THE CAUSES AND IMPACTS OF SOIL EROSION ON THE UPPER SLOPES OF MOUNT KILIMAJARO. A CASE STUDY OF TEMA VILLAGE, MBOKOMU WARD, MOSHI RURAL DISTRICT

BARAKA BERNARD N
(BEM/0501/21/DF)

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DECLARATION

I, BARAKA BERNARD. N (BEM/0501/21/DF). I hereby declare that to the best of my knowledge, this research work presented in this dissertation is original unless otherwise stated and has never been submitted to any university or institution for the award of a degree or its equivalent.

Name of Student	:	BARAKA BERNARD. N
Reg. No	:	BEM/0501/21/DF
Sign	:	.....
Date	:	19th September 2005

Name of Supervisor	:	Mrs. ABESIGA NANCY TWESIGE
Sign	:	.....
Date	:	19th. Sept. 2005

DEDICATION

This book is dedicated to all my Parents Mr. and Mrs. Kimaro, who tirelessly sacrificed a lot for my education up to university level. Without them I would not be where and who I am today. God bless you all.

I further dedicate it to my mum Fudasia E. Macha for your support and encouragement you gave through my studies.

I finally dedicate to mum Bertha. E. Macha for the joy and sunshine you have brought into my life. In one way or the other you made my work a success.

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To enable this report reach its completion, many individual were involved. I would like to convey my sincere gratitude personally for the hospitality they have extended to me. Unfortunately this is not easy. However I would like to thank all who were involved in one way or another in facilitating my field study. Please accept my gratitude wherever you are, and at whatever time. You honoured me, and you honoured my work. Feel proud of this output. Nevertheless let me applaud specific contribution to this report.

A very valuable and outstanding parallel contribution is the one that comes to my supervisor Mrs. Abesiga Nancy Lecturer; a lot can be said about her particularly in relation to this report. However, most important is to admit that without her, this report could not have become a reality. Thank you very much for the enabling environment for academic work, stimulating challenge, guidance and discussion, and making me feel the impact of your strong outstanding proficiency. Indeed, I learned a lot from you.

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ABBREVIATION

UNEP - United Nations Environmental Programme

UNDP - United Nations Development Programme

CFSCDD - Community Forests and Soil conservation Development Programme

FAO - Food and Agricultural Organisation

Kihamba - Home gardens

UWANGOMA – Women Pastoralist / farmers Union

TEACA – Tanzania Environmental Action Association

ICARD – International Center for agriculture Research in Dry areas

MFONGO - Irrigation Channel

VULI – Short rains

MASIKA – Long rains

MASALE - Draciana species

ABSTRACT

In this 21st century the problem facing rural areas in developing countries like Tanzania are numerous. Formidable Social and Economic services are deteriorating and proving to be unsustainable; school enrollment rates are declining, food situation is precarious, infant and maternal mortality rates continues to be high, unemployment is on the rise, land shortage, triggering off high population which led to the land degradation.

This study investigated the causes and impact of soil erosion on the upper slopes of Kilimanjaro Mountain which carried out in Tema village, Mbokomu ward, Moshi rural district. In this study the main variables were the forms of soil erosion, causes, impact, conservation measures in Tema village and recommendation to control soil erosion in Tema village. Various methods for data collection were used including interviews, questionnaires, observation and photographs.

The findings show that soil erosion is caused by rainfall, topography, vegetation destruction, drainage, ignorance, inadequate extension services and disruption of transport among others. Findings also revealed that population pressure has enhanced soil erosion through deforestation, land fragmentation, over cultivation, burning and socio-economic development in terms of infrastructure like roads which have placed much burden to the soils of Tema Village hence leading to erosion, Agriculture malpractices like digging up and down the slope without strips, bands and terraces have accelerated soil erosion.

It was also found out that, the impact of soil erosion are loss of soil fertility, loss of living organisms, destroyed crops, soil loss, declining agricultural yields, and impact on road.

In order to reduce the impacts, the following techniques were put in place terracing and contouring, crop intercropping, mulching agro-forestry and using of animal manure. Basing on the above it is recommended that Farmers have to practice a forestation and re-aforestation, checking the population numbers to reduce fragmentation of land carrying out land surveys, surface drainage, educating and training local communities on how to control erosion.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

1.1.1 Soil as a resource

Soil covers large parts of the dry-land surface of the globe; without it, the earth's surface would be barren rock and sand and could not support life. Soil is composed of chemically weathered rock in fine granular form mixed with humus, partially decomposed organic matter. It also contains atmospheric gases, water, and living organisms. Air, rock, water, sunlight: these are the sources of all life, and they come together dynamically in the top layer of soil. Soil is the biologically active zone where the atmosphere, water, sunlight, and the earth's crust mix and interact: the soil is highly active chemically and physically and also highly complex in its composition. Soil is constantly changing its composition in response to changing conditions. It supports a host of communities of living things which are interdependent and survive by endlessly exchanging energy and chemical resources.

To understand the importance of the soil in sustaining terrestrial life on the planet, it is helpful to think of the soil's critical part in a number of the natural cycles and interactions on which all life depends: the carbon cycle, the moisture cycle, the nitrogen cycle, the oxygen cycle, the mineral cycle Many of the chemical and physical processes which sustain these cycles take place in the soil. The soil is one

of the planet's most active regions of energy exchange, particularly through the decomposition of organic materials.

Soil is obviously the medium necessary for terrestrial plant life. And since human beings live on plants and animals, which in turn nourish themselves on plants, it is easy to see why soil is the fundamental resource of civilization. It is in fact the fundamental resource of terrestrial life.

1.1.1.1 Global perspective

France is richly endowed with agricultural resources. The fertile soils of its basins and plains have supported a robust farming culture since antiquity. Today, France is the largest exporter of agricultural goods in the European Union (EU). The French landscape, most of which receives abundant precipitation, also supports a thriving timber industry. Today, about one-quarter of France is forested, and commercial tree farms constitute a significant share of this total. France is not exceptionally rich in natural mineral resources. The coal deposits of northern France and the iron ore deposits in the east were important to the nation's early industrialization. (Greenland *et al.*, 1994).

1.1.1.2 Africa case

Healthy soils are vital to a sustainable environment. They produce food and timber; filter water; store carbon; support wildlife and the urban and rural landscape. They preserve records of our ecological and cultural past. Africa, with a total land mass of about 30.7 million km^2 and a

population exceeding 746 million persons, has generally depend on agricultural activities. Sub-Saharan Africa (excluding South Africa) is the poorest developing region, with 29 out of 34 countries being some of the poorest in the world are all depend on agriculture. (Tiffen, Mary; Michael Mortimore et al 1994)

According to Hamilton (1997).Marginal lands and unsuitable lands, identified, should be managed to preserve their quality as they may be too uneconomical or unsustainable to support more than very low intensity traditional systems. These areas are of benefit to other types of land use such as wetlands needed by breeding fish stocks and wildlife refuges. These marginal lands have been shown to be income producers when managed for wildlife. Kenya and Zimbabwe have been successful in attracting tourists to view wildlife in 'marginal' land set aside as wildlife refuges. Tourism contributes many millions of dollars to the local and national economies of both countries.

1.1.1.3 Regional perspective (East Africa)

With the exception of a few countries such as Kenya, detailed information on the soil resource base is generally inadequate for most developmental purposes. In most countries, farm-level information and detailed soil maps are non-existent. When this is coupled to other socioeconomic constraints, including land titling and availability of capital for land management investments, it provides one explanation for the lack of progress in poverty alleviation and food security. In 2002 agriculture contributed 16 percent of Kenya's GDP. Agriculture accounted for 38 percent of GDP. Kenya's principal domestic commodities

are the food crops maize (corn), millet, sorghum, and cassava. The most important export crops are tea, coffee, horticultural products (flowers, fruits, and vegetables), chrysanthemums (flowers from which pyrethrum insecticides are made), and sisal. (Cleaver and Schreiber, 1994).

1.1.1.4 Tanzania`s case

Tanzania is one of the poorest countries in the world. Agriculture, forestry, and fishing are the main sources of employment. Tanzania contains rich deposits of gold and diamonds, as well as large amounts of coal and iron ore. Forestland constitutes one of the most substantial natural resources of the country. Among the many hardwoods found are mahogany and camphorwood. The economy of Tanzania is primarily agricultural. Some 84 percent of the economically active population is engaged in farming, forestry, or fishing, and agricultural products account for a significant share of annual exports. The country is one of the world's largest producers of sisal and cloves. With an estimated per capita income of $270 a year, from agricultural products. (Anderson, Jock R 1990).

People in Tema Village Mbokomu ward depend on the soil for crop farming and livestock, and as such it is a valuable natural resource. Soils form continuously as a result of natural processes, and can therefore be regarded as a renewable resource.

1.1.2 Soil degradation

1.1.2.1 Global perspective.

Soil degradation is on the increase worldwide, especially in the countries within the tropics. Mismanagement of arable areas by farmers and grazing areas by livestock owners is one of the major causes of soil degradation. More sustainable management of lands would reduce environmental pressures. Conservation tillage, i.e. reduced or no tillage, is the key to sustainable arable land management as it protects the soil resources, increases the efficiency of water use and, of special importance in semi-arid areas, reduces the effects of droughts (FAO 1999).

Soil degradation can either be as a result of natural hazards or due to unsuitable land use and inappropriate land management practices. Natural hazards include land topography and climatic factors such as steep slopes, frequent floods and tornadoes, blowing of high velocity wind, rains of high intensity, strong leaching in humid regions and drought conditions in dry regions. Deforestation of fragile land, over cutting of vegetation, shifting cultivation, overgrazing, unbalanced fertilizer use and non-adoption of soil conservation management practices, over-pumping of ground water (in excess of capacity for recharge) are some of the factors which comes under human intervention resulting in soil erosion.(World Resources Institute, 1990. & L R Oldeman et al, Wageningen, Holland, 1990.)

