IMPACT OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES ON FLOOD RISK REDUCTION IN WESTERN REGION, KENYA

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A Research thesis submitted in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Disaster Management and Sustainable Development of Masinde Muliro University of Science and Technology

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DECLARATION

This thesis is my original work and has not been presented in any other university or institution for a degree or any other award.

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CERTIFICATION

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DEDICATION

I dedicate this work to my husband Dan Buyela, family, my parents, my brothers and sisters who were my inspiration, my mother Pauline, daughter Serena, Venus and son Joel who kept on encouraging and praying for me and for their understanding and enduring my absence during my coursework and while writing this thesis.

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ABSTRACT

In the recent past there has been dramatic increase in frequency and intensity of floods all over the world, both in developed and developing nations due to climate change. Crops, settlements and infrastructure have been destroyed wherever flooding occurs. But Sustainable Land Management Technologies (SLMT) is the cornerstone of formalized action for reducing such natural hazards. However, the adoption level of the technology still very low creating a gap between adoption of the technology and flood risk reduction. The severity of damage as a result of floods has been documented to have a relationship with the land management technologies. Overuse on the Land resource has been increasing and limited capacity to practice Sustainable Land Management Technologies has led to land degradation and thus enhancing flood risk in Western region of Kenya. The overall objective of this study was to examine the impact of Sustainable Land Management Technologies on flood risk in Western region Kenya. To achieve this overall objective, three specific objectives were pursued. Firstly, the study determined the type and extent of the existing Sustainable Land Management Technologies prevalent in the study area. The second specific objective was to examine the prevalence of flood risk by farmers in Western region, Kenya and lastly evaluate the strategies for mitigating flood risks in Western region of Kenya. Three research designs guided each objective. The research was underpinned by a conceptual framework guided by Diffusion of Innovation Theory and Pressure and Release Model of Vulnerability. The study area included Sub-County of Nyando and Budalangi. The sample size for the study was 384 households. Primary method of data collection comprised questionnaires, interviews and Focus Group Discussion guides. Secondary and Quantitative data were analyzed using MS excel. Statistical Package for Social Scientists (SPSS) version 26 was used to obtain statistics including Pearson's, Spearman's rank Correlation Coefficient. Qualitative data was analyzed using narration techniques to support quantitative data. Quantitative data was presented using tables, graphs and charts while for qualitative data coding was conducted and most prominent narrations were captured. The results on the type and extent of SLMT practiced in Western Kenya, indicated 37.5% (146) acknowledged that they practiced cropping management, 29.2% (111) practiced Water management practices, 25% (96) practiced crop slope barriers, 6.3% (23) forest management and 2.1% (8) respectively. On the prevalence of flood risk results revealed that household who had stayed for a long period had more knowledge on flood risk and a strong positive significant correlation ($r_{s=}$ 0.934, p□ 0.001) with knowledge on Flood risk in Western region Kenya. The results further suggested that duration of stay played a significant role on knowledge about flood risk. The findings on evaluation of the strategies for mitigating flood risks showed that extension service 92% (353) was the best strategy whereas existence of project meeting at 80% (307) benefited a lot from them. The study concluded that the SLMT are used in the Western region and the communities have the knowledge and experience on flood risks. The study recommends adoption of holistic management of the SLMT policies and increased training areas to create environmental equity for Sustainable Development. The study is expected to assist in strengthening extension services with involvement of both the County and the National government.

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LIST OF ABBREVIATIONS AND ACRONYMS

DRR	Disaster Risk Reduction
FAO:	Food and Agriculture Organization of the United Nations
IFAD:	International Fund for Agricultural Development
IFPRI:	International Food Policy Research Institute
KALRO:	Kenya Agricultural Livestock Research Organization
KEFRI:	Kenya Forestry Research Institute
MFTF	Micro Finance Trust Fund
SLMT:	Sustainable Land Management Technology
SPSS	Statistical Package for Social Science
SSA:	Sub-Saharan Africa
SWC:	Soil Water Conservation
PMCC:	Product Moment Correlation Coefficient
UNCED	United Nations Conference on Environment and development
UNDP:	United Nations Development Programme
WB:	World Bank
WHO:	World Health Organization
WOCAT	World Overview Conservation Approaches Technology
NBA	Nature Based Approach

OPERATIONAL DEFINITION OF TERMS

Flood Risk Management: Approaches used in minimizing the occurrence of situations that makes people or Community Vulnerable to floods

Flood Risk Perception: how people see and care about the flood disaster occurrence in the area

Flood Risk Reduction: Measures of minimizing flood impacts caused by flood disasters

Impact: The outcome of a flood occurrence

Land: The terrestrial ecosystem that contains natural resources (soil, near surface air, vegetation and Biota and water), the ecological processes, topography, and human settlements and infrastructure that operate within that system (adapted from FAO, 2007 and UNCCD, 1994; see also Lal, 2010a; Koch *et al.,* 2013).

Land degradation: Is the reduction or loss of the biological or economic productivity and complexity of rain—fed cropland, irrigated cropland, or range, pasture, forest or woodlands resulting from natural processes, land uses or other human activities and habitation patterns such as land contamination, soil erosion and the destruction of the vegetation cover.

Land Degradation Neutrality: a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems

Land Potential: The intrinsic, long-term ability of the land to sustainably produce ecosystem services, which indicates the ability and resilience of the natural capital based on the land in the face of ongoing environmental change.

Land Rehabilitation: The restoration of ecosystem functionality by actions where the provision of products and services is prioritized over the establishment of the pre-existing ecological structure and function

Land Restoration: The process of supporting a degraded ecosystem's recovery; restoration aims to restore the ecosystem's original ecological structure and function, including biotic integrity.

Pro-Poor: Is defined as the increase in benefits (through rewards) and/or decrease in costs (through compensation) in monetary and non-monetary forms that should lead to increased wellbeing of the poor and reduction of poverty

Soil Health: Continued capacity of a soil to function as a vital living system (within ecosystem and land-use boundaries) to sustain biological productivity, maintain quality of air and water, and promote plant, animal and human health. Soil quality is often used synonymously with soil health.

Soil Security: The maintenance and improvement of the world's soil resources so they can continue to provide food, fiber and fresh water, make major contributions to energy and climate sustainability, and help maintain biodiversity and the overall protection of ecosystem goods and services

Sustainable Land Management: A knowledge-based procedure that helps integrate land, water, biodiversity and environmental management (including input and output externalities) to meet rising food and fiber demands, while sustaining ecosystem services and livelihoods (World Bank, 2008)

Sustainable Land Management Technology: the practice of using natural resources like soil, water, animals, and plants to produce things that meet evolving human needs in a way that doesn't deplete those resources and doesn't harm the environment.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Flooding has been recognized as one of the worst disasters (Chan *et al*., 2019). The social and physical losses caused by floods have affected hundreds of millions of people around the world, with serious effect on a country's economy (Changnon *et al*., 2000). Flooding stood out as the most persistent natural disaster in terms of frequency of occurrence and human casualties (Ogie *et al.,*2020). There has been a dramatic increment of floods all over the world, both in developed and developing nations due to climate change (Berndtsson *et al.,*2019). Presently, floods are the most common hazards with the highest death toll economic misfortunes because of being higher than other hazards, (Cornia *et al.,*2016). Poor groups are more at risk because their livelihoods are vulnerable due to limited access to services and infrastructure (Richmond *et al.,*2018). According to (Peters *et al,* 2019), DRR strategies are the most crucial aspect of institutionalized action to lessen the risk of disasters caused by natural hazards and to chart the course for making a region, country, or area more resilient.

The Sendai Framework for Disaster Risk Reduction Vision 2015-2030 seeks to improve local Disaster Risk Reduction programs and drastically cut disaster-related loss and damage by the year 2030 (Aitsi-Selmi *et al.,*2015).

However, the presence of more solutions did not ensure that danger would be mitigated on a regional level. African countries' yields are over a third lower than those in Asia and half as high as those in South America, both of which are significantly higher than the world average. Most irrigation development projects in semi-arid areas of Africa drove poor farmers and pastoralists away from their original water and land sources, pushing them to relocate to more ecologically vulnerable areas that are more susceptible to Land and Resource Degradation (Bhattarai, 2019).

There was a consensus in the literature that effective flood risk management and disaster reduction strategies could be implemented if farmers in flood prone areas adopted Sustainable land management methods at a higher rate as natured based approach (Koutsovili *et al.*, 2023). The ecosystem based-adaptation being a strategy for adapting to climate change harnessing nature-based solutions according to united nation Environmental program 2016. The farmers in the study area could stand a better in using a technology that will improve their livelihoods.

The World Conference on Disaster Reduction (WCDR) urges all governments to adopt disaster risk reduction policies and asks the international community to keep helping poor nations lessen the impact of natural disasters by incorporating DRR measures into their development plans (Seddiky *et al.*, 2022). Reducing flooding and increasing food security in flood-prone areas may be possible with the help of Sustainable Land Management Technologies incorporated into DRR and appropriately structured into a complete development plan.

Since its inception in the early 1970s, FAO has worked to meet a wide range of food and agriculture-related requirements and agricultural emergencies and has been working on a number of projects related to Disaster Risk Management in various fields (such as early warning systems, vulnerability analyses, agricultural relief operations, drought management plans, pastoral risk management, soil and water conservation techniques, and improving small-scale fishermen's safety at sea, as well as managing wild land forest fires (Muricho *et al.,* 2019). More recently, FAO has launched initiatives to help member countries make the transition from emergency relief operations to better planned, long-term Disaster Risk prevention and preparedness strategies (Sarmiento *et al.,* 2015). These initiatives focus on integrating aspects of proactive Disaster Risk Management into ongoing agricultural sector development work. Disaster preparedness efforts greatly benefited from public input. This was especially true in rural areas, where stakeholders from all affected sectors and communities had to be involved in practically every move (Li *et al.,* 2017). The need of studying people's risk perception levels in order to adopt effective flood risk management and disaster reduction programs cannot be overstated. Finally, an assessment of the role of Sustainable Land Management Technology in lowering flood risks considered the availability of funds to enable concrete results based on DRR measures proposed in national plans and the necessity of local-level implementation, which necessitated services and actions that aided local farming communities and promoted resilient livelihoods (Heidkamp *et al.,*2021).

However, studies that attempted to focus on public flood risk reduction in the small and medium-size city in Kenya, like in Budalangi and Nyando were minimal (Wisner & Pelling, 2012). Therefore, the purpose of this study was to examine the impact of Sustainable Land Management Technologies on flood risk reduction, in the study area.

An evaluation on Sustainable Land Management Technologies for flood Risk Reduction employed by people in Western region therefore highlighted the aspects to be improved in the DRR and inspired the National government consequently, (Tiepolo & Braccio, 2020). It was along these lines that governments needed to be more proactive in decreasing flood threat instead of being more reactive by offering post-catastrophe response and recovery, (Otieno, 2016). He asserted that the initial move towards a proactive model was to conduct a flood risk assessment to recognize the vital Disaster Reduction policies required to scale down the threat of flooding in the study area that actually interfered with food productivity leading to food insecurity in the County.

1.2 Statement of the Problem

Flooding has been recognized as one of the worst hydro meteorological disasters (Chan *et al*., 2019). The physical and social losses caused by floods have affected hundreds of millions of people around the world, and they can have a serious effect on a country's economy (Changnon *et al*., 2000).

The impact of floods has worsened and induced forced migration of the already vulnerable community in Africa. In Kenya high poverty levels among the people of western region made them more vulnerable because they live in flood plains which are hazardous. They have fewer resources which makes them vulnerable to disasters. In Budalangi and Nyando, overuse on the Land resource has been increasing and least technology adoption and refusal to adopt the Sustainable Land Management Technologies by the farmers has led to land degradation and thus enhancing flood risk. Although (Belachew *et al.,*2020) claims that more bio-diverse farming systems have the potential to bring large environmental advantages, it is uncertain how much they lower risks from stressful weather conditions that are expected to occur more frequently in the future. Many Ecosystem based approaches such as (SWC) measures have been advocated, farmers have not been able to put them into practice to better reduce flood risks (Belachew *et al.,*2020)

Despite substantial efforts made to ensure ecological and economic benefits, the implemented practices have not been widely adopted by small-holder farmers in study area.

It was against this background that this study undertook to investigate how the interactions amongst land and water resource users within the catchments could collectively design Nature based approaches to improve their livelihoods and control flooding effect basing on nature-based solutions.

The study therefore aimed at examining the impact of Sustainable Land Management Technologies on Flood Risk Reduction in Western region Kenya. However, lack of such knowledge on the existing Sustainable Land Management Technologies on flood risk reduction is likely to lead to divergence between actions prescribed by policy makers and those taken by the public to mitigate effects of land productivity and flood risk reduction. Moreover, there was limited research on the relationship between people's perception of flood risk and Sustainable Land Management Technology practices, particularly the agriculturally dependent communities as well as the role of experiential influences on perception of global risks (Wachinger *et al*., 2013).

1.3 Research Objectives

Overall objective of the study was to examine the impact of Sustainable Land Management Technologies on Flood Risk in Western Region, Kenya

To accomplish this overall objective, the study adopted the following specific objectives:

i. To determine the type and extent of the existing Sustainable Land Management Technologies employed by farmers in Western Region, Kenya

ii. To examine the prevalence of flood risk by farmers in Western region, Kenya
iii. To evaluate the Strategies for mitigating flood risks in Western Region, Kenya

1.4 Research Questions

The research was guided by the following questions:

i. What are the existing types and extent of Sustainable Land management Technologies employed by farmers in Western Region, Kenya?
ii. What is the prevalence of flood risk by Farmers in Western Region, Kenya?
iii. What are the Strategies for Mitigating flood risk by farmers in Western Region, Kenya?

1.5 Justification

1.5.1 Philosophical and Academic Justification

In a study by Kiragu in Kenya SLM Base line project 2010, Land degradation was a major threat to agricultural productivity in Kenya and it was caused by unsustainable anthropogenic activities as well as natural occurrences such as drought and flooding. Loss of soil fertility was the most significant manifestation of land degradation through soil erosion by wind, water, soil compaction among others. The study by (Kiluva, 2007) on development of Sustainable Low-cost Non-structural Flood Mitigation Strategy highlighted that structural flood mitigation strategy tends to be costlier and when not properly managed it becomes ineffective. It was on the basis of this that the current research tends to fill the gap on flooding by examining the SLMT that would rather be effective and less costly in control of Flood Risks at the study area.

According to (Moses AN, 2017) in his published thesis on GIS based Modeling of Land use dynamic in River Nzoia Basin Kenya, where he indicated that the upstream had effect on Lower Stream of the basin hence the problems of Land- use dynamics must be emanating from the upper down to the lower basin. Based on this statement the study is justified that the Flood risk are mostly experienced in the lower basin hence examining the impact of SLMT in control of Flood risks was in order. However, it was important to note that Land degradation and Flood risk negates efforts by Kenya's strategic plan of Vision 2030 and strategic development goals (SDGs) especially goal number 13 on climate action and this is what the livelihood are experiencing.

1.5.2 Policy Justification

Findings from the study, conclusions and recommendations shall provide guidelines for policy frame works with various stakeholders to adopt improved and more Sustainable Land Management Technologies that would make a positive contribution in flood risk reduction. Additionally, the study reinforced the existing capacities and institutions as they look into the historical concerns that emanates from the social-economic, demographic and household headship. The geo-database constituted to promote preparedness and Sustainable development was used by all the stakeholders in formulating and implementing policies to help the Counties find solutions that reduce flooding and create environmental equity for Sustainable Development.

1.6 Scope of the Study

The scope of the study included: Household heads, FGDs and Key Informants from ministry of agriculture, KMD, County disaster department and from non- state actors NGO and CBOs from the Western region (Budalangi and Nyando). The periodization of the study covered the period, from 2012 to 2020 when floods were extreme in the study area according to (Otieno, 2016). The actual data collection covered a period of three months from July to September, 2022

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presented a review of literature from previous studies in the context of the study problem formulated and objectives articulated. It covered literature on adoption of Sustainable Land Management Technologies in control of soil erosion, literature on Flood risk perception by public globally, regionally and narrowing down to the local perspective, examining the impact of SLMTs on flood risk reduction. Furthermore, the literature review discusses the theory of Diffusion and Innovation and Pressure and Release Model by (Blaike, 1994). A conceptual framework is presented at the end of the chapter showing the relation between independent and dependent variables.

2.2 The type and extent of Sustainable Land Management Technology

This section reviewed literature related to knowledge and understanding of SLMT. This discussion entailed: awareness and knowledge of SLMT, understanding the causes and impacts of adopting the SLMT and sources of information

2.2.1 Sustainable Land Management Technologies

Sustainable land management (SLM) has emerged as an issue of major international concern. This is not only because of the increasing population pressure on limited land resources, demanding for increased food production, but also by the recognition of the fact that the degradation of land and water resources is accelerating rapidly in many countries in general (Gachene *et al.,* 2020). It is also becoming clear that the limits to lands, which are suitable for agriculture, are now being reached due to issues of floods. If the lands, which are moderately or well suited for agriculture, are currently in use, then it follows that further increases in production, to meet the food demands of rising populations, must come about by the more intensive use of existing agricultural lands in a more sustainable way (Petersen & Snapp, 2015). To combat the often-cited deleterious effects of flood risks, particularly with regard to environmental effects requires the development and implementation of technologies and policies, which will result in sustainable land management (Azadi *et al.*, 2020)

Adoption of SLMT can be hampered by a number of factors, including the direct impact on human populations and the mix of human and natural pressures on land, as well as policy and economical restraints (Kahiga, 2016).

Water scarcity, soil degradation, degraded vegetation and low production, climate change, resource use conflicts, and migration are just some of the common dry land threats that are evaluated in the World Overview of Conservation Agriculture Technology (WOCAT) report (Haregeweyn et al., 2023)

The report also analyzes 30 SLM technologies and 8 approaches. Crop management, water management, cross-slope barriers, grazing land management, and forest management are the five categories into which the thirty recorded SLM technologies were sorted. Common SLM categories were used to form the groups, as these are well-known to SLM experts, as were common mechanisms for addressing degradation (such as agronomic measures for Cropping Management, Management measures for grazing Land Technologies, and Structural measures for Water Management). Cross-slope barriers and Forest Management are two categories of SLM Technologies that include a wide range of measures, some of which are combined into hybrid technologies (Kahiga, 2016)). Among the effects attributed to the reported technologies, varied and improved output and better management of water and soil degradation due to water harvesting, increased soil moisture, and decreased runoff were highlighted most frequently.

SLM technologies can generate both private and public benefits and thus constitute a potentially important means of generating “win-win” solutions to addressing poverty and food insecurity as well as environmental issues (Branca *et al.,* 2011). In terms of private benefits to farmers, by increasing and conserving natural capital (including soil organic matter, various forms of biodiversity, water resources) SLM can generate productivity increases, cost decreases and higher stability of production (Branca *et al.,* 2011). SLM practices contribute to improving soil fertility and structure, adding high amounts of biomass to the soil, causing minimal soil disturbance, conserving soil and water, enhancing activity and diversity of soil fauna, and strengthening mechanisms of elemental cycling (Lal, 2020). This in turn translates into better plant nutrient content, increased water retention capacity and better soil structure, potentially leading to higher yields and greater resilience, thus contributing to enhance food security and rural livelihoods (Qi & Dang, 2018). At the same time, widespread adoption of SLM has the potential to generate significant public environmental goods in the form of improved watershed functioning, biodiversity conservation and mitigation of climate change. The technical potential for mitigation from agriculture by 2030 is estimated to be between 4,500 (Long *et al.*, 2016).

Professionals in SLM checked the accuracy and thoroughness of the documentation for these methods and technologies (Nkonya *et al.,* 2013). Together with the case study authors, we progressively supplemented missing information and resolved any inconsistencies or contradictions that arose during quality control. SLM technologies will be divided into three categories for the purposes of this research: crop management, water management, and cross-slope barriers. The groups are made based on common SLM categories that most SLM experts are already familiar with and shared ways to deal with degradation, such as agronomic measures for crop management and structural measures for water management (Vema *et al.,* 2022). Water management, which includes Rain Water Harvesting (RWH), better irrigation efficiency, and providing drinking water for people and animals. Water supply systems were also a part of this process, although agriculture was the primary focus due to irrigation and water harvesting (Pavelic *et al.,* 2012)

Cross-slope barriers are structures built across slopes, such as soil bunds, stone lines, gully barriers, vegetative strips, and terraces (Barrow, 2014). They are employed for a wide variety of land applications, but predominantly on crops and for gully management. Indigenous peoples' wealth of resource conservation practices suggest that land users' lack of knowledge isn't the only factor limiting their ability to manage land resources sustainably; rather, political, social, and economic factors also play a role (Baland & Platteau, 1996) The initiative reports that unreliable ownership of land discourages maintenance spending. Soil degradation, water quality reduction, biodiversity loss, and an uptick in plant disease incidence were identified as signs of non-sustainability; SLM was used to address these issues (Giger, 2022). Users of the land were frequently aware of instances of poor SLM but powerless to do something about it. Highland Ethiopian peasants are well-aware of the dangers of soil erosion, and they have developed a sophisticated set of methods and a protective infrastructure to combat the issue (Hălbac-Cotoară-Zamfir *et al.*, 2019). Farmers face challenges in a socioeconomic and geopolitical environment that is not always friendly to them (Hurni, 1997).

The vicious cycle of Land Degradation and poverty can be broken if SLMT focuses on sustainable development by safeguarding, enhancing, and making use of natural assets (Hurni, 1997). Soil erosion, nutrient insufficiency, poor organic matter, acidity, crusting, and moisture stress are all problems that plague African soils. While some of these limitations are inherent to tropical soils, Land Management-related degradation processes amplify others. Increasing agricultural yields, elongating the harvesting season, and bettering the quality of produce are all possible thanks to biomass transfer, the human transfer of green manure to crops that improves soil fertility. Green *tithonia* leaves are worked into the soil before planting in Western Kenya to (Kiptot *et al.,* 2006) increase yields of corn, beans, kale, French beans, and tomatoes.

2.2.2 Land degradation and Sustainable development

Degradation of land causes a slow but persistent decline in its natural resources and its capacity to provide specific commodities and services essential to human well-being. In particular, assets like fresh water, arable land, fuel wood, and timber, biodiversity for uses like herbal medicine, fisheries, and grazing resources are depleted. Silted lakes and rivers, dried catchment regions, filthy air, and climate change causing longer and more frequent droughts and flooding are all signs of a decline in the ability to offer environmental services (Islam & Karim, 2019)

Degradation of land poses a danger to those living in rural areas. In that it degrades and renders insufficient the natural resources available to the home for production or support to livelihoods, it erodes the natural capital of the local communities (and, by extension, the nation). It starts a downward spiral that eats away at all other sources of income. Land users generate degradation processes through inadequate Land Management and Land use practices related, (Karamesouti *et al.,* 2015), which has costs for the entire country as a result of regional depressing effects on national capital. Over cropping, insufficient replacement of soil nutrients, improper tillage, inefficient irrigation, excessive grazing, cutting down trees without replacing them, and using marginal areas are all examples of bad agricultural practices. Nearly every country, including over 80 developing nations, is negatively impacted by land degradation. This process is cumulative and affects approximately 23% of the land under human use has been degraded, (Prăvălie, 2021), as much as a third of all agricultural land and 16 percent of crop area have been severely degraded, according to estimates.

As a result of overgrazing, deforestation, and increased agricultural operations, water erosion has caused the most damage, followed by wind erosion, soil nutrient depletion, and salinization (Hossain *etal.,*2020). The following are the major proximate causes of land degradation: conversion of forests, woodlands, and bush lands that are unsuitable for permanent agriculture; overgrazing of rangelands; excessive exploitation of natural habitats (for example, harvesting for fuel wood in woodlands); and unsustainable agricultural practices, such as farming on steep slopes without sufficient use of soil and water conservation measures, excessive tillage, and declining use of fallow without applying conservation measures (Delgado *et al.*,2021)

2.2.3 Agricultural Systems and Degradation in Water basins

Since the publication of Boserup's (1965) theory on the role of population pressure as a leading element in the transition to sustainable agriculture in tropical small-scale farming, the topic has been the subject of extensive discussion (Copestake & Wellard, 2023). Although agricultural intensification is not the same thing as enhanced sustainability of small-scale agricultural systems, there is emerging evidence that it can occur alongside and contribute to it in a context of increasing strain on lands.

There are significant increases in cultivated area, total yields, and the widespread adoption of continuous cultivation in place of fallow-based cropping systems in sub-Saharan Africa, all of which pose significant development difficulties (Maruta *et al.,* 2020). However, annual declines in food output of roughly 2% per capita have been occurring since 1960. A significant explanation for the 1% annual drop in per capita income in Africa between 1983 and 1993 is the persistence of constraints on expansion in agricultural sectors (Maruta *et al.,* 2020).

Yields in African nations are significantly below the global average, and are almost one-third that of Asia and half that of South America. This is because irrigation development projects in semi-arid regions of Africa cause flooding, which ultimately forces poor farmers and pastoralists to leave their traditional water and land sources and move to more fragile environments vulnerable to resource degradation (Barbier, 2000). Planners of irrigation projects sometimes overlook the possible implications of upstream water diversion on downstream users of water and land, leading to unnecessary environmental entitlement loss (Bhattarai, 2019). This research aims to close the knowledge gap on the subject of adopting SLMT in the study area, which will guarantee farmers a reduction in flood risks and, by extension, an increase in their income. The extended flood risks in the study area has always affected the land due to water logged soils. It took too much time for the soils to retain its normality hence affecting farming and settlement of livelihoods.

As agricultural productivity rises around the world, more nutrients are needed and more are produced. But in East and Southern Africa, productivity is falling short of population expansion, and the future of soil fertility appears to be in jeopardy. Soil fertility levels were rather stable in early agriculture, reflecting patterns seen in natural ecosystems (Bese, 2020). After three or more cropping seasons, the site was ready for shifting cultivation based on protracted fallow intervals, which replaced the era of food gathering. The extent to which anthropogenic factors like deforestation or poor management are to blame for observable degradation is an area of active discussion.

Both are interconnected, as climate change shocks, like as a lengthy drought, will limit vegetation, making it difficult to quickly alter herd size, and in the event of rainfall, flooding will occur. The environmental issues that arise from farming are now also a top priority. Total forested land in Africa decreased by 50 million hectares during the 1980s due to market development and intensification of farming, which decreased the supply of wood products for fuel and construction, degraded range resources, and exposed sensitive soils (Gibbs *et al.*, 2010). In the study area the cultivation cover especially forest cover has been depleted and needs afforestation to improve the vegetation cover and minimize land degradation (Okeyo-Owuor *et al., 2012)*

Long-term agricultural potential is threatened in many places due to soil deterioration caused by improper farming methods and nutrient depletion, especially in highly populated highlands and in dry terrain. About 1.2 billion poor people directly rely on a range of agro-forestry products and services (Sanchez & Leakey, 1997). This is because agro-forestry systems are more prevalent in developing countries. Agroforestry's potential to boost farm incomes and find lasting solutions to pressing environmental issues is demonstrated in five case studies conducted in sub-Saharan Africa.

In addition to its various economic and social benefits, it is more financially profitable to local farmers than traditional agriculture. As such, it has the potential to serve as a viable alternative growing strategy that aids in poverty alleviation and the shift to sustainable farming. In order to make a sub-county, country, or region more resilient to disasters, SLM Technologies are the backbone of structured action to reduce disaster risk associated to natural hazards. Every nation should begin by raising public consciousness about SLMT, since you can only deal very well with the problem you're aware of. According to (Ajadi *et al.,* 2011) Lagos survey, an overwhelming majority (85%) of respondents expressed a desire to learn more about eco-friendly practices, only 5% agreed, while 10% strongly disagreed. The purpose of this research is to learn from local farmers about the SLMT's impact on flood risk reduction in the region.

2.2.4 Sustainable Land Management Technologies employed by farmers

Sustainable land management (SLM) comprises measures and practices adapted to biophysical and socio-economic conditions aimed at the protection, conservation and sustainable use of resources (soil, water and biodiversity) and the restoration of degraded natural resources and their ecosystem functions (Oduniyi, 2022)

It is crucial that the agricultural sector increase the resilience of its livelihoods by increasing the capacities of technical staff and the options available to farmers in order to implement a wide range of good practices to reduce hazard risk exposure, damages, and losses. Integrated farming techniques and crop diversity are devalued, making agriculture communities more susceptible to the effects of disasters, although these approaches are underutilized (Bese, 2020).

There is considerable accumulated experience on SLM practices, many of which have been tested and fine-tuned to produce packages of best practices for the sustainable management of land and water (Tamene & Abera, 2020) . Adoption of such technologies by farmers is slow, however, and FAO aims to speed it up by, among other things, supporting countries to provide an enabling environment and promoting tools to ensure the selection of the most suitable techniques and technologies for a given set of biophysical and socio-economic condition.

Targeted retirement of some agricultural land is necessary for SLMT practices including wetland restoration, grass rivers, and riparian buffers, which reduces total agricultural yields but may provide greater nutrient export reduction and other advantages per unit area. Because of its widespread effects on hydrology, nitrogen cycling, soil fertility, and other processes, SLMT cost-benefit analysis is complex. Although the effectiveness can vary depending on watershed characteristics, SLMT location, and storm magnitude, previous studies have largely focused on assessing SLMT performance in reducing nutrient and sediment loss and the subsequent impacts on water quality (Yeo *et al.* 2014); SLMT that promote slow runoff are effective in reducing sediment detachment and transport (Bernués *et al.,* 2016). The positive impacts of SLMTs on water quality may be obscured, according to an argument made by (Chaubey *et al., 2010)*. Specifically, in high-pollution areas, showed that SLMTs effectively cut down on nutrient loads (Bernués *et al.,* 2016). Uncertainties on land conditions and farming methods (Kurkalova, 2015) and lag times between SLMT deployment and water quality improvement further complicate the task of accurate evaluation of SLMTs' efficacy. However, there is consensus that the water quality may be steadily and significantly improved through the widespread, site-specific adoption of various SLMTs.

Western Kenya has been the site of extensive study into Sustainable Land Management Technology (Mutoko, 2013). The majority of the work for the Kiragu document on the Kenya Sustainable Land Management baseline was done in Kakamega, Bungoma, and Siaya Counties. The research project was motivated by the following questions: how did previous SLM projects choose the SLM technologies and how did farmers benefit from them; what strategies did the project use to reach beneficiary farmers outside of SLM Technologies Promotion; to what extent did the project address and improve social, economic, or institutional enabling conditions for the adoption of SLM Technologies; and whether the project was successful in achieving lasting adoption of SLM Technologies (Kiragu & Flohr, 2016). In contrast to the Kenya SLM Baseline, this study focuses on the impacts of sustainable land management technologies on lowering flood risk in the study area western region.

The Kenya SLM Baseline focused primarily on agricultural residue management, planting woody perennials, pile composting, compost utilization, and crop rotation as SLMT practices to be encouraged in the study area. However, this study will take a different approach by conducting a comprehensive analysis of the SLMTs of cropping, cross-slope barriers, and water management, each of which will be broken down into its constituent parts and examined in detail (Schwilch *et al.,* 2014). For the purposes of this study, the detected SLMT have been addressed in detail as follows:

2.2.4.1 Cropping Management

Use of organic and inorganic plant fertilizers, minimal soil disturbance, crop rotation, and permanent soil cover (including agroforestry systems) are all examples of techniques that contribute to better soil fertility management (Powlson *et al.,* 2011). They are utilized in croplands as well as in crop-tree and crop-grazing mixed land use systems. Below, we'll go through how evaluating, assessing, and examining the agriculture sector can help with flood control and how changing agricultural practices can preserve a lot of our precious land.

Crop Rotation: Is a method in which different crops are planted on the same plots of land at different times. The same grain is grown year after year by Indian peasant farmers in the same field. This method depletes the soil of its nutrients, making it unfit for the intended crop (Tamene *et al.,* 2020). The potential of crop diversity to mitigate climate change-related risks is becoming more widely acknowledged (Bowles *et al.,* 2020). Due to the "portfolio effect," in which various crops respond differently to stress, crop diversification at the farm size and beyond decreases economic and production risks. How crop diversity affects yield resilience of individual crops over time, particularly resistance to yield decreases in the face of stress, is another potentially important form of risk reduction at the field size that has received little attention (Waaswa *et al.*, 2022).

Crop rotation (the sequence of crops cultivated throughout time) is one example of temporal crop diversification that farmers have employed for centuries to boost yields by restoring soil health and interrupting the life cycles of herbivores, weeds, and pathogens (Sarkar *et al.,* 2020). The implementation of this strategy, which is crucial for increased productivity and better flood management, needs to be verified in the research area. Producing food for a growing population while also improving environmental sustainability is a major problem for humanity, (Wright & Nyberg, 2017). While it is evident that more bio-diverse agricultural systems have the potential to bring significant environmental advantages, it is less clear whether or not they also lower risks from stressful weather conditions anticipated to occur more frequently in the future.

Checking Shifting Cultivation: The shifting cultivation method is a strategy mostly employed by tribal groups to transition from shifting cultivation to permanent agriculture (Maithya *et al.,* 2022). Relocation plans for indigenous communities can teach them about the most effective farming methods in their new home. Land degradation and forest loss are both exacerbated by shifting farming, which is still common in flood-prone areas. (Carley & Christie, 2017). In the study area the relocation of people due to flood risks makes it relevant for the community to practice shifting cultivation for proper management of the farms.

Use of Early Maturing Varieties: It's a method whereby the ground is seeded with rapidly maturing, early-flowering kinds of crops (Hu *et al.,* 2022). Consequently, less strain is placed on the ground (Takagi, 2020). As a result, soil erosion can be mitigated. The soil is eroded and the water that carries it away during rainstorms (Lucas-Borja *et al.,* 2019). This latter process causes shallow top soil layers and low organic matter content, which in turn results in poor water retention. Low water infiltration rates will result, with just 10–15% of rainfall being utilized by crops for transpiration because of the aforementioned causes. This means that the amount of water available to crop roots in the soil profile is a significant barrier to the development of resilient agricultural systems. Numerous soil and water conservation techniques, including stone lines, half-moons, contour hedgerows, rock bunds, filter walls, agroforestry, contour ridges, benches, and no-tillage, have been created and are now widely used as a result of unpredictable rainfall patterns and decreased agricultural productivity (Lucas-*Borja etal*., 2019). Technologies have been demonstrated to decrease runoff, soil erosion, and increase water infiltration and soil hydration. However, widespread promotion of only a few options, with the assumption that "one size fits all," may be why their uptake fell short of expectations. The farmers are advised to plant strains of crops that mature early in different weather patterns in the study area to ease the risks. In actuality, research has shown that the effectiveness of these technologies depends on a variety of variables, including rainfall (some performed better than others in drier areas, while others performed better in humid zones), soil productivity potential (some performed better in less fertile soils), and labor availability (Muller *et al.,* 2017).

2.2.4.2 Cross-Slope Barriers

These include soil bunds, stone lines, gully barriers, vegetative strips, and any type of terrace on sloping terrain (Mwenge Kahinda *et al.,* 2021). They are utilized in a wide variety of agricultural and drainage systems, among others. Mainly in the Tunisian region, technology used in the topic under investigation includes the following examples:

Strip Cropping: Cross-Slope Barriers on sloping land can be reduced by the use of strip cropping, which entails growing crops in alternating long, narrow strips of land (Karlen & Cambardella, 2020). When the slope is too steep for any other type of erosion control, this technique is employed. The forages' primary role is as protective cover crops. Strips of land, parallel to one another, can be used to grow different crops in rotation. Some plots could be left fallow while others would be planted with various crops including tiny tree crops, grains, grass legumes, and so on. This strategy ensures that the area is never completely uncovered, regardless of the season (Koomson *et al.,* 2020). Many different Soil Water Conservation strategies have been tried and true thanks to development programs and farmers' insider knowledge. It is critical to foster conducive conditions so that a sizable number of farmers can reap the benefits of SWC methods (Belachew *et al*., 2020). Only until the methods are consistently applied and incorporated into the farmers' daily routines will they be considered completely adopted? Therefore, SWM cannot be achieved via the simple presence of SWC practices; users must also take the next step of fully adopting them. Small-holder farmers in the research area have not largely adopted the established techniques despite extensive efforts to ensure ecological and economic benefits. Farmers were unable to improve DRR by the implementation of recommended SWC methods. (Belachew *et al*., 2020).SWC activities are less effective since they are typically carried out in campaigns rather than on an ongoing basis, and because agricultural growers and livestock keepers are often left out of the process. Sustainable land management technology adoption by farmers is influenced by demographic, economic, institutional, and physical variables.

