjaro faces several environmental problems that need to be addressed before the biodiversity of the region is adversely affected. As stated by Maddox et al. (1996) despite the fact that the slopes of Mount Kilimanjaro have reliable rainfall ranging between 1,500 –2,500 mm per annum it has experienced fluctuations of rainfall including droughts. As observed by Mbonile (2000) these rainfall fluctuations have been occurring in well-established cycles of about every 10 years. Most households in the area remember the 1974 and 1983 droughts. The northern zone of Tanzania suffered another drought in 1993/1994. These droughts were sometimes interspersed with periods of heavy rainfall such as the El Nino of 1997. Both drought and excessive rainfall have a great impact on land management. Drought has been the main cause of the invasion of wetlands by both pastoralists and farmers. Since wetlands are the last to dry, humans, livestock and wildlife concentrate in these small areas leading to overgrazing and related effects such as land degradation. On the other hand, spells of heavy rainfall lead to the flooding of river flood plains and lowland areas. As a result the population of animals and people are compelled to migrate to the uplands, as was the case of Kifaru Village in the 1997 El Nino. The resultant concentration in the highlands leads to more land degradation.

Pests and diseases are other natural factors with a large influence on land management and biodiversity. As in other highland areas such as Mount Meru, the slopes of Mount Kilimanjaro have been suffering from armyworms, locusts, green grasshoppers, cutworms and moles. People said during discussions that most pest disasters occur immediately after the dry season. Coffee Berry Disease (CBD) has also greatly affected coffee production in the region (Mbonile, 2000). The main repercussion of this disease on land management and biodiversity is the reduction of coffee production and increase of annual crops like beans, tomatoes and maize. A disease that attacks bananas, a staple food, has made people change to eat food made out of maize which in the past was seen as food of foreigners *(chasaka*).

Another natural factor that is influencing the slopes of Mount Kilimanjaro is global warming. Recently a strong debate has emerged on the impact of global warming on the glaciers of Mount Kilimanjaro. As stated by Mbogora (2002), the scientist Lonnie Thompson has found that one third of the glaciers on the mountain have disappeared in the last two decades due to global warming. They also predict that if the glaciers of Mount Kilimanjaro continue to retreat there will be serious repercussions on more than one million population residing on the slopes of the mountain and on the tourist industry, which is one of the main sources of income for the country. Currently the peak of Mount Kilimanjaro attracts more than 20,000 tourists per year. It is also the main source of water of the River Pangani and inland lakes like Lake Chala, and the main source of fuelwood and building materials for the people residing on the slopes of Mount Kilimanjaro.

The retreat of glaciers on Mount Kilimanjaro may be partly the result of local human activities. Deforestation and farming activities in the area contribute to the building up of heat trapping gases like carbon dioxide, methane and nitrous oxides, and the reduction of humidity. The intensive use of chemical fertilisers, which break down into methane and nitrous oxides, and the increase in the frequency of bush fires used by farmers to clear land and beekeepers to chase bees are causes of warming.

Generally, the capacity of any government to cope up with environmental problems depends not only on a sound environmental policy but also on the prevalence and efficient institutions that can deal with environmental issues. In this case Tanzania is very fortunate because there are more than 10 ministries, several parastatals and government scientific institutions, and more than 100 non-governmental organisations which deal with environmental matters. The sectoral ministries which deal with environment include the Vice President's Office, Finance, Education, Health, Land and Settlement Development, Agriculture, Water and Livestock development, Power and Mining, Natural Resources and Tourism, Cooperatives and Crop Marketing, Planning and Privatisations and others. The parastatal institutions involved in environmental matters include those, which deal directly with Mount Kilimanjaro like Kilimanjaro National Park (KINAPA) and Tanzania Wildlife Corporation (TAWICO), National Food Corporation (NAFCO). In addition, in 1983 the National Environmental Management Council (NEMC) was established and one of its major tasks was to advise the government on matters concerning conservation and sustainable utilization of the environment. Also it was to act as one of the leading organisations in the campaigns to register for national utilization of resources and land reclamation in the most affected areas (Bagachwa, et al, 1995).