In the table below, the five most common reasons for soil degradation are given for several areas, and the world.

Actual erosion of the soil often follows the initial period of degradation.

Table 1: Causes of soil degradation Globally

Causes of soil degradation (% of degrading land)					
area	deforestation	fuelwood	overgrazing	agriculture	Industrialization
Europe	38	-	23	29	9
Africa	14	13	49	24	-
North America	4	-	30	66	-
Central America	22	18	15	45	-
South America	41	5	28	26	-
Asia	40	6	26	27	-
Oceania	12	-	80	8	-
World	30	7	35	28	1
Source: World Resources Institute, 1990. & L R Oldeman et al, Wageningen, Holland, 1990					

In every continent the main causes of soil degradation differ: Europe suffers most from deforestation although agriculture is a close contender. In Africa, its cause is overwhelmingly overgrazing, whereas in North America it comes with agriculture. The figures for Oceania are dominated by Australia and New Zealand where overgrazing is by far the largest contributor. World-wide these figures average out. Degradation due to fuel wood cutting, is large in the poor continents, while absent in the rich continents, where fossil fuel has taken its place

The main problems for soils in the EU are irreversible losses due to increasing soil sealing and soil erosion, and continuing deterioration due to local contamination and diffuse contamination (acidification and heavy metals). The incremental loss and deterioration of Europe's soil resource will continue, and will probably increase as a result of

climate change, land-use changes and other human activities. (UNEP/FAO, 1996)

Soil degradation is mainly caused by urbanization and infrastructure development (in western and northern Europe) and erosion (in the Mediterranean region). There is a significant risk of water erosion mainly in southern and central Europe and the Caucasus region; at present, this risk is high to very high in one-third of Europe. Tillage practices also affect soil structure. Proper tillage reduces soil aggregates to the most effective size for a favourable seedbed. Excessive tillage, however, can break down soil aggregates, destroying the soil structure formed by good crop and residue management. Excessive tillage will also contribute to undesirable compaction, accelerate erosion, and waste time and energy. Timeliness of tillage operations is also important. For example, working finely-textured soils when wet should be avoided in order to prevent compaction, puddling, and the resulting formation of hard clods when dry. Timely tillage will help maintain soil structure and reduce its erosion potential (Lutz and El Seraphy, 1988).

1.1.2.2 Africa's case.

South Africa apartheid policies ensured that 42% of the people lived on 13 % of the land (the "homelands"). This overcrowding has resulted in severe erosion. As the land became increasingly degraded and thus less productive, subsistence farmers were forced to further overuse the land. The intensive agriculture and overgrazing that followed caused greater degradation. Soil erosion can be seen as both a symptom of underdevelopment (i.e. poverty,

inequality and exploitation), and as a cause of underdevelopment. A reduced ability to produce, invest one's profit and increase productivity, contributes to increasing poverty, and can lead to desertification, drought, floods, and famine. On commercial farm lands, overstocking, mono-cropping, and the ploughing of marginal lands unsuitable for cultivation has led to soil erosion and desertification. Frequently these practices have been unwittingly encouraged by the state offering subsidies which made it profitable to exploit the land in the short-term (FAO 1999).

The agents of soil erosion are water, wind and human activities each contributing a significant amount of soil loss each year. Soil erosion may be a slow process that continues relatively unnoticed or it may occur at an alarming rate causing serious loss of top soil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damage networks. World Resources Institute, (1990).

In general background erosion removes soil at roughly the same rate as soil is formed. But accelerated soil erosion loss of soil at a much faster rate than it is formed is a far more recent problem. It is always a result of mankind unwise actions, such as overgrazing or unsuitable cultivation practices. These leave the land unprotected and vulnerable. Then during times of erosive rainfall or windstorms, soil may be detached, transported and (possibly traveling a long distance) deposited.

With growing population, the need for productive soils is increasing. Soil loss in many developing countries is a major cause for concern and will become a major issue in future. According to World Bank and United Nation Environmental Programme (1998) emphasizes that most of growth in worlds population is taking place in developing countries. Thus much pressure has been exerted on land resource due to increased population which has resulted into land degradation and soil erosion which is a serious problem throughout Africa.

1.1.2.3 Regional Perspective(East Africa)

Scoteny and Dijkhuis(1989) In the eastern parts of Mbale (areas around Mt. Rwenzori) the area is prone to soil erosion and other areas of southwestern Uganda especially the highland areas. They assert that the district has experienced demographic explosion that even encroaching the originally marginal lands like forests, wetlands and steep slopes and even over cultivation have become the order of Mbale district and Uganda as a whole.

1.1.2.4 Tanzania`s case

Ngorogoza I. (1967).Stressed that declining soil fertility due to inadequate farming practices, deforestation and overgrazing are among the primary impediments to increased agricultural productivity in Sub-Saharan Africa. These causal factors, driven by social, economic and political forces, manifest themselves in market, policy and institutional failures, inappropriate technologies and practices. This is also the case in Tanzania where over 90

percent of the population is rural and depends on land resources for its livelihood

Soil form in processes operates very slowly and the misuse or mismanagement of the soil lead to erosion or can disrupt the processes by which the soil forms. When this happens the resources are degraded or even lost. In Tema village Many human activities cause damage to soils; these include bad farming techniques, ignorance, overgrazing, deforestation, construction, mining, contamination, pollution and fires. The most critical result of these is Soil erosion.

1.2 STATEMENT OF THE PROBLEM

The problem of soil erosion in Tema village is influenced by factors such as rainfall, topography, vegetation destruction and increased population. Other factors include Ignorance, surface drainage, lack of information and inadequate extension services.

Tema village has been seriously affected by the problem of soil erosion for the past 20 years. As a consequence many problems have come up for example destruction of agriculture land, reduced yields, disruption of transport and reduced soil fertility. However up to now still there are no systematic studies that documents the extent, major causes and impact of soil erosion in Tema village.

In 1970s various methods of conserving the soil were introduced which include terracing and contouring but these are no longer effective because of poor management. Thus the importances of the study to provide or serve as a preliminary source of information that will enable understand the real local causes and consequences of soil erosion.

1.3 STUDY OBJECTIVES

1. To describe and the forms of soil erosion
2. To find out the causes of soil erosion
3. To describe the consequences of soil erosion
4. To find out soil conservation techniques used

1.4 RESEARCH QUESTIONS

- What are the forms of soil erosion?
- What are the major causes of soil erosion?
- What are the consequences of soil erosion?
- What are the conservation techniques used?

1.5 SCOPE AND PURPOSE

The scope of the research is based on the majorly the forms of soil erosion, causes and the consequences of soil erosion. The study covers the description and examination of forms of soil erosion its causes and consequences as well as measures put in place to control soil erosion in the study area.

The study is intended to suggest the appropriate measures and recommendation to control soil erosion in Tema village

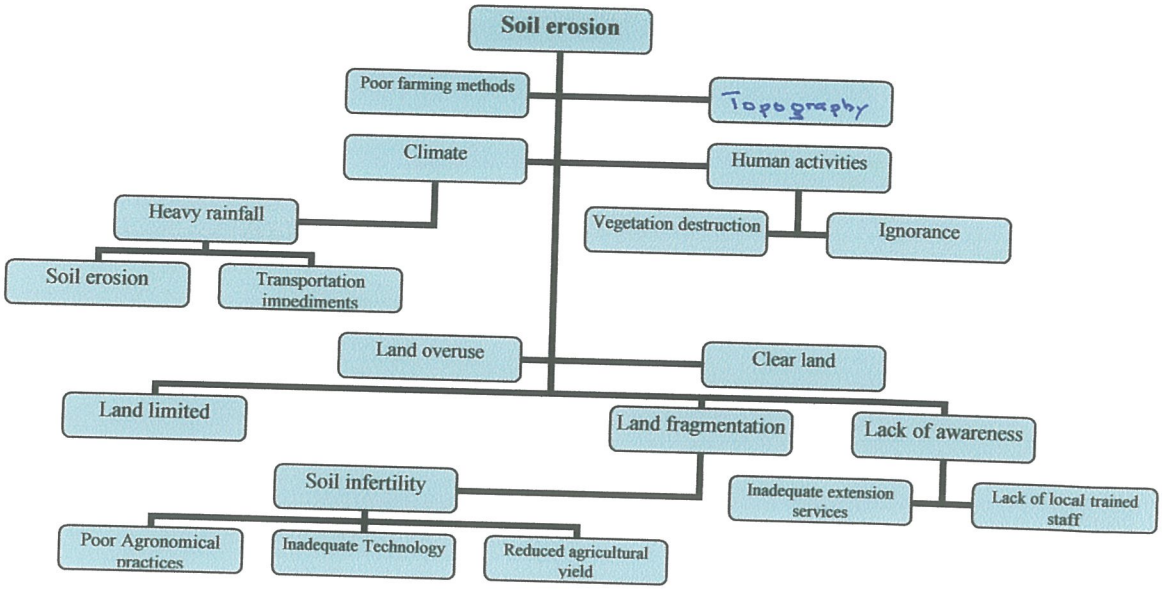
1.6 SIGNIFICANCE OF THE STUDY

The study will be useful in providing information of associated problems and single out conservation techniques appropriate to the problems.

It may provide data to be used in improving soil condition through the identification of forms of soil erosion, causes, impacts, conservation techniques and control measures.

The information may be useful as a center of reference for further research nationally and even in other countries with the similar environment in Africa. The information will be available for use by policy makers, academicians in policy development implementation and academic work respectively.