Contour Ploughing: These slope-crossing cultivation techniques encourage the growth of stable crops while lowering the risk of soil erosion and runoff. Better soil structure, less soil, seed, and input loss, cleaner waterways, and fewer legal fees and fines are all benefits of plowing with the contour (Mulwale *et al.,* 2020). Plowing is done perpendicular to the slope of the hill, following the land's organic shape. Water running downhill is slowed by the ridges and furrows created by this process (Pretty *et al*., 2019). Reduced gullies mean less dirt is washed away in storms. More water will be able to reach the plants as it develops and reduces run-off.

Terracing and Contour Bunding are measures used on steep slopes with the purpose of terracing application to enhance the slope's utility and increase its agricultural potential. To perform this task, contour lines of the altered slope are used to generate flat surfaces (Bocco & Napoletano, 2017). Spreading surface runoff water over a wider area at a slower rate helps it percolate deeper into the soil thanks to the flat, bench-style platform. In areas at risk of soil erosion due to steep slopes, climatic conditions, and erodible soils, terraces are often cited as an effective means of preventing erosion. The combination of scant vegetation and other factors can reduce this method's effectiveness. Bench terraces, Back-sloping bench terraces, stone-wall terraces, and *Fanya juu* terraces are the most well-known forms of terraces in the world. It has been asserted that terracing is among the earliest techniques used to preserve soil quality. Effective hillside landscaping techniques include terracing and contour banding. This is achieved by slicing the hillside into a series of terraces, each of which will have a flat top and steep sides. The use of terracing has been found to be effective in reducing soil erosion caused by water flow (Ojha, 2017).

Since the quantity of soil lost is proportional to the velocity of surface water flow, efficiency in minimizing the rate of soil erosion is linked to reducing the volume and speed of rain surface runoff. In the study area terracing and contour bunding have led in to improved run off by soils minimizing the flood risks due to crop destruction. Terracing's effectiveness in reducing soil erosion has been the subject of numerous published reports, which compare the erosion rate of converted and untransformed slopes in the same soil and climate enhancing flood risk reduction (Ojha, 2017).

2.2.4.3 Water Management Practices

Improved irrigation efficiency and reliable access to clean water for human and animal consumption are two of the goals of water management practices (Mutiga *et al.*, 2010). Various land applications are required for Rain Water Harvesting (RWH), including irrigation and water supply systems for crop production. One example is the provision of both irrigation and drinking water using the same method. Countries like Tunisia and Botswana make extensive use of this technology. Water management technologies include, but are not limited to, the following

Water Harvesting Structures: Even while RWH technologies are widely used, especially in drylands (Oweis *et al.*, 2012), this article only touches on a small subset of them. Rooftop RWH systems in Botswana's case study largely improve the country's potable water supply. Runoff-harvesting systems in Spain and two locations in Tunisia capture water from an upstream catchment region and channel it to agricultural areas. Thus, the average annual rainfall in Spain is increased by a whopping 550 millimeters because to the country's time-honored system of water collection and storage. Flood Water is captured and reintroduced to the aquifer in the case of the recharge well in Kenya (Dillon *et al.,* 2020). tiny-scale structural solutions like holes, pits, bunds, or tiny basins built in the field to collect runoff are examples of in-field/in-situ systems.

Rainfall harvesting refers to the process of capturing rainfall, transporting it, storing it, and then using it later (for human consumption, watering livestock, or irrigating crops, for example) (Jones & Hunt, 2010):

Flood Water Harvesting: is a technique that helps divert surface runoff and collect water in reservoirs (dams, weirs, sand dams, tanks, farm ponds, or pans) (Oguge & Oremo, 2018). There are two main varieties: one that uses contour strips made of wood or vegetation barriers like Bamboo or Olive trees, and another that uses terraces. Most commonly used on slopes that are moderately to steep, contour strips provide two primary functions: (a) minimizing soil erosion and runoff, which prevents soil fertility loss and subsequent downstream impacts; and (b) collecting water and nutrients inside and above the strips for plant growth. The use of highly prolific trees and shrubs to reinforce barriers is associated with significant initial investment and ongoing upkeep expenses (Chesterman & Neely, 2015). Both the olive trees of Spain and the apple trees of China are grown on terraces. While in Spain the terraces are built from the ground up and fortified with shrubs and grasses, in the Loess Plateau the terraced area is expanded around the apple trees over a period of 5-10 years. Spontaneous irrigation is an example of a method of diverting and storing floodwaters in the soil profile and crop root zone. In Kenya, dams, sand dams farm ponds and pans are used according to (Oguge &Oremo, 2018)

In-situ Water Harvesting and Conservation: These are measures used in soil and water conservation structures such as terraces, retention ditches, stone bund sand vegetative barriers, as well as agronomic practices example mulching, deep tillage, and soil management. Runoff farming is use of runoff water to augment natural rainfall or simply Water Harvesting for crop production. In areas with annual rainfall ranging 100 to 700 mm, runoff farming may provide a workable solution if irrigation water from other sources is not available (Rosa *et al.,* 2020).

In runoff farming, there is deliberate collection of Rainwater from a surface (called a catchment) and its conveyance onto a cropped area (or run-on area), so that the soil profile absorbs more rainfall, (Kumar *et al.,* 2021). Catchment area is the part of the Land from which Rainwater collects or runoff emanates from. It can be small, less than a meter to several meters or Square Kilometers; Conveyance system – usually a channel or space that connects the harvested runoff from the catchment to the target/ponded area. Cropped area- is where the harvested water ends up, in a specially prepared cropped area, such as a ditch, pit, basin, or terraced land. Runoff farming system has several types including: Pitting where the pit holes are made and they act as runoff harvesters; Contour ridges Semi-circular hoops and demines & Triangular bunds; Contour bench terraces; Eye brow terraces and Hill slope micro catchments (Kumar *et al.,*2021). Cultivated reservoirs, Semi-circular bunds and stone dams all used in water harvesting to control runoff and applicable in the study area (Mekdaschi & Liniger, 2013)

Zai System of Water Harvesting: Zai these are measures of planting pits that offer a runoff Farming Technology that emanated from Northern Burkina Faso, and which in the Tahoua region of Niger is referred to as "tassa" in the Haussa language. The English terms used to describe zai pits include "planting pockets", "planting basins", "micro pits", fertility basins, fertility pits and small water harvesting pits (Danso-Abbeam et al., 2019), which is understood in Kenya. In semiarid regions, where rainfall is minimal and highly erratic, zai pits are utilized. Water harvesting and conservation are two very significant functions of the pits. In regions where, yearly precipitation is between 300 and 800 millimeters, zai pits become very useful. The pits may become flooded if the amount of rain falls above a certain threshold. When farmers are confronted with insufficient rainfall, the Zai system helps them to concentrate soil fertility and moisture in the crop roots, hence increasing crop yield (Bado *et al*., 2022). Soil conservation, water conservation, and erosion protection are all met simultaneously in the planting trenches' encrusted and filled soils. Although the method can be used on encrusted surfaces and damaged canals, it is most commonly used on silt and clay soils. Zai also reduce the amount of water that may drain off an area, which helps to reduce soil erosion.

Construction of Dams: They are typical techniques for stabilizing sedimentation, lowering through-water velocity, reducing catchment erosion and raising a dam's reservoir storage capacity for reduction of water velocity, (Kondolf *et al.*, 2014). The erodible stream bed and check dams make this location a highly erosive one. Check dams were studied to see how the dam's reservoir storage capacity and soil erosion rates may be regulated through the construction of transverse structures (Zema *et al*., 2018). Dams constructed across rivers help prevent soil erosion caused by flooding. Soil erosion can be greatly reduced if water velocity is regulated.

Cultivation of Bamboo to prevent Soil erosion: The application measure of this Technology; the site should be selected along the stream banks especially where the risk of erosion is occurring (Kibwage *et al.,* 2014). Bamboo should be planted approximately 3 meters from the edge of the bank. Bamboo is grown to protect the bank on one side of the stream from soil erosion whilst the other side of the stream is protected by Natural Bamboo species; Land preparation involves the clearance of bush around the planting pits. Bamboo rhizomes (*Bambusa oldhamii*) should be gathered locally from the parent plants. This should amount to approximately 120 healthy one-year old rhizomes each having a considerable number of feeder roots with a length of 60 to 70cm. Forty holes measuring 50cm x 50cm and 50 cm depth should be dug in a row leaving a gap of 5 meters between each hole along the stream bank when the bamboo's rhizome grows up it will cover the gap for few meters from pits (it will take about 4-5 years) (Kibwage *et al.,* 2014).

After the Land has been prepared 2-3 Bamboo rhizomes should be replanted in each of the holes. The refilling of the holes with Soil and Watering should take about one day. Planting can be undertaken in dry season because soil texture in dry season is less sensitive to erosion. This is a suitable time for Bamboo as the roots will propagate faster. In the dry season Watering needs to be done twice a week until the rhizomes establish new roots and stems (Akinlabi *et al.*, 2017). Generally, the Bamboo will grow 4-5 new stems during the first year after having been replanted, but at this stage it is still unable to protect the banks from erosion. Some vegetation around the pits has been cleared before replanting and leaves some vegetation on the edge to minimize erosion when the Bamboo trees still young (Maviton *et al.*, 2023).

Logs to reduce surface run-off during the rainy season: This technology is meant to help maintain nutrient levels on topsoil as without a technology the nutrients are being flushed down the hillside (Kogo *et al.,* 2022). It can be assembled using a collection of local logs approximately 4-5 meters in length and around 15-20 cm in diameter (obtained through the clearance of upland rice fields). The logs should be arranged horizontally at the position of a designated drainage site where the run-off flows from a particular agricultural area. They should be stacked on top of one another until reaching a height of about 1 meter. A buttress should also be erected using mature bamboo poles as supporting posts with a length of 1.5 meters and diameter of about 10 cm so as to prevent the logs from sliding down the hillside (Elamon *et al.,* 2022). The benefits of this technology include mitigating the impacts of soil run-off whilst facilitating the distribution of soil nutrients around the agricultural plot of land. The Water and top soil run-off are slowed down when it reaches the log wall and is then directed to flow out on either side of the technology

2.3 The prevalence of Flood Risk among farmers in Western Region Kenya

This idea is fundamental to the field of Disaster Risk Management because it determines what risks individuals focus on and how they respond to those risks. Rather than relying on their knowledge of objective risk indicators, the public typically relies on their own subjective views and intuition, as well as inferences drawn from a limited collection of facts, such as media coverage (Shin *et al.,* 2019) Researchers now understand they need to pay more attention to the relationships between people, their risk perceptions, their exposure to, and their vulnerability to the hazards in which they are immersed (Cardwell & Elliott, 2019). While this study will not be exhaustive, it will focus on the most important previously discovered prevalence with flood risk:

2.3.1 Flood Risk and protective behaviors

The literature evaluation shows that the link between preventive behavior and disaster readiness predictions has been weak and inconsistent. Several studies have found a direct correlation between risk perception and mitigation action. For instance, (Reynaud & Aubert, 2020), found that households' flood-protective practices are influenced by their perception of flood risks (Nguyen *et al.,* 2021). Risk perception and disaster readiness, on the other hand, were shown to have no or only a weak correlation in an empirical study by (Ge *et al.*, 2021). Three factors contribute to the weak connection between Risk perception and individual actions: (1) people accept Risk because the benefits they anticipate outweigh the risks they fear; (2) people don't feel responsible for their own actions and instead put the burden on others; and (3) people can't do much to change the situation because of how few resources they have. The literature study reveals that there are many complexities, contradictions, and disputes around the links between exposure, experience, trust, and risk perception, as well as risk perception and protective behaviors. The goals of this study include determining how locals in the study area feel about the likelihood of flooding. How do exposure and prior experience in the place affect one's view of the dangers present there? How does one's view of risk influence one's level of social trust and their prophylactic actions?

2.3.2 Flood Risk and Exposure

The term "exposure" refers to the type and level of contact that a receptor, such as individuals, infrastructure, or urban areas, has with a hazard in the natural environment (Kaźmierczak & Cavan, 2011). Algorithms or spatial models can assess vulnerability to natural hazards (Wang *et al.,* 2019). Natural disaster exposure is an integral part in assessing overall disaster risk. However, researchers have not come to a consensus on a solution. (Krasovskaia *et al.,* 2001)) looked examined the perception of flood risk in a flood-prone area of Norway and found that residents there thought it was low. (Pagneux *et al.,* 2011)provided a case study in an Icelandic town vulnerable to ice-jam floods and found similar results in their country. They also discovered that locals have an inaccurate understanding of the danger posed by floods (Pagneux *et al*, 2011). This view was corroborated by (Ludy & Kondolf, 2012), research in a US floodplain. They showed that even highly trained experts were unaware of the dangers posed by the floodplain. Communities in floodplain areas outside of a river dyke in Vietnam were shown to have a low public perception of catastrophic flood risk in 2007 (Hung *et al.,* 2016). However, some authors have argued that exposure is linked to how we feel about risk. (Ruin *et al.,* 2007), employed cognitive mapping in conjunction with GIS data processing to determine drivers' perceptions of flash-flood risk, and they discovered that drivers' risk perception was greatest when impacts were witnessed in close proximity to their homes.

The study by (Heitz *et al.,* 2009), highlights significant disparities in respondents' views, especially depending on location, of muddy flood danger in three high-risk catchments of France. The connection between risk consciousness and physical proximity to danger has attracted the attention of academics recently. Flooding riverbeds, active volcanoes, and earthquake epicenters are all examples of hazards with varying degrees of closeness, as defined by distance from their respective sources (Arias *et al*, 2017). However, studies into the links between physical closeness to hazards and feelings of risk have yielded mixed results. Increased danger information through media and authority or through observable environmental cues may modify the effect of hazard proximity on risk perception in the study area (Lindell & Hwang, 2008). The community is vulnerable since they stay in the hazardous area culminated by frequent floods (Oluoko-Odingo, 2011).

2.3.3 Flood Risk Experience

Direct experience, such as going through a natural disaster firsthand, is one type of experience, while indirect experience, such as hearing about or reading about a natural disaster from a friend or family member, is another. Several studies, including Miceli's in an Italian Alpine valley, Ruin's with people who've experienced flooding, Ming-Chou's with people who've been caught in a landslide, and Paton's with people who've been caught in a volcanic eruption, all show that firsthand knowledge influences an individual's assessment of risk. However, other studies, such as Hall's research on homeowners' reactions in the Oregon coast range, and Scolobig's findings from case studies in an Alpine Region, have shown that disaster experience can reduce individuals' risk perception. According to Wachinger's analysis, people's opinions are influenced by the amount of damage they personally sustained during hazard incidents. Therefore, low-severity and infrequently experienced dangers might provide a false sense of security, whereas only high-severity hazards can increase risk awareness. Education, the media, and eyewitness accounts all count as indirect experience (Wachinger *et al.,* 2013). According to Siegrist, those who have already been exposed to dangers have a minimal reaction to news reports about them. Nonetheless, Felgentreff contended that residents in the German Odra river basin were prompted by media coverage to reflect about a flood that occurred in 1997. There are two types of experience: first-hand observation and involvement, and second-hand learning and exposure. But other studies, like Hall's research on homeowners' reactions in the Oregon coast range and Scolobig's findings from case studies in an Alpine Region (Hall and Slothower 2009; Scolobig *et al*., 2012), have shown that disaster experience can reduce people's risk perception. The purpose of this study is to determine whether direct experience, such as personal injury, influences respondents' views, and whether indirect experience, such as knowledge gained from books, television, and personal accounts, influences respondents' views.

2.3.4 Flood Risk and Trust

Public confidence in government's ability to mitigate risks is measured by the extent to which people put their faith in those in authority (Choon *et al.,* 2019). An additional hotly contested topic in risk perception studies is how trust affects how risks are perceived. There appears to be a link between trust and the way risks are perceived, according to some research. This study aims to investigate whether or not trust has a role in how people in flood-prone areas evaluate risk and react to it.

2.4 Strategies for Mitigating Flood Risks in Western region, Kenya

Strategies in the reduction of flood risk among farmers in study area can be classified into demographic, institutional, farm, livestock and socio-economic factors, (Chinangwa, 2006). This section also attempts to hypothesize how each of these strategies aid in the reduction of flood risk by providing supporting literature.

2.4.1 Informational strategy for mitigating Flood Risk

Contact with extension agents, availability to loans, and involvement in Farmer's groups were identified as factors impacting adoption in a research conducted in Central Kenya (Ouma *et al.,* 2002). To begin, farmers rely heavily on extension services as a way to gain access to technical information. According to Enyong (1999), one of the most influential variables in Flood Reduction is communication with extension agents. This was due to the fact that farmers who interacted with extension agents were more likely to learn about the Technology and take part in demonstrations. (Tenge *et al.*2004) also finds that participation in farmer groups has a beneficial effect on lowering flood risks. Soil fertility control programs implemented by farmer cooperatives in West Africa had a greater rate of success in terms of new Sustainable Land control techniques being adopted. Credit allows farmers more freedom to invest in pricey new technology like hybrid seeds and fertilizer (Bello *et al.,* 2021). Money and credit constraints are major factors in a farmer's family decisions and the adoption of new technologies. When compared to males, rural African women have less access to financing, making it difficult for them to invest in inputs and implement Sustainable Land Management methods that include contracting out for labor. As a result, research on the role that information play in shaping farmers' approaches to flood preparedness is warranted.

2.4.2 Farm characteristics in mitigating Flood Risk

The study tents to look at main characteristics of the farm found to influence Flood Risk Reduction. The adoption of reduced tillage in Nigeria is found to be positively related to farm size. In West Africa, however, farm size is not found to be a significant factor influencing adoption of SLMT (Adesina and Baidu-Forson, 1995). Similarly, the area of land under food and cash crops in hectares has been found to positively influence adoption decisions as cash crops and food crops can be sold to generate income that may be used to hire labour or purchase fertilizers (Muriu, 2005). The study intents to establish the relationship between the various characteristic of farm that may influence Flood Risk Reduction with the expectation that the community will increase its food stocks and probably generate income from the sale of surplus produce

2.4.3 Socio-economic factors in mitigating Flood Risk

Thangata and Alavalapati (2003) in a study conducted in Malawi identifies socio-economic factors influencing Flood Risk Reduction as farmers' perception of soil fertility, land productivity, increase in ecosystem services as a problem, off-farm income, level of education, ability to hire labour, security of tenure and participation in agricultural training activities. Further, in Southern Africa, found that availability of off-farm employment decreased adoption potential. Moreover, availability of labour was cited as a major limiting factor to Flood Risk Reduction. In West Africa, it was reported that most of the labour in farms was provided by family members and the exodus of the youth from rural to urban areas was noted as affecting the extent to which these adoptions occurred.

Only 7% of farmers in East Africa ploughed crop wastes back into the soil, while only 5% of farmers in Tigray used lengthy fallows, enhanced fallows, mulch, or green manures. Ethiopia's Amhara area have upgraded only a small fraction of their plots. In Uganda, Pender *et al,* 2004) discovered that just 20% of plots had been treated with inorganic fertilizer, manure, compost, or mulch, and 25% had included crop leftovers.

Some technologies, such Contour ridging and Zai pits, are gaining popularity in the Sahel. The number of people engaging in such techniques, such as enriching soils with nutrients, remains low. Farmers participating in the study need to be asked about their current Sustainable Land Management techniques so that researchers may determine the most effective ways to improve environmental outcomes. As such, there is a need to further investigate the impact of inceptives on adoption patterns, integrating and further mainstream them within development.

2.4.4 Household Headship role in mitigating Flood Risk

The concept of the household has been interpreted in several ways throughout the growth literature. Households have been defined as a group of people who share a dwelling and prepare and eat their meals together, whether or not they are related to each other. A household consists of a head, any living relatives, and anyone else who shares the household for economic or social reasons. Additionally, inter-household dynamics focus on difference and similarities on how decisions are made and resources used across male and female headed households. Similarly, intra-household dynamics focus on how decisions are made and resources allocated within a male or female headed household, (Doss, 2013)

(Gladwin *et al,*2002) discovered that the breadwinner or the decision-maker in a home is not sufficient criteria for determining the household's head. They propose one such attempt; they identify four characteristics of family headship: authority, decision-making, economic power, and the right to children in the event of a divorce. She also proposed separating "female-headed" homes from "female-supported" households, the latter of which are characterized only by economic contribution. Having more money means greater responsibility, but it doesn't mean being the breadwinner automatically makes you the head of the household.

(Sharaunga *et al.*, 2016) claim that two distinct categories of female-headed families have been discovered in the research. There are two types of households: de jure households, in which the female head is unmarried or recently divorced, and de facto households, in which the female head is the wife of a male migrant. De facto headship is more transient than legal headship because it is typically assumed by the husband whenever he is physically present. While he is away, important matters still require his attention. When a widowed mother moves in with her son and his family, the situation is a de jure kind. Oftentimes, the married son will honor his mother's wishes and name her as the head of the home. This in no way indicates that she is involved in significant policy decisions. Many countries in sub-Saharan Africa now have a significant percentage of households in which a woman serves as the primary breadwinner. The average percentage of households in Kenya that are headed by women whose husbands work abroad is 47% (FAO, 2001). Both legally and unofficially female-headed households tend to have lower resources available for agriculture due to factors such as smaller land holdings, smaller family numbers, and fewer agricultural adults. While previous research has found that female-headed households with limited income are more likely to adopt technologies with low resource requirements (Mudhara *et al*., 2006), the results of the current study suggest that income level does not reliably predict whether a technology will be adopted, rejected, or abandoned.

Knowledge Gaps identified

Based on the evidence presented in this literature review on the flood risk problem in Africa, and particular in Western Kenya, it is apparent that concerted efforts are required to reverse this situation. A lot of work has been done in western Kenya with a view to introducing and educating farmers on Sustainable Land Management Technologies such as agroforestry and Biomass transfer, Cultivation of Bamboo to prevent Soil Erosion, Zai System of Water Harvesting and use of Logs to reduce surface run-off during the rainy season coupled with proper management and application of manure and inorganic fertilizers Mugendi *et al., (*1999). The introduction of these Technologies is done to improve soil fertility, and increase crop yield, improve quality and quantity and availability of water, with the ultimate goal of enhancing food security among farming communities in the area but the extent to which control of runoff at the basin is still wanting.

Second, poor adoption rates have been found in socioeconomic studies of these Sustainable Land Management Technologies (Muriu, 2005). Different socioeconomic factors, including gender, technical advantages, farmers' resource endowments, and biophysical elements of farming, including slope of land and farm/plot size, have been cited as causes for this trend. It is against this background that this study will undertake to investigate how the interactions amongst Land and Water resource users within the catchments could collectively design locally suited incentives to improve their livelihoods and control flooding effect, examine the Flood Risk prevalence among the farmers. Finally, to evaluate the strategies for mitigating Flood Risks in study area and analyze the informational strategy, socio-economic, farm characteristics and demographic factors that influence adoption decisions. As such, the findings of this study are intended to fill gaps in the body of knowledge and provide useful recommendations to future researchers, policy makers, extension agents and project implementers that could inform future actions geared towards increasing the Flood Risk Reduction measures to aid in control of erosion due to Flooding effect.

2.5 Theory and Models

2.5.1 Diffusion of Innovation Theory

Rogers's theory of the spread of innovations was employed for this research. Rogers notes that the adoption of new ideas has been studied for over 30 years, and his book, spread of Innovations, describes one of the most common adoption models. Rodgers' theoretical framework on the spread and acceptance of new technologies has been widely adopted and used in many fields. Rogers (2003) often treated "technology" and "innovation" as interchangeable in his writing because of the prevalence of technological innovations in studies of diffusion. A technology, in Rogers's view, is "a design for instrumental action that reduces uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p. 13). It consists of a hardware component and a software component. Hardware is "the tool that embodies the technology in the form of a material or physical object," whereas software is "the information base for the tool" (Rogers, 2003, p.

A decision to "fully use an innovation as the best course of action available" (p. 177) is an example of adoption, whereas a decision "not to adopt an innovation" (p. 177) is an example of rejection. The term "diffusion" is coined by Rogers, who describes it as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5).

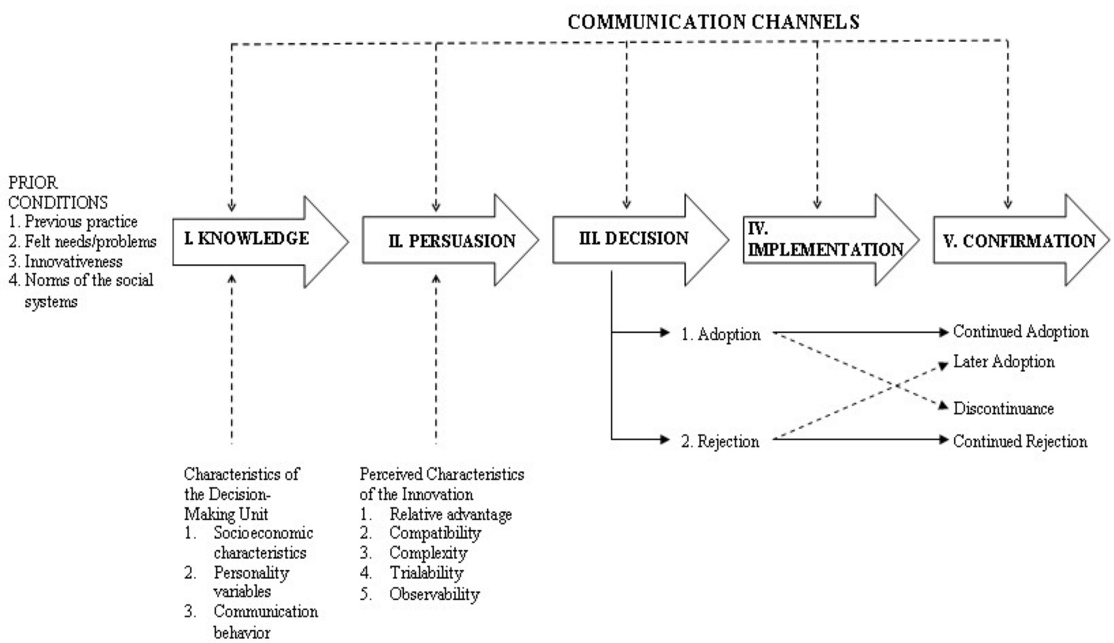

Figure 2.1: A Model of Five Stages in the Innovation-Decision Process
(Source: *Diffusion of Innovations, Fifth Edition* by Everett M. Rogers)

Rodgers's five-stage model for the innovation-decision making process; At the "knowledge" level, a person becomes aware of an innovation and actively searches out more details about it. How, why, and what for? In this step, one tries to figure out "what the innovation is and how and why it works" (Rogers, 2003, p. 21).

Principles-knowledge: Principles of operation that explain how and why an innovation functions are included in this body of knowledge. An innovation can be embraced without this information, but its misuse could lead to its eventual abandonment. An individual's attitudes also determine whether they adopt or reject an innovation, so even if they have all the information they need, that is no guarantee that they will use it.

In the study area, the Sustainable Land Management Technology practiced by farmers is an innovation that has taken different dimension by individuals. Given it is an area that has been researched on by different researchers but still the issue of floods has persisted every time there are adverse rains experienced in the country perhaps this could be taking shape just like Rogers who says as the technology can be adopted or rejected depending on several challenges which this study needs to examine and evaluate. Given most of the livelihood derive income and Sustainability in agriculture then the question of how the adoption rate of the innovation and technology of SLMT in the area performs in control of flood risk is of great concern. The theory and model of diffusion on innovation suits very well in this study on achieving the intended objective of existence on Sustainable Land Management Technology. How the technology will be adopted, why it should be adopted and when was very important for this research.

2.5.2 Pressure and Release Model of Vulnerability

This research examined Blaikie *et al.'s* (1994) Pressure and Release Model of Vulnerability (PAR), which is a simplified representation of the intricate relationships between the underlying social processes that generate vulnerability and the hazard itself. These two opposites are what give the model its foundation. The 'pressure' in this model arises from increased susceptibility to and exposure to dangers, while the ‘release' represents the measures taken to lessen the severity of the disaster by decreasing vulnerability (Blaikie *et al.,* 1994). On the pressure side of the model, the Root Causes are at the beginning of a continuum of vulnerability that culminates in the vulnerabilities caused by particular political and economic ideologies. Those on the margins of society, whether economically, politically, or socially, and who lack power are doubly vulnerable. These communities are less likely to benefit from government assistance and are hence less likely to have stable access to adequate means of subsistence (Blaikie *et al.,* 1994). The following simplified model illustrates the interplay between Vulnerability and Hazards that, when influenced by certain conditions and exposure to the Hazard, results in Risk.

Progression of vulnerability

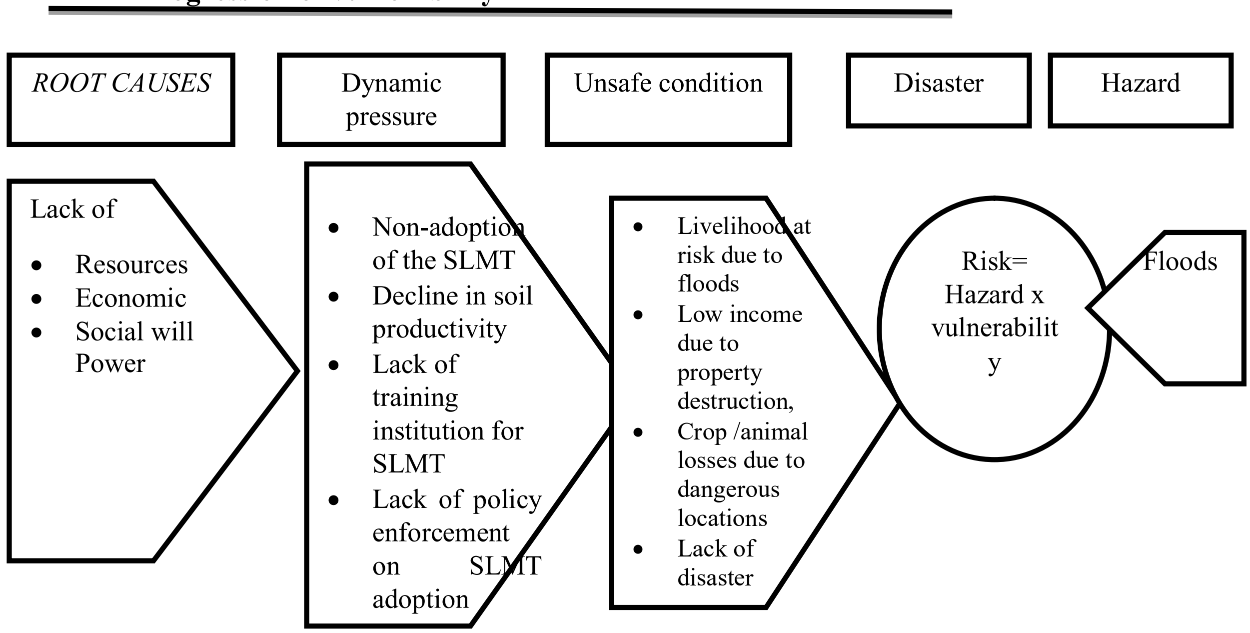

Figure 2.2: PAR Model - Progression of Vulnerability
Source: Modified from Blaikie *et al,* 1994

One of the model's flaws is that it puts too much emphasis on the pressures, or vulnerabilities, and not enough on the releases, or protective factors, that might strengthen resilience and general coping capacities. The comparison of polar forces tends to simplify things too much. Thus, the risk appears to be independent of the conditions that create vulnerability (Blaikie *et al.,* 1994, p.22). Additionally, the model provides a static depiction of vulnerability: the generation of vulnerability is not adequately integrated with the way in which hazards themselves affect people...it exaggerates the separation of the hazard from social processes in order to emphasize the social causation of disasters (Blaikie *et al.,* 1994, p. 46).

The model is consistent with the findings of this study on flood risk assessment carried out in the western region, which relied purely on vulnerability and hazards. There was a lack of coordination between vulnerability creation and the impact of hazards. The research filled a knowledge gap on how risks are perceived by people's behavior experience, trust, and hazard proximity, none of which require disentangling the hazard from the social process in order to emphasize the social causation of disaster. Since Risk is equal to Vulnerability multiplied by the Hazards linked to the community and the exposure of the Risk, the sum of the underlying root causes, dynamic pressure, and dangerous circumstances at the basin, and the subjection of the community to the Hazards is total Risk.

2.6 Conceptual Framework

The independent variables are the SLMT that are adopted and practiced by farmers in the study area. Technologies, such as crop management, cross-slope barriers and water management are linkages to reducing flood risks. Flood risk impacts such as crop and animal losses, livelihood and property destruction and even death are the dependent variables which depend on the uptake of the technology and extent of practicing the technology to help control flood risks. The intervening variables will mediate between the independent and dependent variables. The enforcement of the laws by Government, County, intergovernmental agencies, disaster management policies and even Flood insurance agencies will aid in relieving the pain as they intervene in Sustainable technology. Figure 2.3 shows Conceptual frame work model for the study.

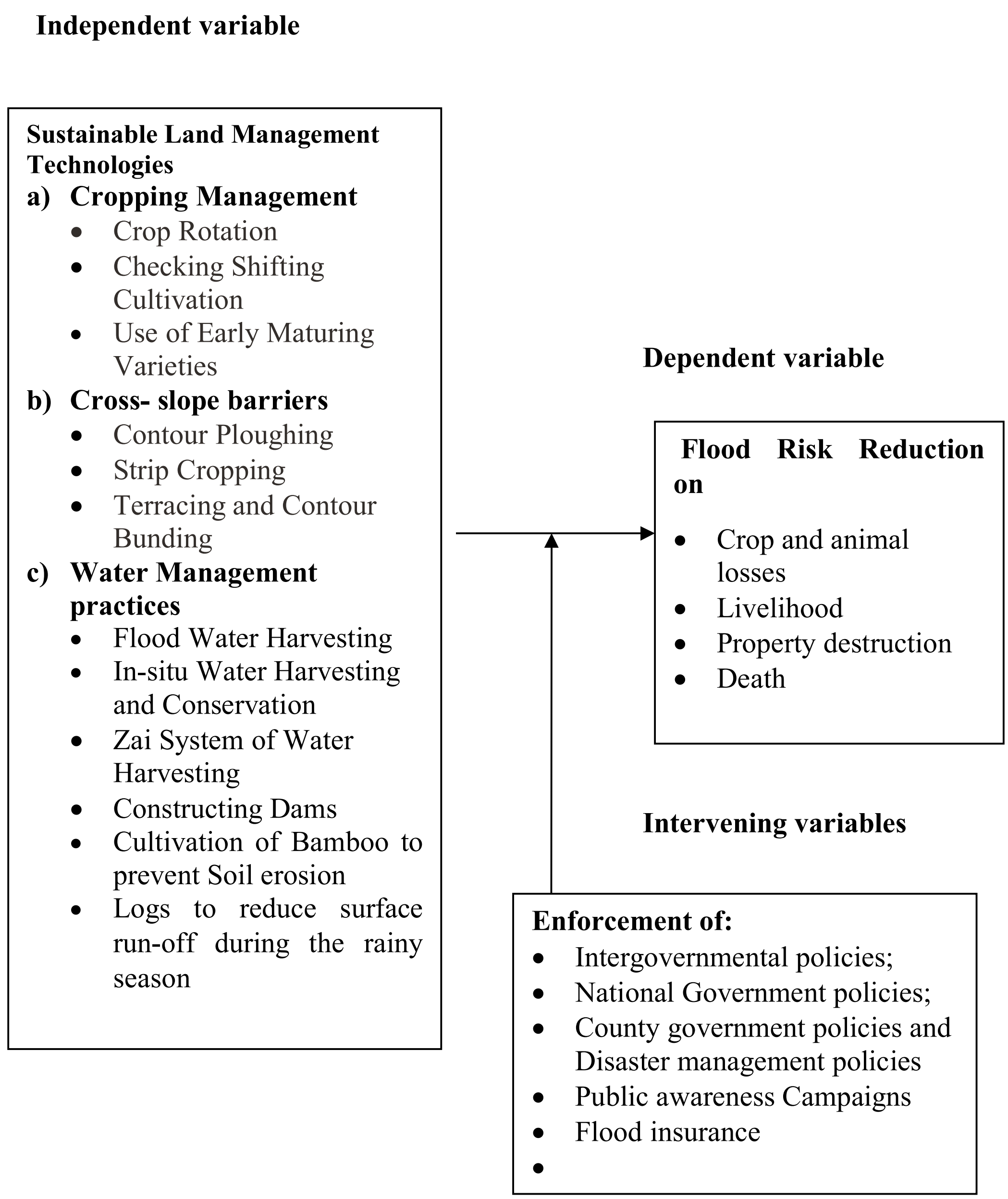

Figure 2.3: Conceptual framework
Source: Researcher, 2022

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section details the study's rationale and methodology, as well as the demographic characteristics, sample size, sampling procedure, data collection strategies, instruments, reliability, validity, analysis, and ethical considerations.