The number of non-governmental organizations dealing with environmental issues is increasing every year. Some of these internal NGOs include the Tanzania Wildlife Conservation Society, the Malbhai Club of Tanzania (MCT), the Tanzania Environmental Society (TES), the Hifadhi Ardhi Dodoma (HADO), the Soil Conservation in Arumeru (SCAPA), the Tanzania Green Belt Movement. International NGOs include the Swedish Free Mission PACT, World Wide Fund for Nature (WWF). All these non-governmental organisations are mainly concerned with the mobilisation aspects and their campaigns have

managed to restore some of the most degraded areas both in the highlands and lowlands (Bagachwa, et. al., 1995).

4.8 Peoples' Perceptions of Environmental Change

The study of people's perceptions on environmental change has been very important because it gives a clear view of what the stakeholders perceive on the utilization of natural resources. The results of the study revealed insights into land use/cover change on Mt. Kilimanjaro. As a response to the current debate about a change in the ice cap of Mount Kilimanjaro, about 36 respondents said a change had occurred (90%) while only 4 said it had not (10%). Therefore, it can be concluded that the people are aware that there is change in the ice cap without the influence of other people or mass media. Obviously if there is change in the ice cape of Mount Kilimanjaro it will have a widespread impact on the biodiversity of the mountain and neighbouring regions.

When they were asked to state the reasons that might have led to these changes, a number of reasons were given (Table 11). The majority of the respondents held the opinion that the ice cap has decreased because there was a change in climatic conditions on the mountain. These climatic changes included:

- Rainfall was greater the past
- Summer rains came earlier in the past
- Rainfall is falling in showers (more intensely)
- Cold has decreased
- The ice used to cover a larger area.

Table 11: Reasons that Support that the Ice Cap is Decreasing

Reasons	No of Respondents	Percent
Change in weather conditions	23	57.5
Decrease in trees/forest drying	8	20.0
Water sources drying	4	10.0
Pollution of rivers	1	0.3
Increase of fires	2	0.5
Land degradation on slopes	2	0.5
TOTAL	**40**	**100.0**

Other reasons for a change in the ice cap include the decrease in forest cover or drying of tress (20%), drying of water sources (10%) and to a lesser extent the pollution of rivers by eroded soils, land degradation on the upper-most slopes and an increase of forest fires. Besides this, the elderly and some of the middle aged population castigated the new generations as responsible for this change in climatic conditions simply because they are more motivated with getting money and so they rampantly cut trees and leave the land bare.

In response to the question of whether there was a change in soil fertility, 32 (80%) agreed that there was a big change and only 8 (20%) did not perceive that there was a big change. Most (30 out of 40) indicated there was a decline in food crop productivity, especially bananas and coffee, and only 10 out of 40 indicated thought there was an increase because of the application of fertilisers, particularly chemical. The elderly population felt that when they were young, only irrigation was required for someone to have a bumper harvest but nowadays you have to use a lot of fertilisers. They also complained that the removal of subsidies has made some farmers buy no or small quantities of fertiliser which has had an impact particularly on big farms and on crops like coffee which need fertilisers.

Also asked was whether the volume of the water in rivers and springs was changing. The results indicate that all 40 respondents agreed that there was a decline in water volume of big rivers like Lukaranga in Mandaka village, Longoi in Longoi village, Mlusunga and Mbori in

Korini Juu village and Semira and Kikafu in Foo village. The respondents predicted that if these rivers continue to dry, there is strong possibility that there will be less irrigation on the slopes of Mount Kilimanjaro and that this would completely change the farming and cropping system of the area.