CONCEPTUAL MODEL



1.7.0 BACKGOUND OF THE STUDY AREA

1.7.1 AREA OF STUDY

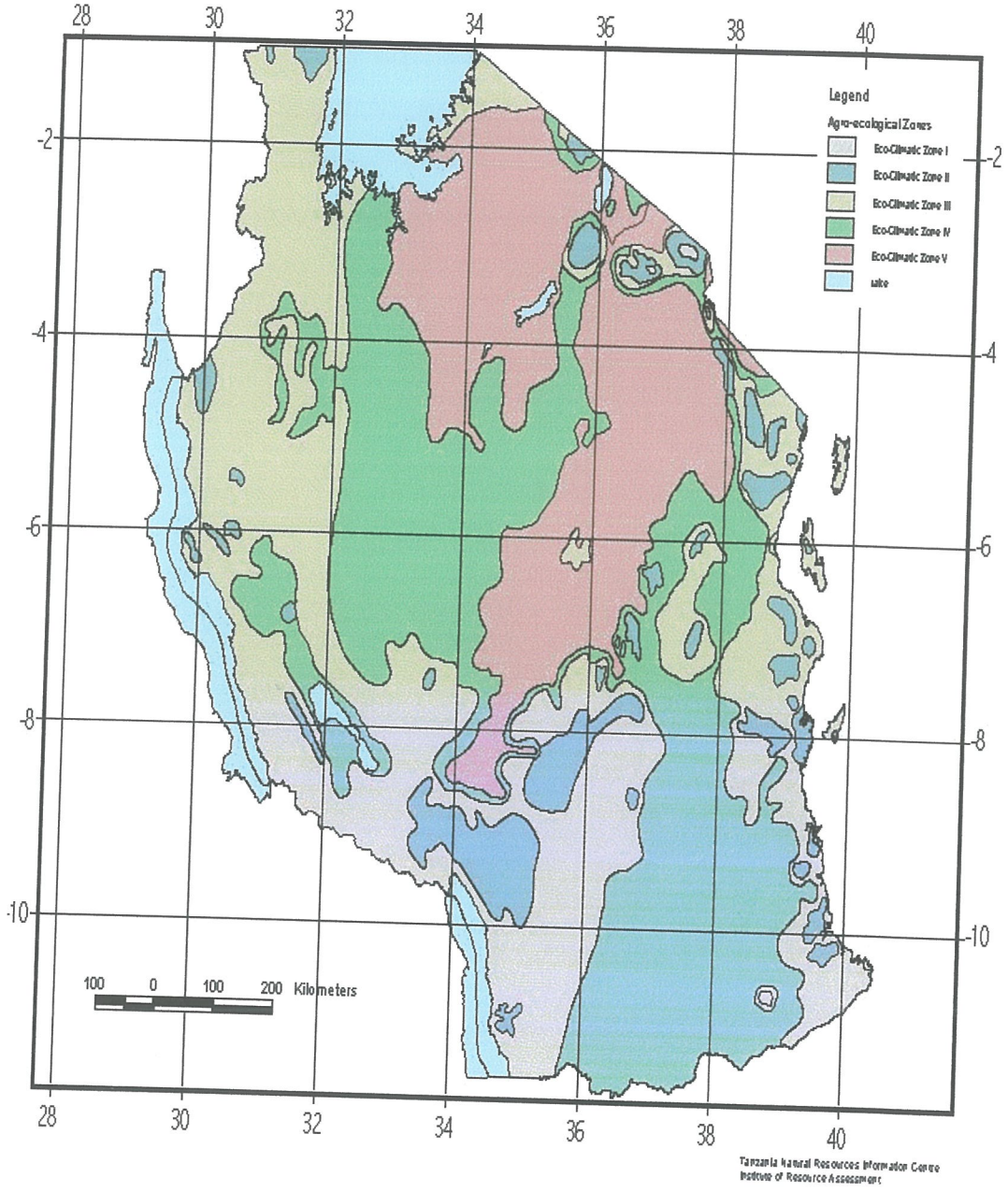
Tema Village is found in Mbokomu Ward, East Hai Division Moshi rural District in Kilimanjaro Tanzania.

1.8.2 GEOGRAPHICAL LOCATION

Tema village is located on the upper slope of Mount Kilimanjaro in Mbokomu Ward, East Hai Division. It is between 18 km away from Moshi municipality towards Mt Kilimanjaro in highland zone. It is found in Moshi rural district. The village borders with Msurunga River to the west and Msaranga River to the east. To the south it borders with Tella Village and Kilimanjaro forest reserve to the North. . It lies between 37° 15'– 37° 21' E longitude and 3° 03'– 3° 20' S.

1.7.3 CLIMATIC CONDITION

Map 1: Eco-climatic zones of Tanzania



[source: Tanzania National Resources Information Center 2003)

1.7.3.1 TEMPERATURE

Temperature of Moshi Rural District range between 12°C up to 27° C in the warm season

Table 02: Average Maximum/Minimum Temperature (Degree Centigrade

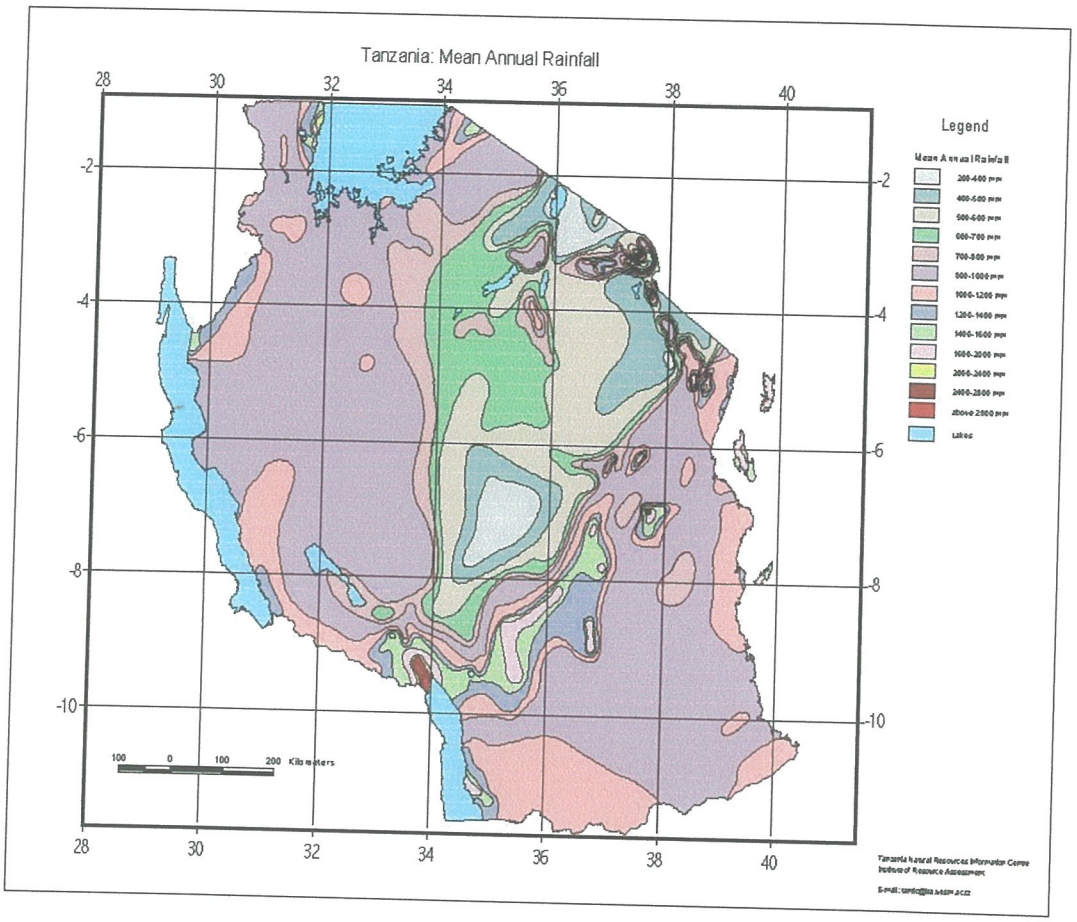
City Kilimanjaro	JANUARY	APRIL	JULY	OCTOBER
Maximum(°C)	28.1	25.2	21.8	27.2
Minimum(°C)	13.7	16.2	12.4	13.9

[source: Tanzania National Resources Information Center (2003)]

1.7.3.2 RAINFALL

Rainfall ranges between 750mm to annual rainfall of more than 1250mm. The climate regime is bio-modal type of rainfall with most of the rains falling between March through June while July and August experience a cool climate and September till November are the hot and dry seasons. Short rainy (Vuli) season is in November through January.

Map 2: Tanzania Mean Annual Rainfall



[source: Tanzania National Resources Information Center 2003]

1.7.4 RELIEF AND DRAINAGE

The relief of Mbokomu ward which is the landscape of the area is characterized largely by high hills, ridges with slopes of varied length, shape and steep cliffs.

The village is located for the greater part on volcanic slopes of very high relief at the slopes of Mount Kilimanjaro (5895 m asl). The altitude of the area is lying between 1500m asl to about 2000m asl.

1.7.5 POPULATION

The people who live on the slopes of Mount Kilimanjaro are collectively known as Chagga. There is no sign of indication of other ethnic group found in this area.

Tema village is densely populated with about 850 households and about 4036 people, and a population increase of about 1.2% (Office of the Chairman, Statistics 2004). In this Village population density is currently estimated at 500 to 800 persons per Km2 and the average land size is estimated to be 0.1 to 0.2 ha

1.7.6 VEGETATION

The vegetation of the study area basing on the classification of Selian Agriculture Research Institute Arusha (1994) is basically categorize vegetation types which can be identified in Tema Village:

- *Grevillea Robusta*
- *Camphor*
- *Ficus species*
- *Eucalyptus*
- *Cyprus*
- *Albezia species*
- *Raufolia cafra*
- *Mamarie*
- *Mengore*

- *Acacia*
- *Laquat*
- *Olea welwitchii*

1.7.7 SOCIAL SERVICES

With regards to social services, the villagers have very limited services. They have only two Primary Schools and one Secondary School for instance. The village has got two project financed by NGOs. The Tree Nursery Project, Financed by the Tanzania Environmental Action Association, (TEACA). This is involved in the establishment of Tree nurseries in Primary Schools in the village and in assisting individual farmers to start their own tree nurseries. Olimo Primary School is a live example. They have also Water Project which aiming at tapping water sources and directing water to the village for domestic use.