3.2 Study Area

This study was carried out in two sub-county Budalangi and Nyando. Budalangi wards comprised of Bunyala , Matayos, Butula, Nambale , Samia, Teso South and Teso North. While Nyando sub-county included: East Kano/wawidhi; Awasi/Onjiko; Ahero, Kabonyo and Kobura.

Busia County extends from latitude 0º to 0º 45’ North and longitude 33º55’ to 34º25’ East (869.3 km^2) and has 137 km^2 of its land under wetland conditions. Between 33° 20' and 35° 20' East and 0° 20' and 0° 50' South is where you'll find the Nyando Sub-County. Figure 3.1 shows a study map of lower Nzoia river basin and Nyando River basin.

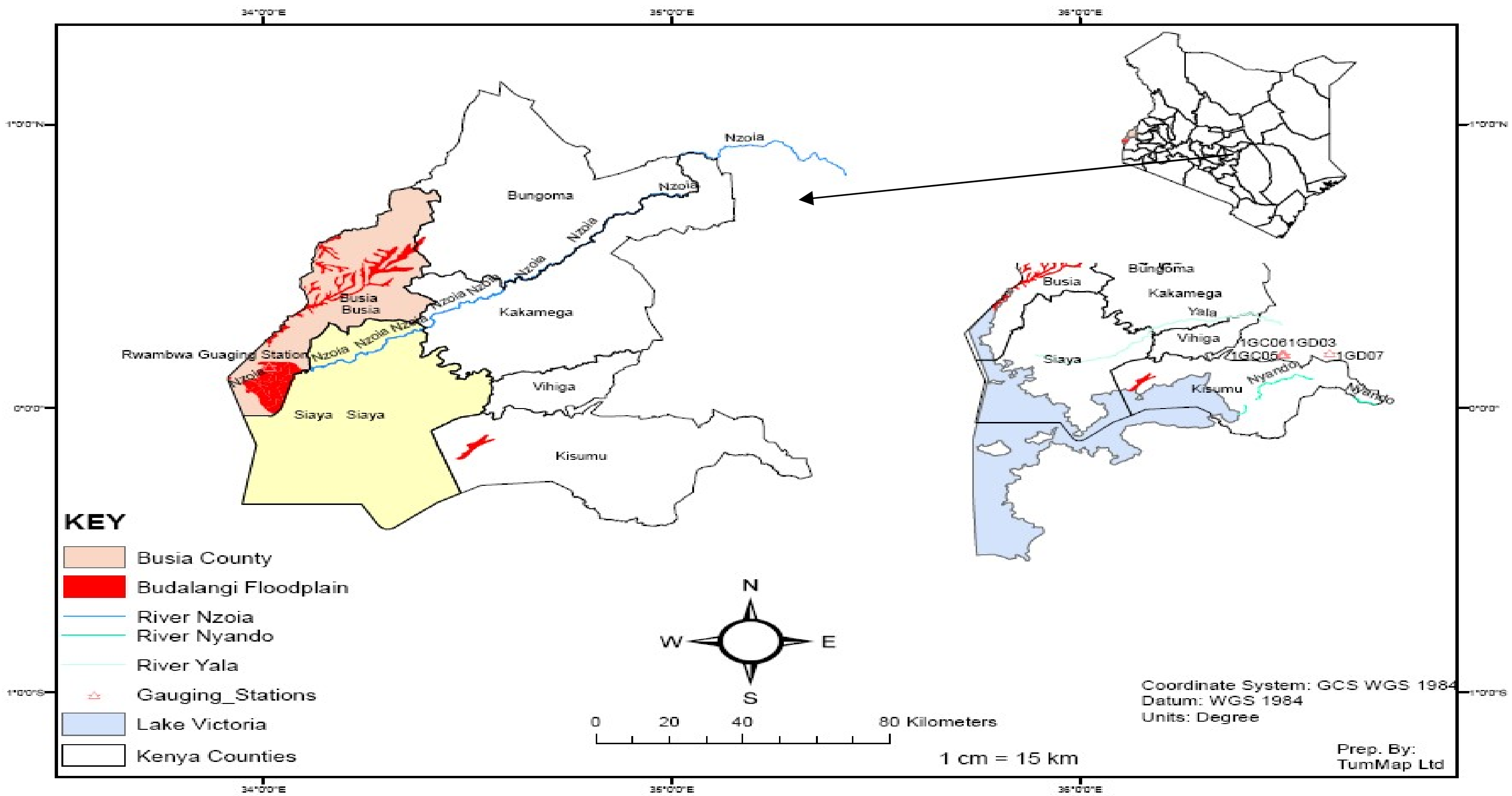

Figure 3.1: Study map of Lower Nzoia River Basin and Nyando River Basin Including Gaging stations

Source: Researcher 2022

3.2.1 Climate of Nzoia Catchment and Nyando plain

Average annual daytime temperatures range from around 16 °C in the higher semi-arid regions of the Basin (around Cherang'ani and Mt. Elgon) to around 28 °C in the lower semi-arid regions. Annual mean lows range from around 4 degrees Celsius in the highlands to around 16 degrees Celsius in the semiarid plains. The average annual rainfall varies from 600 millimeters to 1100 millimeters

The inter-tropical convergence zone (ITCZ) is responsible for bringing four distinct seasons to the region under investigation every year. There are two distinct rainy seasons: a (Roothaert *et al.,* 2003). Normal weather patterns are altered, nevertheless, by the local relief and the effects of Lake Victoria.

The Kano Plains, at 3,356 square kilometers, are a part of the Nyando Basin's overall catchment area of 4484 square kilometers. Seventy-three thousand hectares (ha) make up the Kano Plains, of which thirteen thousand are swamp and twenty-five thousand are planned for paddy irrigation. The 45 kilometers inland from the lake are relatively flat. The channel and dykes are approximately 200-250 m in width. Over time, the river's capacity has decreased due to the buildup of sediment in the riverbed. About 75 kilometers inland, near the border between the Nyando and Kericho Districts, the slope changes and the river widen to a maximum of 40 meters, at which point it periodically meanders. The valley floor is mostly unpopulated. However, most residents farm for subsistence and raise cattle. Highland portions of Kericho District can be found further inland, where a V-shaped canal, high altitude, and steep slopes characterize the landscape. The low plain receives an average of 1260 millimeters of precipitation per year, with a larger peak in the months of March and May and a lesser one in the months of September and November. January and February are the driest months of the year. Lakeshores experience heavy convective rainfall.

3.2.2 Physical and topographic features

Lake Victoria is the primary water source for the majority of Busia County. The elevation varies widely, starting at roughly 1,130 m above sea level near Lake Victoria and peaking at almost 1,500 m above sea level in the Samia and North Teso Hills.

The central portion of the county, particularly the sub-counties of Butula and Nambale, consists of a peneplain characterized by low flat divides of approximately uniform height, frequently crowned by lateritic, and a shallowly incised swampy drainage system. Samia Hills contain banded quartzite and iron stones, as well as acid and sub-acid lavas, tuffs, and agglomerates. While the northern half of the county is dominated by granite, the southern part is home to the Kavirondo series rocks, which can be found in and around Busia, Nambale, and Butula. Large granitic hills and tors, such as Amukura and Chelelemuk, may be found in the northern section of the central region. These outcrops are actually a component of the peneplain. In the south, the range of hills known as the Samia and Funyula Hills can be seen stretching from the northeast to the southwest and ending in Port Victoria. The Yala Swamp, a down warped area linked to the creation of Lake Victoria, covers the southernmost half of the county. A colony of papyrus grows here, interrupted by crooked waterways and the occasional green island formed by a small dam. Lacustrine and alluvial sediments from the Holocene and the Pleistocene cover this area. In addition to the Malakisi and Sio rivers, the Funyula and Nambale sub-counties also have access to the Malaba and the Central Region's northern entry. Budalang'i Sub-county serves as the outlet for the River Nzoia, which flows into Lake Victoria.

Kano Plain, on the other hand, is around 300 kilometers from Nairobi, the capital of Kenya. Kisumu County is where you'll find it. Northern and eastern Nandi Hills, the Nyabondo Escarpment, and the Kavirondo Gulf all border the lowlands. About 3,600 kilometers drain into the Nyando River, which has a discharge of about 15 cubic meters per second. The overall area is around 163 km2, and there are about 73,227 residents. The primary river is the 148-kilometer-long Nyando, which flows through the counties of Kericho, Nyando, and Kisumu. Its catchment area is 2,606 square kilometers. The Aino mutua River is its primary tributary and drains an area of 845 Km^2. The Luanda, Nyaidho, Miriu, and Awach rivers are the others. The river system begins in the highland districts of Kericho and Nandi, which get between 1800 and 2000 millimeters of precipitation per year on average. Upstream in the river basin, the rivers' courses are clearly defined, but downstream in the flatter, lower-lying areas near Lake Victoria, the rivers meander and occasionally exceed their banks before draining into the surrounding swamps. Forests (Tinderet Forests) make up the bulk of the upper catchment's vegetation

All the rivers that travel across the Plains have their origins in the mountains, which get between 1500 and 2000 millimeters of precipitation annually. Drainage in the research area is intricate. The current route of the main river, the Nyando, takes it west through a succession of marshes before emptying into Lake Victoria at a position south of Kisumu, where it meets the Kibos River. A rising papyrus reed region fosters silting conditions and locks up a backlog of waters at flood seasons, further impeding the Nyando's course as it now spills out into the Miruka marsh south of the Plains.

Extreme floods above 850 m3/s imply severe siltation, although the Nyando's flow regime is unpredictable, with lows as low as 2 m3/s. Recent estimations by Lake Basin Development Authority (LBDA) for the years 2000-2003 are fourfold greater than the Italconsult findings, which are in the region of 685,000 tonnes per annum. Experts from LBDA conducted a survey recently and found that the Nyando's peak discharges have decreased. The team's projections for the 25- and 50-year return periods in 2003 are 776 and 879 m3/s, respectively, whereas the figures produced by Italconsult in 1983 were 1100 and 1300 m3/s. However, sediment loading has been found to rise by a factor of three. Two major rivers, the Kibos and the Nyando, flow through the low plain, while the intermediate catchment can be considered vegetative, consisting of trees and grass that have been distributed around. However, this vegetation has been drastically altered by human activities such as clearing, agriculture, and burning.

The Kano Plains, at 3,356 km^2, are a part of the total catchment area of the basin, which is 4484 km^2. With a total area of 73,000 hectares, the Kano Plains consist of 13,000 hectares of marsh and 25,000 hectares designated for paddy irrigation. It's mostly flat for 45 kilometers inland from the lake.

3.2.3 Ecological Conditions

Northern and central Busia County are covered in dark clay soils, whereas the rest of the county has sandy loam. Sandy clays and clays are two additional types of soil. The northernmost parts of the county have an ideal topography for growing both food and cash crops like tobacco and cotton. Teso South's lower northern region, including sections of Nambale, Butula, and Amukura, is ideal for growing maize, robusta coffee, and sugar cane. The county's central and southern regions are ideal for growing commodities like corn, cotton, and vegetables. Samia and Bunyala counties' lowlands have drainage and irrigation needs, respectively, whereas substantial sections of Bunyala county at the rivers' low points have irrigation and drainage issues (Masibayi, 2011). There are essentially four main regions within the basin: Most farming takes place in flood-prone areas and transition zones that are low and swampy; the mountain zone is forested but suffers from significant soil degradation.

Soils of the Kano plain are ideal for growing rice since they are recent alluvial, medium to heavy clays with poor drainage and structure. The National Irrigation Board is responsible for managing two irrigation schemes: a. Ahero, which covers 860 hectares (ha) and has 490 tenants using pumped water from the river Nyando, and b. West Kano, which covers 810 hectares (ha) and has 500 tenants using irrigation water pumped from Lake Victoria and drainage water pumped back to Lake Victoria. The Nyando River, which flows across the Kano Plains and floods a major section of the lower plains, is the worst offender. Most of the Nyando River basin's vast catchment areas are located in very rainy climates. Large marshes can be found near the mouths of major rivers. The silt and suspended particles collected in the catchment areas are being dumped by the rivers. The river in the basin has overflowed due to decades of siltation. The riverbed is rising due in part to the recent construction of a few small embankments. (Kiluva, 2007)

3.2.4 Natural Resources and Sources of Livelihoods

Budalangi sub county has population density of 286 (persons/Km^2). Main economic activities are maize, sorghum, and fishing farming. The area has great potential for irrigation but the government has not put much effort in assisting the local residents set up irrigation project this is in accordance with Busia County development plan 2015.

More than 90% of the local population relies on agriculture and animals for their livelihood. The farms range in size from 1 hectare to 3 hectares, and are all privately owned. Districts like Trans Nzoia and Uasin Gishu, on the other hand, are characterized by big commercial farms of 50-100 hectares or more in size. Cash crops include coffee, sugar cane, tea, wheat, rice, sunflower, and horticultural crops; food crops include maize, sorghum, millet, bananas, groundnuts, beans, potatoes, and cassava. In addition to the more conventional methods of raising animals, dairies are also common. (Wetende *etal*, 2018)

Agriculture, tourism, fishing, forestry, mining, and transportation are just some of the industries that benefit greatly from the River Basin's location and productivity. Nzoia Sugar Company, Mumias Sugar Company, and West Kenya Sugar are three of the most major industrial organizations in Western Kenya, and they all rely on this river as their primary source of water for their operations. There are also a great deal of smaller sugar mills (Jaggeries), coffee roasteries, wood-processing facilities, and tea-making establishments. Eldoret, Kitale, and Kapsabet also have manufacturing facilities. Local communities supplement their income from subsistence activities by working in these sectors. Soil erosion and sedimentation, deforestation, flooding, wetland degradation, pollution and solid waste, river bank cultivation, sand harvesting, brick manufacturing, human-wildlife interaction, and the influence of a lack of developed infrastructure on fish farming methods are some of the most pressing issues in the basin. Schell *etal*, (2021)

Kano Plains on the other hand relies on agriculture, fishing, and a diverse economic activity for its economy. The Kano Plains have roughly 50,000 ha of arable land that can be used for farming. Some of the most common crops grown include rice, corn, beans, sorghum, and sweet potatoes. About half of the cultivable area has been converted to paddy farming, using the Nyando and other small streams for additional irrigation. Over bank flows of the river have the potential to inundate a region of around 20,000 hectares? As of 2010, (Ochola*, etal,* 2010). Commercial farming in the Lower Kano Plains primarily entails sugar cane, dairy, irrigated rice, and limited horticulture. Maize, beans, sorghum, cattle, and sweet potatoes are the mainstays of subsistence farming (Ochola, *e tal,* 2010). Irrigated farming is used to generate all of the rice grown in the Kano Plains. The River Nyando provides the majority of the irrigation water, and its periodic floods not only displace large numbers of people but also deposit a great deal of fertile silt all throughout the plain. Some of Kenya's most prosperous sugarcane farms can be found around the northern and eastern outskirts of the Kano Plains.

3.2.5 Communication and infrastructure network

The total length of the county's road network is approximately 1,600 kilometers (km). This includes 169.64 kilometers of paved roads, 591.91 kilometers of gravel roads, and 838.55 kilometers of unpaved roads. However, some of the highways are impassable during rainy seasons due to inadequate drainage. A portion of Busia-

Kisumu and Malaba-, Mombasa are Class A roads in the county, while Busia-Mumias, Busia-Malaba, and Malakisi are Class B roads. Class C roads include Ruambwa, Nangina,Bumala, Machakusi, Amukura, Butula, Class D roads include Nambale-Shibale, Adungosi-Segero, and Sisenye-Sio port. The county is traversed by only 11 kilometers of railroad and is serviced by a single railroad crossing into the Republic of Uganda at Malaba Town. The Kenyan government has identified two corridors for the development of a modern, high-capacity Standard Gauge Railway (SGR) freight and passenger transport system. The completion of Phase 1 (472 km) from Mombasa to Nairobi and the commencement of Phase 2 (490 km) from Nairobi to Kisumu to Malaba in Busia County. There is no operational airfield or airstrip in the county, but there are two ports on the shores of Lake Victoria. The Sio Port in Samia Sub-County and Port Victoria in Bunyala Sub-County are primarily used for fish landings.

3.2.6 Agriculture

Nearly half of the Budalangi population works in agriculture, growing crops like maize, sugarcane, cassava, and beans as well as cattle. Population increase in the basin has outpaced economic growth, leaving many local households vulnerable to hardship, especially in the wake of recent floods. Food insecurity and environmental consequences from widespread land degradation and flooding plague the County, despite its high food crop yield. Sugarcane and rice farming are common sub-county operations in Nyando, both on a small and large scale. However, sugarcane is the main source of revenue in the basin, and it is cultivated in Muhoroni, Miwani, and certain locations within Nyando Sub County. Irrigated rice fields can be found in the lower Nyakach and Nyando regions.

3.2.7 Economy

Farming and fishing are the backbones of Budalangi's economy. According to the Busia County integrated plan, despite the area's high potential for irrigation, the government has not made significant efforts to help local communities set up irrigation projects. When compared to the other 11 sub-counties in the County, Nyando has the eighth-lowest population density. Malaria, respiratory tract infections, skin disorders and infections, diarrheal diseases, and urinary tract infections are common, as are the economic mainstays of rice and oilseed cultivation and fishing.

Diseases such as malaria, lung infections, diarrhea, intestinal worms, and skin infections are common in Budalangi, despite the area being one of the least densely populated in Busia County.

3.3 Study population

The study targeted the following categories of study population in study area. Household heads, local administration, leaders from the various farmers groups, extension officers, disaster respondents, community-based organization, faith based, Non-governmental organization and County executive from KALRO. These categories of respondents were sampled from various Sub-counties within study area. The area of study was purposively selected based on the location of the river of study.

According to the Kenya population and Housing Census (KPHC) of 2019, Busia County has a population of 886,856 (KNBS, 2019). Further the KPHC report indicated that there are 198,152 households in Busia County with an average household size of 4.5. Table 3.1 shows the distribution of population by sub-county in

Busia County. Nyando has a population of 38460 (KNBS, 2019) according to Kenya Population and Housing Census (KPHC) of 2019.

Table 3.1a: Distribution of Population and Numbers of Households by Sub-County in Budalangi, Busia County

Sub county	Population	Number of household
Bunyala	85,645	19,039
Matayos	138,274	33,160
Butula	140,051	32,213
Nambale	111,543	23,892
Samia	107,004	23,884
Teso North	136,804	29,395
Teso South	167,535	36,569
Total	**886,856**	**198,152**

Source: KNBS, 2019

Table3.1b: Distribution of Population and Numbers of Households by Sub-County in lower Nyando Kisumu County

Sub county	Population	Number of households
East Kano	9149	2126
Awasi/Onjiko	35854	8700
Ahero	10824	2396
Kabonyo	2830	628
Kobura	9170	2198
Total	**67827**	**16048**

Source: KNBS, 2019

3.4 Research design

This study adopted descriptive design and was concerned with determining the type and extent of the existing SLMT by farmers in western region Kenya, correlation design which dealt with examining the prevalence of flood risk in Busia and Nyando and evaluation design in the strategies for mitigating flood risks in the flood prone area. The descriptive design enabled the researcher to understand the type and extent of the existing SLMT applicable in the study area.

Correlation design helped in understanding prevalence of flood risk in the study area. The study adopted a mix of qualitative and quantitative methods which makes it possible to pool the strength of different methods through triangulation (Gilbert, *eta l*, 2001). Triangulation helped to minimize specificity in bodies of knowledge while measuring variables and reducing biases that could stem from single methodology (Nachmias *e tal* 1996). The objectives, the variables measured and their corresponding designs are indicated in the Table 3.2.

Table 3.2: Summary of research design as per specific objective of the study and respective measurable variables/indicators for Western region Kenya.

Objective	Measurable Variables/ Indicators	Research Design
Determine the type and extent of the existing Sustainable Land Management Technologies employed by small holder farmers in Western Region, Kenya	• Crop rotation • Seasonal cropping • Agroforestry • Flood water harvesting • In situ water harvesting • Mulching • Zai technology	Descriptive design
To examine the prevalence of flood risk by small holder farmers in Western region, Kenya	• Protective behavior • Exposure • Experience • Trust	Correlation design
Evaluate the strategies for mitigating Flood Risk among small holder farmers in Western Region, Kenya	• Institutional factors • Farm characteristic • Socio economic factors • Household headship	Evaluation design

Source: Researcher, (2022)

3.5 Sampling Strategy

The Busia County has seven sub- counties; based on 30% sampling units as supported by Mugenda and Mugenda (2003) two out of the seven sub- counties have been purposively selected for the study due to the nearness of them to the Flood zones in the lower basin. The sub-counties selected include Bunyala and Matayos. Bunyala had 19,039 household and a population of 85,645 whereas Matayos has 33,160 households and a total population of 138,274, (KNBS. 2019). Nyando has five sub-counties two out of the five sub-counties were purposively selected and this was due to the frequency of occurrence by the floods. The sub-counties selected included East Kano/Wawidhi and Awasi/Onjiko. East Kano had 2,126 households and a population of 9149 and Awasi/Onjiko has 8,700 households and a population of 35,854 population census (KNBS. 2019). The target population was not uniform since all the farmers did not have similar characteristics in terms of Land use, population distribution and land characteristics. As such the main item in the sampling frame for the study was the household heads who were 52,199 in the two sub-counties in Busia and 10,826 in Nyando. Total household for the study area was 63,025. The information for the sampling unit is elaborated in Table 3.3.

The sample size for the households' heads was determined based on Fishers *et al.,* (1983) cited in Mugenda and Mugenda, (1999). In this regard therefore, since the target population is greater than 10,000, the desired sample population was determined using Fisher's formula for sample size determination.

The formula is stated below

$$n = \frac{z^2 pq}{d^2} \text{ -- } 3.1$$

Where: n= desired sample size if the target population is above 10000).

Z= the standard normal deviate at the confidence level of 95% is 1.96.

p = the proportion of the target population estimated to have characteristic being measured is set at 50%

d = level of statistical significance set at 0.05

$$n = \frac{(1.96)^2 0.05 \times ((1-0.05)^2)}{((0.05)^2)} \text{ -- } 3.2$$

n= 384

Table 3.3: Summary of sampling unit as per the purposed random sampled sub-counties from Western Region Kenya

Sub- county	Household heads	Proportionate sampling (Size)
Bunyala	19039	116
Matayos	33160	202
East Kano/Wawidhi	2126	13
Awasi/Onjiko	8700	53
Total	**63025**	**384**

Source: Researcher 2022

Simple random sampling and convenience sampling were utilized to reach each household. Each sub-county's target sample size was calculated by using stratified proportionate sampling, which considered the total number of homes in that area. Mugenda & Mugenda (2003) advocated selecting a sample size of 10% of the target population for key informants when the sample frame is broad and when the number of respondents is expected to be greater than 30. In light of this, the following groups of responders' 10% of responders in each group were chosen at random. Focus group discussions (FGDs) were conducted with a sample of 40 individuals, chosen in accordance with the principles that guide the structure of FGDs, as justified by Stewart, & Shamdasani, (2014), who stated that the conventionally recommended size of focus groups in research is 10–12 individuals. It was observed that focus groups with more than 10 people are too difficult to manage, resulting in less opportunities for people to voice their opinions.

Two focus groups were conducted in each of the four Sub-counties for this study's total of 40 participants. Table 3.4 provides a description of the sampling strategies, sample size, and population subgroups that will be used in the study.

Table 3.4: Summary of sampling method and Sample size, for study population in Western Region Kenya

Study population nits	Busia	Nyando	Sampling unit	Sampling method	Sample size
Household Heads	52199	10826	63025	Multi-stage Random Sampling	384
Famers Groups	60	30	90	Stratified proportionate Random Sampling	9
County Disaster officers	2	2	4	Purposive sampling	4
Civil Society Organizations	100	60	160	Stratified proportionate Random Sampling	16
Chiefs	40	10	50	Stratified proportionate Random Sampling	5
Extension officers	10	10	20	Stratified proportionate Random Sampling	2
Kenya meteorological	15	5	20	Purposive sampling	2
FGDs	2of 10	2 of 10	4 of10	Quota	4

Source: Researcher, 2022

3.6 Data Collection and administration of instruments

The study utilized both primary and secondary data. Various methods were utilized in the process of data collection to meet the objective of study.

3.6.1 Primary Data

The study's principal data gathering instruments were a questionnaire, an interview schedule, and a focus group discussion guide. The primary data for this study came from questionnaires, interview schedules, and Focus Group Discussions, and it revealed the existence and scope of Sustainable Land Management Technologies, investigated the frequency with which farmers face flood risk, and assessed the efficacy of various approaches to reducing flood risk in the study area. Using content analysis, the root reasons were pinpointed, and the methods now in use to address them were outlined.

3.6.1.1 Questionnaire for Household Heads

A pre-tested household questionnaire was used to get information from the household heads. Household Questionnaires used to collect data on all the three objectives of the study. The questionnaires were administered directly to the respondents through face to face interviews by the researcher and the research assistants so as to avoid misinterpretation of the questions.

3.6.1.2 Key Informant Interview Schedules

Interview guides were used to obtain rich and contextual information from Key informants who are major actors and stakeholders in Sustainable Land Management Technology and flood risk reduction from the study area. The key informants were selected purposively with an intention to elicit an incisive and enlightening opinion of potential Sustainable Land Management Technology to enhance flood risk management in the County. Key Informants were mobilized from among various core actors in the management of Floods from the government, NGOs and partners.

3.6.1.3 Focus Group Discussion Guides

In this study, Focus Group Discussion was used to collect data where groups formed were homogenous on the basis of gender and setting of the community. According to Silverman (2009), Focus Group Discussion (FGDs) is defined as semi-structured group discussion that yield qualitative data on the community level by facilitating interaction between participants. Participants in a focus group are able to open up to one another and share their thoughts and experiences in a way that wouldn't be possible in an individual or household interview. The discussion was broken up into small groups of 10 people to ensure it went smoothly. Each group utilized an open-ended question guide to facilitate discussion and data collection.

3.6.2 Secondary Data

Secondary data was synthesized from books, periodicals, journals, newsletters, electronic media (internet) and reports from the Government ministries and the County Development Plans. Sustainable Land Management related publications and articles were reviewed with a view of gathering information on potential Sustainable Land Management Technologies. The review done to support the primary data for this research included journals, internet reports from County and National Government Disaster Sector**;** Ministry of Agriculture, and Kenya Meteorological department.

3.7 Validity and Reliability of Data instruments

3.7.1 Validity of Data Collection Instruments

According to Walingo and Ngaira (2008), validity refers to an instrument's capacity to measure what it is intended to measure. It evaluates whether or not the data collected in the study correspond to the variables of the study. Research findings based on such information are more reliable, applicable, and substantive. Following the advice of (Biddix *et al*., 2009), we pre-tested the preliminary research instruments on a sample of respondents to ensure their readability, internal consistency, and applicability. Data collection tools' face validity, construct validity, and content validity were evaluated with the use of pilot study results.

3.7.2 Reliability of Data Collection Instruments

When an instrument is used on the same respondents over time and the replies are consistent, it is said to be reliable (Drost, 2011). In this research, the Cronbach Alpha Coefficient (CAC) was used to determine the consistency of the questionnaires. The pilot study instrument, including the questionnaire and interview guide, underwent a reliability test that included all research items with a computable response. The pilot sample comprised of residents from Kobura ward and Budalangi ward, and the instruments were administered and assessed by the researcher. In this method, study looked for relationships between responses to individual items and overall test results. SPSS reliability testing showed a CAC of 0.955 for the questionnaire and 0.946 for the interview script. Similarly, if a research instrument's reliability falls between 0.7 and 1.0, it is considered credible. In the pilot study, participants were asked to rate one instrument for completeness, clarity, and completion time. Both Kobura and Budalangi had high quality internal consistency (0.854 and 0.755, respectively). The results of the pilot study informed the instrument's refinement and the creation of the final version.

3.8 Data Analysis and Presentations

3.8.1 Analysis and Presentation of Quantitative Data

Version 26.0 of the SPSS- Scientific Package for Social Scientists was used to analyze quantitative data. SPSS was used to produce inferential and descriptive statistics, with the latter taking the form of frequency and percentage distributions. Pearson's Product Moment Correlation Coefficient and Multiple Regression Analysis were used for inferential analysis. Bivariate Pearson's Correlation tables were generated using the SPSS data set and an investigation of the Pearson's Moment

Correlation Coefficient. Both the probability values (p-values) and the significance indices (r) were included in the statistics. Analysis for both positive and negative Covariance, Correlation Coefficient (in absolute value) ≤ 0.352= low or weak correlation; 0.36-o.67= moderate Correlations, 0.68-0.89= strong or high Correlations and ≥ 0.9= very high Correlations (Perdices, 2018). SPSS data tables were used for multiple linear regression analysis.

3.8.2 Analysis and Presentation of Qualitative Data

Focus group discussion and interview results were analyzed qualitatively. The data came from participants' written responses to the interview and Focus Group Discussion guide's open-ended questions. Content and interpretive analysis was used to provide detailed explanations and insights on the study's findings. The research items that mirrored the study's aims were identified, and the resulting data were transcribed before being coded and categorized. After the data analysis was completed, a generalization was performed, and the results were presented in narrative form. Summary on methods of analysis used with reference to specific objectives and research design and indicated in Table 3.4

Table 3.4: Methods of Data Analysis used with reference to specific objective and Research designs in Western Region, Kenya

Objective	Measurable Variables/ Indicators	Research Design	Method of Analysis
Determine the type and extent of the existing Sustainable Land Management Technologies employed by farmers in Western Region, Kenya	• Crop rotation • Seasonal cropping • Agroforestry • Flood water harvesting • In situ water harvesting • Mulching • Zai technology	Descriptive design	Descriptive statistical analyses and Chi square test
Examine prevalence of Flood Risk by farmers in Western Region, Kenya	• Protective behavior • Exposure • Experience	Correlation design	Descriptive statistics, chi square test spearman rank order correlation
Evaluate the strategies for mitigating Flood Risk among farmers in Western Region, Kenya	• Institutional factors • Farm characteristic • Socio economic factors • Household headship	Evaluation	Descriptive statistics, chi square test spearman rank order correlation

Source: Researcher, (2022)

3.9 Ethical Considerations

For ethical considerations the researcher acquired permission to conduct research from the university and other relevant bodies. The process of data collection was voluntary based. Respondents were not compelled to provide information they were not willing to give. The confidentiality of the respondents was guaranteed. The permission to conduct research was obtained from the National Council of Science Technology and Innovation after the proposal had been approved and accepted by the Directorate of Postgraduate studies (DPS) of Masinde Muliro University of Science and Technology.

The letter of permission to carry out the research in the study areas was provided by the DPS directorate. To avoid plagiarism all academic work and publications used in this research was acknowledged.

3.10 Limitation of the Study

1. The respondents tended to withhold information due to fear of victimization. This was countered by ensuring them confidentiality.
2. Respondents attempted to give inadequate or untrue information during interviews just to please the researcher. This was handled by the researcher who clearly explained the objective of the study until they were convinced.
3. The researcher had an introductory letter from the university and local administration to assure the respondents that the study was strictly for academic purposes.

3.11 Assumptions

The following assumptions were made regarding the study:

1 Respondents were available when needed and willing to give truthful information about the Sustainable Land Management technologies used

2 The security of the environment was conducive for successful completion of the study

3 Information gathered from the study was to be generalized for other regions with same situation in the country

CHAPTER FOUR

TYPE AND EXTENT OF THE EXISTING SLMT EMPLOYED BY FARMERS IN WESTERN REGION, KENYA

4.1 Introduction

This chapter discusses the findings and presents data on socio-demographic characteristics of respondents. Socio-demographic characteristics such as place of residence, ethnicity, gender, marital status, education attainment, employment and age of household and household income are presented. Furthermore, the results pertaining specific objective number one are presented and discussed under this chapter.

4.2 Socio-demographic Characteristic of the respondents and Flood Risk Reduction in the Western Region Kenya.

4.2.1 Place of Residence in relation to Flood Risk Reduction

With the help of the questionnaire respondents were asked to state whether they stayed in the rural or urban settings. The findings of the inquiry summarized in Figure 4.1, 92% (353) Western region household heads were rural based while 8% (31), were in urban settings. Rural communities are highly dependent on natural resources that are mainly affected by floods. Similar response from each of the two sub counties were also determined 77% (293) Budalangi and 15% (60) Nyando they acknowledge staying in the rural set up while 6% (25) Budalangi and 2% (6) Nyando settled in the urban settings.

These communities face particular common problem of flooding and have had difficulties in responding to the impact. This however stimulated the response test on Sustainable Land Management technology application as a strategy for flood risk Reduction. The study agrees with that of (Murigu, 2022), on land tenure where he focuses on the role the place of residence play in sustainable land management with special reference to Kenyan rural areas. The rural setup determines the adoption or rejection of the technology. People in the rural areas had the potential of understanding the impact of flood risks on the community compared to non-residence. Sustainable land management (SLM) requires the integration of technologies, policies and activities in the rural sector, according to (Dumanski, 1997), particularly agriculture sector to enhance economic performance and maintain quality functions on the natural resource base. The Chi- square test conducted on residence distribution gave (χ^2 0.001=33.33) which shows that there was significant ($P < 0.01$) variation among the residence. This indicates that the higher margins of the respondents are affected by flood risks and therefore they experience the impact of floods. The place of residence is therefore directly linked to adaptive measures that help reduce the impact of floods thereby practicing Sustainable Land Management Technology since most of them are farmers who depend mainly on agriculture for sustainability and food security.

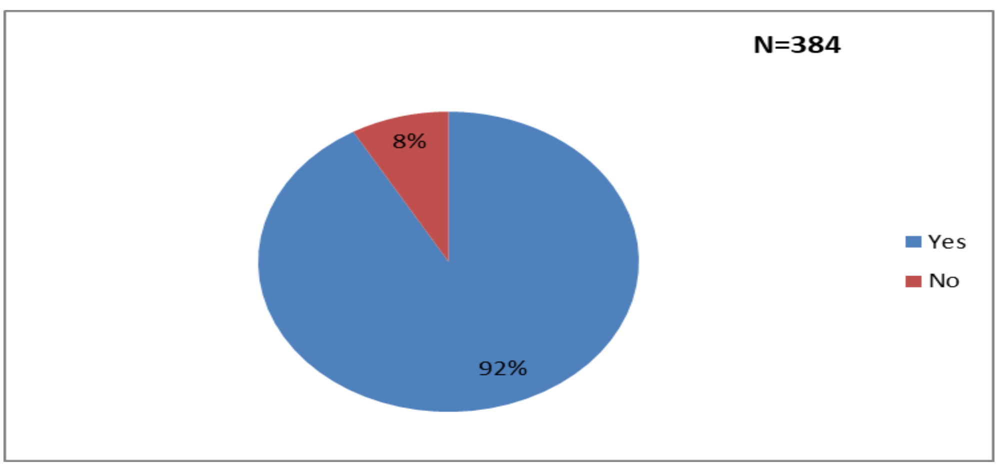

Figure 4.1: Household heads residence distribution in Western Region, Kenya
Source: Field data (2022)

The response by the FGDs from Nyando indicated that they had very few non - residence 2% of 8% of the total above this was due to the nature of small pieces of land that could not allow settlement. The response agrees with (Dovey *et al.*, 2020) on his study on morphogenesis of informal settlement as a practice of adaptation to the forces of real urban conditions and hence forcing those in the rural areas to acquire the technology that will help in flood risk reduction.