Respondents were also asked to suggest possible solutions to this problem. Respondents thought that the most feasible solution to this problem was afforestation (55%), to stop deforestation (10%) or protect water sources (30%) (Table12). Only a few gave no solution to the problem (5%). In focus group discussions, the elderly suggested a revival of the traditional furrow management system, which they say has declined because young people are more interested in getting money rather than protecting water sources. Current users of traditional furrows are supposed to pay for water, and this has led to favouritism for those who are able to pay more. Also in more recent years the traditional furrow controllers have turned corrupt because of the absence of the old *mangi* system, which used to mediate when there was an injustice in water utilization.

Table 12: The solutions to the drying of water sources

Solutions	No of Respondents	Percent
Afforestation	22	55.0
Stop deforestation	4	10.0
Protect water sources	12	30.0
No solution	2	5.0
TOTAL	**40**	**100.0**

When respondents and focus groups were asked to state whether there were changes in rainfall during the past twenty years, most of them agreed that there was big change (39 out of 40 respondents) and only 1 out of 40 indicated that he did note these changes simply because he had not been in Kilimanjaro for a long period. They suggested that the main factors which have led to these changes include the recent increased cutting trees and burning of forests. Others just thought that it was the will of God.

The respondents were also asked to state whether there were any changes in the natural vegetation cover, wild animals, birds or insects in their area. In the case of forest and other vegetation cover, all 40 respondents and focus groups agreed that it was decreasing and the root causes for the change of forest cover was clearing forests for farming (45%), clearing land for settlement (25%), fires (20%) and drought (10%) (Table 13).

Regarding animals, 37 out of 40 stated that the number of wild animals has decreased. The major types of animals that were highly affected cover a wide range such as livestock (cattle, goats, etc.) and wild animals such as monkeys, warthogs, antelopes, impala, giraffes, hare, black and white colobus, banana bats, leopards and moles. On the other hand, some of the most popular insects among farmers have decreased or disappeared. These include butterflies, grasshoppers and bees. Since these pollinate flowers, their decrease has a serious repercussion on crop and honey production. In the case of birds, a large number of types have decreased or disappeared and including woodpeckers, sunbirds, parrots and robins.

When the respondents and focus groups were asked to state whether the main crops were increasing or decreasing, all 40 respondents and focus groups indicated that only rice has increased in the lowlands due the establishment of Lower Moshi Irrigation scheme. They also indicated that nearly all major crops in the area were decreasing (Table 14). Some differences existed between the lowlands and the highlands in which crops were decreasing. People in the lowlands felt that their staple food maize was decreasing at a fast rate when compared to other crops like beans that have a relatively higher price. They categorically stated that cotton, which had been a major cash crop in the lowlands, has totally disappeared. The other crops

whose production has decreased in the lowlands include sorghum and sunflower. In the highlands, the main crops whose production has declined include coffee, bananas, yams, potatoes and fruit.

Table 13 Decrease of Forest Cover, Animals, Insects and Birds

Reasons for decrease of forests	**Responses**	
Decrease of Forest	**No of Respondents**	**Percent**
Clearing of forest for farming	18	45.0
Clearing of forest for settlement	10	25.0
Burning of trees	8	20.0
Drought	4	10.0
TOTAL	**40**	**100.0**
Type of Animals Decreasing	**Response Frequency**	**Percent**
Livestock	10	15.2
Monkeys	12	18.2
Warthogs	4	6.1
Hare	2	3.0
Impala	4	6.1
Antelopes	20	30.2
Giraffes	4	6.1
Colobus	6	9.1
Leopards	2	3.0
Moles	2	3.0
TOTAL	**66**	**100.0**
Type Insects Increased	**Response Frequency**	**Percent**
Green grasshoppers	24	40.7
Army worms	35	59.3
TOTAL	**59**	**100.0**
Type of Insects Decreased	**Response Frequency**	**Percent**
Butterflies	21	30.0
Brown Grasshoppers	24	34.3
Bees	25	35.7
TOTAL	**70**	**100.0**
Type of birds Decreased	**Response Frequency**	**Percent**
Banana Bats	12	18.5
Woodpeckers	16	24.6
Parrots	8	12.3
Robins	14	21.5
Sunbirds	15	23.1
TOTAL	**65**	**100.0**