Accessibility to Tema village is through Pick-ups. The village can be accessed by road which is not tarmac and is connected to Old Moshi, Kiboriloni and Moshi Town

Communication by Telephone is also possible, the Ward can be reached on phone by Vodacom – Tz and Celtel – Tz. Radio Sauti ya Injili, Clouds Fm, Triple A Fm, Radio One, Radio Free Africa, Kiss Fm and Independent Television (ITV) signals are clearly received

1.7.8 ENERGY

With regard to energy it was learnt that in Tema Fuel wood is the major source of energy. It provides more than 90% of the energy requirements. It is mainly used for cooking. The use of Charcoal and paraffin is on the increase. Electricity is also available in the village since 1997.

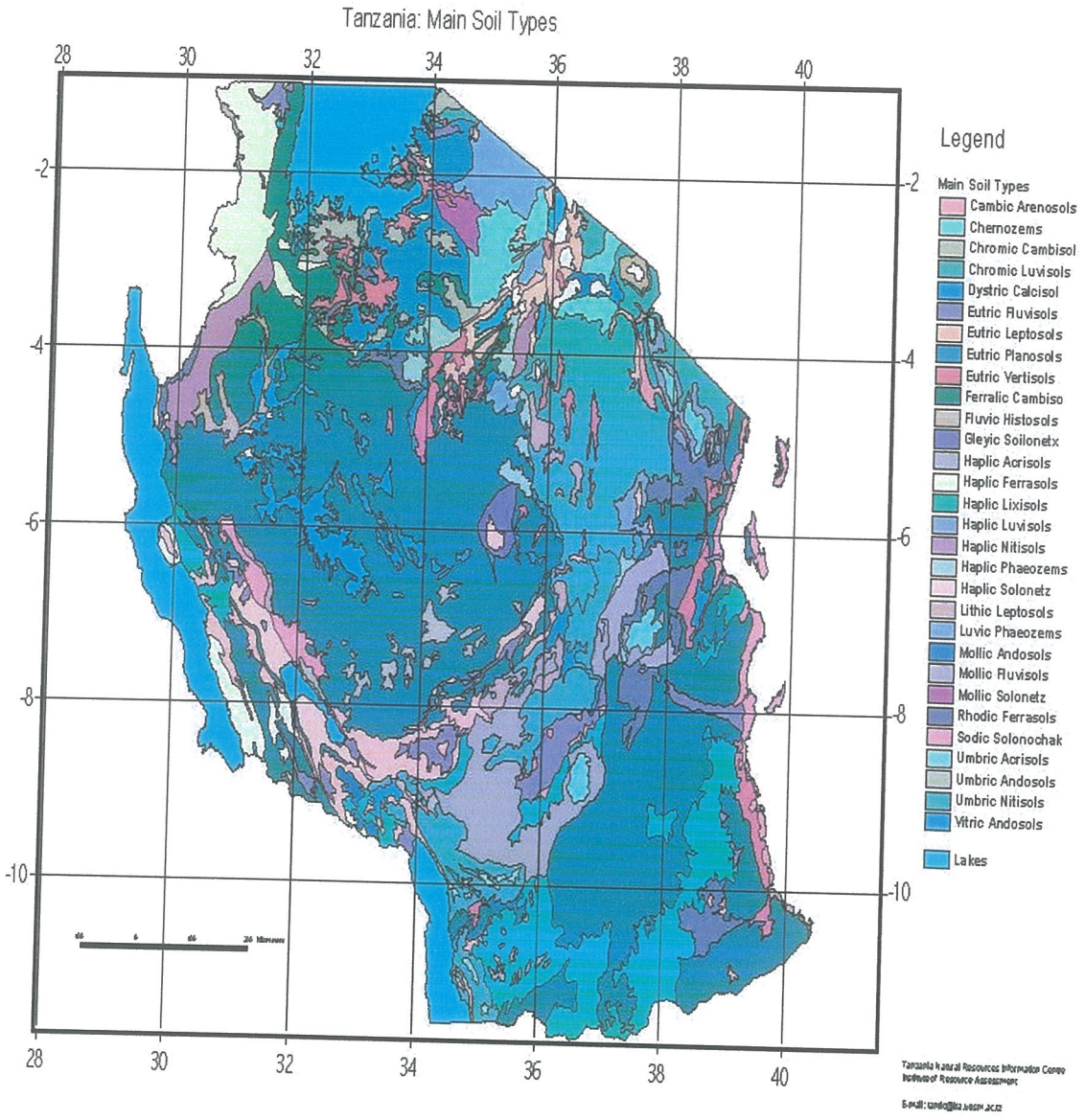
1.7.9 SOILS

The soils in Tema Village fall into four major groups [4]:

1. Humic nitosols and associated humic andosols.
2. Chromic cambisols and associated eutric cambisols.
3. Orchric andosols and associated chromic cambisols and vitricandosols
4. Mollic andosols and associated eutric nitosols. In general, these volcanic soils are fertile with a high base saturation and cation exchange capacity. A major limitation is the steep slopes which prevent mechanization and require substantial erosion control work. Other limitations include stoniness or a shallow petrocalcic horizon.

SOIL TYPES

Map 3: Soil map of Tanzania



[source: Tanzania National Resources Information Center 2003)

CHAPTER TWO

LITERATURE REVIEW

2.1 DEFINITIONS

Soil is naturally removed by the action of water or wind: such 'background' (or 'geological') soil erosion has been occurring for some 450 million years, since the first land plants formed the first soil. Even before this, natural processes moved loose rock, or regolith, off the Earth's surface, just as has happened on the planet Mars. David Mc Geary *et al* (1992)

In general, background erosion removes soil at roughly the same rate as soil is formed. But 'accelerated' soil erosion — loss of soil at a much faster rate than it is formed — is a far more recent problem. It is always a result of mankind's unwise actions, such as overgrazing or unsuitable cultivation practices. These leave the land unprotected and vulnerable. Then, during times of erosive rainfall or windstorms, soil may be detached, transported, and (possibly traveling a long distance) deposited

Norman. H, (1971) defines soil erosion as the mechanism by which soil particles are removed, transported and deposited some where else. The main agent being water and wind. Soil erosion can be geological that is normal erosion that goes on for a long time without being easily recognized. While accelerated soil erosion occurs swiftly when geological erosion has being subjected to man's activity and the result is non other than erosion rate exceeding soil formation.

2.2 FORMS OF SOIL EROSION

2.2.1 Introduction

Margon R.P.C (1986) identifies forms of soil erosion according to agents, Soil erosion by water which is the result of rain detaching and transporting vulnerable soil, rainsplash or indirectly by rill, sheet and gully erosion.

2.2.1 Erosion by Water

Water plays an important role in erosion by carrying away material that has been weathered and broken down. When an area receives more water (in the form of rain, melting snow, or ice) than the ground can absorb, the excess water flows to the lowest level, carrying loose material with it. Gentle slopes are subject to sheet and rill erosion, in which the runoff removes a thin layer of topsoil without leaving visible traces on the eroded surface. This erosion may be balanced by the formation of new soil. Often, however, especially in arid areas having little vegetation, the runoff leaves a pattern of gullies formed by rivulets. Blair T.A (1978)

2.2.1.1 Splash Erosion

Soil movement by rainfall (raindrop splash) is usually greatest and most noticeable during short-duration, high-intensity thunderstorms. Although the erosion caused by long-lasting and less-intense storms is not as spectacular or noticeable as that produced during thunderstorms, the amount of soil loss can be significant, especially when compounded over time. Runoff can occur whenever there is excess water on a slope that cannot be absorbed into the soil or trapped on the surface. The amount of runoff can be increased if infiltration is reduced due

to soil compaction, crusting or freezing. Runoff from the agricultural land may be greatest during spring months when the soils are usually saturated, snow is melting and vegetative cover is minimal. Shante H. *et al* (1973)

2.2.1.2 Sheet Erosion

Sheet Erosion the most common form of erosion. Unprotected soil particles are loosened by trampling, through wind erosion and by the impact of rainfall. The soil particles are then transported by rainwater surface flow to the river and stream systems. Sheet erosion is characterised by a general lowering of the soil level, leaving raised pedestals where the root mass of the remaining vegetation protects it. Kellogg C. E (1951)

2.2.1.3 Gully Erosion

Gully Erosion the most obvious and dramatic demonstration of erosion, although in most areas actually less significant in terms of total land degradation. Gully erosion rarely occurs without sheet erosion. The trigger for gully erosion can be the loss of vegetation in areas where the microtopography results in concentrated stream flow during the rains. They can also be triggered by erosion along livestock tracks, footpaths and road edges. The process can start with "rills" and end up with gullies that are tens of metres deep. Kellogg C. E (1951)

2.2.2 Erosion by wind

Wind erosion less common, but again takes place after vegetation has been lost and when soil particles are loosened. Early signs of wind erosion include deposition of sand particles around plants and micro-ripples on the surface of exposed areas. The final extreme is the classic sand desert dune structures. Ayres Q. C (1986)

2.3 CAUSES OF SOIL EROSION

2.3.1 Topography

Naturally, the steeper the slope of a field, the greater the amount of soil loss from erosion by water. Soil erosion by water also increases as the slope length increases due to the greater accumulation of runoff. Consolidation of small fields into larger ones often results in longer slope lengths with increased erosion potential, due to increased velocity of water which permits a greater degree of scouring (carrying capacity for sediment).According to Ngorogoza. P. (1967) observed areas of Umatengo hills in Tanzania, Kenya highlands, plus Kigezi highlands in Uganda as areas of severe soil erosion. He classified these areas basing on slope steepness, vegetation cover, management plus rainfall intensity.