4.2.2 Gender and Flood Risk Reduction

The term gender refers to the socially- constructed roles behavior, activities and attributes that a society considers appropriate for a person based on his or her assigned sex at birth. Most of the household respondents were female as they comprised of 51.0% (196) western region respondents and male 43% (165). Similarly, 42% (162) Budalangi and 9% (34) Nyando indicated female percentage while male respondents from each of the sub county accounted for 34% (131) Budalangi and 9% (34) Nyando. Chi-square test conducted on gender gave (χ^2 0.56=0.333) which showed that there was no significant (P> 0.05) variation among household on gender distribution. Figure 4.2 shows the results.

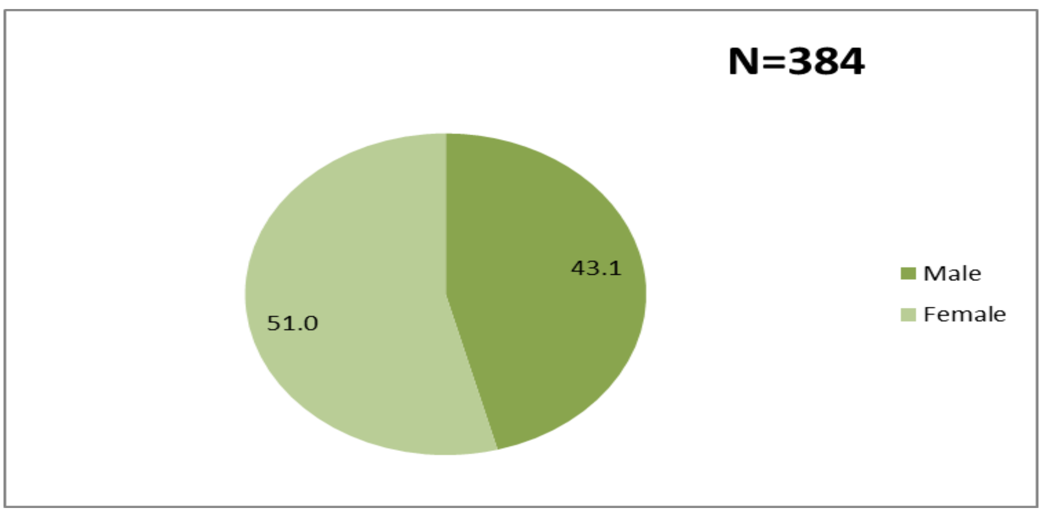

Figure 4.2: Household heads gender distribution in Western Region, Kenya
Source: Field data (2022)

Similarly, participation in the focus group discussion and interviews were comprised of both gender with equal representation. Understanding the gender implication and facets of natural disasters on sustainable development is critical in to effective flood risk reduction practices that enable communities and countries to develop resilience to disasters. All women, male, boys and girls do not face the same needs and vulnerabilities in the face of flood risk as natural disasters, there are different within each group and between individuals regarding specific protection concerns and capacities (Adan, 2018). Gender plays a very important role in management of disasters by practicing sustainable development technologies. The study disagrees with the one conducted by Mwakubo *etal,* (2004) who recorded that many households in sub-Saharan Africa were headed by males. The high percentage on female respondent is attributed to the fact that mostly women in the community are looked upon as people who should remain at home while their counterpart male has gone out on employment opportunities. The findings on female being more significant on the issue of accessibility during the survey is because they are the people who are mostly affected when eventuality happens meaning that they are knowledgeable to issues regarding Sustainable Land Management technologies in disaster risk reduction. These findings agree with those of Mutimba *etal*, (2010) who argued that Kenyan women are Knowledgeable and particularly vulnerable to climate change due to their household responsibilities and gender dependence on weather- sensitive livelihoods. There are however opportunities associated with flood risks due to climate change. One of them is improved technologies to reduce vulnerability and build resilience in key sectors such as agriculture, water and human settlement and access to funding from new financing mechanisms that support mitigation and adaptation action plans. The report continues to say that in order to harness these said opportunities, there is need to incorporate gender perspective into policies, action plans and other measures on sustainable development. This can be achieved through carrying out systematic gender analysis, collecting and utilizing sex disaggregated data, enabling gender sensitive benchmarks and indicators in developing tools to support increased attention to gender perspective. This is supported by (Ruszczyk *et al.,* 2020) in the study on Empowering women through participatory action research in community-based disaster risk reduction efforts where he says there is clear evidence of women's empowerment and capacity building, sustainability of initiatives which depends on the commitment of local authorities to incorporate the initiatives into local policies and actions.

4.2.3 Marital status and Flood Risk Reduction

Over half of the respondents were married as shown by 75% (288) of the household respondents while single was 6% (23). Other marital status categorized included widows at 15% (58) and divorced at 4% (15) in the whole of western region. In the specific sub county responses on the married indicated 62% (238) Budalangi and 13% (50) Nyando while single response gave 5% (19) Budalangi and 1% (4) Nyando. Response on the widow 12% (48) Budalangi and 3% (10) Nyando, divorced were also responded to at 3% (13) Budalangi and 1% (2) Nyando. Chi-square test conducted on household head marital status gave ($\chi^2_{0.00}$=65.16) which showed that there was highly significant ($P < 0.01$) variation among the household head marital status distribution. Among the respondents, the widow, single and the divorced are the most vulnerable to disasters shocks. Figure 4.3 indicates the results

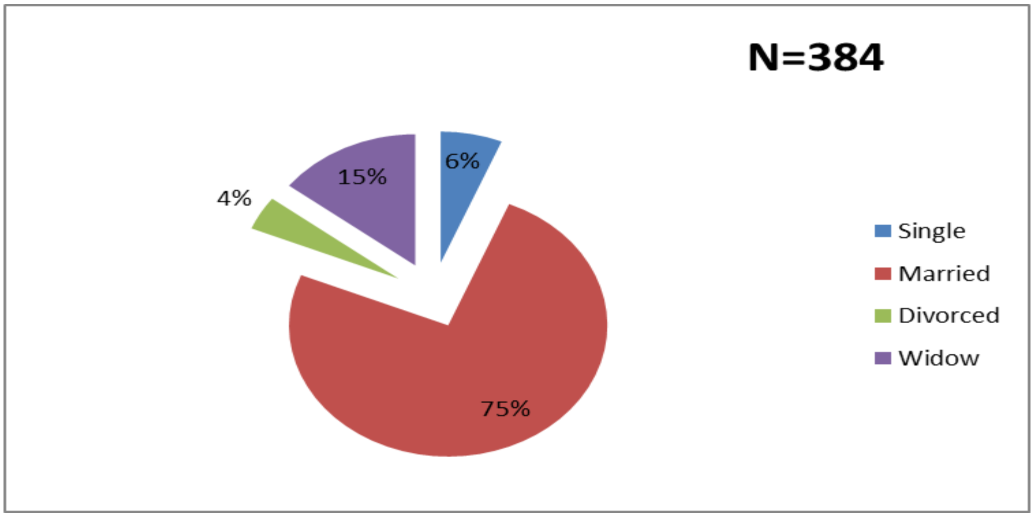

Figure 4.3: Household respondents on marital status in Western Region, Kenya
Source: Field data (2022)

This study is in tandem with (Palm and Carroll, 1998) who asserted that the psychosocial aspects of marriage manifest as a strength among married couples during disaster and even after disasters while the widows, divorced and single families are hard hit by disaster shocks and losses. In terms of making decision regarding disasters, the married make jointly owned decisions in responding to disaster threats by pulling resources and earnings together lessening the burden. The widows and divorced are affected negatively because the burden of raising children and solely in making decision alone considering meager income and emotional needs. Flood risk occurrence adds to their suffering and may not easily recover from the shocks. This study agrees with that of (Bronfman *et al.,* 2019) where it is argued that Natural disaster preparedness in a multi-hazard environment ; Characterizes the sociodemographic profile of those better as the married group and ill prepared for the risks as single who carries the burden of before and after math of the risk solely. The research findings are strengthened by (Rabby *et al.*, 2019) who observed that various social factors such as educational level, poverty, and socio-economic status make communities differentially exposed to the impacts of disaster. To illustrate, marginalized people with lower levels of education, income, and socio-economic status are more likely to be affected by Floods and less likely to recover from disaster effect and hence they require assistance in flood risk reduction mechanism (Ardaya *et al.,* 2017)

4.2.4 Educational level and Flood Risk Reduction

The respondents were asked to state their level of education. Figure 4.4 indicates the results

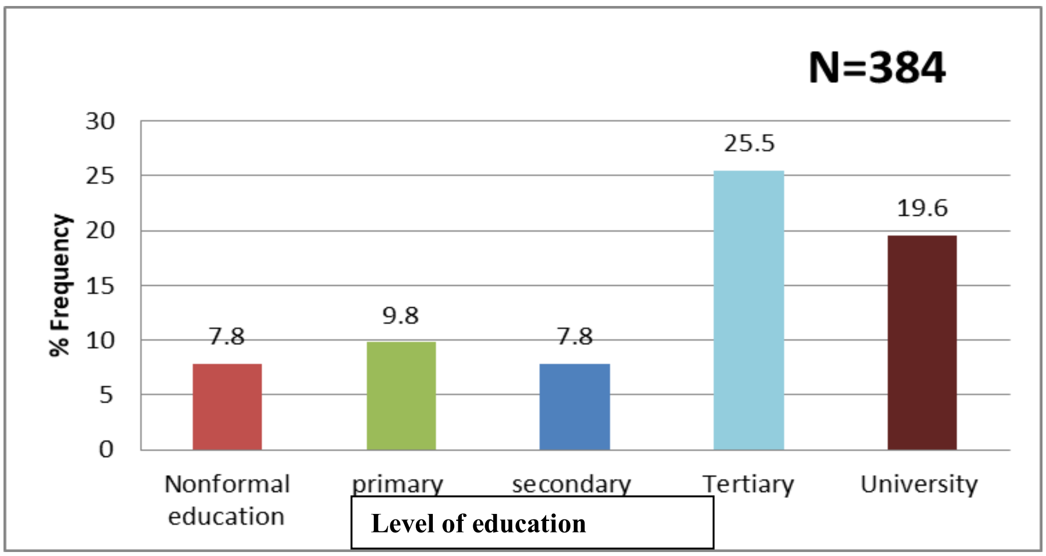

Figure 4.4 Household respondents on Level of Education in Western Region, Kenya
Source: Field data (2022)

Many of the respondents of the household had tertiary level of education at 26% (100) western region, secondary, 20% (77) university level; 10% (38) primary level; 9% (38) primary school dropout; 8% (31) secondary school dropout and primary level drop out at 4% (15) while non-formal education level at 8% (31).

Respondents for respective sub counties on tertiary level 22% (83) Budalangi and 4% (17) Nyando; secondary level 17% (64) Budalangi and 4% (13) Nyando; primary level 8% (31) Budalangi and 2% (7) Nyando; 7% (26) Budalangi and 1% (5) Nyando; primary dropout 7% (26) Budalangi and 1% (5) Nyando. Chi- square test conducted on household level of education gave ($\chi^2_{0.533}$= 1.5) which showed that there was highly significant ($P < 0.01$) variation among household head level of education. Successful adaptation of technology requires people to see the need to adapt, have knowledge about the available options and have the capacity to assess and implement the options. Education in its general sense is a form of learning in which the skills, values, beliefs, knowledge and habits of a group of people are transferred from one generation to the next. The level of education of an individual affects his or her level of vulnerability to disasters since it determines every single step a person takes in his or her daily lives.

This study disagrees with that done by Anyango *e tal*, (2016) who found that educational level of the respondents with non- formal education at (9.8%) and University level at (3.8%) in the same study area. The fewer numbers of those without formal education could be attributed to increased access to education due to free primary and the capitation given to secondary school student. This has enabled many students to pursue education at various levels. The results indicated that education tended to be the single strongest predictor of public awareness of flood risks and Sustainable Land Management Technology, the higher the level of education the greater the number of those who had heard of the technology and the flood risks. This observation is consistent with the work by Ongeko, (2017) who opined that insufficiency of trained and skilled personnel can limit the county's ability to implement the adaptations options. Education and learning can take place in different environments in more or less formalized ways. They can influence disaster vulnerability as the capacity to anticipate, cope with, resist, and recover from natural hazard in direct and indirect ways (Hoffmann & Blecha, 2020), Directly, through education and learning, individuals acquire knowledge, abilities, skills and perceptions that allow them to effectively prepare for and cope with the consequences of disaster shocks. Indirectly, education gives individuals and households access to material, informational and social resources, which can help reducing disaster vulnerability such as those emanating from flood risks.

4.2.5 Employment and Flood Risk Reduction

The respondents were asked to state their employment status and the findings summarized in Figure 4.5. 37.5% (146) were employed and at the same time 37.5% (146) were unemployed while 25% (96) were self- employed. For the specific sub counties results are indicated as those employed 31% (121) Budalangi and 6% (25) Nyando; unemployed 31% (121) Budalangi and 6% (25) Nyando; for the self-employed 21% (79) Budalangi and 4% (17) Nyando responses. The Chi- square test conducted on employment status gave ($\chi^2_{0.21}$= 14.71) which showed that there was highly significant ($P < 0.01$) variation among household head on status of employment.

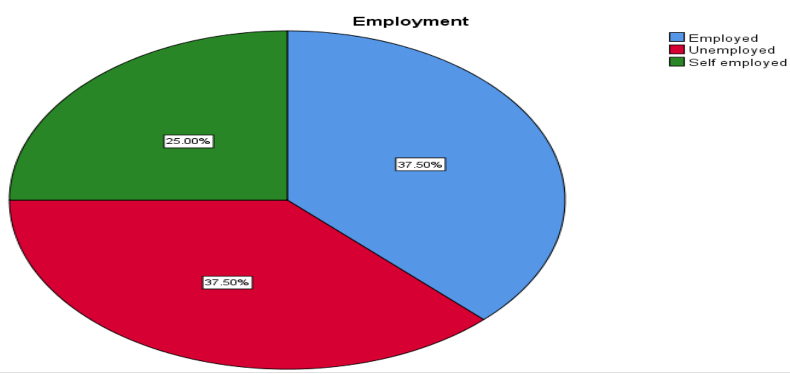

Figure 4.5 Household respondents on status of employment in Western Region, Kenya
Source: Field data (2022)

Access to employment opportunities is a prerequisite for reducing levels of poverty and technology adaption among the communities. Without productive work engagement household cannot generate sufficient income for their basic need and savings. Adoption of the SLMT requires resources which will be limited with only a few people employed. Poverty eradication and awareness, nature-based sustainable land management practices such as SLMT, environmentally friendly agriculture such as Farmer Managed Natural Regeneration supported by the necessary political will and institutions are critical in flood risk management (Adenle *et al.,* 2022). This means therefore that the dependency level is very high and that very little resources can be spared for adoption of new technologies. This makes the unemployed very vulnerable to disaster occurrence. Reduction in agricultural productivity decreases the demand for labor in the agricultural sector, which negatively affects the agricultural wage earnings of rural households (Chowdhury *et al.,* 2022). Moreover, the findings suggest that sustainable land management technologies can reduce the impact of such large shocks if the community can move away from local nonproductive land tenure and adopt the technologies that are sustainable and nature based.

4.2.6 Age and Flood Risk Reduction

The respondents were called upon to state the age distribution of the household. The findings were summarized in Figure 4.6. Majority of the respondents were in the age bracket of 35 and 55 years old as shown by 40% (154); 26 and 35 years, 29% (111); 55-75 years 21% (81); above 75 years at 8% (31) and 15-25 years 2% (8) respondents. The respondents per sub -counties were done on the same on age bracket 35-55 years 33% (127) Budalangi and 7% (27) Nyando; 26-35 years 24% (92) Budalangi and 5% (19) Nyando; 55-75 years 17% (67) Budalangi and 4% (14) Nyando; above 75 years

7% (26) Budalangi and 1% (5) Nyando and 15-25 years 2% (7) Budalangi and Nyando reported zero. The Chi- square test conducted on household age gave ($\chi^2_{0.01}$= 22.21) which showed that there was highly significant ($P < 0.01$) variation among household head on Age distribution. This indicates that 40% of the household heads are below the age of 55 years hence a population in its productive age that can take part in climate change adaptation and disaster risk reduction using Sustainable land Management technologies in reduction of flood risks. The young aged people of 35 years had high levels of awareness attributed to their access to multiple sources of information. The young and the elderly are the most vulnerable group in any given community or society. The study agrees with (Duží *et al.,* 2017) who confirmed in his research that socio-demographic characteristics appear to influence flood risk reduction measures contextually, although a few financial factors corroborate with some literature from other locations, suggesting similarities across contexts. A vast literature analyses socio-economic and demographic characteristic in relation to flood risk reduction with some results matching the findings of the study (Heidenreich et al., 2020).

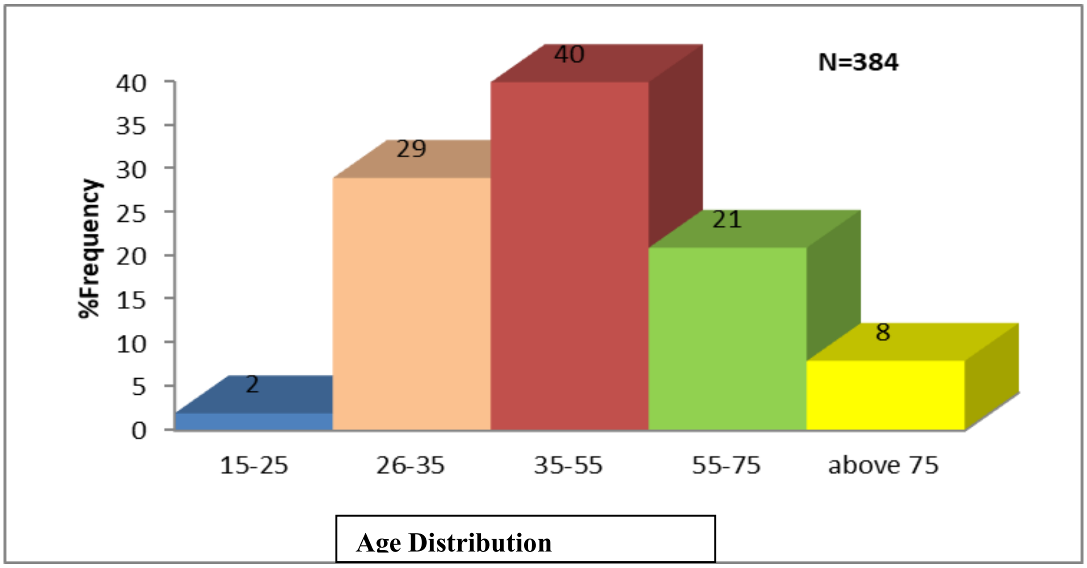

Figure 4.6 Household respondents on Age distribution in Western Region, Kenya
Source: Field data (2022)

4.3 The existing Sustainable Land Management Technologies in Western Region, Kenya

The respondents were asked to choose the kind of technologies that were majorly being practiced in the area of residence. The findings summarized in Figure 4.7.

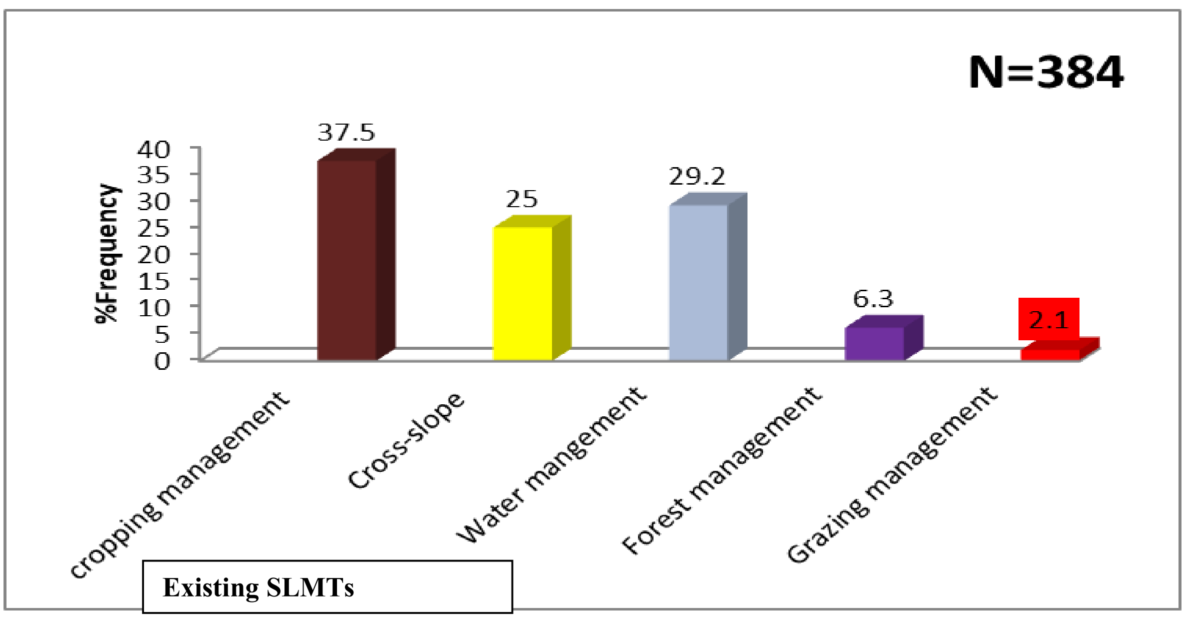

Figure 4.7 Household respondents on existing SLMT practiced in Western Region, Kenya
Source: Field data (2022)

For the respondents 37.5% (146) acknowledged that they practiced cropping management, 29.2% (111) practiced Water management practices, 25% (96), practiced crop slope barriers, 6.3% (23), forest management at 6.3% (23) and 2.1% (8) got involved in grazing management practices. Break down results for each of the sub counties were also recorded; cropping management, 31% (121) Budalangi, 6% (25) Nyando; water management 24% (92) Budalangi, 5% (19) Nyando; crop slope barriers 21% (79) Budalangi, 4% (17) Nyando; Forest management 5% (19) Budalangi, 1% (4) Nyando; grazing management 2% (7) Budalangi, 0% Nyando (1). The Chi-square test conducted on SLMT existence indicated ($\chi^2_{0.00}$= 22.21) which showed that there was highly significant ($P < 0.01$) variation among existing SLMT employed by farmers. The results agree with those of GoK, (2015), which indicated this SLM technology was promoted because it enables efficient utilization of soil nutrients, serves to control pests and diseases and helps to diversify crop production. Some of the projects promoting crop rotation are KACP, CA-SARD, STEP, and linking soil fertility and improved cropping strategies to development interventions project as per GoK, (2015). From the results as depicted in Figure 4.7 it is evident that most common conservation agriculture technologies include zero tillage, minimum tillage, and use of cover crops. Furthermore, planting cover crops was more preferred across the projects because there were minimal and relatively affordable input requirements compared to zero/minimum tillage. Minimum tillage required use of herbicides and certain farm implements such as jab planters and rippers which were perceived to be costly by farmers (Kienzle *et al.,* 2022). However, the results obtained from Kenya SLM baseline report of 2010 indicated that it was only practiced because of increase in soil fertility that enhanced maximum productivity. This study looked at the way SLMT could reduce flood risks. Perceived profitability is a key factor in explaining farmers' decision to adopt or not adopt sustainable land management (SLM) technologies. Data are taken from the World Overview of Conservation Approaches and Technologies technology database on how the SMLTs are useful in flood risk management (Nigussie *et al.*, 2017) who agrees with the findings in the study. One of the key informants acknowledged that indeed for the farmers who had accepted the SLMT faced minor challenges from flood risks as opposed to those who never adopted the technology and practiced it.

4.3.1 Ranking the Existing Sustainable Land Management Technologies practiced

The respondents were asked to rank the existing SLMT practiced by residents. The results were summarized in Figure 4.8. Majorly 58.8% (227) acknowledged to have slightly practiced cropping management, 29.4% (111) practiced water management technology and cross- slope was extremely practiced at 3.9% (15) and forest management was never practiced at 2% (8) respondents. Results for each sub county were obtained as follows cropping management 49% (188) Budalangi, 10% (39) Nyando; water management 24% (92) Budalangi, 5% (19) Nyando; cross slope barrier 3% (12) Budalangi, 1% (3) Nyando and forest management was little practiced at 2% (8) Budalangi. The Chi-square test conducted on rating SLMT practiced indicated ($\chi^2_{0.00}$= 46.15) which showed that there was highly significant ($P < 0.01$) variation on rating SLMT by respondents. Similarly, respondents in Focus group discussion had the same opinion that the most practiced SLMT was cropping management since the residents were farmers on small scale. Land users already utilize SLMTs approaches, but there hasn't been enough of an effort to scale them up. It seems possible to take what is learned from local SLM practices and apply it to other similar socio-ecological systems as a means of improving both. Case study authors may exaggerate positive effects and downplay unintended consequences. Incorporating stakeholder perspectives, especially that of land users, may help mitigate this latter effect.

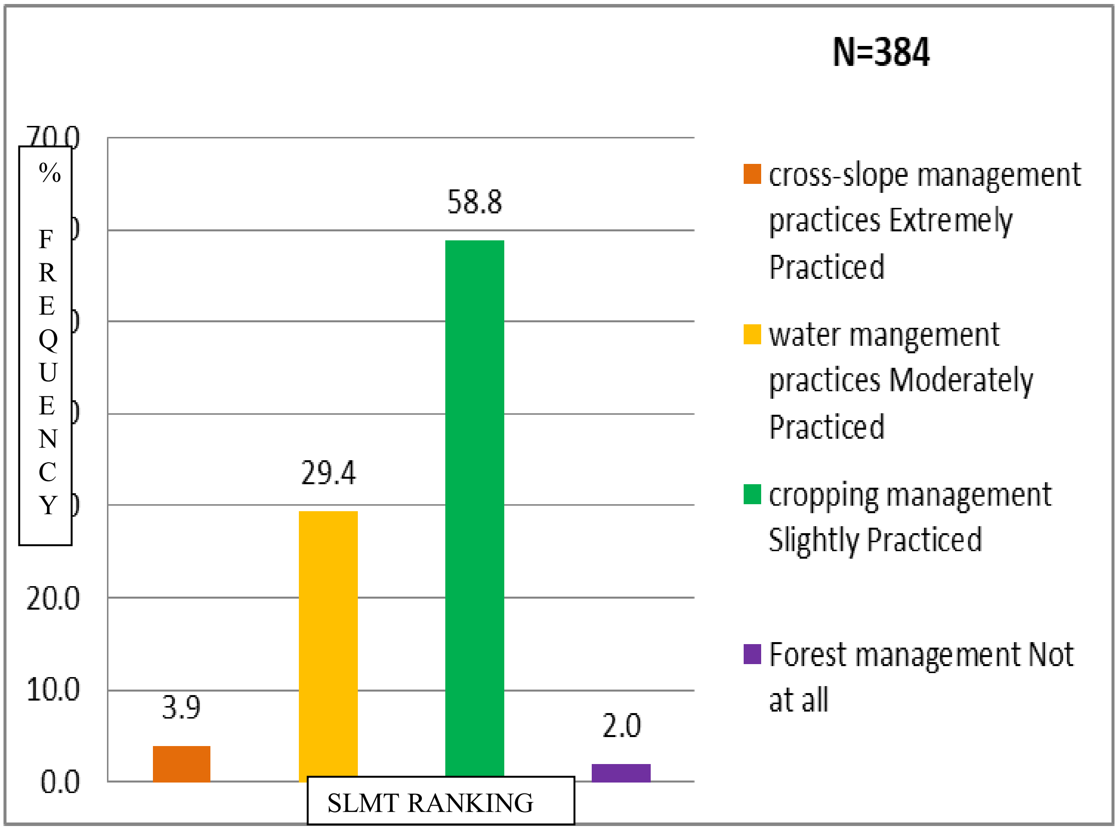

Figure 4.8 Household rating of SLMT in Western Region, Kenya
Source: Field data (2022)

In Chile, peas are consumed as a vegetable, whereas lupines and vetch are consumed as animal feed. All types of legumes are grown as a fodder crop in Turkey and Morocco (Nasir *et al.,* 2022). Fodder legumes provide a number of advantages when used in crop rotation. Their ability to fix nitrogen improves soil organic matter and soil structure for the next growing season. As these crops frequently take the place of a previously vegetated (or even plowed) fallow period, they also greatly increase the soil's cover. Legumes can thrive in dry, rocky, or otherwise impoverished soils thanks to their aggressive root systems (Garrett & Gibson, 2020). Most households practice crop rotation because it is the most known and affordable as opposed to other systems. Though the rest of the SLMT exist in the area response to them by respondents was minimal. The response was backed up by the FGDs and Key informant especially the extension officers from the study areas who acknowledged that crop rotation was being practiced across almost in every household since it was the easiest and famers were planting short seasoned legumes to benefit from the small individual farms as they waited for the main period of planting main itemized crops. The other methods were also available but they were costly and needed more keenness when practicing them hence slow pace of adaptability. Mulching was minimally practiced since most of farm wastes were being fed to animal or being burned (Koul *et al.,* 2022). This agree with the study done on waste management that slash and burn method was a way of controlling waste on the farm as opposed to mulching which uses the remains to conserve the soil. The technologies that help farmers increase output are generally well-known. However, they are hesitant to finance them unless they are guaranteed a ready market for the resulting crop surpluses and this has been a challenge even in adopting SLMT for flood risk reduction.

4.3.2 Effect of Land size on the existing Sustainable Land Management Technologies

The respondents were called upon to rate effect of Land size on existing SLMT. The findings summarized in Figure 4.9. Majority 72.9% (280) of the respondents acknowledged that land size affected highly moderate the existence of SLMT followed closely by moderate effect of 22.9% (88) and slightly moderate at 4.2% (15). Similarly, the results for each of the sub county were also obtained, 59.6% (232)

Budalangi, 12.3% (48) Nyando rated land size effect on SLMT as highly moderate; moderate effect at 19% (73) Budalangi, 3.9% (15) Nyando and slightly moderate at 3.3% (12) Budalangi, 0.8% (3) Nyando. The Chi-square test conducted on effect of land size on SLMT practiced indicated ($\chi^2_{0.00}$= 36.37) which showed that there was highly significant ($P < 0.01$) variation on land size on existing SLMT.

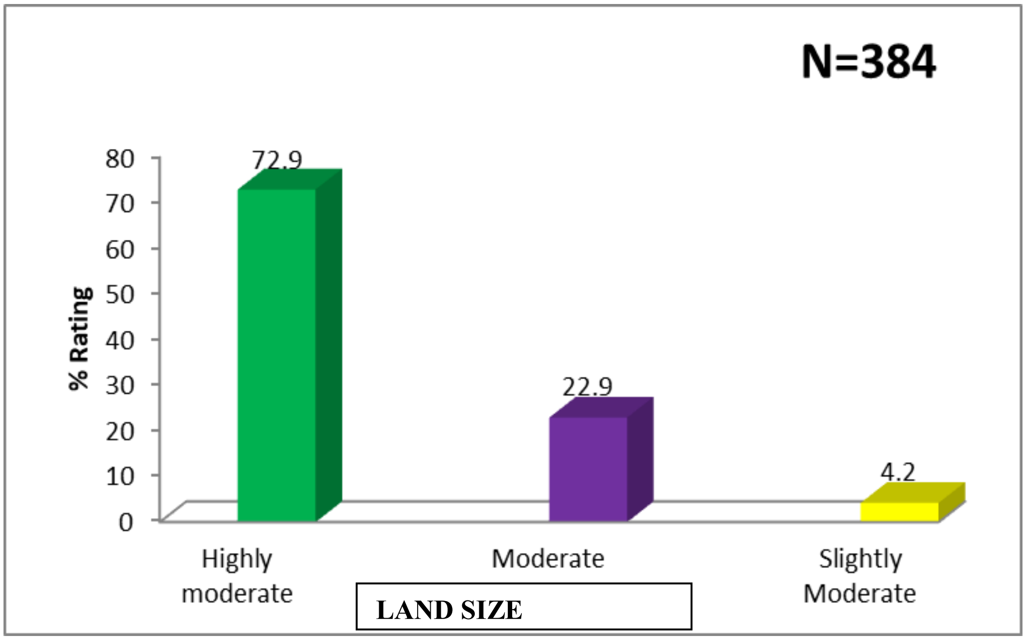

Figure 4.9 Household respondents on Land size on existing SLMT in Western Region, Kenya

Source: Field data (2022)

This indicates that land size is directly proportional to the existence of the SLMT applied. The smaller the land sizes the minimal existence of the technology. The results agree with that of (Wachira, 2009), an evaluation of potential sustainability on SLM Practices. As in most places in Africa, there is a noticeable variation in holding size, but there are very few large farms. For example, in the western Kenya sites, the range in farm sizes within a village is generally small and these affect the existence of SLMT.

A question to the Key informant on whether land size has contributed to the effect of existing technologies in the study area and if so how, generally the sizes of the land has contributed immensely in the working of the existing SLMT which has led to slow adoption of the technology due to land sizes that are too small. One interviewee said that:

> Yes, the existing technology in this area has been immensely affected by the size of the land that household holds. Most of households have very small sizes of land in such a way that practicing the technology in the manner expected is impossible because the sizes are too small and so they mainly just plant using the knowledge well informed to them. (one of the extension officers during the interview held on August 2, 2022 at the County offices in Busia).

Farm size has been found to be positively associated with technology use (Rogers, 1983). Small farms have been said to have a greater likelihood of adopting improved varieties as they are more intensively managed. The adoption of reduced tillage in Nigeria was found to be positively related to farm size at 45%. In West Africa, however, farm size was not found to be a significant factor influencing adoption of soil fertility improvement technologies (Adesina and Baidu-Forson, 1995) at 60% all this contradicts the study.

4.3.3 Effect of slope of the farm land on the extent of Sustainable Land Management Technologies

The respondents were asked to rate the effect of land slope on extent of SLMT. The results were summarized in Figure 4.10. Majority 48.3% (186) of the respondents acknowledged that land slope affected highly moderate the extent of SLMT followed closely by moderate effect of 39.6%, (152) slightly moderate at 12.5% (48) and 4.2% (13) affected slightly. Response per the sub county 39.9% (154) Budalangi, 8.3% (32) Nyando rated slope of the land highly moderate, moderate at 32.8% (126) Budalangi, 8.3% (32) Nyando, slightly moderate at 10.4% (40) Budalangi, 2.1% (8) Nyando and slightly affected 3.4% (13) Budalangi and 0.8% (3). The Chi-square test conducted on effect of land slope on SLMT practiced indicated ($\chi^2_{0.00}$= 22.17) which showed that there was highly significant ($P < 0.01$) variation on land slope on existing SLMT. Water harvesting improvements were mostly governed by the slope (Poredoš *et al.*, 2022), with crop management and cross-slope barriers being the primary means by which this was accomplished. They were able to maximize water storage and handle surplus water thanks to the water management systems they had developed.