Table 14: Types of Crops whose Production is Decreasing

Crops	**Response Frequency**	**Percent**
Coffee	22	24.5
Bananas	16	17.8
Yams	4	4.4
Potatoes	2	2.2
Cotton	8	8.9
Beans	10	11.1
Maize	22	24.5
Sunflower	2	2.2
Sorghum	2	2.2
Fruits	2	2.2
TOTAL	**90**	**100.0**

Generally, the main causes of this decline in agricultural production include declines in soil fertility, and low prices on the world market for cash crops like coffee. Also they indicated

that some farms are over-cultivated and overcrowded with crops because farmers want to use every bit of space on the farm. Others indicated that the out-migration of the young population has left the elderly population behind who cannot cope up with heavy labour required to maintain crops like coffee. Finally, diseases such as Coffee Berry Disease and pests such as the coffee borer have reduced the yield of coffee by almost a quarter.

5.0 CONCLUSION

Mount Kilimanjaro is an important ecosystem because its socio-economic activities and cultural values influence a wide area in the country. However, recently it has undergone major land use/cover changes leading to a loss of biodiversity. The main land use change has been the replacement of natural vegetation by cultivation. Indeed, the lowlands and the highlands are now both intensively cultivated, there has been encroachment into forest reserves, and exotic trees have replaced natural vegetation in some areas. Agriculture has expanded into some areas formerly used for grazing and wildlife conservation.

The study revealed several determinants or root causes of land use changes on the slopes of Mount Kilimanjaro. Firstly, the rapid population growth in the region has doubled the population size every twenty years that has caused major land use and management changes.

Secondly, land use and land cover have been influenced by policies introduced by the Government, such as the alienation of land for national parks, forest reserves and large-scale plantations, that have reduced the land available for cultivation and grazing. The lack of an effective energy policy to develop alternative energy sources from firewood has made common firewood species such as *mijohoro* be depleted at an alarming rate. Other policies such as Structural Adjustment Programmes (SAPS) have had a strong impact on land use and resource management. For example, the decline of commodity prices led people in Mount Kilimanjaro to substitute traditional cash crops like coffee with annual crops like tomatoes, beans and maize. The abolishment of local institutions such as like chiefdoms and cooperatives had a strong impact on land management. Some legal reforms also had a negative impact on the biodiversity of Mount Kilimanjaro.

Socio-cultural factors such as land inheritance structures have led to land fragmentation leading to some plots losing productivity and becoming highly degraded. Land degradation is also caused by the strong dependence on farming and the lack of agricultural inputs making over-cultivation inevitable.

Last but not least, environmental factors such as rainfall variability, floods and drought have adversely affected land management on the slopes of Mount Kilimanjaro. This observation is supported by people's perception that global warming is reducing the snow cover of Mount Kilimanjaro.

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APPENDIX

LEGISLATIONS

L*and Act of 1923*

Native Authority Ordinance Cap 72 of 1926

Government Ordinance Cap 333 of 1953

Free Titles (Conversion) Act of 1963

Land Acquisition Act of 1967

Government Leaseholds (Conversion of Occupancy) Act of 1969

Decentralization Government Administration Interim Provision act of 1972

Ujamaa Land Act of 1975

Local Government (District Authorities) Act) No 7 of 1982.

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Local Government (Urban Authorities) Act No 8 of 1982.

Local Government Services Act No 9 of 1982.

Local Government Services Act No 10 of 1982.

Local Government Negotiating Machinery Act No 11 of 1982.

Decentralization of Government Administration (Interim Provision)(Amendment) Act No 12 of 1982.

Natural Resources Act No 15 of 1984.

Regulations of Land Tenure (Establishment Village) Act No 2 of 1992.

Regional Administration Act of 1997.

Land Act No 6 of 1999