According to CFSCDD, (1986) erosion has been identified in areas of highlands such as the Ethiopian highlands and Kolla in Ethiopia. It also indicates that areas which receive rainfall between 900mm and 1400mm like Cameroon highlands and Mozambique are prone to erosion. Other areas have been Libya dominated by wind erosion

According to Wilson (1959) it is steepness of the surface, which determines the rate of erosional process that takes place. Mountain and hill masses through having relatively steep slopes are naturally liable to erosional and mass movements. This process is a natural one and is influenced by the many other

factors like vegetation, climatic factors and man activities among others.

2.3.2 Rainfall

Hudson N. (1971) emphasizes that soil erosion is a result of rain erosivity, characteristics, topography, landuse and crop mismanagement. But these out lined causes can not wholly address the real situation in Tema village since they neglected the drainage pattern which brings about steam bank erosion.

Dasman (1983) propounded a theory of environmental parameters for mechanisms of earth movement occurrence that following the law of gravity, soil will move down hill when it is exposed to the mechanical impact of raindrops and hydraulic flowing water. It will do so regardless of our economic needs or political commands.

Mbokomu ward (the study area) is mountainous and hilly and receive high rainfall amount annually this could be enough reason why erosion is in this area.

2.3.3 Geological conditions

Legget (1967) notes that all types of erosion anywhere in the world are associated with the movement of materials as part of earths crust, movement caused by gravity and taking place because of some inherent instability in the arrangement of materials concerned. All types are dependant completely on the nature materials involved and on their relative arrangement. That is local geology at the site of the slide.

2.3.4 Vegetation destruction

Soil erosion potential is increased if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infiltrate. The erosion-reducing effectiveness of plant and/or residue covers depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to the surface and the most efficient in controlling soil (e.g. forests, permanent grasses). Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil.(Barber, R.G., (1995))

Bagoora (1988) indicate that due to favourable conditions such a cool temperatures relatively fertile soils and other social and historical factors, the highlands are densely populated. To population consists mainly of peasants dependent upon indigenous agriculture and pastoralism with little or no conservation practices. Extensive human activities related to agriculture, grazing, clearing of forests and excavation of roads deplete the cover, intensity accelerated soil erosion

This is soil erosion problem in Kondoa (Dodoma region) and Shinyanga where livestock keeping and encroachment of forest has been reported to be major causes. Soil erosion is also very common on steep slopes where there is vegetation clearing, intensive cultivation and poor land management practices

(Murray-rust, 1973; Kaihura, 1991; Lat, 1995 and Dejene, 1996).

2.4 IMPACTS OF SOIL EROSION

2.4.1 Productivity losses

Charles C. *et al* (1997) identify the on-site effects and off- site effects of soil erosion. He presents the on site effects as productivity losses and aesthetic losses. The off-site effects include the loss of water storage capacity caused by sedimentation, increased turbidity of water ways or eutrophication of lakes, damage to roads and maintenance.

2.4.2 Economic losses

UNESCO/ UNEP (1994), indicate that losses due to soil erosion range from productivity losses to increased costs of clearing disaster. These costs include loss of productivity of agricultural land, forest land and temporary closure of markets due to interruption of transport system.

Troeh F.R (1980) presents the impacts of soil erosion on physical environment like soil and water resources which he detailed as water pollution through sedimentation and development of ungraded topography, socio-economic factors which affect incomes of individual and government by either reducing it or enhancing it.

Scotney and Dijkhuis (1989) indicate that soil erosion affect other economic sectors such as energy and water supply. In continent where too many people are already malnourished, crop yields could be cut by half within 40 years if degradation of cultivated lands were to continue at present rates.

2.4.3 Decline in fertility

Oldeman (1994) indicates in South Africa soil erosion has increased the in-situ impacts like decline in fertility, soil losses alone are estimated to be as high as 400 million tones annually. Thus into soil compaction and desertification.

2.4.4 Sedmentation

UNEP (1994) argues that soil erosion rates increase which gives rise to sedimentation in water sources like rivers, lakes and oceans. There is accumulation of nutrient elements like nitrogen and Phosphorous which often lead eutrophication of water. Sediment which reaches streams or watercourses can accelerate ban erosion, clog drainage ditches and stream channels, silt in reservoirs, cover fish spawning grounds and reduce downstream water quality. Pesticides and fertilizers, frequently transported along with the eroding soil can contaminate or pollute downstream water sources and recreational areas. Because of the potential seriousness of some of the off-site impacts, the control of "non-point" pollution from agricultural land has become of increasing importance in Ontario

2.5 CONSERVATION MEASURES

2.5.1 Contours and Terraces

According to Bennett. H. (1939) describes methods of how soil erosion can be contained. These methods include use of

terraces and contours on high lands, use of dam to capture water.

According to Morgan P.R.C (1995) he put across the following practical methods as the way to curb the problem of soil erosion as contouring, bunds, terraces and water ways.

2.5.2 Agro-forestry

Hudson. N. (1971) suggest that soil erosion control can be dealt with via agro forestry, restoration of landslide shears, aforestation, restoration of pasture, embarkment as entire slopes, sand dunes restoration and restoration of recreational areas.

2.5.3 Surface Drainage

CFSCDD (1986) emphasis on Ethiopian highlands concentrated on developing and stabilizing water ways by constructing graded structure on slopes less than 15 percent gradient you can apply grass strip of soil which has good infiltration especially sand soil texture, cut off drain water towards next water way graded bunds and cut off drainage are needed to remove excess water run off during heavy storms.

CHAPTER THREE

METHODOLOGY

3.1 RESEARCH DESIGN

The research work followed a general survey research design in which the following variables were investigated, forms of soil erosion, causes of soil erosion, consequences of soil erosion and the conservation techniques used in the field area.

3.2 SAMPLING FRAMEWORK AND SAMPLE SIZE

3.2.1 Sampling Framework

Mbokomu ward has three administrative villages; in the north Tema (Korini Kaskazini village with 5 sub-villages), Korini Kusini Juu (with 4 sub-villages), and Korini Kusini to the south. Tema village (Korini kaskazini) is comprised of 5 sub-villages of Maiden, Tema, Foyeni, Kimambony, and Mwika. In all those villages Tema was purposely selected for the research work because is where erosion occurred mostly and it is the most affected village in the whole ward.

3.2.2 Sample Size

The sample population was selected using purposive and random sampling. Purposive and random sampling was selected purposefully to include those who appear to have adequate information about erosion. The study comprised of

community members between the ages of 17 to 65 years from different households. It included executive officers of village government, sub-village and members of social groups and local organisation/ associations.

Table 3 : Respondents by method of interview

Type of Respondent	Number interviewed
Local council leaders	5
Heads of household/ farmers	70
Teachers	5
Students	6
TEACA members	10
Total number	**96**

3.3 METHODS OF DATA COLLECTION

Data was collected from both primaries and secondary sources. The various methods that were used include interview, Observation, Questionnaires, Documentation and Photography.

3.3.1 Interview

Interviews were conducted in Swahili language which was more understood by Tanzanians and the first National language. The purpose of this was to improve on the data validity and acquire information about the history of soil erosion in this area. The social-economic or well as the social culture. Also information such as people's attitude towards soil conservation techniques was got from the respondence through interviews

3.3.2 Observation

Observation was widely used to visualize sight especially on the forms of soil erosion, inputs of soil erosion by its indicators, land use plus the practical conservation techniques in place to control soil erosion problem.

3.3.3 Questionnaire

A logically designed set of questions was used to investigate the forms, causes, and impact of soil erosion on the upper slopes of Mount Kilimanjaro, with specific reference to Tema village. They were designed on the following variables; forms, causes, impact, and control measure and recommendation.

3.3.4 Documentation

Apart from observation and interviews data sources by use of documentation was used. The purpose of this was to get information on existing population density, distribution, population and erosion as well as recorded climatic data, geology and soil relief and drainage and examine soil erosion problem.

3.3.5 Photography.

This provided rich detail about several features like forms of soil erosion, the landscape and effects of soil erosion like destruction of agricultural land.

3.4 ETHINICAL CONSIDERATION

Before the study permission was sought from the chairman, executive officers and village government. At household level permission was also sought. The purpose of the study was explained to the concerned person at all levels. An introduction letter from Kampala International University served as the initial information to supporting organization

3.5 LIMITATION OF THE STUDY

3.5.1 Topography

The area of study (Tema village) is hilly and mountainous and most areas are difficult to reach. This hampered easy collection of data and reaching the respondents in time

3.5.2 Weather

The research study conducted between the months of February and March and yet the area of study begins to receive heavy rainfall amounts in the same period of the year. There were difficulties in reaching some respondents in time. Also it didn't allow the researcher to spend enough time with the respondents as expected.

3.5.3 Financial constraints

Some of the respondents demanded for money in order to allow audience to the researcher, there was also lack of fund to process all requirements

CHAPTER FOUR

PRESENTATON AND DISCUSSION OF RESEARCH FINDINGS.

4.1 INTRODUTION:

In this chapter there is presentation and analysis of the forms of soil erosion, causes and impact and conservation measures in Tema village, Mbokomu ward. The villagers noted that soil erosion has increased in the area since 1980s. This situation has been evidenced by a group of farmers mostly women who since 1989 have formed a group of women farmers under the name "UWANGOMA" whose main objective is to conserve soil through construction of terraces and planting of fodder trees and grasses for their cattle. They also observed that construction of contours was introduced in 1960's but has gone down since then due to neglect.

4.2 FORMS OF SOIL EROSION IN TEMA VILLAGE

In this area the forms of soil erosion include splash erosion, Sheet erosion, rill erosion and gull erosion.
In order to understand this, the following research question was designed.