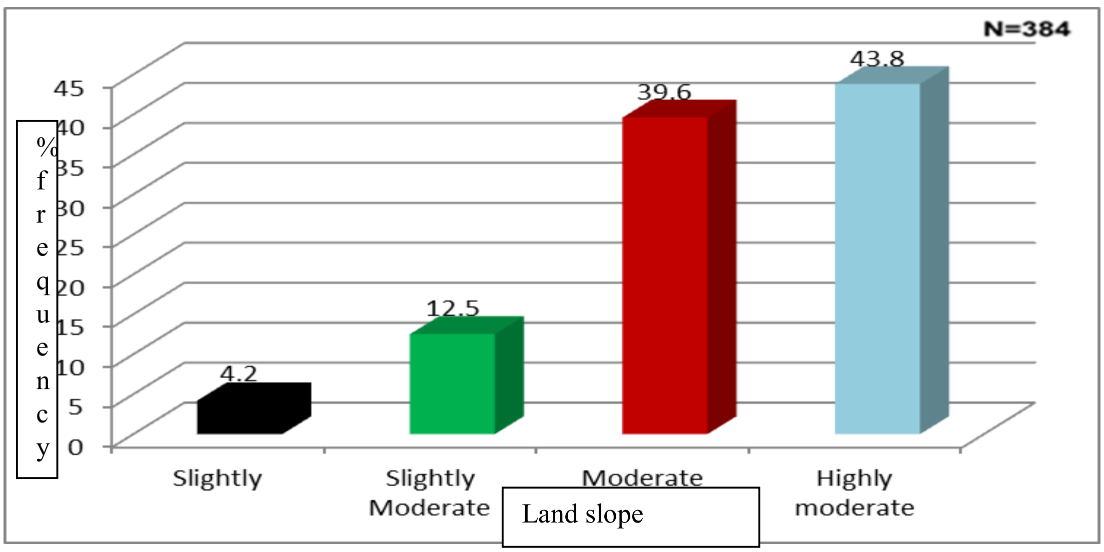

Figure 4.10 Household respondents of Land slope on SLMT in Western Region, Kenya

Source: Field data (2022)

Rapid population growth has resulted in shrinking and increasingly fragmented cultivated lands as well as expansion of cultivated lands to vulnerable hillsides, which has further contributed to a high level of land degradation, low productivity, and greater poverty (Nigussie *et al.,* 2017). Despite numerous efforts to introduce sustainable land management (SLM) strategies and practices, their adoption by the primary target group, small-scale farmers in developing countries, has been Low

(Visser *et al.,* 2019). The response agrees with this study that slope of the land influences adoption of the technology and extent of SLMTs. Responses from some members of FGDs also agreed that the slope of the land influenced technology adoption since due to flood impacts those around sloppy areas experienced lots of soil erosion hence they had to look for the solution to reduce the flood risks.

4.3.4 Fertility status of the farm land on the extent on Sustainable Land Management Technologies

The respondents were called upon to rate the fertility status of farm land and how they affected the extent of SLMT. Results were indicated in Figure 4.11.

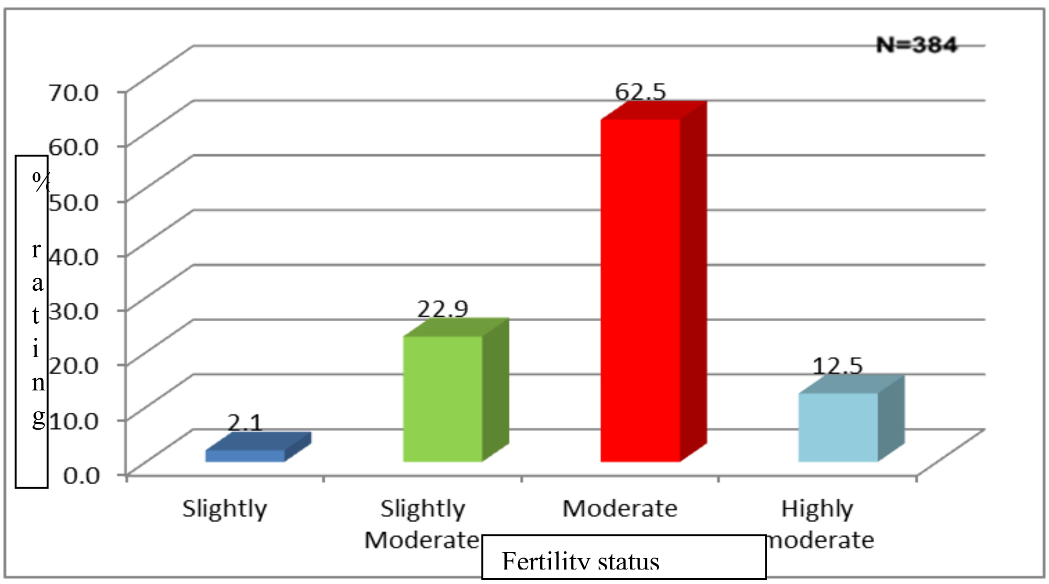

Figure 4.11 Household respondents on Fertility status of Land on SLMT in Western Region, Kenya
Source: Field data (2022)

Majority of the respondents (62.5%) Nyando (240) rated moderately the fertility status of land on SLMT, slightly moderate at (22.9%), (88) highly moderate at (12.5%) (48) and slightly rated at (2.1%) (8). Respondents per sub county indicated moderate rating at 51.8% (199) Budalangi, 10.7% (41) Nyando; slightly moderate at 19% (73) Budalangi, 3.9% (15) Nyando and highly moderate at 1.6% (6) Budalangi and 0.5% (2) Nyando. The Chi-square test conducted on fertility status of land on SLMT practiced indicated ($\chi^2_{0.00}$= 40.17) which showed that there was highly significant (P < 0.01) variation on status fertility of land on extent of SLMT. The most fertile land could not encourage SLMT practices. The response agreement from the key informant and FGDs from both study sites agreed to the fact that:

> Fertility status of land determined the extent of SLMT practiced and chosen. The goals were met by increasing farmers' ability to make informed management decisions and broadening their alternatives for managing resources and crops (Youth FGD Participant during an FGD held on August 2, 2022 at Bulemia village)

Crops are chosen using soil fertility as an indicator, and organic and inorganic production methods are used in a complementary fashion (Tabe□Ojong *et al.,* 2023). The extension officer, who was a primary source, shared these similar goals of encouraging the cultivation of crops adapted to the climate of western Kenya's highlands and guaranteeing access to sufficient quantities of high-quality seed of priority crops and varieties. The findings corroborate the Kenya SLM baseline data of 2010. The fertility status of the land will determine the adoption of the SLMT because the farmer is guaranteed of the productivity from the produce and utilization of the technology will be of beneficial to farmers,

4.3.5 Effect of degree of erosion on the extent of Sustainable Land Management Technologies

The respondents were tasked to rate degree of erosion on extent of SLMT. The results are indicated in Figure 4.12. Majority 39.6% (152) of the respondents acknowledged that degree of soil erosion affected moderately the extent of SLMT followed closely by slightly moderate effect of 31.3% (100) highly moderate at 27.1% (104) and 2.1%

(8) affected slightly. Per sub county response degree of erosion were rated moderately 32.8% (126) Budalangi, 6.8% (26) Nyando; slightly moderate was at 24.7% (79) Budalangi, 6.6% (21) Nyando; highly moderate rating at 22.4% (86) Budalangi, 4.7% (18) Nyando and slightly affected 1.8% (7) Budalangi and 0,5% (1) Nyando. The Chi-square test conducted on effect of erosion on SLMT practiced indicated ($\chi^2_{0.002}$= 15.00) which showed that there was highly significant (P < 0.01) variation on degree of erosion on extent of SLMT. Soil erosion, crusting and sealing, and damage to neighboring fields and public/private infrastructure were drastically reduced thanks to cropping management and cross-slope barriers, although forest and grazing management also played a significant role. This was confirmed by focus groups and interviews with key informants, showing that soil erosion did have a role in determining the magnitude of SLMT as predicted by SLM technology.

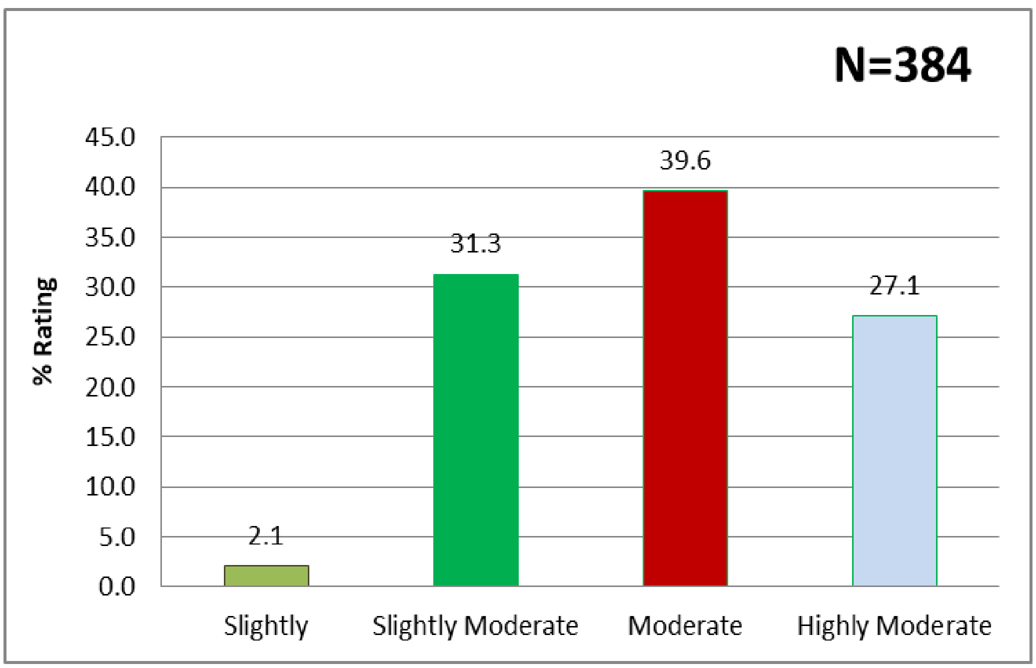

Figure 4.12 Household respondents on degree of erosion on SLMT in Western Region, Kenya
Source: Field data (2022)

The study is supported by (Borrelli *et al.,* 2020) who strongly recommends that potential mitigating effects attributable to conservation agriculture and the need for more effective policy instruments for soil protection will enhance the adoption of the SLMT that will otherwise reduce soil erosion. The degree of SLM is directly linked to the dynamic change in land cover and land use which greatly influence the adoption of the technology and the benefits attributed to the adoption (Xie *et al.*, 2020). This affirms the study that the degree of soil erosion determines the uptake of the SLMT in the study area.

4.3.6 Causes of soil erosion on Farm holdings in the study area

The respondents were called upon to indicate the major causes of soil erosion in the various areas of stay. The results are indicated in the Figure 4.13. Majorly 31.3% (120) stated that the main cause of soil erosion on individual farms was cultivation along the river bank, 18.8% (72) deforestation was the cause, flooding and settlement was at 14.6% (56) each, irrigation overgrazing, and mono-cropping at 10.4% (40), 8.3% (31) and 2.1% (8) respectively. Results for specific sub county; 25.8% (99) Budalangi, 5.5% (21) Nyando indicated cultivation along the river bank was the main cause of soil erosion; 15.7% (60) Budalangi, 3.1% (12) Nyando, deforestation was the cause; 12% (46) Budalangi, 2.6% (10) Nyando showed flood and settlement as the main cause respectively;8.6% (33) Budalangi, 1.8% (7) Nyando irrigation was the causal problem; 7% (26) Budalangi, 1.7% (5)Nyando overgrazing contributed to erosion and 1.8% (7) Budalangi, 0.2% (1) Nyando monocropping was the cause of erosion. The Chi-square test conducted on causes of erosion on individual farms indicated ($\chi^2_{0.009}$= 17.04) which showed that there was highly significant ($P < 0.01$) variation on causes of erosion on individual farms. Cultivation along the river bank was major cause of soil erosion in most individual farms. This response is strengthened by the responses from the FGDs and Key informants who also acknowledged that people have been seriously cultivating on riverine areas making the soils around the area weak thus subjecting the soils into being washed away downstream and so reducing water velocity and increasing sedimentation downstream leading into river meandering. This study response agrees with that of (Akali, 2015) in his study on GIS-Based modeling of land-use Dynamics in River Nzoia Basin Kenya. This study shows clearly that people must avoid cultivating along the river banks by doing so flood risks will be reduced. Deforestation was another important aspect to be looked at since from the previous discussions the response from the study areas people rarely practiced afforestation and these clearly shows that every tree cut down was rarely replaced by one irrespective of the sensitization that had been made early by Kenya SML baseline and other projects too.

Flooding and settlement were the causes of erosion and these shows that flooding and settlement of people along the river banks contributed immensely as a cause of soil erosion. Flooding affected the soils by washing way the top soils leaving them fallow and bare. Settlement will always affect the pattern of stay and this will lose the soil subjecting to erosion by sheet erosion.

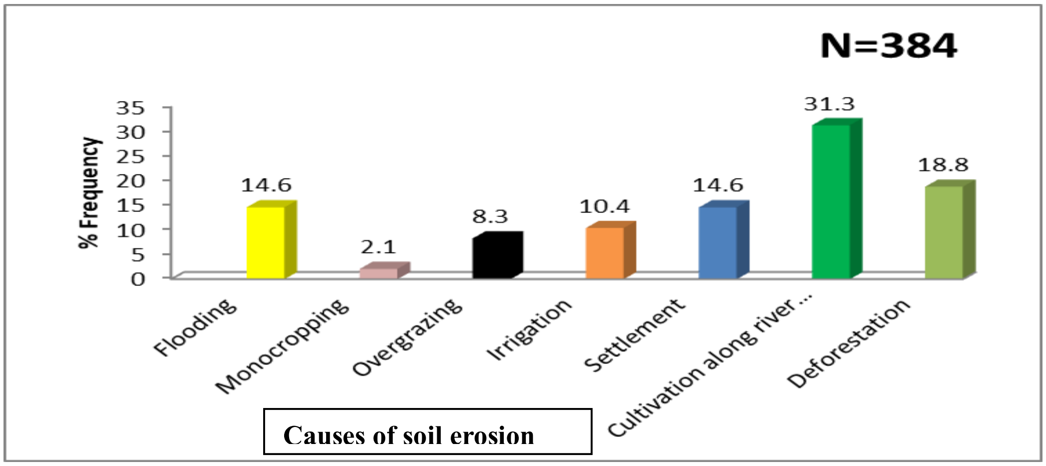

Figure 4.13 Household respondents on causes of soil erosion in Western Region, Kenya
Source: Field data (2022)

4.3.7 Common Water Harvesting Structure used by communities in the study area

The respondents were asked to respond on common water harvesting structures used in the community. The results are indicated in the Figure 4.14. Majorly 59% (227) flood water harvesting was the common method used on individual farms, 29.0% (111) dam construction was rated second, Bamboo cultivation and in situ water harvesting at 6% (33) each respectively. Results for respondents per sub county on flood water harvesting 48.9% (188) Budalangi,10.1% (29) Nyando; dam construction, 24% (92) Budalangi, 5% (19) Nyando; 5.0% (19) Budalangi, 1% (4) Nyando were both for bamboo and in situ water harvesting. The Chi-square test conducted on common water harvesting structures on individual farms indicated ($\chi^2_{0.001}$= 35.17) which showed that there was highly significant ($P < 0.01$) variation on common water harvesting structures on individual farms.

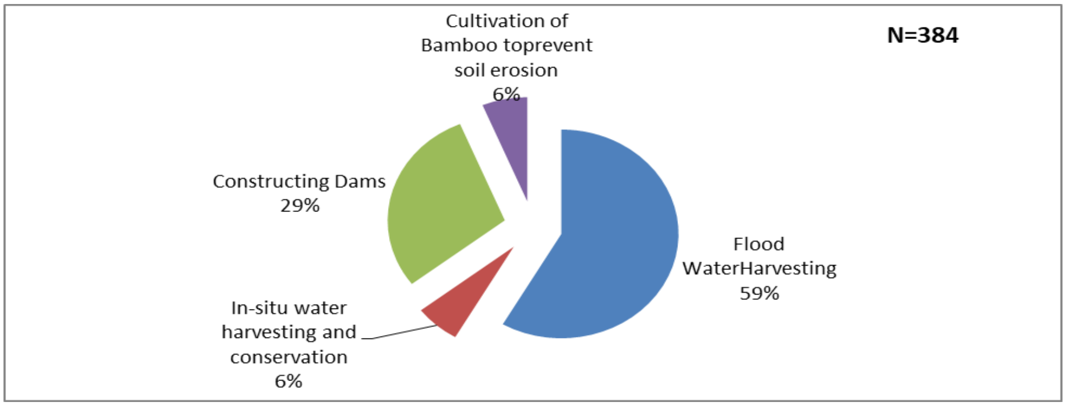

Figure 4.14 Household respondents on common water harvesting structures in Western Region, Kenya
Source: Field data (2022)

Flood water harvesting was rated most because the area has been prone to floods for a long period of time which some were using for important mission of irrigation in areas that needed water. This response is strengthened by the responses from the FGDs and Key informants who also acknowledged that floods have led to loss of property. Due to poverty levels people have become more vulnerable because they live in more hazardous areas prone to floods (Sarkar *et al.,* 2020). Poverty levels affect the resilience and process recovery from disasters. Disaster mitigation, preparedness and prevention needs to address socio economic issues. The findings of this study concur with study by Kandji, (2006) which reported that floods are also a concern for crop production destruction and other properties. Floods constitute a hazard only when human encroachment into flood prone areas has occurred. People have been seriously facing water logging in farms and this has always stalled the working of sustainable technologies and so Flood water harvesting mechanism was of great importance in the area that community expects improvement. The study disagrees with that of (Brown *et al.,* 2022), who argues that the lake basin is intended to return water from irrigated agriculture to the environment but requires comprehensive, accurate water accounting to achieve the objective. Floodplain harvesting the diversion and storage of overland flows into on-farm dams is widely practiced by irrigators. Reducing volumes of river flows, floodplain harvesting has negative effects on downstream water users and the environment. The volume of diversions is not known, creating a major source of uncertainty over water availability and use by the community. The study by (de Sá Silva *et al.*, 2022) on Exploring environmental, economic and social aspects of rainwater harvesting systems agree with findings of this research and that Sustainable water management through the use of RWHSs involves several aspects, such as a decentralization of public water supply systems and assistance in protection against floods (Stephan & Stephan, 2017). A RWHS is one of the ways to diversify water sources and provide greater water security (Marlow *et al*., 2013). This increase in water security represents a sustainable use of rainwater (Toosi *et al.,* 2020) and can assist in minimizing the impacts of climate change, as they can cause a greater number of intense rain showers and a longer period of consecutive days without rain, which can affect water supply services (Li *et al.,* 2017). Therefore, RWHSs can reduce the impacts of climate change and assist in reducing the environmental impact from buildings and cities, prone to floods making them more sustainable.

CHAPTER FIVE

THE PREVALENCE OF FLOOD RISK BY FARMERS IN WESTERN REGION KENYA

5.1 Introduction

This chapter presents results and discussion of the second specific objective of the study which was to examine the prevalence of flood risk by farmers in Western region Kenya

5.2 Duration of stay by respondents in Western region Kenya

The researcher set out to examine the prevalence of flood risk on farmers. The first aspect was to look at the period the residents had lived in the area and the knowledge they had in relation to flood risk. The respondents were asked to state the longevity period of stay in the study area. The findings were summarized in Table 5.1. Majority of the respondents indicated that 52.9% (203) had stayed in the area for over twenty-six years against, against 47.1% (181) who had stayed between 11-25 years. The results for specific sub counties were computed and 43.8% (168) Budalangi, 9.1% (35) Nyando was for over twenty-six years of stay in the area and for 11-25 years 39% (150) Budalangi, 8.1% (31) Nyando. Chi-square test conducted on duration of stay in the area gave ($\chi^2_{0.674}$= 0.176) which showed that there was highly significant ($P < 0.01$) variation on duration of stay in the area by households.

Table 5.1: Household respondents on duration of stay in Western Region, Kenya

Duration of stay	**Western Region**		**Budalangi**		**Nyando**	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
above 26 years	52.9%	203	43.8	168	9.1	35
11-25 years	47.1	181	39	150	8.1	31
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

The Key informants and FGDs participants indicated that most of the residence in the area had stayed for long enough to be able to understand the flood risk and the impact expected from the flood risk. One of the Key informant sentiments:

> the period I have stayed in this Budalangi has taught me enough lesson and I know when the floods are likely to occur and when not. The issue of sustainable land management technology should not be something new to them since they have enough experience (CEC agriculture during the interview held on 12 August, 2022 at the County offices Busia)

Duration of stay in the area provided room for the households within to be able to understand the flood risks they have experienced and be able to predict and find out measures put in place to help them develop resilience. Those who had no experience in terms of years of stay were not able to understand the flood risks as opposed to those who stayed long enough in the area. The findings were also supported by a member of the FGDs who said:

> Majority of the people especially the elderly has the experience of knowing when floods are likely to occur and the impacted expected, but taking the initiative is what is the problem (Youth FGD Participant during an FGD held on August 1, 2022 at Mundika Primary School).

The study agrees with (Ludy & Kondolf, 2012) who articulates that the odds of being flood risk lovers are increased by household duration in the flood zone, size of household, the experience of past flood occurrences and residence close to flood prone areas.

5.3 Knowledge on the concept of Flood Risk

The respondents on knowledge concept indicated they had knowledge on Flood risk occurrence and the impact accompanied by floods results shown in Table 5.2. Majorly the results indicated 96% (369) respondents acknowledged that they understood what the flood risk meant and 4% (15) had no or little knowledge on flood risk. Response per sub counties 79.6% (306) Budalangi, 16.4% (63) Nyando understood the flood risk while 3.2% (12) Budalangi and 0.8% (3) Nyando had no slightest idea on flood risk. Chi-square test conducted on knowledge on flood risk gave ($\chi^2_{0.001}$= 43.31) which showed that there was significant (P < 0.01) variation about knowledge on concept of flood risk by households.

Table 5.2: Household respondents on knowledge concept of flood risk in Western Region, Kenya

Flood risk knowledge	Western Region		Budalangi		Nyando	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
Yes	96	369	79.6	306	16.4	63
No	4	15	3.2	12	0.8	3
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

According to New Jersey Department of Environmental Protection; the probability of floods occurring is multiplied by the value of the assets in danger. The probability of flood threats and the value of the assets at risk together constitute flood risk. This justifies that if people have the knowledge on the risks prevailing then practice of the SLMT that are to help in control of the problem should be embraced with ease (Liniger *et al.,* 2019). This suggests that only after a specific amount of flood knowledge education would the public's perception of the risk of flooding improve. As a result, the government should mandate increased flood education in order to promote sustainability via technological means. The study agrees with (Norén *et al.,* 2016) who articulates in his article Flood risk assessment practices in flood prone areas that defense or flood control is therefore gradually turning into flood risk management where not only the flood phenomenon is considered but also its impact on society and society's vulnerability. A risk management approach also means that measures should be taken and prioritized in relation to the nature and magnitude of the risk. A correlation was carried out to understand how the period of stay and experience on flood risk correlate and spearman moment correlation established and results indicated in Table 5.3

Table 5.3: Correlations between duration of stay and experience on flood risk Western Region Kenya

Spearman's rho			Duration stay	Experience on flood risk
	Duration of stay	Correlation Coefficient	1.000	
		Sig. (2-tailed)		
		N	384	
	Experience on flood risk	Correlation Coefficient	.934**	1.000
		Sig. (2-tailed)	.001	
		N	384	384

** Correlation significant at the 0.01 level (2 tailed).

Source: Field data (2022)

The results in Table 5.3 shows that duration of stay had a strong positive significant correlation with experience on Flood risk in Western region Kenya ($r_{s=}$ 0.934, p= 0.001. The results suggested that duration of stay played significant role on experience towards flood risk in Western region. The more years' people have stayed in the flood risk area the more experienced they have become on the issues of disaster risk reduction. The findings present a major shift in the study area where by households who had stayed more than eleven years and above showed to have more experience on issues preparedness and predictions on impact of flood risks compared to those with less period of stay. This study concurs with that of SLMT baseline 2011, who found out that people who have stayed in the area long enough are well able to understand the risks and management. It disagrees with Innovation diffusion theory by (Rogers, 2003) where he states that period of stay matters not but the acceptance and adoption of the technology is what matters.

5.4 Type of Houses lived by Households

The Respondents were asked to indicate the type of houses they occupied and the results shown in Table 5.4. 98% (376) respondents indicated they lived-in single-family houses and 2% (8) only managed to live in Block flat. Sub county responses were computed. Those living in the single-family houses, 81% (311) Budalangi, 17% (65) Nyando respondents while those in Block flats indicted 1.8% (7) Budalangi and 0.2% (1) Nyando. Chi-square test conducted on type of residences occupied gave ($\chi^2_{0.001}$= (43.01) which showed that there was minimal significant ($P < 0.01$) variation on type of houses lived in the area by households.

Table 5.4: Household respondents on type of houses lived in Western Region, Kenya

Type of houses	Western Region		Budalangi		Nyando	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
Single -family	98	376	81	311	17	65
Block flat	2	8	1.8%	7	0.2	1
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

The results concluded that the residents simply occupied single-family houses because most of them had been affected by impact of flood risks often and any time floods occurred they had to migrate to higher and safer grounds. They simply dwelt on building simple houses that were cheaper and offered safety before flooding season. After the floods subsided, the displaced families returned to their houses. Those whose homes were wiped out in the floods rented new accommodations in the city areas. Due to a lack of resources, this population was unable to return to their original residences. Some families relocated to live with non-displacement-related relatives. (Omungu, 2014). This study agrees with that of (Attems *et al.,* 2020) which indicated that the kind of structures and materials used in construction determines the impact felt by the residents. The houses that bears required building codes according to flood resistance are less likely to face strong challenges of impacts compared to those lacking. The kind of houses and occupancy is determined by the economic and financial status of the families. The outcome of flood risks does not consider the occupancy (Van De Lindt *et al.,* 2020) but it is a natural occurrence.

5.5 Distance to the nearest river lived by the Households

The Respondents were asked to indicate the distance they lived near to the river and results are shown in the Figure 5.1 31.4% (121) respondents indicated they lived about one kilometer near to the river, above 1km and about 500m at 27.5% (106) each respectively and 13.7% (53) lived less than 100M. Response to individual sub counties indicted 26% (100) Budalangi and 5.4% (21) Nyando for those living a kilometer near the river; 22.8% (88) Budalangi, 4.7% (18) Nyando above a kilometer and 500m each respectively. 11.4% (44) Budalangi and 2.3% (9) staying away less than 100m. Chi-square test conducted on distanced lived gave ($\chi^2_{0.300}$= (3.67) which showed that there was no significant ($P > 0.01$) variation on the distance lived by residence near to the river.

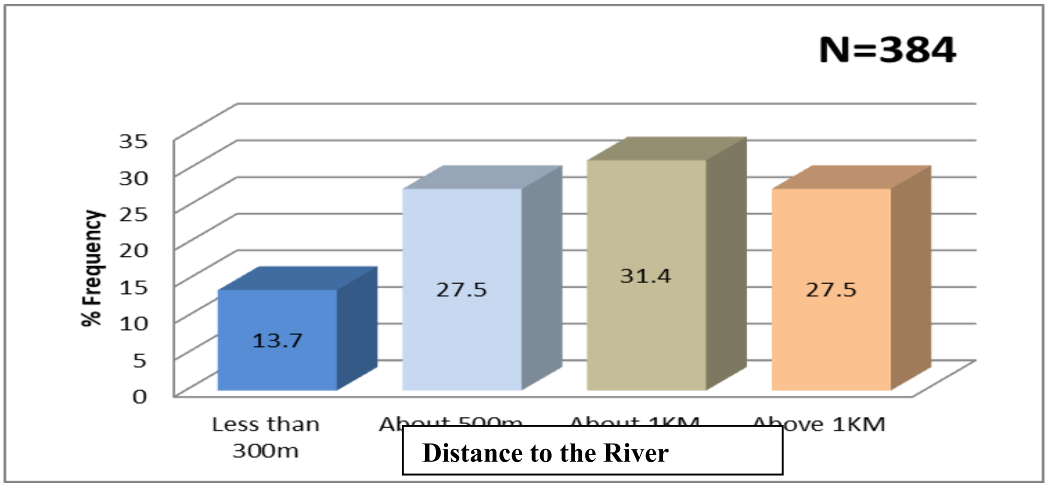

Figure 5.1 Household response on Distance to the River in Western Region, Kenya
Source: Field data (2022)

According to Omungu (2014), the majority of individuals who were forced to leave their houses were residents of the area's lower regions near the river, while the region's non-displaced residents were concentrated in its higher regions. This research confirms the findings of (Omungu, 2014) that the concentration of casualties was highest in areas close to rivers. The research contradicts (Water, 2018), who found that the impact of floods and people's perception of risk were the same regardless of how close or far away the affected area was. People had to find new places to live because their homes either flooded or were too chilly to live in. The distance a home or other valuable was located from the river bank likely determined how long flood waters lingered there. Evidence from the data showed, for instance, that homes located near the river channel were subjected to floodwaters for a longer duration than those located in elevated locations. The length of time it takes for floodwaters to recede may also be affected by factors such as the soil type, the availability of flood drainage systems, and the presence of human settlements in valleys (Omungu, 2014). The findings disagrees with those of (Rafiei-Sardooi *et al.,* 2021) on evaluating urban flood risk using hybrid method and learning where he argues that flooding does not necessarily depend on the distance to the river since flash floods occurs in town and they deadly yet the rivers may be lacking in town,

5.6 Flood occurrences

The researcher set out to find out the flood occurrence on household. The respondents were asked to state the occurrence of floods in terms of years and the experience they acquired; the results are shown in Table 5.5. Majority of the respondents 31.4% (121), indicated floods occurred after a period of (11-25); (6-10 year) 25.5% (98); (2-5 year) 25.5% (98); 1 year 11.8% (45) and above 25 years at 5.9% (23). Results per the sub county indicated in the table below. Chi-square test conducted on frequency of flood occurrence in the areas of stay gave ($\chi^2_{0.0001}$= 75.04) which showed that there was highly significant ($P < 0.01$) variation on frequency of flood occurrence in the area by households. The information contradicted with the one of Key informant and Focus group discussion which indicated that the floods were experienced every after five years and that many people faced lots of challenges.

Table 5.5: Household respondents on frequency of flood occurrence in Western Region, Kenya

Period of occurrence in years	Western Region		Budalangi		Nyando	
	(%)	(f)	(%)	(f)	(%)	(f)
11-25	31.4	120	26	100	5.4	20
6-10	25.5	98	21	81	4.4	17
2-5	25.5	98	21	81	4.4	17
1	11.8	45	9.7	37	2.0	8
Above 25	5.9	23	4.	19	1	4
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

Those who had been through a flood before were more prepared for the next one, knew what to expect, and sought out information about how to stay safe. The most disaster-prone communities were found to have tiny flood control facilities in front of their homes, food storage for the flood season, and mutual help agreements amongst neighbors, all of which were uncovered during field study. Some of the indigenous knowledge on flood indicators were sort. Prediction and early warning is based on the observation of behaviors of animals, birds, insects, shrubs, trees, wind, temperature cloud movement. This study agrees with (Abdulrashid, 2020) article on use of indigenous knowledge in flood disaster forecasting for flood Disaster risk reduction in Northern Katsina state where he also established that prediction and early warning of floods was achieved through indigenous knowledge on observation biotic components behavior in the environment and climatic variables.

Occurrence of extreme climate events is attributed to tropical deforestation and unsustainable land management technologies which had consequences on agricultural systems. From 1990-2020), flood frequency has been increasing and lasting longer as natural forest cover declined in tropical countries (Adan, 2018). Loss of tree cover reduces canopy interception and soil infiltration, resulting in greater run-off during heavy rainfall event. Floods can adversely affect crop establishments, survival, growth and untimely yield.

5.7 Flood-Risk effects

Investigation on flood risk revealed that the household suffered a great deal since it was a major measure that could aid in practicing the Sustainable Land Management Technology adoption or rejection depending on the extent of damage. The study revealed that 43.1% (166) of interviewed households had ever suffered damage to homage; results are shown in Figure 5.2. Most people lost homes whenever floods occurred and were forced to move to higher grounds. The damage to farm land 39.2% (146) acknowledged. Loss of farmland and crops is a strong indicator that people's means of subsistence have been severely compromised in the area under consideration. This is because most people in western region rely on crop agriculture for their income. When flood waters cover farmland, it can never be used for farming again. The households are unable to farm until the fields dry off. The length of time that farmland is inaccessible due to flooding. It takes longer for families to return to farming if it takes longer for flood waters to recede (Devi, 2022).

Those households most impacted are located near the river. Because of the prolonged flooding, their agricultural potential is diminished. Households' interviews revealed that it can take months for flood waters to recede from farmers' fields who live in close proximity to riverbanks. Most families are unable to return to farming quickly after a flood because the mud in the fields prevents cultivation. Some individuals revealed that irrespective of the flood risk still other members were adamant since most of the victims were receiving donations whenever the risks were encountered. When floods destroy farmland, it messes up people's planting seasons, which leads to hunger and financial hardship since people can't afford to buy food (Wells *et al.,* 2020). Livestock losses occur on a regular basis.

On rare occasions, floods have been responsible for the deaths of livestock such as calves and goats. During times of flooding, grass is sometimes submerged under water, leaving livestock without enough to eat. In addition to the cold and crowding, they catch diseases at the evacuation camps. Livestock, starving from a lack of food, often eat the worm-infested grass that grows after floods (Coates, 2007). When taken together, these impacts devastate a society by taking away their means of subsistence.

Households respondents 7.8% (30) showed that relative suffered damages and some never experienced damages, 7.8% (30). While 2% (8) indicated they suffered physical damages. For specific sub counties damage to homage 35.5% (137) Budalangi and 7.5% (29) Nyando; farm land damage 33.3% (124) Budalangi and 7% (26) Nyando; damage experienced by the relative and those never experienced each respectively 6.5% (25) Budalangi ,1.3% (5) Nyando and physical damage experience 1.8% (7) Budalangi and 0.2% (1) Nyando. Chi-square test conducted on frequency of flood risk effects experienced by households gave ($\chi^2_{0.0001}$= 38.90) which showed that there was highly significant (P < 0.01) variation on frequency of flood damages experienced in the area by households.

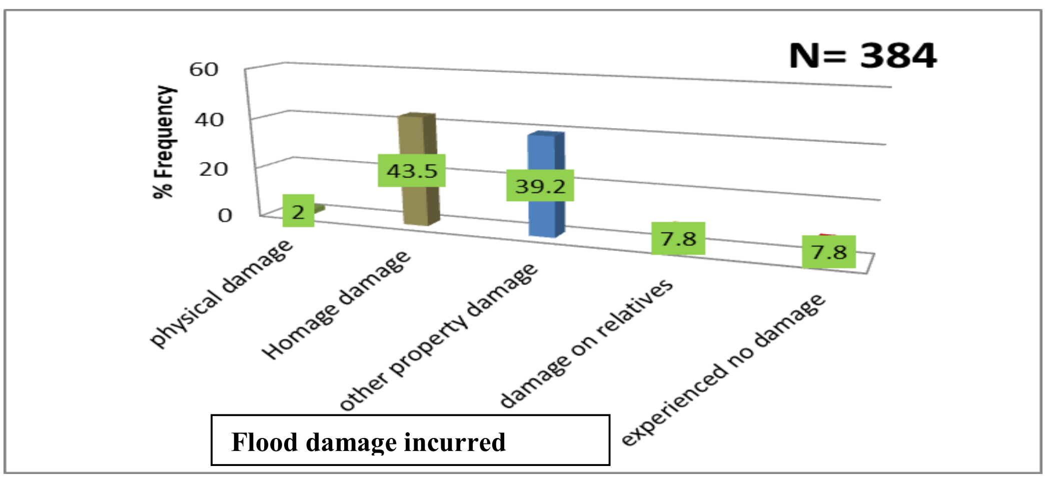

Figure 5.2 Household response on flood damage incurred in Western Region, Kenya
Source: Field data (2022)

5.8 The type of feeling experienced on flood events

The respondents were called upon to state the several feelings experienced in relation to damaged due to flooding. Summary of the findings indicated in Figure 5.3.

Majority of respondents 66.7% (256), indicated they were mostly scared for loss of family member, 13.7% (53) were scared of their own lives and afraid for property damage each respectively, 5.9% (23) weren't scared at all. Results for each of the sub county captured, scared for family 55.2% (212) Budalangi and 11.5% (44) Nyando; scared for own life and property damage 11.4% (44) Budalangi, 2.3% (9) Nyando and those not scared at all 4.9% (19) Budalangi and 1% (4) Nyando. The Chi-square test conducted on feeling experienced on recalling flood events by households gave ($\chi^2_{0.0001}$= 48.05) which showed that there was highly significant (P < 0.01) variation on feeling experienced on recalling flooding events in the area by households. Since many people in the study region had to evacuate their homes, most were worried about the safety of their loved ones. People had to leave their homes because they were destroyed or because the water made it too chilly to live there. After the floods subsided, the displaced families returned to their houses. Those whose homes were wiped out in the floods rented new accommodations in the city areas. Due to a lack of resources, this population was unable to return to their original residences. Some families relocated to live with relatives who had not been affected by flooding.

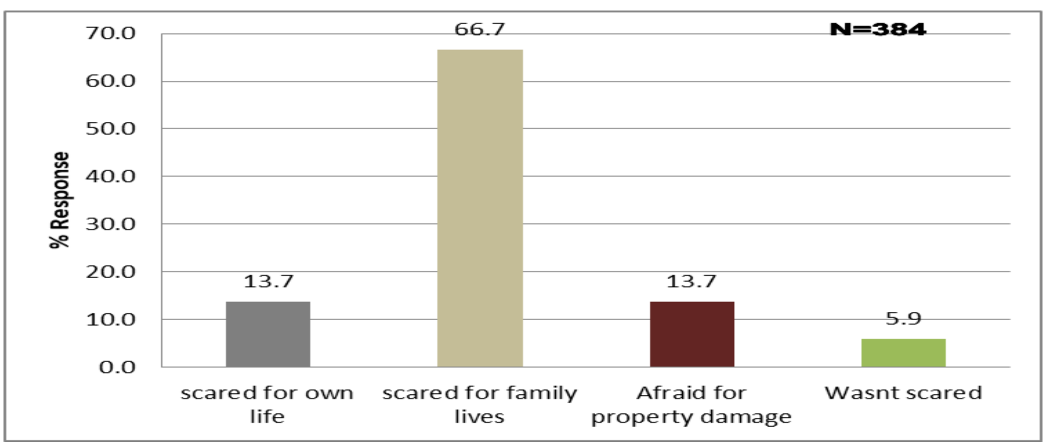

Figure 5.3 Household response on Feeling experienced on flooding event in Western Region, Kenya
Source: Field data (2022)

The displaced population was concentrated in the downstream of the study region, whereas the non-displaced population was concentrated in the upper stream. This study agrees with that of (Omungu, 2014). The Key informants and Focus group discussion had similar sentiments that actually people were afraid of losing lives of their family members as opposed to other losses. However, Loss of agricultural products was also a sentiment where Key informant extension workers indicated that after flooding food security is always affected and most families have no food hence starvation is high. This therefore means that Sustainable Land Management technology when practiced ends up providing a solution to the Flood risks. According to the environmental and sustainable development benefits of SLM are numerous. Adaptive management, incorporating land users and other stakeholders to use local knowledge, and paying attention to competing aims at the landscape or watershed scale all increase the benefits (Reed *et al.,* 2016).

5.9 Access to early warning information on flooding

The respondents were asked if they were in a position to predict an event in advance before the eventuality strikes. Findings summarized in Figure 5.4. Majority 88% (338) indicated they are able to predict an event while 12% (46) had no knowledge of how to predict the event. Response for each of the sub county 73% (280) Budalangi 15% (58) Nyando acknowledged they are able to predict an event while those unable to predict an event 9.9% (38) Budalangi and 2.1% (8) Nyando. The Chi-square test conducted on the ability to predict an event by households gave ($\chi^2_{0.0001}$= 29.82) which showed that there was low significant ($P < 0.01$) variation on ability to predict an event in the area by households

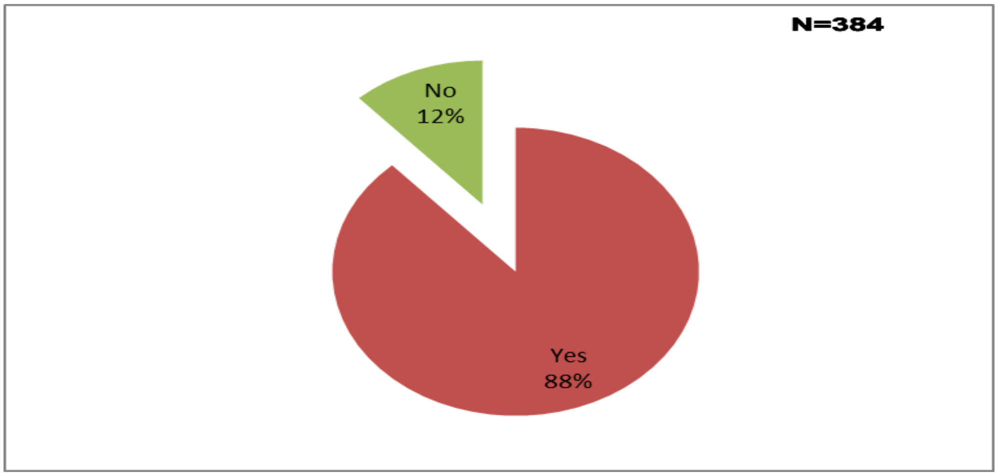

Figure 5.4 Household response on ability to predict flood event in Western Region, Kenya
Source: Field data (2022)

Ability to predict an event is important in disaster preparedness and essential in disaster risk reduction as they set out clearly what to be done, when, where, how and the acceptable standard (Twigg, 2004). Participants of FGDs and key informants indicated most people were able to predict the event but then they never took seriously on the outcome. The finding of the study emphasized the importance of households knowing how to predict the event. (Rose *et al.,* 2007)argues that it is well understood that the effectiveness of disaster prediction strategies and level of prediction can determine the success of disaster response. While there is recommendation for household predictions in Australia very little is known about the actual level of household who understand the issues of predictions. This therefore means despite people having knowledge in prediction of the event they have not taken seriously what is expected of them due to ignorance just the same way they have known about SLMT but then they have lightly taken up the technology. These findings agree with the Rogers theory innovation diffusion where he says the technology will remain new to those who know it and have not applied it until it is accepted and practiced.

5.10 Flood disaster risks

Respondents were asked why they thought floods were dangerous to the households and community at large. The findings are shown in Figure 5.5. Majority 35.3% (136) respondents indicated that it was due to lack of adequate protection from the concerned parties, 29.4% (113) showed adoption of bad behavior from the community and households that exposed them to dangers of floods such as practicing of unsustainable land management technologies in the area such as mono cropping, overgrazing and deforestation that exposed the area into soil erosion hence flooding risks. Danger of flooding due to poor management 17.6% (68) acknowledged danger of flooding was due to poor management by the local authorities and floods being unpredictable for each respectively. Responses for each sub county indicated lack of protection from concerned parties 29.5% (113) Budalangi, 6% (23) Nyando; adoption of bad behavior 24.5% (94) Budalangi, 4.9% (19) Nyando; danger of flooding and floods being unpredictable 14.5% (56) Budalangi and 3.1% (12) Nyando for each respectively. The Chi-square test conducted on the dangers of flooding by the household gave ($\chi^2_{0.19}$= 4.77) which showed that there was highly significant ($P < 0.01$) variation on dangers of floods in the community households.

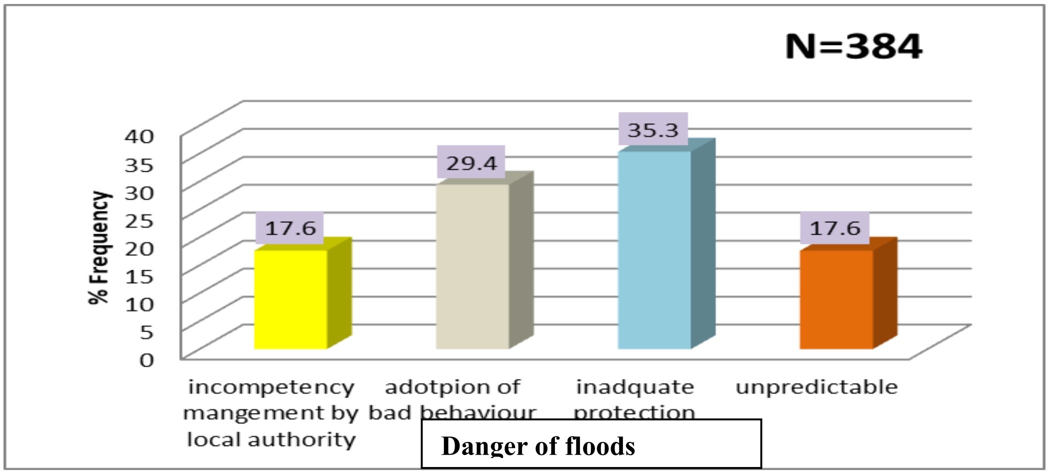

Figure 5.5 Household response on danger of floods in Western Region, Kenya
Source: Field data (2022)

On the dangers of the household agriculture losses was important because agriculture is a major source of livelihood in the study area. Destruction of agricultural assets due to unsustainable Land management technologies therefore means loss of sources of livelihoods and food insecurity resulting into poverty. Due to lack of adequate protection from the required agents flood risks and impacts have become long lasting problem to most of the households in the study area.

An example of a piece of land that has been water logged in Nyando due to unpredictable flood occurrence and has flooded the whole of the field is shown in Plate 5.1. Flooding in the low land areas has always affected the communities and households. The water takes long time to dry from the fields inconveniencing the farmers to till the land and even go back for settlement. (Chen *et al*., 2022)

Plate 5.1 Agriculture farms Water logged with Flood waters in Nyando.

Source: Field data (2022)

This is attributable to sub-parameter SLMT resulting from the adoption of unsustainable technologies by households, which causes annual increases in flood-related losses of crops, livestock, and homes. There has been a steady rise in livestock and crop losses since 2010 (Odero & Mahiri, 2022). In a focus group discussion with a village elder who'd spent the last 75 years in the Kobura area corroborated the rising frequency and severity of floods. According to her, the worst flood that has occurred since 2003 occurred between 2013 and 2020.Children and the elderly were particularly at risk, and it also triggered mass displacement, property destruction, and the loss of cattle, crops, and other agricultural output. She claimed the floods used to only affect a small portion of the lower region, but now they affect the entire area around Kobura. She described how the area's first flood began in 1961 with little more than average rain that quickly inundated the waterways and gardens. In 1962, it prompted thousands to relocate, prompting government aid. Water levels continued to rise rapidly, causing widespread flooding. As a result, many people moved to safer areas. The death toll was highest in this flood. People died from contagions, overcrowding at shelters, and hunger. She claimed that the area did not experience any flooding until 1998, and that the flooding has continued ever since.

Key informant from the area indicated:

> Adoption of unsustainable technology by locals and households such as deforestation, cultivation along the water reign areas and more so sand harvesting has always exposed land to soil erosion making it vulnerable to flood risks. (a Key informant from County disaster during the interview held on August 11, 2022 at County offices Busia)

This study findings agree with those of (Omungu, 2014) where she established that most dangers of flooding emanate from upper stream and not necessarily downstream.

5.11 Main causes of floods

The respondents were asked to rate the main causes of floods in the area occupied by different households on the scale from 1 the lowest Probability to 5 highest probabilities. The summary findings are shown in Figure 5.6. Majority of the respondents rated the main cause with the highest probability of five the cause flooding of major rivers being at the lead with 68.5% (263); breaking of the main river banks at 13.5% (263); poor farming practices rated at medium 12.0% (46); heavy rainfall at 5.3% (30) and flooding of minor rivers rated lowest probability of one at 0.7% (3). For each sub county flooding of major river rated 56.8% (218) Budalangi, 11.7% (45) Nyando; breaking of main river bank 10.8% (211) Budalangi, 2.7% (52) Nyando; poor farming practices 9.9% (38) Budalangi, 2.1% (8) Nyando; due to heavy rainfall 4.5% (17) Budalangi, 0.8% (3) Nyando and flooding of minor rivers 0.5% (2) Budalangi and 0.2% (1) Nyando. The Chi-square test conducted on the probability rating of the main causes of floods in the area by households gave ($\chi^2_{0.0001}$= 42.45) which showed that there was highly significant ($P < 0.01$) variation on probability rating on the main causes of floods in the area by households. The flooding contribution is affiliated to flooding of major rivers where they decrease the velocity of water wave. Due to low velocity the water meander leading to flooding of the affected areas (Masibayi, 2011).

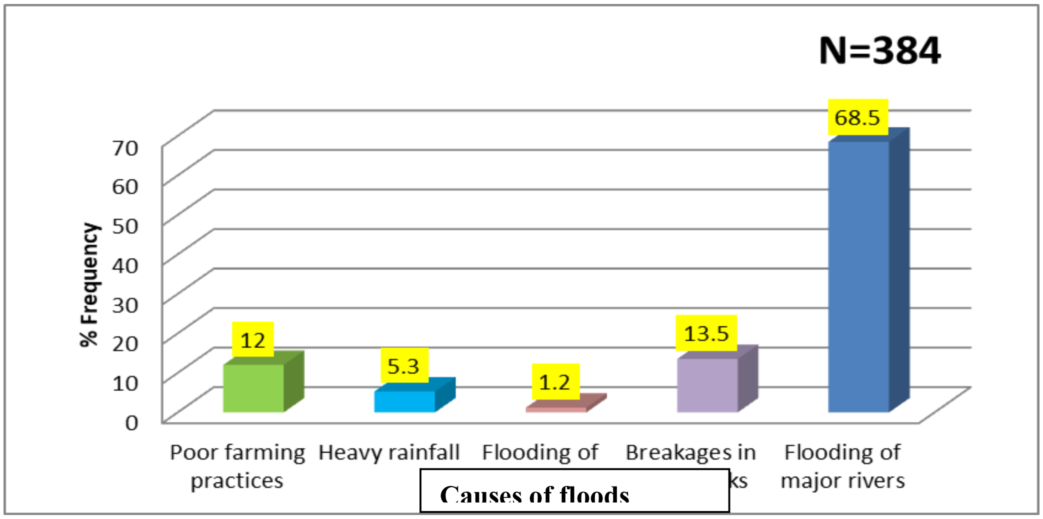

Figure 5.6 Household response on the main causes of floods in Western Region, Kenya
Source: Field data (2022)

The key informants indicated that the main causes of floods in western region were attributed to flooding of major rivers and whenever they occur, major losses were experienced such as crop destruction, homestead, animal and loss of bread winners and not forgetting disease outbreak in the study area. Also, FGDs participants had similar sentiments to the household heads responses. According to (Ongeko, 2017) high poverty levels among the people of western region made them more vulnerable because they live in flood plains which are hazardous. They have fewer resources which makes them vulnerable to disasters. They are less likely to predict the event and act in advance, (Masibayi, 2011).

Furthermore, even if predictions and warnings were issued, they have fewer options for reducing the losses due to flood risks in timely manner. These affect the resilience and process of recovery from the disasters. The findings of the study agree with most studies carried out in the Western region of Kenya as well as other African countries. In Ghana, (Musah *et al.*2013) discovered that floods in the Tolonto district often destroy farm lands, often resulting in the loss of an entire harvest. Only 21.7% of respondents (out of 120) said that floods produced erosion, which in turn prompted the formation of galleys in their communities and on their farmlands. When homes are flooded, their belongings are damaged, which has a detrimental effect on the household's economic situation. This agrees with the findings of the study by (Wachira, 2013) that flooding is a problem in Sustainable land management since it threatens human and animal life. Many countries are still experiencing rising flood damage losses despite enormous investments in flood defense. While most floods occur naturally, the flood hazard is mostly the result of human actions and poor behavior (such as land use change). Large events, although still within the normal range of stream flow, are the most common cause of flooding. As stated by (Adan, 2018), floods only pose a threat when people move into naturally flood-prone locations.

5.12 Knowledge of flood risk in Neighborhood

The respondents were called upon to rate how much they were informed on what was happening in the Neighborhood and the results are shown in Figure 5.7. Majority of respondents 29.4% (123) indicated they were well informed about the flood risk in the neighborhood, 27.5% (106) acknowledged that they were moderately informed, 19.6% (75) very much informed on flood risk and 15.7% (60) were highly informed about the risk in the Neighborhood. Sub county breakdown on responses well informed 24.4% (102) Budalangi, 5.1% (21) Nyando; moderately informed 22.8% (88) Budalangi, 4.7% (18) Nyando; very much informed 16.2% (75) Budalangi, 3.4% (13) Nyando and highly informed 13.1% (50) Budalangi, 2.6% (10) Nyando. The Chi-square test conducted on how well informed of flood risk in the neighborhood by households gave ($\chi^2_{0.094}$= 7.92) which showed that there was highly significant ($P < 0.01$) variation on information on flood risk by households in the neighborhood.

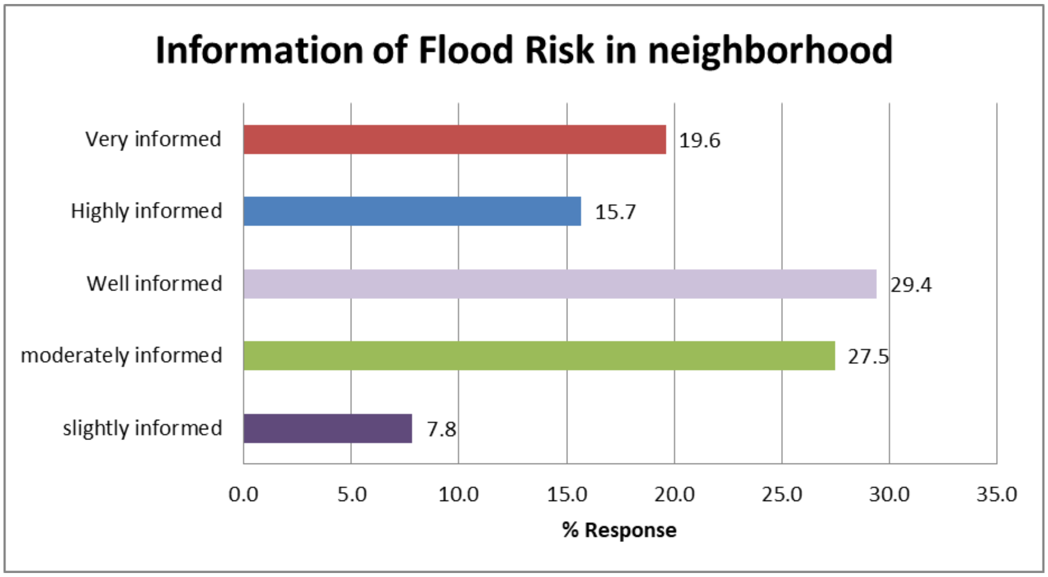

Figure 5.7 Household response on knowledge for flood risk in neighborhood in Western Region, Kenya
Source: Field data (2022)

Experts' narrow conception of danger makes them more likely to miss something important to inform the local community, but public perception of risk suggests the opposite. (Margolis, 2011) says in his research that what really accounts for the intractable disagreements is not what specialists notice that others don't, but rather how the general public feel about risk that experts don't take into consideration. Policymakers and scientists often agree that the general public lacks the cognitive capacity to grasp the complexities of environmental issues and is more likely to react emotionally or subjectively to them. These issues underscore the need to close the knowledge gap between the general public and professionals and to enhance the general public's appreciation of risk. This therefore makes the people in the community to make informed choices on what they see and experience from the neighborhood. Understanding the flood risks in the neighborhood is critical for future planning and predictions of the disaster risk in advance and necessary action taken in advance.

5.13 Flood preparedness

The respondents were asked to state how well prepared they were for the flood event. Findings indicated in Figure 5.8. Majority of the respondents 84% (323) indicated they were never prepared for the flood event, 14% (54) showed positive response on preparedness to face the flood event while 2% (7) had no idea on what was happening. Sub county responses 69.4% (267) Budalangi, 17.6% (56) Nyando they were never prepared for the flood event; 11.7% (45) Budalangi, 2.3% (9) Nyando were prepared and 1.7% (6) Budalangi, 0.3% (1) Nyando never understood what was happening. The Chi-square test conducted on how well prepared by households to face the flood event gave ($\chi^2_{0.0001}$= 60.71) which showed that there was high significant ($P < 0.01$) variation on preparedness of flood event by households in the area. A flood risk has always been a big threat to the community and society at large whenever it occurs.

The foregoing results point to the importance of a two-way information exchange in facilitating conversation. Institutions will need to learn what locals find confusing about risk communication, according to a key source from the Kenya Meteorological Department in Busia, while others have suggested that better education and more straightforward language could help. Lack of communication and understanding between people of floodplains and experts/policy makers appears to be a more substantial and crucial gap than any difference in risk assessment between the two groups. These results were backed up by the FGD participant indicated:

> Mostly technologist used the technical language when passing information about early warning systems and so majority of the locals could not comprehend what was being communicated (Male FGD

Participant during an FGD held on August 15,2022 at mulukoba village)

However, others members disagreed and said that most household heads were just ignorant and had no interest in the whole process. Some Key informants had a different approach where they said that sensitization was the key thing on issues of preparedness. The findings agree with that of (Masibayi, 2011) where he reveals that for people to be able to prepare for the Floods then timely offer of early warning system must be communicated in advance to pave way for preparedness.

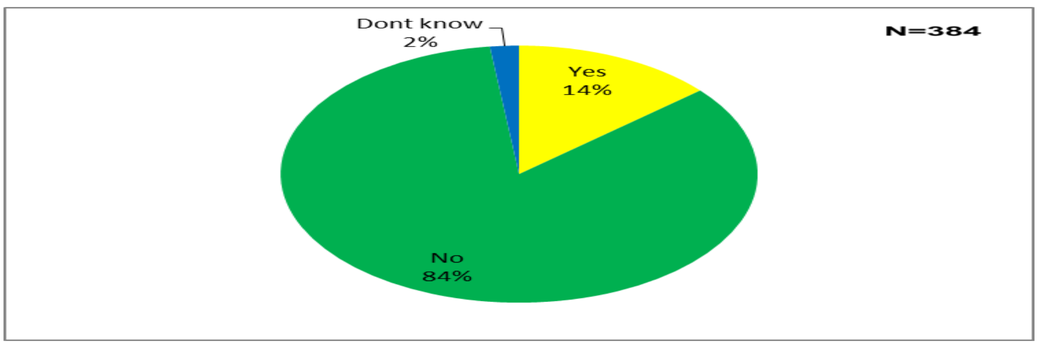

Figure 5.8 Household response on flood preparedness in Western Region, Kenya Source: Field data (2022)

5.14 Training related to flood risk

Respondents were asked to state if they ever attended trainings in any way related to flood risk and how they could handle the situation. The responses are shown in Figure 5.9 Majority 80% (307) said they never attended the training and 20% (75) had attended the training. Sub county responses 66% (254) Budalangi, 14% (53) Nyando acknowledged that they never attended the training; 17% (64) Budalangi, 3% (13) Nyando they had attended the training, The Chi-square test conducted if the households attended any training of Flood risk gave ($\chi^2_{0.0001}$= 18.84) which showed that there was highly significant (P < 0.01) variation on training attended households on Flood risk.

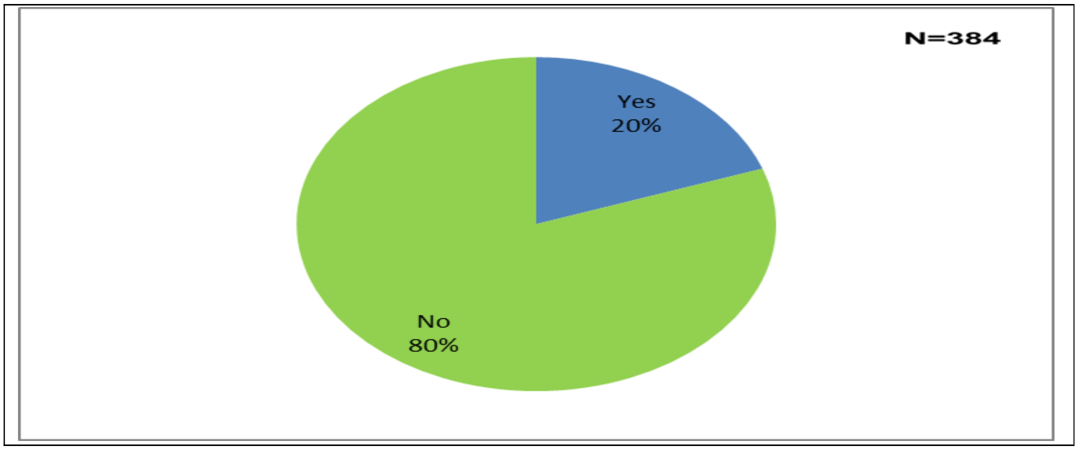

Figure 5.9: Household response on Flood risk training attended in Western Region, Kenya
Source: Field data (2022)

Historically, the public's perception of risk has been thought to be based on more subjective judgments of danger, while expert risk assessment and decision-making have relied on logical, objectively computed evaluations of likelihood. When pushed beyond the bounds of available evidence and relying on intuition, even experts' judgment appeared to be prone to many of the same biases as the public (Slovic *et al.*, 2011). Consistent with the idea proposed by (Slovic *et al.,* 2011), this research shows that both specialists and the general public rely on subjective considerations when making disaster management decisions. There is a disconnect between the technical community and the general population in other respects as well; notably, there is a failure to appreciate common problems and worries. According to the technical experts, locals' impression of flood risk is skewed, and they aren't aware of the true danger they face. The majority of technical responders agreed that some people living in floodplains do not fully grasp the concept of flood frequency. Experts in the field, however, could not agree on whether or not people in their communities get too much information that is too technical and difficult. (O'Hogain *et al.,* 2018) claims that Education on floods has been found to have a significant impact on people's sense of safety. The perception of flood risk was lower among those who knew less about the factors that contribute to floods. Similar to other research, the current study found that people with higher levels of flood knowledge education also had a higher level of flood risk perception. The perception of flood risk was lowest in the group that received the most information about flooding, while it was highest in the group that received the least. Trainings on flood risk problems are crucial for prevention and reduction of flood-related damage (De Wrachien *et al.*, 2011)

5.15 Information centers on flood risk

Communication and information are very important and a measure to help people or community understand what is happening in the vicinity. The respondents were called upon to rate the organization where they got information concerning flood risks. Majority of the respondents indicated that Non- governmental Organization were acknowledged with great deal at 96.1% (370); Community Based Organization 82.4% (316) and those with fair acknowledgement included 68.6% (263) and 56.9% (218); National government and County Government respectively results shown in Figure 5.10. Specificity sub county responses on great deal, NGOs 79.5% (306) Budalangi, 16.7% (64) Nyando; great deal responses on CBOs 69.8% (262) Budalangi, 14% (54) Nyando; fair acknowledgement of NGOs 56.9% (218) Budalangi, 11.7% (45) Nyando; Community Based Organization 47% (180) Budalangi and 10% (38) Nyando. The Chi-square test conducted on rating of the information centers where they received news by households on Flood risk gave ($\chi^2_{0.0001}$= 57.16), ($\chi^2_{0.0001}$= 36.61), ($\chi^2_{0.000}$= 89.91) and ($\chi^2_{0.000}$= 90.35), in order of National government, County government, CBOs and NGOs respectively which showed that there was highly significant ($P < 0.01$) variation on centers information was got from by household on Flood risk.

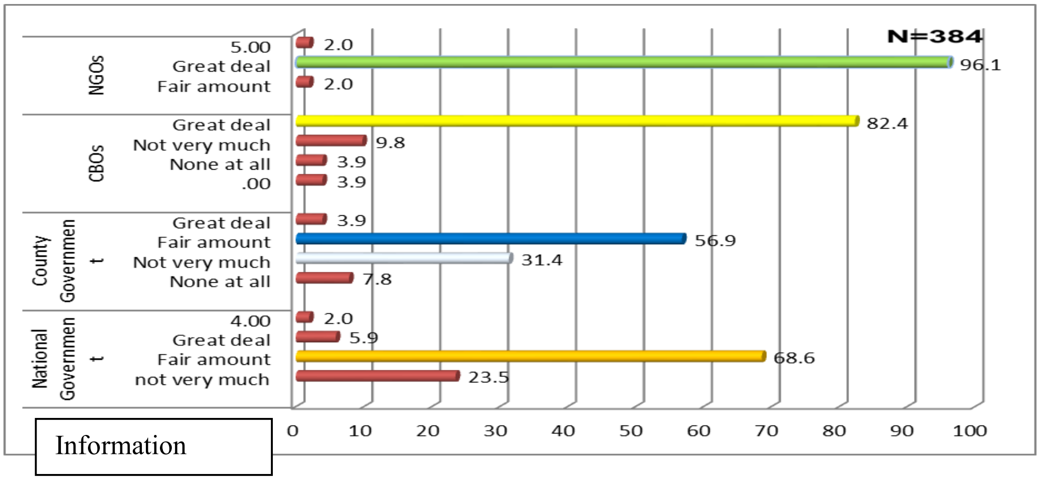

Figure 5.10 Households response on information centers in Western Region Kenya
Source: Field data (2022)

This suggests that only after a specific amount of flood knowledge education would the public's perception of the risk of flooding improve. As a result, the government should mandate additional flood education. It has been discovered that how people feel about their own personal roles in flood protection might affect how they feel about the risk of flooding in general (Mondino *et al.,* 2020). Higher flood risk perception was seen among respondents who thought they themselves should be responsible for flood protection in this study. It's possible that those who are more personally at risk from flooding have a greater flood risk perception and prefer to take self-protection measures since they are skeptical of the efficacy of 'public' protective measures (Ngo *et al*., 2020). These findings also show how important it is to educate the public about the need of flood safety in order to reduce the danger of flooding and manage it better. This study indicated that distrust in government was inversely connected to how seriously people took the threat of flooding. The respondents held the very low trust in the government perceived highest flood risk than other three groups ($p < 0.01$ for all). One possible explanation is that professionals' faith in the government is symbolic of the public's faith in the government.

5.16 Responsibility for flood disaster preparedness

The respondents were asked to mention who was responsible for preparing them for the flood disaster. The results are shown in Figure 5.11. Majority 64.7% (246) of the respondents had a trust that the Government and individuals were responsible for the preparedness; 23.5% (90) they acknowledged that they were solely responsible for the disaster preparedness and 11.8% (45) said the government was primarily for preparing people for the flood disaster. The sub county responses on Government and self-preparedness 53.4% (203) Budalangi, 11.3% (43) Nyando; those solely in flood preparedness 19.3% (74) Budalangi, 4.2% (16) Nyando; Government primarily in flood preparedness 9.7% (37) Budalangi and 2.1% (8) Nyando. The Chi-square test conducted on who is responsible for flood preparedness by households gave ($\chi^2_{0.001}$= 23.65) which showed that there was highly significant ($P < 0.01$) variation on who is responsible person for flood preparedness.

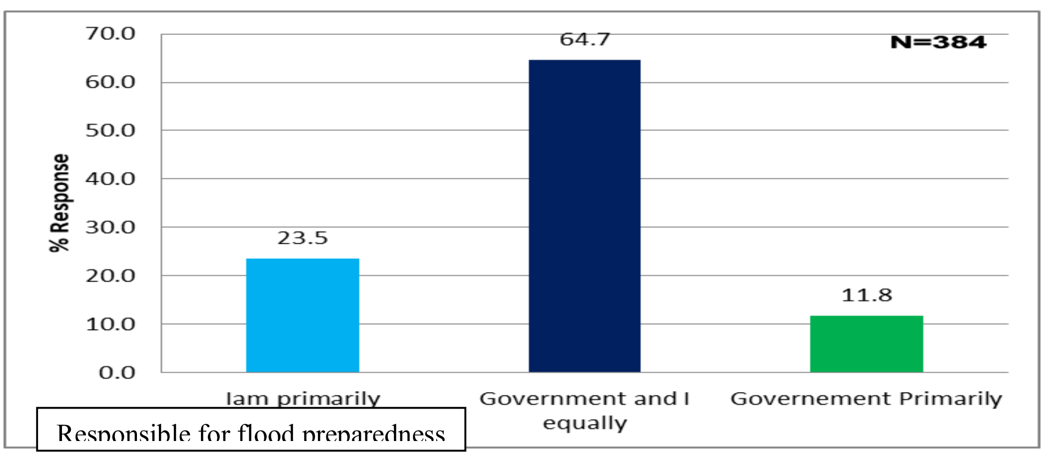

Figure 5.11 Households response on who is responsible for Flood preparedness in Western Region Kenya
Source: Field data (2022)

Respondents' high confidence indicated that they expected the government and themselves to successfully manage potential flood risks without requiring excessive self-preparation. Those with less faith in the government were skeptical that it could provide adequate flood warning and rescue operations in a timely fashion (Hermans *et al.,* 2022). They choose to learn about floods, seek out information about floods, and take precautions instead. The vast majority of research that have been conducted verified these findings. Results showed that flood help offered by government and non-government organizations was ineffective in mitigating flood-related damage (Pangali Sharma *et al.,* 2022). Household interviews corroborated this, showing that the recipients' current food aid levels are inadequate. The effectiveness of food aid is reduced because it is not distributed on a daily basis. As a result, the food insecurity issue brought on by the floods will not be resolved by the aid (Shimada, 2022). These are temporary fixes that won't even guarantee enough food in the near future. People can be moved to safer areas before a flood disaster occurs thanks to early warning systems (GoK, 2015). Households reported receiving flood early warning alerts via radio, but never acted on them. The people did not have faith in the flood warning systems. Early flood warnings have a 50/50 success rate, meaning that sometimes they actually occur and other times they don't. To this day, they still wait to see if it actually takes place. The study was justified by a member of FGDs who actualized that:

> The government was doing all that it required in terms of preparedness but sometimes when the prediction was done and never materialized so people never took it seriously and now they ignored any other move taken by the government (Female FGD participant during an FGD held on August 16, 2022 at Bulemia village).

This element is supported by the diffusion of innovation theory used in this research where by Rogers defines diffusion as the process in which an innovation is communicated through certain channels over time among the members of a social system. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. This therefore means for them to be successful then the community and the government should work together in the issues of preparedness to reduce impact of flood risks otherwise the idea will still be new to them.

5.17 Rating prevalence of flood risk by farmers

The impact of floods has worsened and induced forced migration of the already vulnerable community in Western region. Household heads respondents were asked to rate the prevalence of flood risk by farmers and results shown in Figure 5.12. Out of the 384 households 49.0% (288) indicated that the prevalence was moderate on flood risk control, 35.3% (236) was slightly prevalent, 9.8% (38) felt highly prevalence and 5.9% (23) said not prevalent in any way. The frequency and percentage for each of the sub county were recorded, 40.5% (238) Budalangi, 8.5% (50) rated moderately the prevalence; 16.9% (113) Budalangi, 3.5% (23) Nyando, slightly moderate; 8% (31) Budalangi, 1.8% (7) Nyando rated highly prevalent; 4.9% (19) Budalangi and 1% (4) Nyando there was no prevalence of flood risks.

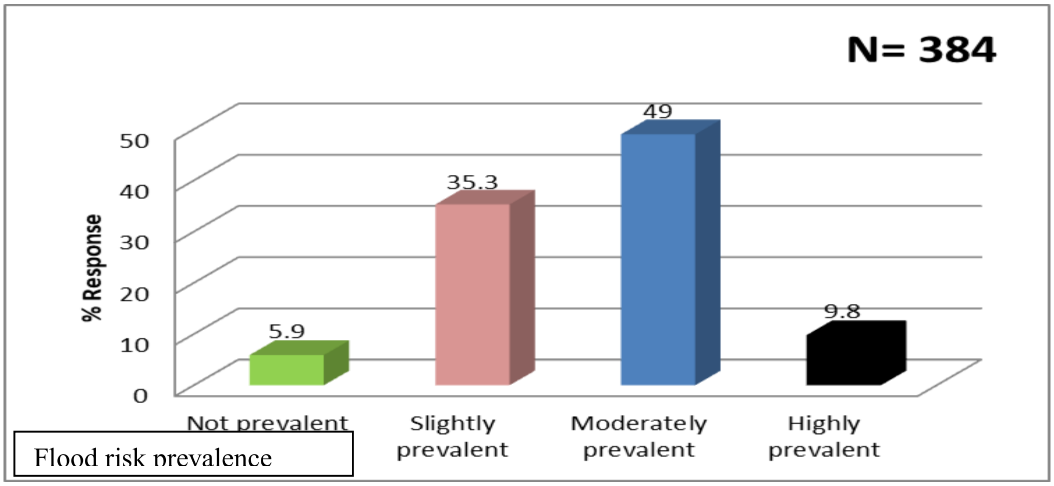

Figure 5.12 Households response rating of flood risk prevalence in Western Region Kenya
Source: Field data (2022)

The Chi-square test conducted on prevalence of flood risks to farmers in the various household gave ($\chi^2_{0.000}$= 26.10) which showed that there was highly significant ($P < 0.01$) variation on Flood risk prevalence. The key informants and some members of FGDs from Busia pointed out that SLMT had a positive influence on flood risk impacts only that the government had not shown much interest in idea of helping the community to embrace the technology and the importance of adopting the technology as a way of reducing poverty and controlling the impact of flood risks using the Sustainable Land Management Technology. However, those from Nyando indicated that concerned authorities took it to be business as usual, cycle and the 'paper plan syndrome' rather than looking at it as a crisis that is an impediment to sustainable developments that requires broad- based and holistic approach. Land degradation is a central challenge to sustainable development (Vlek *et al.,* 2017). Sustainable land management had been defined as a system of technologies and/or planning that aimed to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra- and intergenerational equity (Hurni, 1997). SLM thus composed of the three development components; technology, policy and land use planning. A stakeholder impact and responsibility analysis have to be integrated in establishing sustainable land use practices in order to understand the interplay of factors, levels of interaction and the responses for addressing issues within the watershed (Barletti *et al*., 2020). The main drivers within the integration of sustainable land use practices include local community, national and international organizations among others. The legislative and policy framework that yield to the adoption of the integrated management at watershed level, encourage the settlers within the river basin to adopt agricultural practices that increase agricultural output of which the enforcement is lacking. Communities have preferred to develop their own domestic legislation to enhance them practice the technology. Moreover, they embrace conservation practices such as cropping management and water conservation measures to gap flood risks.