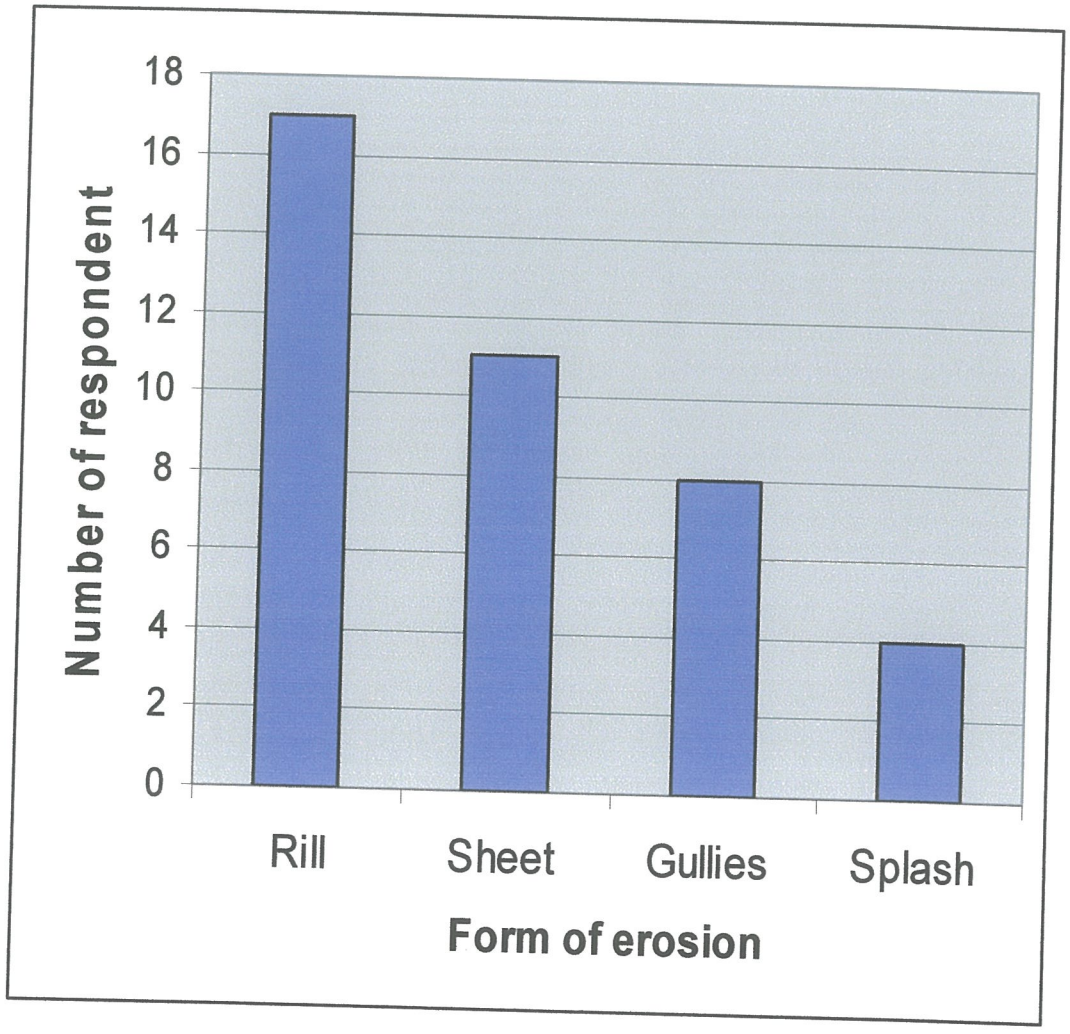
Research question **1:** What are the forms of soil erosion in Tema village?
The different forms of soil erosion are presented in table 3 below;

Table 4: Forms of soil erosion in Tema village

Forms of Soil erosion	Number of respondents	Ranks
Rill erosion	17	1
Sheet erosion	11	2
Gullies erosion	8	3
Splash erosion	4	4
Total	**40**	

Source: From the field by the researcher.

Figure 1: Form of Soil Erosion in Tema Village



Source; Derived from Table 4

In general the most dominant form of soil erosion is Rill erosion (42.5%). Others are Sheet erosion (27.5%), Gullies (20%) and Splash erosion (10%)

4.2.1 Splash Erosion

From the research findings splash erosion was identified by the researcher, splash erosion mainly occurs when rain drops fall on to bare soil surface. This is mostly effective in mid March and April when the rain falls with sufficient intensity. So as the rain drops hit bare soil is able to detach and move soil particles.

4.2.2 Sheet and Rill Erosion

Sheet erosion and rill erosion were noticed by the researcher. Sheet erosion is soil movement from raindrop splash resulting in the breakdown of soil surface structure and surface runoff. In Tema village it occurs rather uniformly on wide area over the slope especially in cultivated areas and may go unnoticed until most of the productive top soil has been lost. Erosion happens mostly in a cultivated field from which crops have been harvested; the soil is often left bare, without protection from the elements, particularly water. Raindrops smash into the soil, dislodging soil particles. Water then carries these particles away. This movement takes the form of broad overland flows known as sheet erosion. Rill erosion was also discovered to exist in this field area. It was noticed that rill erosion results when surface run-off concentrates forming small channels.

Plate 01; Sheet erosion on slopes

Source: taken from the field by the researcher

4.2.3 Gully Erosion

There are few farms in Tema village that are losing large quantities of soil. It was noted that surface run-off causing gull formation is usually the result of improper outlet design for local surface and sub surface draining system. This is very evident in the foreground to middle ground of the photograph below. If such gullies are not checked the area will develop into bad land.

Plate 02; Rills and Gullies erosion

Source : Photo taken by researcher from the field

4.3 CAUSES OF SOIL EROSION IN TEMA VILLAGE.

4.3.1 INTRODUCTION

In Tema village, soil erosion is attributed to causes such as rainfall, relief, vegetation destruction, poor farming methods, Ignorance, and land fragmentation. In order to understand this the following research question was postulated.

Research question 2: What are the causes of soil erosion in Tema Village?

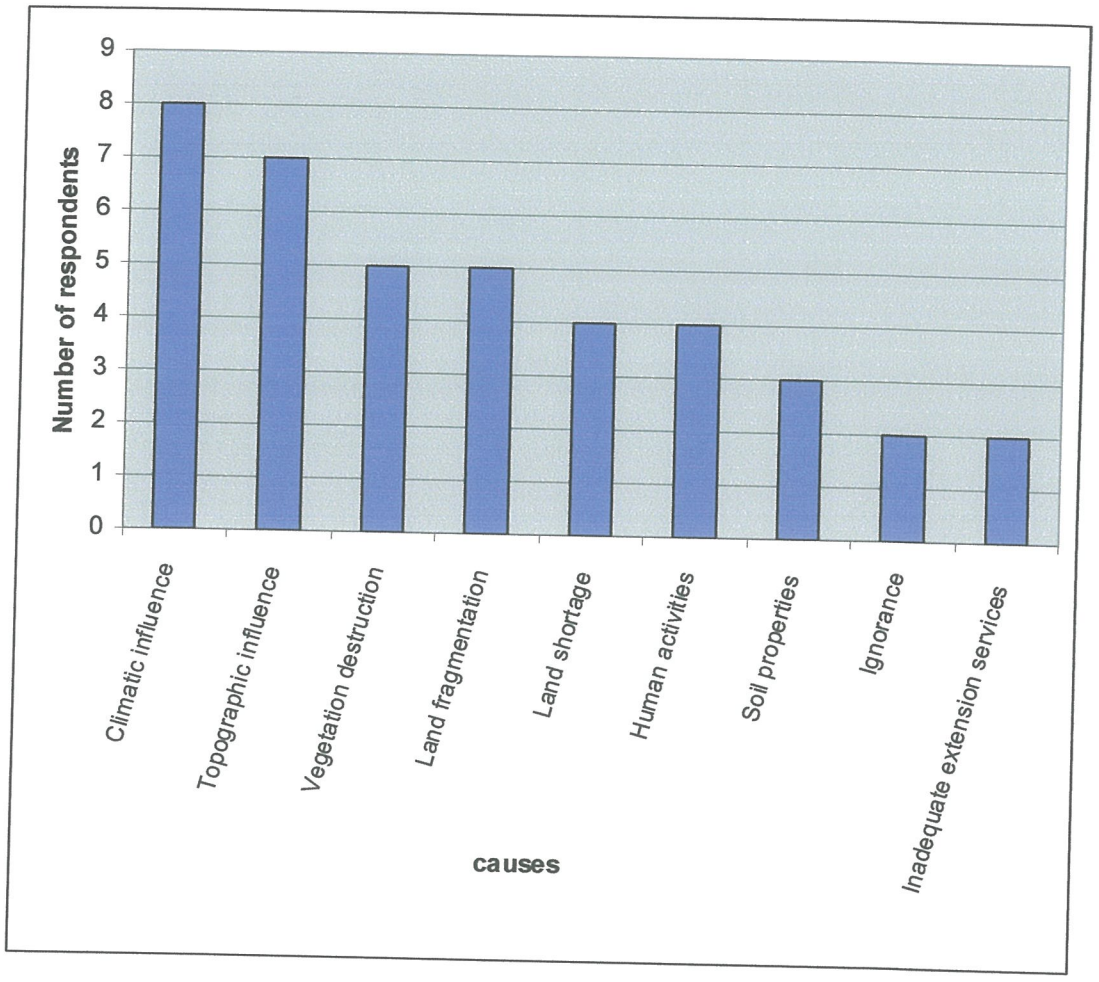
The information is presented in table 4 below;

Table 5 : The causes of soil erosion in Tema village

Causes	Number of respondents	Ranks
Climatic influence	8	1
Topographic influence	7	2
Vegetation destruction	5	3
Land fragmentation	5	3
Land shortage	4	4
Human activities	4	4
Soil properties	3	5
Ignorance	2	6
Inadequate extension services	2	6
Total	**40**	

Source: Data from the field by the researcher

Figure 2 : The causes of soil erosion in Tema village



Source: Derived from the table

During the research it was found out three agents of soil erosion as were pointed out by farmers during interviewing in Tema village. It was found out that water is the major agent of soil erosion since 24 respondents out of 40 pointed out. Also human activities was also pointed out as agent of soil erosion by 12 respondents out of 40 while 2 respondents pointed out wind as another agent of soil erosion.