CHAPTER SIX

STRATEGIES FOR MITIGATING FLOOD RISKS IN WESTERN REGION, KENYA

6.1 Introduction

This chapter presents result and discussion of the third specific objective of the study which was to evaluate the strategies for mitigating Flood Risk by household heads in Western region Kenya. These strategies include:

6.2 Strategy in mitigating flood risks

There are a number of strategies used in mitigating flood risks. They include Informational strategies such as Community self- groups, project meetings, Farmers group membership; soil conservation strategy; modification on SWC as a strategy and Governance actors on SLMT.

6.2.1 Community self-help groups

The respondents were asked if they belonged to any community self- help group. The findings were summarized in Figure 6.1. The study revealed that 65% (230) the respondents belonged to at least a community self-help group, 31% (119) did not belong to self -help group and 4% (15) didn't even know the existence of self-help.

For individual sub county response indicated 53.7% (190) Budalangi, 11.3% (40) Nyando resp0ndents acknowledged they belonged to the group; 25.5% (98) Budalangi, 5.5% (21) Nyando had no group identity; 3.2% (12) Budalangi and 0.8% (3) Nyando said they had no knowledge on the existence of the group. The Chi-square test conducted on existence of community self-help groups gave ($\chi^2_{0.000}$= 28.35) which showed that there was highly significant ($P < 0.01$) variation.

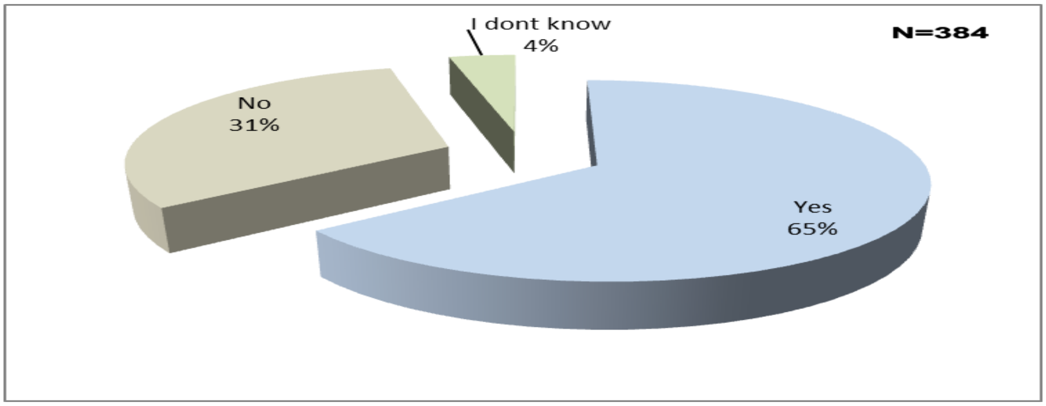

Figure 6.1 Households response on community self-help groups existence in Western Region Kenya
Source: Field data (2022)

One FGD participant said that,

> Belonging to a community group, they had acquired more knowledge and skill including use of the new skills among others in practicing agriculture. (Male FGD participant during an FGD held on August 23, in Mukami village)

Women participated more in the groups; indeed, the number of women in a group was higher in the mixed sex group. There were also women exclusive project groups, no men project groups were found. The project groups may be the solution to certain cultural constraints, which hinder adoption of the SLMT, (Munyua, 2000). The information from one of the Key informants from Nyando indicated that group projects were in existence in the area. However, the organization of the groups was wanting and hence they could not achieve the designed objective. The findings agree with those from Busia where one member of FGDs revealed that

> Projects had good intentions but due to inconsistence and poor organization the objective was never met (Male FGD farmer from during an FGD held on September 2, 2022 at Bukoba village)

The study findings agree with that of (Wachira, 2013) who in her study revealed that community self-help group was a solution to most of the SLMT adoption and acceptance.

6.2.2 Project meetings on Flood risk reduction

Households were asked to indicate whether they attended project meetings as informational strategy for mitigating flood risks. Results are shown in the Figure 6.2 Majority of respondents 80% (307) gave a yes response that they were in attendance to the project meetings, 16% (61) said they could not attend the project meetings and 4% (15) did not know at all whether people were attending project meetings. Each result for the sub county determined, 66.2% (254) Budalangi, 13.8% (53) Nyando attended project meetings; 13.1% (50) Budalangi, 2.9% (11) Nyando never attended and 3.2% (12) Budalangi, 0.8% (3) Nyando did not know at all. The Chi-square test conducted on attendance of project meetings as a strategy for mitigating flood risks gave ($\chi^2_{0.00}$= 51.88) which showed that there was highly significant ($P < 0.01$) variation on attending project meetings by households as a strategy for mitigating flood risks.

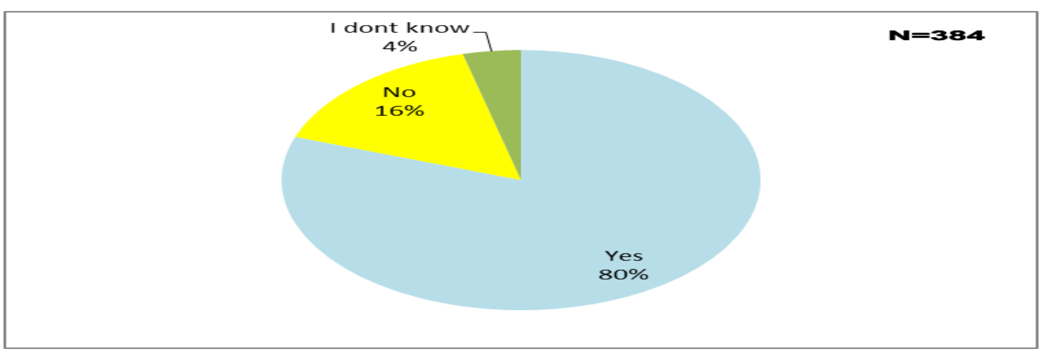

Figure 6.2 Household respondents on project meeting attendance in Western region Kenya
Source: Field data (2022)

Project or group membership has always boosted knowledge on the side of the members (Castellani *et al.,* 2021). The research was supported by:

> One Focus group discussion member who acknowledged that households that were font of attending meetings and trainings had an upper hand since they could reason and agree to disagree on the issues of flood risks as opposed to those who never attended meetings (Youth FGD Participant during an FGD held on September 2, 2022 Bukoba village)

An interviewee from ministry of Water and environment pointed out that:

> They had easy time dealing with members who were captured in various projects since they understood what was required and that the only opposing factor in the implementation was limited finances on the side of the farmers (one of the participants during an interview held on September 2, 2022 Bukoba village

At the same time, we a group that never attended project meetings and when they were interrogated as to why they never attended project meetings majority of respondents 84.3% (322) showed that they never attended project meetings because they completely lacked information from their end, 5.9% (23) felt the venue of the meetings were unsuitable (Attarzadeh & Ow, 2008). results shown in Figure 6.3.

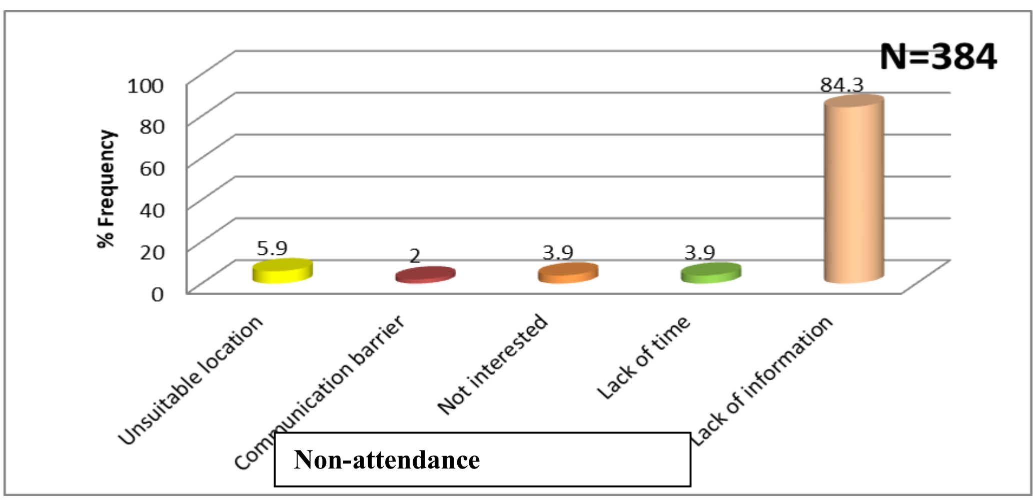

Figure 6.3 Household respondents on non- attendance to project meeting in Western region Kenya
Source: Field data (2022)

Lack of scientific and technical information among the respondents especially farmers can be attributed to the wide –ranging low levels of education in the study area emanating from lack of training facilities for farmers (Odini, 2014). Similar research was also reported in research by Asian Foundation, 2012 in which majority of the respondents 56% (215) not knowing what to do was the foremost reason for not engaging in the trainings this was perceived by most household as a barrier to successful mitigation in the area.

Other responses on non-attendance to the project meetings Figure 6.3 were communication barrier at 2.0% (7) those who lacked time due to poor planning for the project meetings were at 3.9% (15) and those who had no interest 3.9% (15). All this point out on the issue of community preparedness and education through sensitization were still wanting and therefore more empowerment is required for any success to take place.

6.2.3 Farmers group membership on Flood risk reduction

The respondents were asked to state why they thought they did not want to join any group membership in the findings summarized in Table 6.1. Majority of respondents 68% (261) acknowledged that group problems were many and so it hindered them from joining, 12% (46) indicated lack of time since most of the time they were out busy trying to vendor for food 6% (23) had the opinion that they lacked information on when the groups were being formed, lack of permission from the spouses also affected respondents at 8% (31) lack of interest, lack of labor on the farm and others at 2% (8) each respectively.

Table 6.1 Household response on farmers group membership in Western region Kenya

Issues in groups	Western Region		Budalangi		Nyando	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
Group problems	68	261	56.3	216	11.7	45
Lack of time	12	45	9.9	38	2.1	8
Lack of information	6	23	5	19	1	4
Lack of permission from spouse	8	31	6.7	26	1.3	5
Lack of interest	2	8	1.8	7	0.2	1
Lack of labour	2	8	1.8	7	0.2	1
Other	1	4	0.8	5	1	2
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

The aforementioned responses are consistent with (Blaike's,1994)., Pressure and Release Model of Vulnerability (PAR), which is a simplified representation of the intricate relationships between the social processes that produce vulnerability and the danger itself. These two opposites are what give the model its foundation. According to this model, the 'pressure' increases as people become more vulnerable and exposed to hazards; respondents reported that they lacked information, time, and permission to prepare for such events (Daramola *et al.,* 2016). The ‘release', on the other hand, represents the actions taken to mitigate the disaster's effects by decreasing people's vulnerability; in this case, by inviting extension officers to teach the community about SLMT (Blaikie *et al.,* 1994). Respondents in this study who were unable to secure approval from the relevant parties to facilitate their participation in SLMT training represent a double source of risk for economically, politically, and/or socially vulnerable individuals and groups (Löbmann *et al.,* 2022). The study agrees with that of (Bottema, 2019) on institutionalizing area-level risk management: Limitations faced by the private sector in aquaculture improvement project. The results indicate that AIPs struggle with institutionalizing risk management at an area-level because of the difficulties both NGOs and buyers face in inducing horizontal cooperation to address shared risk between farmers. This is attributed to the poor capacity of these actors to align either top-down or bottom-up comprehensive AIPs with the social and environmental conditions of production. AIPs are more likely to be successful in institutionalizing shared area-level risk management if they build on the existing social networks of farmer through formation of groups. However, it is argued by (Chepkoech *et al.,* 2020) that small holder farmers need not necessarily groups for them to manage the sustainability instead they require more financial support. In the study on understanding adaptive capacity of smallholder African indigenous vegetable farmers to climate change in Kenya which disagree with the findings in this study that stresses farmer groups to enhance knowledge exchange in mitigating flood risks.

6.2.4 Effect on Lack of farmers group membership in flood risk reduction

The respondents were asked the effect encountered on being non-member of the farmers group and the understanding of flood risk. The results are shown in Figure 6.4. Majority of respondents 64.7% (248) acknowledged that they were extremely affected by not being members of any group, 11.8% (45) were slightly affected, 5.9% (23) moderately affected, 3.9% (15) had been highly affected and 11.8% (35) not affected at all. The results per the sub county computed 53.5% (205) Budalangi, 11.2% (43) acknowledged effect to be extreme; 9.7% (37) Budalangi, 2.1% (8) Nyando, slight effect realized; 4.9% (19) Budalangi, 1% (4) Nyando, moderately affected; 3.1% (12) Budalangi, 0.8% (3) Nyando were highly affected; 9.8% (29) Budalangi and 2% (6) Nyando were no affected at all. The Chi-square test conducted on non- membership on flood risk understanding gave ($\chi^2_{0.000}$= 67.4) which showed that there was highly significant ($P < 0.01$) variation on effect of non-membership on flood risk understanding.

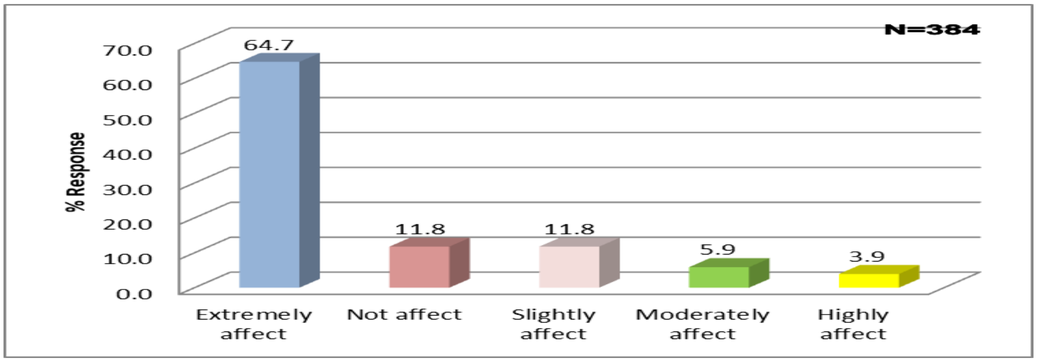

Figure 6.4 Household respondents on lack of group membership in Western region Kenya
Source: Field data (2022

The results indicates extremism in lack of membership, this has affected the communities that never took seriously issues of groups and the training accompanied by them. It was observed that the areas affected lacked progress in terms of land management in relation to flood risks. This study agrees with (Ntontis *et al.,* 2020) in the study endurance or decline of emergent groups following a flood disaster: had negative mplications for community resilience. Despite the indisputable importance of strong pre-existing networks for community resilience, such approaches have been criticized for not considering how pre-existing groups come to mobilize or how novel groups can emerge in absence of pre-existing networks Considering the criticisms outlined above, (Ntontis *et al.,* 2021) advocate for a social psychological approach based on the concept of social identity and group membership to account for the contextual micro-processes of group mobilization in disasters.

General consensus exists that extension services, if properly designed and implemented will improve SLMT (Evenson & Mwabu, 2001). The performance of the public agricultural extension service in Kenya has been a very controversial subject. The system has been perceived as top-down, uniform (one-size-fits-all) and inflexible and considered a major contributor of the poor performing agricultural sector and especially on flood risk understanding, (Wachira, 2013).

6.3 Soil Water Conservation strategy

The respondents were asked if SWC as a strategy benefited them in any way. The results indicated in Table 6.2. Most of the respondents indicated that benefits were by sharing knowledge (36%) Nyando (24), Busia (114); training on conservation methods (20%), Nyando (13), Busia (64) demonstration of use at (32%) Nyando (21), Busia (102) and others at (12%) Nyando (8), Busia (38), for specific county results are indicated in Table 6.2. This study is supported by (Edgar *et al*., 2022) in his study on disappearance of African Indigenous Knowledge of Water Conservation and Management in Limpopo Province of South Africa where the research elaborates that the indigenous knowledge was disappearing among the communities due to lack of sharing knowledge with those who understood how the mechanisms were accomplished. The training to members was a major plus to achieving the goal.

In the study area most groups took the initiative to welcome agricultural extension officer to teach them on soil and water conservation measures, for facilitation they contributed to pay the extension officer travel expenses from the savings they had obtained from the group farming produce. Further, the group member ship facilitated the ease of demonstration of SLM practices there by increasing their adoption rate. The invitation of agricultural officer is an illustration of willingness to learn and adopt the sustainable land management technology. According to FGDs response from Busia the group members who were attending the training had knowledge and the will power to adopt the technologies and practice them. This study concurs with the diffusion of innovation theory by Rogers which stipulates that a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome (p. 13). It is composed of two parts: hardware and software. While hardware is the tool that embodies the technology in the form of a material or physical object, software is the information base for the tool (Sahin, 2006).

Adoption is a decision of full use of an innovation as the best course of action available and rejection is a decision not to adopt an innovation (Campbell, 1966). Rogers define innovation as an idea, practice, or project that is perceived as new by an individual or other unit of adoption (Rogers, 2003, p. 12) An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them (Vargo *et al.*, 2020). Rogers claimed there is a lack of diffusion research on technology clusters.

An innovation’s consequences may create uncertainty: Consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation (S. Heidenreich & Talke, 2020). To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences which may be functional or dysfunctional in this case undergoing the training on SLMT.

Table 6.2: Household response on Soil Water Conservation strategy in Western Kenya

Assistance	Western Region		Budalangi		Nyando	
	(%)	(f)	(%)	(f)	(%)	(f)
Knowledge sharing	36	138	29.7	114	6.3	24
Demonstration	32	123	25.5	102	5.5	21
Training	20	77	16.6	64	3.4	13
Other	12	46	9.9	38	2.0	8
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

Income strategies are determined by access to land at the household level, and land management decisions are influenced by several factors operating at various sizes (Wachira, 2013). Biophysical characteristics that determine agricultural potential, population density, and proximity to markets and infrastructure are just a few examples of how location-specific strategies and land management methods can be advantageous (Glatte, 2015). Soil conservation strategies, cropping systems, commodity production technologies, and inputs used are all examples of how these variables can have either broad or narrow effects on Sustainable land management Technology in a given village (Pender *et al.,* 2004).

Table 6.3: Correlations analysis between group membership on SWC and rating most adopted technology on flood risk Western Region Kenya

Spearman's rho			Group membership on SWC	Rating on most adopted technology
	Group membership improvement on SWC	Correlation Coefficient	1.000	
		Sig. (2-tailed)		
		N	384	
	Rating on most adopted technology	Correlation Coefficient	.186**	1.000
		Sig. (2-tailed)	.001	.
		N	384	

** Correlation significant at the 0.01 level (2 tailed).

Source: Field data (2022)

The results in Table 6.3 shows that group membership on SWC had a weak positive significant correlation with rating on most adopted technology on Flood risk in Western region Kenya ($r_{s=}$ 0.186, p= 0.001. The results suggested that group membership on SWC played less significant role on adopting the technology on handling flood risk in Western region. This study is supported by (Mwaura, 2014), findings, where it indicates farm group membership did not necessarily influence the adoption of the technology and that it had insignificant representation. The findings present a major shift in the study area where by households that had groups and those who lacked had no influence on determining which technology to be adopted. This therefore dependents on how the technology has been received, adopted and what benefits the people are likely to get from the technology. All this depends on communication to concerned parties and how they perceive the technology.

6.4 Modifications on Existing Soil Water Conservation on flood risk reduction

The respondents were asked to indicate whether the community had made any modifications on the existing soil water conservation measures available and results shown in Figure 6.5. Majority 62.0% (239) acknowledged that they never made modification on any of the existing technology 8% (31) responded with a yes, they had at least made some modifications which means they had perhaps adopted the technology, 30% (115) did not know whether modification existed or not.

Results per sub county indicated 51.4% (198) Budalang,10.6% (41) Nyando never made any modifications; 6.7% (26) Budalangi, 1.3% (5) Nyando at least modified the technology; 24.8% (95) Budalangi, 5.2% (20) Nyando did not know the existence of the technology. This finding shows high percentage for those who never modified the technology, this means people had not embraced the issue of modifying and benefits of the exercise. According to (Wolka, 2014) SWC was meant to reduce speed of water run off that could reduce erosion and experience land cover dynamics. Community refusing to adopt the technology and modify positively to suit the intended purpose is dangerous. The Chi-square test conducted on whether modification existed on SWCs and gave ($\chi^2_{0.000}$= 45.35) which showed that there was highly significant ($P < 0.01$) variation modification on existing SWC measures.

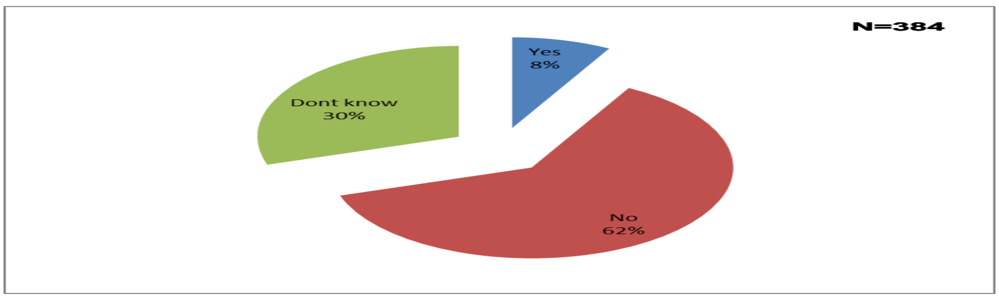

Figure 6.5 Household respondents on modifications of existing SWC in Western region Kenya
Source: Field data (2022)

According to the findings from one member of the FGDs from Busia indicated that irrespective of the trainings they had undergone on issues of SLMT still the turnout of people to adopt the technology and move was still very low. These findings agree with Rogers innovation diffusion theory where he says innovation will remain new as long as it has not been embraced. Soil water Conservation measures had existed but then the uptake of the technology was wanting.

6.5 Governance actors in SLMT technology diffusion and adoption

Respondents were asked to name the strategic institutions that were best in mitigating flood risks. Results tabulated in Table 6.4 Majority of respondents,26% (100) indicated that the Non-Governmental organizations were best in providing the mitigation, 22% (84) felt that the active community participation and involvement improved the community way of perception on the whole issue of flood risk and technology adoption, 20% (76) commented that the Government had made major efforts in ensuring that flood risk is under control and SLMT technology enhanced; 2% (7) depicted that mainstreaming also played a role in ensuring that farmers had some knowledge in flood risk management and SLMT practice in the community. The highest percentage response indicated that all the above-mentioned organization had played a role in mitigating flood risks at 30% (116). The sub county representations 21.6% (83) Budalangi, 4.4% (17) Nyando acknowledged NGO were best in providing the mitigation; 18.3% (70) Budalangi, 3.7% (14) Nyando showed Community participation and involvement improved the perception on flood risk reduction; 16.6% (63) Budalangi, 3.4% (13) Nyando recommended the government efforts in flood risk control; 1.7% (6) Budalangi, 0.3% (1) Nyando mainstreaming was recommended as an option to flood risk reduction; 24.6% (95) Budalangi and 5.4% (21) Nyando opined that all the above strategies had influence of flood risk reduction. The Chi-square test conducted on common strategies for mitigating flood risks gave ($\chi^2_{0.0014}$= 124.3) which showed that there was no significant ($P < 0.01$) variation on strategy for mitigating flood risks in the study area.

Table 6.4 Common Strategic organization for mitigating flood risks in Western region Kenya

Strategies for mitigating flood risk	Western Region		Budalangi		Nyando	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
NGO	26	100	21.6	83	4.4	17
Active Community participation	22	84	18.3	70	3.7	14
Government efforts	20	77	16.6	64	3.4	13
Mainstreaming	2	7	1.7	6	0.3	1
All of the above	30	116	24.6	95	5.4	21
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

Results were backed up by the focus group discussion which supported that actually the major organization that had played a major role in flood risk mitigation was the NGOs and that those who were involving the community to participate made it easier during the engagement. The government also played a good role but the language used was technical and that understanding was a challenge to the farmers this was manifested when the KIs from extension service in Nyando, stated that:

> Normally the technical language used by specialist was tough for the community. Lack of information was also single out by some member who said that most of the people lacked early fast hand information hence knowing when and where demonstration was done was not easy (an extension officer during an interview held on August 3, 2022 at County agricultural offices).

One of the FGDs informed the researcher that:

> The information availed to the respective authorities and especially extension officers was not reaching the intended audience hence some of the communities suffered miss in the information required (Female FGD participant during an FGD held ON September 2, 2022)

This study is supported by the diffusion innovation theory by Rogers who said that sometimes technology might be good for adoption but if it lacked proper communication channel to reach the intended group then it is bound to be rejected on the basis of improper communication due to communication barriers. Similar study was done in the Eastern region of Kenya by (Wachira *et al,* 2006) on an evaluation of potential sustainable land management practices where the study showed that the acceptance of the SLM practices depended on proper training and active community involvement which bore fruits otherwise adoption was not guaranteed. Generally, it is agreed that adaptive capacity will be higher in cases where social institutional arrangements governing allocation of power and access to resources within a community ensures resources are equitably distributed, (Ribot *et al,* 1996). In the current study several institutions and organizations were identified as major strategies used in mitigating flood risks and ensuring that the SLMT are adopted and implemented.

6.6. Barriers on adoption of SLMT on flood risk reduction

Respondents were called upon to indicate if there were strategies and technologies that were not adopted and perhaps why they were never adopted. Findings indicated in Figure 6.6. Majority of respondents indicated afforestation as a strategy that was not well adopted in the area at 31.4% (121); Agroforestry was not also well adopted at 29.4%, (133); crop rotation at 11.8% (45); mulching was also least adopted at 7.8% (30) and the others were below 5% (19). Results for respective sub county; 26% (100) Budalangi, 5.4% (21) Nyando showed least adoption on afforestation; 24.3% (110) Budalangi, 5.1% (23) Nyando, agroforestry with least response; 9.7% (37) Budalangi, 2.1% (8) Nyando crop rotation with low response; 6.5% (25) Budalangi, 1.3% (5) Nyando mulching received least rating and 4.2% (16) Budalangi,0.8% (3) Nyando were others. The Chi-square test conducted on strategies not adopted for mitigating Flood risks gave ($X^{8}_{0.00}$= 46.94) which showed that there was highly significant ($P < 0.01$) variation on strategy not adopted for mitigating flood risks in the study area.

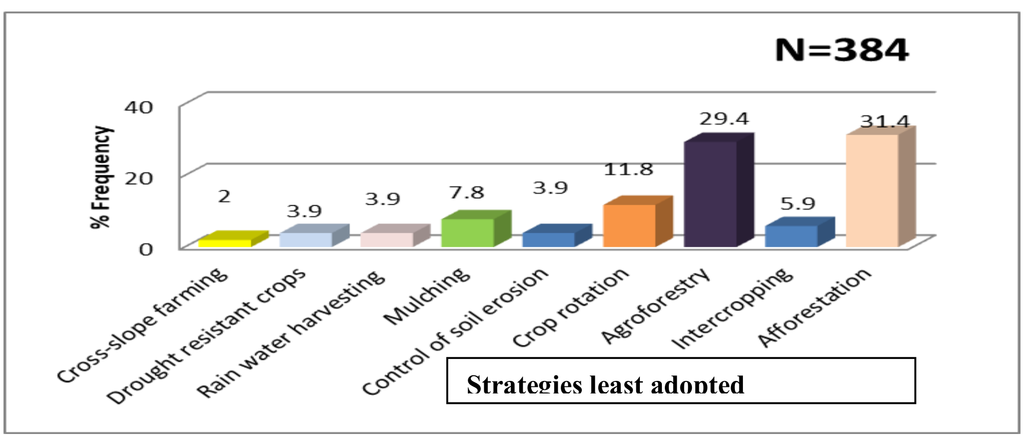

Figure 6.6 Household respondents on strategies least adopted in Western Region Kenya
Source: Field data (2022)

Just as (Rogers, 2003) in his diffusion innovation theory where he emphasizes that the technology can be adopted or rejected depending on the how it has been understood by people and also the benefits it will offer on the intended group. At the same time the technology can be adopted and somewhere on the way it is dropped

Most farmers are aware of the technologies that raise production levels but are reluctant to invest in them unless they are assured that the resultant crop surpluses can be readily sold. In western Kenya, the dominant tree on the landscape is *Grevillea robusta*, which was found to be grown by 86 to 94 per cent of households on their boundaries. When respondents were asked why the strategies were not well adopted especially afforestation and agroforestry. Focus group discussion response one member said that:

> Most farmers depended on trees for domestic use as fuel and even some sold trees for payment of school fees. However, while they were cutting down trees they never thought of replanting. Agroforestry was least practiced and another member responded that some did not get the right trees to plant with the identified variety of crops and mostly believed that tree can never be planted together with crops since they would kill the crops and compete for light (Female FGD participant during an FGD held on September 3, at Mundere primary school).

The respondents who had some knowledge on the afforestation and agroforestry indicated that since weather changes were rampant they resorted to afforestation and agroforestry and most of them said from the time they adopted the strategies they have experienced major changes and even when floods occur the impact is not as it was before.

Secondly most of them have minimized the use of fertilizers and resorted into mulching and crop rotation to increase food productivity.

Another interviewee from Budalangi who had taken initiatives said that:

> I have managed to plant over 3,000 seedlings of *Grevillea robusta* and also minimized the use of charcoal as a main source of fuel (A middle-aged County officer from Water and Environment during an interview held on September 3, 2022 at the County offices in Budalangi

The same factors were found in a similar study by (Meseret, 2016), who indicated that the most frequent responses from farmers towards changes in temperatures and precipitation showed that 20% changed crop 13.3% planted trees while 2.9% involved in Soil Conservation measures. Concerning adaptation to change in rainfall pattern, 42% had not applied any strategy. The most commonly applied was use of Soil conservation methods (30.4%) followed closely by diversification of crop varieties. Similar response was elicited in a study by Anyango *et al.,* (2016), where the respondents said that adoption to technology in control of flood risk they resort to careful timing of planting period (17.1%), agroforestry technologies (1.7%) and afforestation at (2.5%). This therefore means that for the strategies to be adopted and used then more education sensitization and community participation have to be achieved through trainings and government should come in strongly to emphasize on the adoption measures.

6.6.1. Extra farm to adopt the SLMT on flood risk reduction

Household heads respondents were asked whether the household had increased their farm sizes to accommodate the new technology. The findings summarized in Figure 6.7 indicated majority of the respondents out of the 384 households 76.0% (294) indicated that they had not increased the farm size to accommodate the SLMT while 24.0% (92) said they had added some farm size to accommodate the technology.

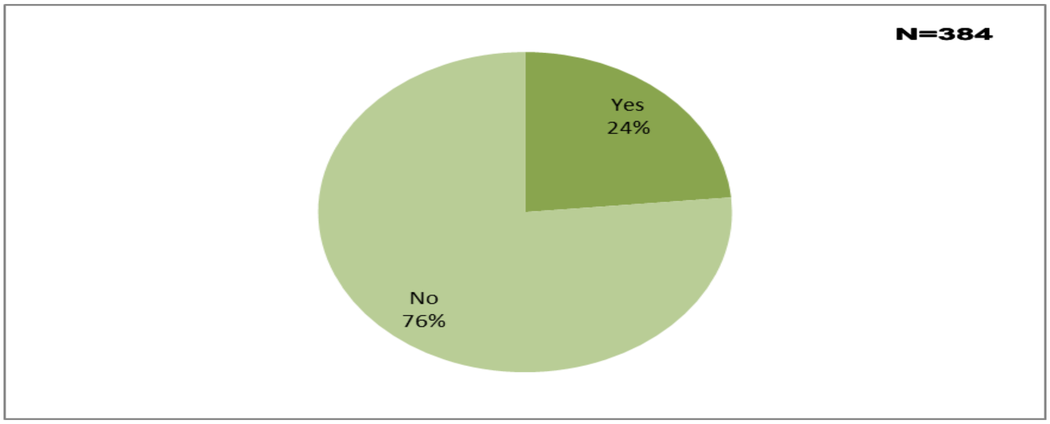

Figure 6.7 Household respondents on extra farm to adopt SLMT in Western Region Kenya
Source: Field data (2022)

Majority of respondents 45.1% (173) indicated no percentage on the issue of farm increase and when they were asked further why they did not increase the farm sizes they responded that they lacked finances which would have helped them accommodate more technology and practice them with ease. The findings from the FGDs from both areas indicated that indeed finance was the biggest problem that lead to low adoption rates of the technology, results shown in Figure 6.8. Sustainable Land Management Technologies are adaptation measures meant to prevent and mitigate projected future impacts necessary to enhance adaptive capacity in order to mitigate possible impacts by assessing the risks of impacts that may occur in the medium and long term according to Kenya baseline research. These measures are bound to control the impacts reduce vulnerability and strengthen resilience. These will include transforming the agricultural production system itself into a more resilient system to impact of flooding such as SLMT and providing incentive for increase on farm sizes to accommodate the new technology introduced, (Ongeko, 2017).

Findings from the Focus group discussion agreed that the major problem on the issue of farm size increase was actually lack of finances as main barrier for the adoption of the strategy. Households concentrated more on small scale farming harvesting crops for domestic use and so issue of technology was never taken seriously due to financial constrain.

A study in Ethiopia by Meseret (2016) also ranked finances as a number two barrier at (43%). In the study conducted in Ghana, (Antwi *et al*, 2015), reported that majority 131 households, (97%) of households in the study villages cited a lack of financial resource as a serious barrier to SLMT adoptions. Financial resources are a key barrier that seriously restricts the implementations of adopted strategies by households. This is because every form of technology adoption will invite some financial cost. Information gathered from the key informant interviews and Focus group Discussion revealed that lack of financial resources included insufficient funds, lack of credit facilities, loans and subsidies, lack of title deeds that they could use collaterally to secure loans from the banks. When asked to indicate the employment status majority of the respondents 73.4% households had no employment and 26.6% were engaged in gainful formal employment.

Distribution of household assets among the households was a proxy indicator for wealth status of the respective households. Therefore, it is widely accepted that poverty is directly proportional to vulnerability (Chan and Parker,2019). When respondents were further interrogated they also indicated in their sentiments that farm size increase was also affected by the fact that the farms were limited to adopt any possible technology at 27.5% (106) those who thought that they never benefited from the technology even after adopting at 21.6% (83) respectively followed with lack of labour and spouse decision hindrance at 3.9% (15) and 2.0% (7) respectively. Results for each of the sub county were computed 22.8% (88) Budalangi, 4.7% (18) Nyando limited farms could not allow adoption of the strategies; 18% (69) Budalangi, 3.6% (14) Nyando indicated they never benefited from the technology; 3.1% (12) Budalangi, .8% (3) Nyando they lacked labour to help them facilitate the adoption; 1.7% (6) Budalangi, 0.3% (1) Nyando they experienced spouse hindrance in adoption of the technology. The Chi-square test conducted on non- farm size increase gave ($\chi^2_{0.000}$= 32.43) which showed that there was highly significant ($P < 0.01$) variation on non- farm size increase due to various reasons discussed in the text.