Table 6 : Agents of soil erosion in Tema Village

Agents	Number of respondents	Percentage
Water	24	60
Human activities	12	30
Wind	4	10
Total	**40**	**100**

Source: Data from the field by researcher

4.3.2 Climatic factors

It was discovered that soil erosion in Tema village is influenced by climatic factors. In this climatic behaviour is the dominant factor for causes of soil erosion. These include mainly the rainfall amounts and intensity plus the temperature fluctuations. It calls for rampant erosion rater that has soil bare prone to wind erosion in dry season. Tema village receives an annual rainfall of about 1250 mm and above. Due to this it leads to over loading of the slope and weakening the strength of the soil top layer which cause the top layer to be eroded easily

4.3.3 Topography.

The factor of Topography which is the function of steepness of the slope, deep valleys, landscape and ridges, slope length are fundamental especially when disorganized by man in attempt to sustain his survival

without knowledge of the environment and in particular soil erosion in Tema village.

The mountain slopes of Tema village are relatively high ranging from 1500m asl.to about 2000m asl. The length of the slope is worth in accelerating run-off because of large exposed areas of erosion agents likewise with shorter profile that does not allow soil erosion intensity. In further analysis of the relationship between relief and soil erosion occurrence it was observed that the upper slope is more eroded compared to the lower level.

Plate 03; soil erosion on steep slopes

Source; From the field by researcher

4.3.4 Soil properties

The reddish in colour of these volcanic soils is associated with inherent resistance to erosion due to high cohesiveness and hence high shear strength. It was found that the soils of Tema village are reddish in colour and were found to be weak and loose and therefore susceptible to erosion, this is supported by Brown and others(1964) who states that the reddish clay loams soils are characterized by weak, weathered and incompetent layers which are mainly clay texture and highly plastic when wet.

4.3.5 Vegetation destruction

It was found out in Tema village that as population increase there is increase in standards of living calling for further cultivation to meet demands and increased needs in land and soil related products such as firewood and food. This leads to destruction of vegetation which normally reduces the capacity of soil to resist erosion. Vegetation in Tema village is usually destroyed for different reasons which include easy cultivation and fresh grasses for animals.

The destruction of vegetation normally reduces the capacity of soil to resist erosion. In the photo below the area devoid of vegetation in the fore ground has been badly eroded. This would become unproduction land if not protected

Plate 04; Vegetation destruction

Source; Photo by researcher from the field

4.3.8 Land fragmentation

It was found out that land fragmentation is one of the causes of soil erosion. Soil erosion is being coursed by the division of pieces of land the farmers have among sons over fixed land they have. Land ownership in Tema village is on an inheritance basis from farther to sons, thus land segmentation has gone to the extent that an individual can own a piece of land the size of 0.4 ha – 1.0 ha for cultivation and other uses such as building and for grazing because farmers keep dairy cattle, goats and sheep under zero grazing, and in an attempt to sustain on the very small piece of land are continuously cultivated which leads to soil erosion.

4.3.9 Poor farming methods

The poor farming methods of cultivation liken over-cultivation, monocropping and in fallow periods, lead to loosening of soil particles. It was discovered during the study that poor cropping and digging practices such as up and down digging on slope leads to the development of rills and gullies running longitudinally the slopes which is taken advantage of by run off to influence erosion.

Plate 05; Poor methods of farming

Source; From the field by the researcher

4.3.10 Inadequate extension services

With regards to agriculture / livestock personnel services the villagers have very limited services. The villagers have

only one agricultural personnel who is almost non-existent at-least in practice. The villagers pointed out that agricultural staff has no office in the village and he is from Mande village 10km away from Tema village, and they do not actually know the exact work of this officer.

According to some of the farmers even when the agricultural officer is present in the village he is not often listened to because he is a young person and the elderly people in the village are suspicious of advice given by the youth and those comes out of the village.

4.4 CONSEQUENCES OF SOIL EROSION ON THE ENVIRONMENT

4.4.1.INTRODUCTION

In Tema village the impact of soil erosion range from individual to community effects from on-side impacts to off-site impacts socio-economic to environmental impacts and are either direct or indirect in nature. These impacts include reduced soil fertility, decline in crop production, rill, sheet and gullies and interruption of transport and communication.

In order to understand the above following question was postulated.

Research question **3:** What are the consequences of soil erosion in Tema village?

Table 7: On-site impacts of Soil Erosion

Types	Number of respondents	Percentage
Reduced soil fertility	22	62.9
Sheet, Rills & gullies	13	37.1
Total	**35**	**100**

Source : Data from the field by the researcher

Table 8 : Off-site impacts of soil erosion

Types	Number of respondents	Percentage
Flourishing crops in low land	25	71.4
Trapped soils in collecting water basin	10	28.6
Total	**35**	**100**

Source : Data from the field by the researcher

From the tables above it was noted that the on-site impacts are negatively affecting and the off-site impacts are positively affecting the natural environment and the socio-economic life of the people.

It was found out that due to the reduced of the fertility of the soil it leads to the decline of the crop production which result in low incomes because farmers depends on

agriculture 99% of their income comes from farm production

On-Site Effects: The implications of soil erosion extend beyond the removal of valuable topsoil. Crop emergence, growth and yield are directly affected through the loss of natural nutrients and applied fertilizers with the soil. Seeds and plants can be disturbed or completely removed from the eroded site. Organic matter from the soil, residues and any applied manure is relatively light-weight and can be readily transported off the field, particularly during long rain season. Pesticides may also be carried off the site with the eroded soil.

Off-Site Effects: Off-site impacts of soil erosion are not always as apparent as the on-site effects. Eroded soil, deposited down slope can inhibit or delay the emergence of seeds, bury small seedling and necessitate replanting in the affected areas. Sediment can be deposited on down slope properties and can contribute to road damage.

4.4.2 Reduced soil fertility

It was discovered that due to erosion especially by water (Rainfall) between March and June particularly in April, farmers are facing a problem of food shortages due to loss of soil fertility. Due to loss of soil fertility most food supplies reduced both qualitative and quantitatively. Loss of the top layer of the soil was evidenced by the researcher when it was raining half of the bucket of the

run-off water collected was mud. The upper part is mostly affected and the top fertility soil ends up in low land areas.

4.4.3 Decline in crop production

During the research farmers pointed out that decline in crop production got season after season. Most of the farmers attribute this decline in crop production to the loss of the top most productive soils. Crop production declined both in quality and quantity. Various crops and agricultural products were declined significantly and most agricultural land rendered useless with no or reduced real values.

Plate 06; Decline in Crop production

Source ; Photo by researcher from the field

Due to erosion and loss of crops, the respondents say that they were facing problem of food shortage in the area. Food supplies reduced both qualitative and quantitatively.

4.4.4 Impacts on Communication and transport

There is only one road which connects the entire village and other places. It is about 14 km up in the middle zone from the minor settlements of Kiboriloni town and 18 km away from Moshi Municipality. Unfortunately traverses Mbokomu ward is most affected by soil erosion. When it rains the access of using this is very difficulty and sometimes is out of use temporarily. This is mostly affected trade, social services delivery and many other aspects of life. Alternative route (Old Moshi Road) takes a long time to connect to other areas, making transport and communication difficult.

Plate 07 ; Impact on road

Source; Photo by researcher from the field

4.5 SOIL CONSERVATION TECHNIQUES USED IN TEMA VILLAGE

4.5.1 INTRODUCTION

There are few signs of soil control measures undertaken. Several farmers have realized how land has been washed away by rain water to the rivers downstream and are now taking appropriate measures by constructing terraces to curb the situation. This situation has been evidenced by formed a group of farmers mostly women who since 1989 have formed a group under the name "UWANGOMA" whose main objective is to conserve soil through construction of terraces and planting of fodder trees and grasses for their cattle. The group also advocates proper use of Farm yard Manure to improve soil structure and nutrient source for their crops.

In order to understand the above, the following research question was postulated;

Research question 4: What are the conservation techniques used in Tema village?

4.5.2 Conservation Techniques

It was learnt that in Tema village there are different types of techniques used in conserving the soil. These conservation techniques can be grouped as physical techniques, biological techniques and chemical techniques.

4.5.2.1 Physical techniques

The physical conservation of the soil basically used in Tema village do reduce the run-off and percolation goes deep. These techniques include terracing and contouring which was introduced in 1970s but has gone down since then due to neglect.

In 1989 farmers formed a group in order to conserve soil. This is mainly done by first educating group members on how to construct terraces and contours and then the entire village. Unfortunately this campaign has not succeed much due to neglect, laziness, alcoholism, lack of contour expert, an expert on catchments conservation and agricultural extension worker

4.5.2.2 Biological techniques

It was also learnt that biological conservation technique is used. These conservation techniques include crops intercropping, mulching, agro-forestry and animal manure from cattle on zero grazing.

It was discovered that most of the crops are intercropped with a multi-storyed system, expect for a few fields of monocropped maize. Major crops grown include coffee, bananas, maize, sweet and Irish potatoes, yams and a variety of vegetables. And this mixed cropping helps in reduces soil erosion rates.

Agro-forestry is practiced where trees are grown for quite a number of uses i.e. shade for coffee fuel wood, timber and for fruits. Trees planted include avocadoes, camphor, Albizia, Ficus species, Mudi, Mashishina and Calliandra.

There is also a local NGO called TEACA which involved in the establishment of tree nurseries in Primary Schools and in assisting individual farmers to start their own tree nurseries by providing them with different tree species. A live example is in Olimo Primary School

Mulching is practiced in Tema village where by loose material such as crop residues, dry grasses, dry leaves dust, old compost and manure are placed on the top of soil to protect the soil from over drying and control soil temperature plus controlling soil loss down the slope.

4.5.2.3 Chemical techniques

It was further learnt that chemical conservation techniques being used. This is mainly used in pest management by spraying coffee, tomatoes, mixing of beans and maize which ends up killing pests such as maize weevils and beans weavils

CHAPTER FIVE

5.0 CONLUSION AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Forms of soil erosion

Soil erosion in Tema village is severe and various forms of soil erosion were observed to exist in the village. The dominant form of soil erosion in Tema Village is Rill erosion (42.5%). Other forms of soil erosion are; Sheet erosion (27.5%), Gull erosion (20%) and Splash erosion (10%).

5.1.2 Causes of Soil Erosion

It was perceived in the village that there are different factors leading to soil erosion. These factors have been grouped into two categories, which are physical or natural causes and those influenced by human activities. Human causes include vegetation destruction, poor farming methods, land fragmentation, over cultivation and ignorance. Physical causes include Topography, Climatic condition, drainage and geology and soils. However the dominant cause of soil erosion in Mbokomu Ward is Water (Rainfall).

5.1.3 Consequences of Soil Erosion

Soil erosion in Tema village has resulted in severe degradation of the resource base including soil, water, forests and biological diversity. These affects of soil erosion on the environment range from physical, social to economic effects. The physical effects include soil physical degradation, formation of rills and gullies, loss of soil fertility and reduced agriculture productivity. The social affect include hunger due to shortage of food, and interruption of transport and communication. The economic effects include reduced supply of food, increased in food prices and reduced farmers' income.

5.1.4 Control Measures

There are few signs of soil control measures under taken in Tema village. The local people in this village have no time for activities like cultivation, soil and water conservation and tree planting especially the youth.

However there are some conservation techniques used which are physical and biological techniques. Physical conservation techniques include contouring and terracing and draining channels which was introduced in 1960s but has gone down since then due to neglect. Biological soil conservation techniques include Agro forestry, use of animal manure from zero grazing and mixed cropping.

A local Non-Government Organisation TEACA reported that they are experiencing difficulties in promoting tree

planting in the area. However according to the chairman of TEACA Mr. A Mcharo TEACA has succeeded in some extent and the live example is Olimo Primary School were they have started tree nurseries.

5.2.0 Recommendations

5.2.1 Aforestation and re-aforestation

Undertake massive aforestation and re-aforestation campaigns especially on affected slopes. This is because the research has discovered that soil erosion are not common under forest land use as compared to any other land use form. Such practices could help in increasing the shear resistance since root reinforced slope surface are more stable, the root network provide mechanical support to the soil, provide both lateral reinforcement , deep rooted trees grow down through the potential failure zone into the underlying soil.

5.2.2 Education and Training of Local Communities

The local people should make aware of their contribution towards soil erosion problem. They should be educated on elements such as reduction on land over use and burning of vegetation, minimizing overstocking and need for family planning to reduce land fragmentation. This could reduce soil erosion through building experience and judgment among people. Education and awareness should therefore be geared at promoting and improving the farmers' technical knowledge of tree planting and soil conservation methods through extension work and education

5.2.3 Crop and Residue Cover

To prevent exposure of bare soil, farmers can use techniques such as leaving crop residue in the soil after harvesting or planting temporary growths, such as grasses, to protect the soil from rain between crop-growing seasons. Farmers can also control water runoff by planting crops along the slope of a hill (on the contour) instead of in rows that go up and down. Farmers should be educated on the benefits of growing the appropriate crops on specific soils is important. Crops help reduce the erosive forces of water and wind by means of their canopy intercepting rain, and acting as a windbreak. Root systems stabilize the soil and reduce losses. Crop residues perform similar functions and, in addition, form small dams that help retain runoff water, thereby reducing erosion.

5.2.4 Crop Rotations

Fallow land has the highest erosion potential in any cropping system. Row crops such as maize or beans reduce this potential by half, which is still considered to be excessive. Sod crops such as hay and permanent pasture keep soil erosion to a minimum and should, therefore, be used in rotation with other crops where erosion is a problem. Compared to continuous maize, hay or pasture crops reduce soil loss. A rotation involving row crops and grain crops, while not as effective as a sod-based rotation, may reduce soil losses much compared to continuous row crops.

5.2.5 Tillage Practices

Farmers may employ proper tillage practices separately or in combination with crop rotations, this can be very effective in reducing soil erosion losses. Compared to conventional fall plowing, a mulch tiller used in the fall can reduce soil loss by erosion. On steep slopes, planting can be done without any previous tillage or following discing only. Soil losses can be reduced by practicing the methods of tillage practice of leaving the soil surface in a rough condition, and, where practical, protected with crop residues. These conditions facilitate easier infiltration of water by slowing surface water runoff, and minimize soil erosion.

5.2.6 Contour and Strip Cropping

Strip cropping alternate elephant grasses and hay strips is an erosion control measure that can be used on long, smooth slopes where forages are part of the rotation. Strip cropping across the slope can reduce soil losses when compared to up-down slope cropping. Contour strip cropping will reduce soil losses even further. Strip cropping, ideally, involves alternating strips of forage and a row crop on the contour. In situations where forage is not being grown, cereal crops are a reasonable substitute to be alternated with maize or soybeans

5.2.7 Surface drainage

When surface water concentrates, rills develop. If these rills are not addressed with appropriate control practices, a gully may result. Water runoff may continue to be a problem on some areas even after conservation tillage and cropping practices are followed. A properly constructed and maintained waterway with good vegetative cover can be a practical way to prevent this type of water erosion. Waterways must have a shallow, saucer-shaped cross-section and an erosion-resistant vegetative cover to carry water safely.

5.2.8 Terracing and contour plowing

Soil conservation involves reforming agricultural soil management methods. Some of the most effective methods include strip-cropping, alternating strips of crop and uncultivated land to minimize erosion and water runoff; contour farming, planting crops along the contours of sloping lands to minimize erosion and runoff; terracing, which also reduces erosion and runoff on slopes; growing legumes, such as clover or soybeans, to restore essential nitrogen in the soil and minimizing tillage, or plowing, to reduce erosion.

5.2.9 Rational landuse planning and management

Management measures aimed at protecting the environment in general and the geo environment especially from soil erosion must be firmly grounded in rational land use principles. Rational land use means

apportioning available areas among several different types of economic endeavor in such a way as to achieve the benefit ratio with due allowance for the cost of instituting all appropriate environmental protection measures.

5.2.10 Legislation

Policy actions that are aimed at preventing and regulating expansion of human population and human activities like destruction of vegetation, cultivations and constructions on the steeper zones or wherever instability is expected. This will however require that any works by man must first be approved before commencement. This helps in regulating unwise use of land especially steep slopes prone to soil erosion and this should be based on past experience by involving geological, hill slope conditions and other major factors contributing to soil erosion.

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KAMPALA INTERNATIONAL UNIVERSITY

ENVIRONMENTAL DEPARTMENT

RESEARCH TOPIC:

THE CAUSES AND IMPACT OF SOIL EROSION ON THE UPPER SLOPES OF MOUNT KILIMANJARO: A CASE STUDY OF TEMA VILLAGE, MBOKOMU WARD MOSHI RURAL DISTRICT.

RESEARCH QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

Name .....

Age.....

Name of village .....

Occupation .....

Marital status .....

Level of Education .....

SECTION B: CAUSES OF SOIL EROSION

What activities do you carry out on your land?

i. .....

ii. .....

iii. .....

iv. .....

For how long have you carried out those activities?

.....

.....

How do you carry out your activities?

.....

.....

.....

Location of activities (Field)

In the valley [ ]

On the slopes [ ]

Do you experience erosion on your land?

Yes

No

If yes could you attribute them to your activities?

Yes

No

If yes explain how?

.....

.....

.....

Other than the above what do you think causes soil erosion?

.....

.....

.....

.....

How do other people's activities cause soil erosion?

.....

.....

.....

.....

For how long have you experienced the above problem?

.....

.....

SECTION C: IMPACTS OF SOIL EROSION

Do you think soil erosion affect your farms?

Yes

No

How are other people's farms affected by soil erosion?

.....

.....

.....

What other problems are faced in this village due to soil erosion?

.....

.....

.....

.....

How does the problem of soil erosion affect the availability of these resources?

Soil productivity.....

Water quality .....

Crop production.....

Others, (specify)....., ...,

.....

SECTION D: RECOMMENDATIONS.

Do you think soil erosion problem can be solved?

Yes

No

a) If yes explain

.....

b) If No why

.....

Of the above what are you practicing on your land?

.....

.....

What are others doing to minimize the above problem on their land?

.....

.....

.....

In your opinion, what other possible measure would you suggest to solve the problem soil erosion?

.....

.....

.....

.....

KAMPALA
INTERNATIONAL
UNIVERSITY
EXPLORING THE HEIGHTS

Ggaba Road, Kansanga * PO BOX 20000 Kampala, Uganda
Tel: +256 (0) 41 - 266 813 * Fax: +256 (0) 41 - 501 974
E-mail: admin@kiu.ac.ug * Website: http://www.kiu.ac.ug

Faculty of Social Sciences and Law

To: WHOM IT MAY CONCERN

MOSHI RURAL DISTRICT

This is to introduce to you Mr. /~~Miss~~ BARAKA BERNARD who is a bona fide student of Kampala International University, He/She is working on a research project, which is a partial requirement for the award of a degree.

I hereby kindly request you in the name of the University to accord him/her all the necessary assistance required for this work.

Thank you very much in advance.

Prof. A.G.G. Gingyera-Pinycwa
DEAN FACULTY OF SOCIAL SCIENCES AND LAW

KAMPALA INTERNATIONAL UNIVERSITY
FACULTY OF SOCIAL SCIENCES AND LAW
P.O. BOX 20000, KAMPALA