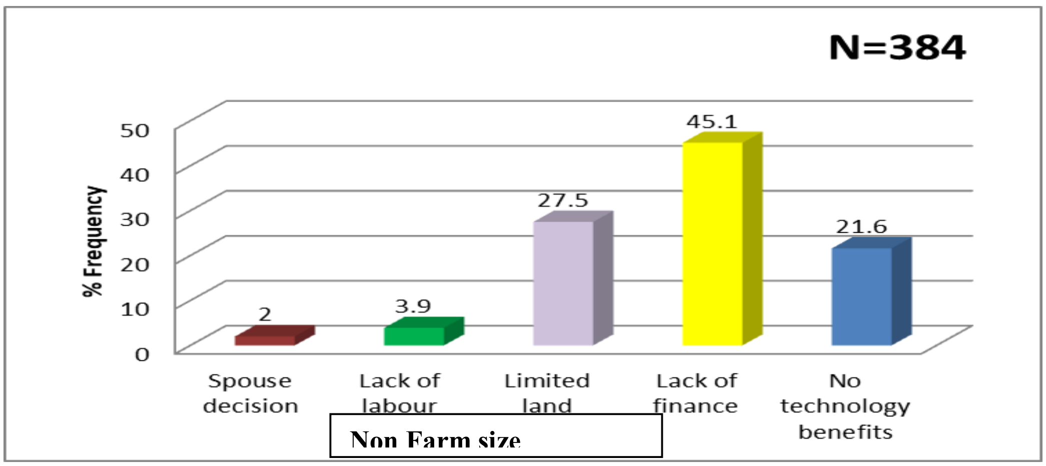

Figure 6.8 Household respondents on non-Farm size increase to accommodate SLMT in Western region Kenya
Source: Field data (2022)

6.6.2 Use of extra harvest to adopt the SLMT on flood risk reduction

The respondents were asked to indicate what they did with extra harvests from their farms and the results are shown in Figure 6.9. Majority 58.8% (226) of the respondents had no extra harvest but instead they used all the harvests on domestic supplies. It was observed that, 21.6% (83) utilized the extra harvest on getting farm supplies to enable them continue with the planting, 15.7% (60) used the extra harvest in selling and paying for school fees for their children at various schools both primary and secondary level, 2.0% (8) used the extra harvest on social commitments such as merry-go rounds. On the specific sub counties, it was observed that 48.9% (187) Budalangi, 10.1% (39) Nyando they had no extra harvest; 18% (69) Budalangi, 3,4% (14) Nyando opined that they used extra income on purchase of farm supplies; 13.1% (50) Budalangi, 2.6% (10) Nyando used it in payment of school fees after being sold; 1.8% (7) Budalangi, 0.2% (1) Nyando extra income was used on social commitments. The Chi-square test conducted on the use of extra harvest by various households gave ($\chi^2_{0.001}$= 55.57) which showed that there was highly significant ($P < 0.01$) variation on what was done with extra harvest.

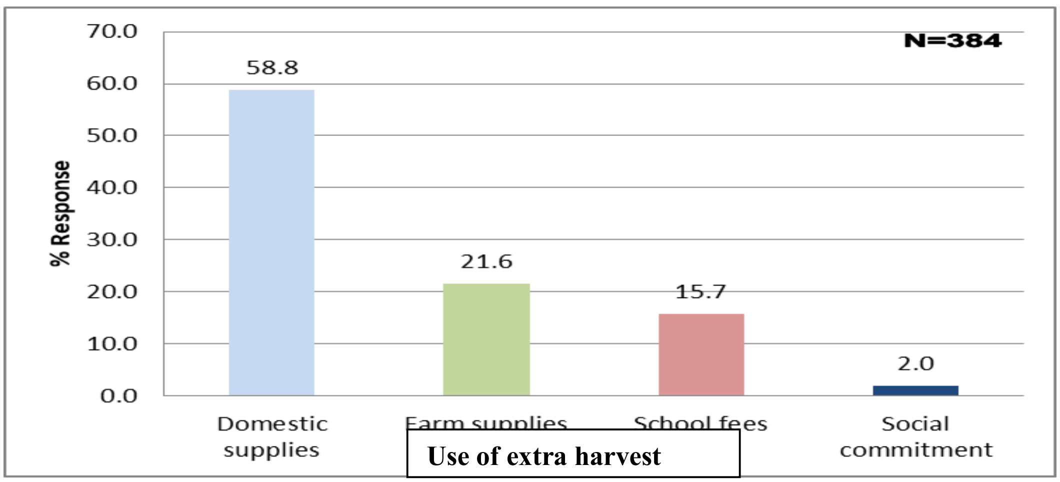

Figure 6.9 Household respondents on use of the extra harvest in adoption of SLMT in Western region Kenya
Source: Field data (2022)

Loss of income generating activities results from flood induced losses and destructions. Displacement from homes and loss of transport because of flood contributed to loss of income generating activities the information obtained from Key informant extension officer from Nyando. Loss of income generating activities reduces access to income which in turn reduces the purchasing power. Extra harvest was used domestically and farm recycling so the SLMT adoption and implementation was hard to be practiced according to FGD member from Busia. The trainings to help in improving the SLMT could not be attended to the maximum. This study was backed up by the Focus group Discussion where one-member from Ayweyo boldly said that:

> Due to the frequent floods experienced in the area could not give them humble time to settle and practice serious farming since they feared the destruction of crops by floods. Instead they concentrated on utilizing what measures existed and got little that they used to rather than new technology that was complicated and needed a lot of keenness (Female FGD participant during an FGD held on September 3, 2022 at Ayweyo Village)

This is cemented by Rogers Diffusion and innovation theory where he says that the technology can be adopted or be rejected completely or be adopted and somewhere on the way abandoned by the community.

6.6.3 Effect of SLMT adoption on standard of living

The respondents from the households were called upon to state whether the adoption of the technology has in any way improved the standards of living for those who had adopted and what were the benefits of the adoption. Results are shown in the Figure 6.10. Majority of the respondents 61.0% (234) indicated that their standard of living had improved drastically and were not experiencing the impacts of flood risks that had hit them hard before the adoption of the technology; 27.0% (104) said they had no improvement in their living standards and 12% (46) had no idea whether they improved living standards or not. The Chi-square test conducted on improved standards of living by the SLMT gave ($\chi^2_{0.000}= 19.18$) which showed that there was highly significant ($P < 0.01$) variation on technology improvement on Standards of living.

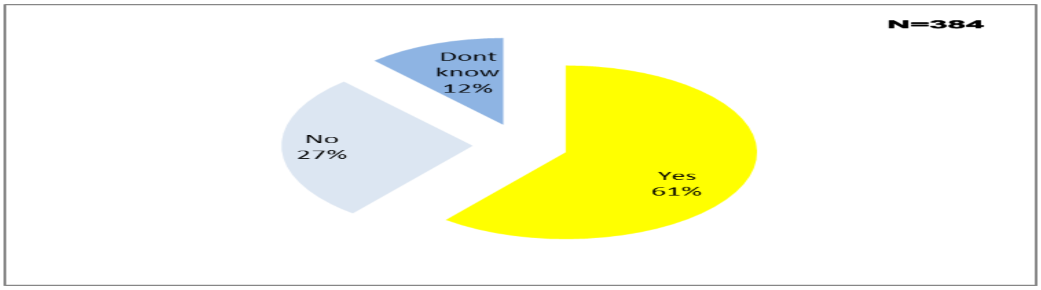

Figure 6.10 Household respondents on effect of SLMT adoption to people's standard of living in Western region Kenya
Source: Field data (2022)

These findings are anchored on the Rogers diffusion innovation theory which says that the technology can be accepted and adopted and when used benefits are observed. However, a technology can also be adopted early and if the benefits are not realized it is then abandoned on the way at the same time people can decide not to adopt the technology at all. The results are a true picture of the community in the study area. Findings of the FGDs from both areas indicated that mostly those who realized the benefits adopted the technology with ease but those who never realized the benefits never bothered

6.7 Access to Extension services advice on SMLT for flood risk reduction

Respondents were asked whether they received any extension advice on mitigating flood risks using the SLMT adopted in the area. The findings are summarized in Figure 6.11. Majority of the respondents 92% (353) indicated a yes that they indeed received extension advices from their agricultural extension officers, 6% (23) never received advice and 2% (8) did not know whether they received advice or not. The Chi-square test conducted on extension services as a strategy for mitigating flood risks gave ($\chi^2_{0.00}$= 79.53) which showed that there was highly significant ($P < 0.01$) variation on extension services advice as a strategy for mitigating flood risks.

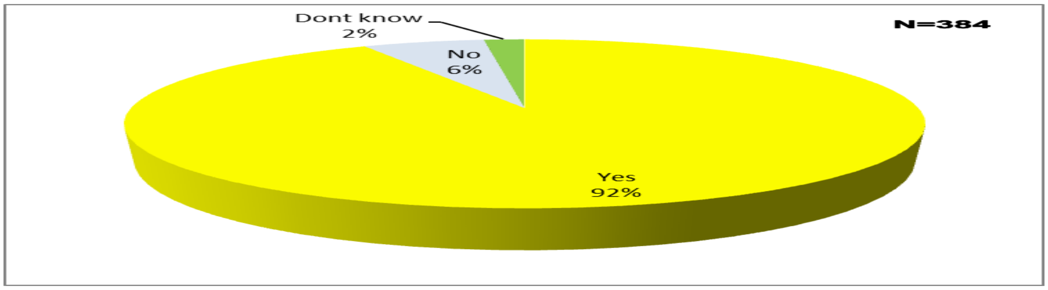

Figure 6.11 Household respondents on access to Extension service advice on SLMT for flood risk reduction in Western region Kenya
Source: Field data (2022)

To determine the level of technology and advice from the extension services, the availability of Extension services from the ministry of agriculture did not trigger much the adoption of SLM as the practices are known but the capacity to implement was lacking. Technological developments of new SLMT are critical to flood risk management. Households only utilized tools and adoptions that were available and relevant to the local setup (Smit and Skinner, 2002) in absence of which they ended up relying on their indigenous knowledge. Lack of technology can impede the County's ability to adopt options thereby limiting the range of possible response (Achiando, 2012). Most of the adoptions at any level require the technology. It must be developed with the perception of the local farmers in mind because the technology envisaged might involve large sums of finances that the farmers mighty not afford (Achiando, 2012).

Evenson and Mwabu (2001), widespread agreement that well-executed extension services boost agricultural output. Public agricultural extension service performance in Kenya has been hotly debated. The system has been criticized for being top-down, uniform (one-size-fits-all), and rigid, all of which have contributed to the agriculture sector's poor performance. Focal Area Approach (FAA), Farmers Field Schools (FFS), and Promoting Farmer Innovations (PFI) are just a few examples of the more participatory approaches that have been developed and implemented to enhance agricultural extension in Kenya. However, the approaches are least utilized in the study area which is a problem in adoption of the technology. Over 70% of all agricultural work in Kenya is done by women, and the government is working to increase their influence by including gender concerns in all agricultural production, processing, and marketing programs (FAO, 2001).

6.8 Knowledge emphasized by Extension officer services

Respondents were called upon to indicate the knowledge that the extension officers emphasized while delivering the advice to the farmers. Results are shown in Table 6.5. Majority of the respondents 64.7% (247) said they received advice on SLMT, soil erosion control at 23.5% (91), pest and disease management 5.9% (23); soil fertility management at 3.9% (15) and 2.0% (8) crop variety use. The response for specific counties was also captured in the Table 6.5. The Chi-square test conducted on areas of knowledge emphasized on by extension services as a strategy for mitigating flood risks gave ($\chi^2_{0.00}$= 71.26) which showed that there was highly significant ($P < 0.01$) variation on areas of knowledge extension services advice as a strategy for mitigating flood risks.

Table 6.5 Agricultural Extension service advice on technology in Western region Kenya

Extension service Strategy	Western Region		Budalangi		Nyando	
	(%)	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**
Knowledge on SLMT	64.7	247	53.7	205	11	42
Soil erosion control	23.5	91	19.4	75	4.1	16
Pest &disease management	5.9	23	4.9	19	1	4
Soil fertility management	3.9	15	3.1	12	0.8	3
Crop variety use	2	8	1.8	7	0.2	1
Total	**100**	**384**	**82.8**	**318**	**17.2**	**66**

Source: Field data (2022)

This results are supported by (Gono, 2020) in his research on Sustainable management by smallholder farmers in Zimbabwe where it was observed that lack of suitable mechanisms for disseminating the available knowledge on sustainable land management through training to smallholder farmers in Zimbabwe presents a barrier to innovation and sustainable adoption of viable land management techniques. More trainings will add positive response on SLMT and hence emphases on the same is valuable

6.8 Communication by government on SLMT for flood risk reduction

Household respondents were asked to indicate what the government has done in ensuring the mitigation of flood risk. Results are shown in Figure 6.12. The respondents 27.5% (106) said that use of agricultural officers from the ministry of agriculture could make a difference in perception, Early warning systems at 19.6% (75); farm field days, trainings, agroforestry and building dykes each at 9.8% (37), afforestation at 2.0% (8); soil erosion and others at 5.9% (23) each. Results for specific counties were captured in the same order 22.8% (88) Budalangi, 4.7% (18) Nyando, noted that agricultural officers played key role reduction of the floods;16.2% (62) Budalangi, 3.4% (13) Nyando indicated early warning as better option; 8.2% (31) Budalangi, 1.6% (6) Nyando,); farm field days, trainings, agroforestry and building dykes each; 2.6% (10) Budalangi, 3.3% (13) Nyando noted soil erosion and others respectively; afforestation was responded at 1.8% (7) Budalangi and 0.2% (1) Nyando. The Chi-square test conducted on government efforts on SWCs as a strategy for mitigating flood risks gave ($\chi^2_{0.04}$= 22.24) which showed that there was highly significant (P < 0.01) variation on government efforts in enhancing adoption of SLMT as s strategy for mitigating flood risks.

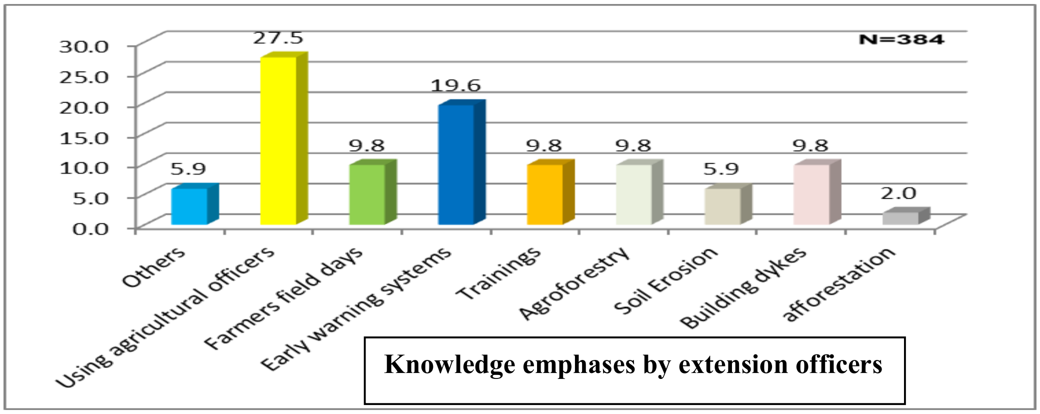

Figure 6.12 Household respondents on knowledge emphases by extension officers on SLMT in Western Region Kenya
Source: Field data (2022)

In the agreement with members of the FGDs one of the key informant from ministry of agriculture said that the responses required for flood risk mitigation include engagement of the County government through environmental ministry, where government is expected to protect forests from destruction, conduct baseline surveys to establish the extent of impacts , plan meetings and mobilization of groups to be used to reach out to individuals, collect and compile data and information provision of materials for engagement of the media to ensure wider audience is covered regarding Sustainability awareness and adoption.

Not only public actors but also private actors are required to implement adaptive measures of sustainability because individuals are usually confronted by barriers and incentives are often not sufficient to reach the adoption level of the technology. However, strategies to expand the limits of adoption reach from investing in research and development, increasing economic growth to simply reducing extent of adopting the SLM technology, (Adenle *et al.,* 2022). The study agrees with (Shiferaw *et al.,*

2009) in the Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices where he suggest that future interventions need to promote joint innovations that ensure farmer experimentation and adaptation of new technologies and careful consideration of market, policy and institutional factors that stimulate widespread smallholder investments. Projects should act as 'toolboxes', giving essential support to farmers to devise complementary solutions based on available option especially communication by the stakeholders.

6.9 Rating SLMT adoption

Having looked at the SLMT and the response from the household heads the technology was subjected to the rating on the scale of 1-5 and the responses are shown in Figure 6.13. Majority 47.1% (180) respondents acknowledged that indeed the technology was slightly adopted in the area, 35.3% (142) was moderately adopted 5.9% (15) respondents showed that the technology was highly adopted and (11.8%) (45) responded by saying that the technology was not adopted at all. Rating per sub county indicated slightly adopted at 39% (149) Budalangi, 8.1% (31) Nyando; moderately at 29.3% (118) Budalangi, 6% (24) Nyando; not adopted at 9.7% (37) Budalangi; 2.1% (8) Nyando; Highly adopted at 4.7% (12) Budalangi, 1.2% (3) Nyando.

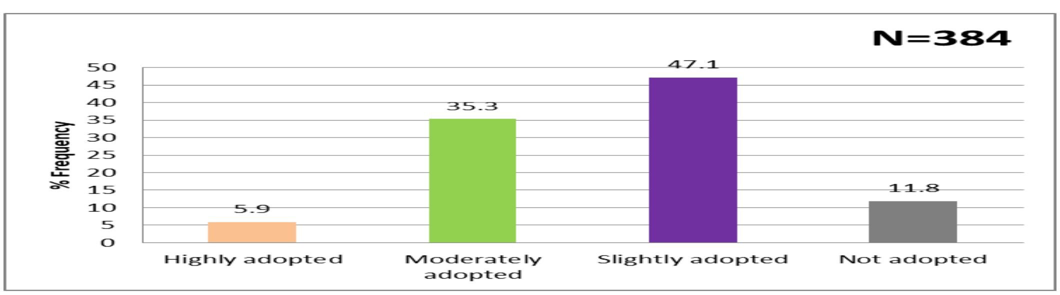

Figure 6.13 Household respondents on rating technology adopted in Western Region Kenya
Source: Field data (2022)

The Chi-square test conducted on SLMT technologies rating by respondents gave ($\chi^2_{0.00}$= 23.12) which showed that there was highly significant ($P< 0.01$) variation on respondents rating of the technologies adopted in the study area as a strategy for mitigating flood risks.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

7.1 Introduction

The chapter presents the summary of the study, conclusion, recommendation and suggestions for further research

7.2 Summary

The research was buttressed by a review of literature on Sustainable Land Management Technologies, the type and extent of the existing Sustainable Land Management Technologies employed by farmers in Western region, Kenya; examined prevalence of flood risk by farmers; strategies for mitigating flood risks were evaluated. The main objective of chapter four was to determine the type and extent of the existing technologies. The major existing SLMT practiced in the study area as indicated by the Households was cropping management at 58.8% (227) slightly practiced; Cross- slope farming was extremely practiced at 3.9% (15) and forest management was never practiced at 2% (8) respondents. The extent of SLMT was affected highly moderate by land size at 72.9% (280) and degree of erosion slope affected slightly moderate at 4.2% (15) the extent of SLMT.

Rating of the common SLMT by the households indicated; Crop rotation was the most practiced technology at 40% (154) rain water harvesting, seasonal cropping rated second at 38% (146) each, cover cropping and terraces at 36% (138) each, Flood water harvesting and mulching at 35% (134) each, agroforestry rated at 31% (119); Zai technology at 26% (100) and in-situ- water harvesting at 22% (85). The study established a strong relationship between the existing SLMT and causal factors affecting the extent of the SLMT in western region Kenya.

The specific objective two in chapter five was to examine prevalence of flood risk by farmers in Western region; the period of stay had influence on SLMT at 52.9% (203) had stayed in the area for over twenty-six years against 47.1% (181) who had stayed between 11-25 years). The distance that the household lived from the flood prone area determined the displacement. Majority of those displaced from their homes were living in the down -stream while those who were not displaced lived in the upper stream. Most people lost homes whenever floods occurred and were forced to move to higher grounds. Respondents 39.2% (146) acknowledged to have suffered damage to other properties such as agricultural land and crops. Loss of agricultural land and crops indicated that damage of sources of livelihoods is very high in the study area. The ability to predict an event had influence of SLMT on flood risks. 88% (338) respondents indicated they are able to predict an event while 12% (46) had no knowledge of how to predict the event. The ability to predict an event is important in disaster preparedness and essential in disaster risk reduction as they set out clearly what to be done, when, where, how and the acceptable standards. (Noren *e tal,* 2016) argues that it is well understood that the effectiveness of disaster prediction strategies and level of prediction can determine the success of disaster response.

Trainings on the issues of flood risk are important for preparedness and mitigation related to the impacts of the floods. According to (Lininger *e tal,* 2016) there was a robust correlation between flood education and a sense of safety. The perception of flood risk was lower among those who knew less about the factors that contribute to floods. Similar to other research, this study found that people with higher levels of flood knowledge education also had a higher level of flood risk perception. The perception of flood risk was lowest in the group that received the most information about flooding, while it was highest in the group that received the least. Response on confidence where information is sourced and passed to the household has influence on SLMT. Communication and information are very important and a measure to help people or community understand what is happening in the vicinity. Non-governmental Organization acknowledged with great deal at 96.1% (370); Central Business Organization at 82.4% (316) and those with fair acknowledgement included 68.6% (263) and 56.9% (218), National government and County Government respectively. This suggests that more flood knowledge education is required if the government is to achieve its goal of raising public awareness of flood risks. It has been discovered that how people feel about their own personal roles in flood protection might affect how they feel about the risk of flooding in general. Higher flood risk perception was seen among respondents who thought they were responsible for flood protection in this study. One possible explanation is that those who have a sense of personal responsibility to take preventative steps tend to be skepticism about the efficacy of 'public' preventative measures. The respondents 84% (323) indicated they were never prepared for the flood event while 2% (7) had no idea on what was happening said the government was primarily for preparing people for the flood disaster. The high degree of trust indicated that respondents have faith in the government and themselves to deal with flood dangers without requiring excessive preparation on their part. Those who had less faith in their government were less likely to expect them to provide prompt flood warning and rescue operations. Instead, people opted to learn about floods, seek out relevant information, and take preventative actions. The vast majority of research that has been conducted verified these findings. Results showed that flood help offered by government and non-government organizations was ineffective in mitigating flood-related damage.

The impact of floods has worsened and induced forced migration of the already vulnerable community in Western region. However, those who had adopted the SLMT faced less impact. Household heads respondents rated the impact of SLMT on flood risk. Out of the 384 households 49.0% (288) indicated that the technology had moderately influenced in terms of flood risk control 9.8% (38) felt the technology had highly influenced the flood risk reduction. Concerned authorities took it to be business as usual, cycle and the 'paper plan syndrome' rather than looking at it as a crisis that is an impediment to sustainable developments that requires broad- based and holistic approach. Sustainable land management has been defined as a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra- and intergenerational equity. Communities have preferred to develop their own domestic legislation to enhance them practice the technology. Moreover, they embrace conservation practices such as cropping management and water conservation measures to gap flood risks.

Findings on specific objective three on evaluating the strategies for mitigating flood risks in western region Kenya are discussed here. The strategies identified for this study included informational strategy where those belonging to community self-help groups were 65% (230) respondents while 4% (15) didn't even know the existence of self-help. Household heads acknowledged that by belonging to a community group they had acquired more knowledge and skills including use of the new skills among others in practicing agriculture. Women participated more in the groups; indeed, the number of women in a group was higher in the mixed sex group. There were also women exclusive groups, no men groups were found. Importance of group membership understanding on Soil Water Conservation as a strategy benefited them by sharing of knowledge at 36% (138); training on conservation methods 20% (77) demonstration of use at 32% (123). Most groups took the initiative to invite agricultural extension officer to teach them on soil and water conservation measures, for facilitation they contributed to pay the extension officer travel expenses. Further, the group member ship facilitated the ease of demonstration of SLM practices there by increasing their adoption rate. The invitation of agricultural officer is an illustration of willingness to learn and adopt the sustainable land management technology. However, some household respondents' non- members 68% (261) acknowledged that group problems were many and so it hindered them from joining; lack of time since most of the time they were out busy trying to vendor for food, some lacked information when the groups were being formed, lack of permission from the spouses, lack of interest and lack of labor on the farm. General consensus exists that extension services, if properly designed and implemented will improve SLMT (Evenson & Mwabu, 2001). The performance of the public agricultural extension service in Kenya has been a very controversial subject. The system has been perceived as top-down, uniform (one-size-fits-all) and inflexible and considered a major contributor of the poor performing agricultural sector and especially on flood risk understanding. The response on barriers to adoption of the SLMT the farm size had effect and if they had increased farm sizes to adopt the SLMT out of the 384 households 76.0% (294) indicated that they had not increased the farm size to accommodate the SLMT while 24.0% (92) said they had added some farm size to accommodate the technology. Findings from the Focus group discussion agreed that the major problem on the issue of farm size increase was actually lack of finances as main barrier for the adoption of the technology. Households concentrated more on small scale farming harvesting crops for domestic use and so issue of technology was never taken seriously due to financial constrain. When asked whether the adoption of the SLMT had improved living standards of households 61.0% (234) indicated that their standard of living had improved drastically and were not experiencing the impacts of flood risks they encountered before the adoption of the technology. These findings are anchored on the Rogers diffusion innovation theory which says that the technology can be accepted and adopted and when used benefits are more. However, a technology can also be adopted early and if the benefits are not realized it is then abandoned on the way at the same time people can decide not to adopt the technology at all. The results are a true picture of the community in the study area. Out of the 384 households on governance actors in SLMT adoption and diffusion, 26% (100) indicated that the Non-Governmental organizations were best in providing the mitigation through active community participation and involvement improved the community way of perception on the whole issue of flood risk and technology adoption. The Government had made major efforts in ensuring that flood risk is under control and SLMT technology enhanced and mainstreaming also played a role in ensuring that farmers had some knowledge in flood risk management and SLMT practice in the community. It is agreed that adaptive capacity will be higher in cases where social institutional and arrangements governing allocation of power and access to resources within a community ensures resources are equitably distributed. On the use of public extension officers on advices and training household respondents were asked whether they received any extension advice on mitigating flood risks using the SLMT adopted in the area 92% (353) indicated a yes that they indeed received extension advices from their agricultural extension officers, 6% (23) never received advice and 2% (8) did not know whether they received advice or not. Agricultural extension in Kenya has evolved through improvements, development and adoption of more participatory systems such as Focal Area Approach (FAA), Farmers Field Schools (FFS) and Promoting Farmer Innovations (PFI). Kenyan women do over 70% of agricultural activities, and the ministry is enhancing their role in agricultural production, processing and marketing by mainstreaming gender issues in all programs (FAO, 2001). Households were called upon to mention the major areas that extension officers emphasized on and 64.7% (247) received advice on SLMT, soil erosion control at 23.5% (91), pest and disease management 5.9% (23); soil fertility management at 3.9% (15) and 2.0% (8) crop variety use.

Project or group membership has always boosted knowledge on the side of the members. The research was supported by Focus group discussion members who acknowledged that households that were font of attending meetings and trainings had an upper hand since they could reason and agree to disagree on the issues of flood risks as opposed to those who never attended meetings. Government efforts were also subjected on the role played in SLMT and flood risk 27.5% (106) said that use of agricultural officers from the ministry of Agriculture could make a difference in perception, early warning systems, field days, trainings, agroforestry and building dykes, afforestation and soil erosion control. Not only public actors but also private actors are required to implement adaptive measures of sustainability because individuals are usually confronted by barriers and incentives are often not sufficient to reach the adoption level of the technology. However, strategies to expand the limits of adoption reach from investing in research and development, increasing economic growth to simply reducing extent of adopting the SLM technology. When it came to rating of the SLMT on flood risk reduction households had to say; 47.1% (180)

respondents acknowledged that indeed the technology was slightly adopted in the area, and 5.9% (15) respondents showed that the technology was highly adopted.

7.3 Conclusions

The overall conclusion of the study, SLMT adoption has led into flood risk reduction Western region Kenya. The specific conclusions:

I. The existing SLMT practiced included: cross-slope farming extremely practiced; Water management moderately practiced; cropping management slightly practiced while forest management and grazing management were least practiced.

II. The prevalence of flood risks in the communities reduced especially for those that adopted and practiced SLMT. However, with the experience they had in flood risk reduction showed that they were never prepared for the disaster.

III. On evaluation of the strategies for mitigating flood risks it was evident that NGOs, community participation and government efforts were forefront in mitigating flood risks.

7.4 Recommendation

I. Community utilization of the existing SLMT that are nature based and affordable should be emphasized by all stakeholders involved in disaster risk reduction

II. On flood prevalence the communities should be encouraged to adopt and practice the SLMT in order to enhance flood risk reduction and reduce the flood impact experienced by the vulnerable communities.

III. To promote SLMT, it is crucial to start national extension programs or integrate the pre-existing agricultural and natural resource management initiatives. Consequently, the communities should be encouraged to embrace measures such as Focal area approach, farmers field schools and promoting farmer innovation.

7.5 Suggestion for further research

I. There is need develop a local knowledge base system to trace farmer's local knowledge on SLMT, adaptations made to those technologies and their practicability at farm level.

II. Future researchers need to further investigate whether farmers who participate in project activities disseminate the information to other farmers and also establish the accuracy of information disseminated to aid in adoption processes hence inform decision-making and action.

III. Investigate if policy makers, extension personnel, researchers and project implementers require sensitization on the need to be gender sensitive in SLMT and Disaster risk reduction considered in policy making, design and dissemination of sustainable land management practices and in the formulation and implementation of Flood risk reduction in agriculture related projects

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APPENDICES

APPENDIX I: INTRODUCTORY LETTER

Dear respondent,

This is to introduce you to the study "Impact of Sustainable Land Management Technologies on Flood Risk Western region, Kenya"

The aim this study is to examine the impact of Sustainable Land Management Technologies on Flood Risk in Western region, Kenya. This will be covered by the specific objectives to: determine the type and extent of the existing Sustainable Land Management Technologies employed by farmers in Western region Kenya; examine prevalence of flood risk by farmers in Western Region Kenya and evaluate the Strategies for mitigating flood risks in Western region Kenya

Your participation in this study is very important as one of the beneficiaries of climate change resilience and Sustainable Land Management Technologies. Secondly, you have been selected to represent the Community within the river basin covering mainly four sub counties Busia and Bunyala, East Kano and Onjiko. The researcher will ensure that their responses remain confidential and that the research is purely for academic purposes.

The respondents will also have a right to refuse to participate or withdraw at any time from the research.

Thank you.

Yours faithfully,

Opilo Betty

Principal Researcher

APPENDIX II

HOUSEHOLD QUESTIONNAIRE

Questionnaire Number--

Household Head…………………………………………………………….

Research Assistant…………………………………………………………...

County………………………………………………………………………...

Sub- County…………………………………………………………………...

Ward………………………………………………………………………….

Village………………………………………………………………………...

Part A: Socio-Demographic Information

	A. BACKGROUND INFORMATION	
1	Residence	Yes NO
2	Ethnic group	Yes NO
3	Age of Household head	15-25__________1 26-35__________2 35-55__________3 55-75__________4 Above 75_______5
4	Gender	Male_________1 Female________2

5	Marital status	Single______________1 Married_____________2 Divorced_____________3 Widow_______________4
6	Employment	Employed________1 Unemployed____________2 Self employed_________3
7	Education	Non________________1 Nonformal education____2_ Primary school dropout _3 Primary level_________4 Secondary school drop out_5 Secondary___________6 Tertiary _____________7 University level________8
8	Household income	Farming_________1 Employment---------2

APPENDIX III

DETERMINE THE TYPE AND EXTENT OF THE EXISTING SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES EMPLOYED BY FARMERS IN WESTERN REGION, KENYA

Household Head details

1) in your own opinion and knowledge tick the existing types of SLMT employed in your area of residence.

1) Cropping Management practices

2) Cross- slope barriers Practices

3) Water Management practices

4) Forest Management practices

5) Grazing Management practices

b) On the scale of 1-4 how do you rate the above practices in your residence?

1) Extremely practiced 2) moderately practiced 3) slightly practiced 4) not at all

2) to what extent does the following affect the type of the existing SLMT employed in your area. Rate on the scale of 1-4

1) Slightly 2) slightly moderate 3) moderate 4) highly moderate

1) Land size

2) Slope of the farm land

3) Fertility status of the farm land

4) Degree of erosion

5) Distance between home and farm land

3) The existing strategies mentioned above do you think they play an important role in mitigating floods and improving soil fertility in the community you live Yes/ No

4) in your own understanding what are the causes of soil erosion on your farm holdings? Please tick in the box

□Deforestation, □Cultivation along river banks, □Settlement □Irrigation □Overgrazing

□ Mono- cropping, □Flooding □ others

b) On the scale of 1-4 how do you rate the main causes of soil Erosion in the area of residence? 1) Little experienced 2) experienced 3) moderately experienced 4) highly experienced

5) What is the conservation measures employed in control of soil erosion in your community? Please select from the list mostly effective and used in your area.

a. Crop Rotation
b. Checking Shifting Cultivation
c. Use of Early Maturing Varieties
d. Contour Ploughing
e. Strip Cropping
f. Terracing and Contour Bunding
g. Flood Water Harvesting
h. In-situ Water Harvesting and Conservation
i. Zai System of Water Harvesting
j. Constructing Dams
k. Cultivation of Bamboo to prevent Soil erosion

6) What is the common Water Harvesting structure used in your community? Select from the list

1. Flood Water Harvesting

2. In-situ Water Harvesting and Conservation
3. Zai System of Water Harvesting
4. Constructing Dams
5. Cultivation of Bamboo to prevent Soil erosion

7). How well do you KNOW the following measures? In the scale of 1-5 PLEASE tick

1) Unwell 2) Slightly Well 3) Moderately well 4) Very well 5) Extremely well

	Rating	1	2	3	4	5
1	Rainwater Harvesting (RWH)					
2	Flood Water harvesting:					
3	In-situ Water Harvesting and Conservation					
4	Zai System of Water Harvesting					
5	Agroforestry					
6	Terraces					
7	Crop rotation					
8	Cover cropping					
9	Seasonal cropping					
10	Mulching					

8). what other approaches that has been used successfully in the community you reside?

APPENDIX IV

EXAMINE PREVALANCE OF FLOOD RISK BY FARMERS IN WESTERN REGION, KENYA

1. How long have you lived in your current place or home in terms of years? Please tick

  i. 4-10 years
  ii. 11-25 years
  iii. Above 26 year

2. In your own opinion do you understand the word risk? I) YES ii) NO iii) I don't know

3. What type of residence do you live in (a) block flat (b) single family houses? Please tick

4. What is the distance to the nearest river or stream to your residence? a) less than 100 M., b) about 500 M., c) about 1 KM., d) more than 1KM.

5 Have you experienced one or more flooding events in your life YES/ NO/ I don't know

6 If yes, please indicate the year, month, place of the flood occurrence:1 = 1 years; 2 = 2–5 years; 3 = 6-10 years; 4 = 11-25 yeas; 5 above 25 year

7. Did you suffer any damages? (Please select at most three options): a) I did not get any damage) relative suffered damages') I suffered damages to other properties (cars, other vehicles, garages, various goods, d) I suffered damages to my homage) I suffered physical damage.

8. Could you indicate the type of feelings you experience now, when recalling what you experienced at that time? (a. I was scared for my life (b. I was afraid for the lives of my family. (c. I was afraid of damage to my property, (d. I wasn't scared

9. Do you think today we would be able to predict an event in advance? • Yes/• No • I do not know

10). How much do you feel exposed to each of these risks: flood, landslide, earthquake, pollution, electromagnetic pollution, robbery, and terrorism? (1) extremely exposed, (2) moderately exposed,

(3) slightly exposed, (4) not at all exposed.

11). In your opinion how do you rate the flood risk of the area where you live? a) low

b. medium c. high d. very high

12). On scale of 1 to 5, how likely do you find flooding in your home within the next 15 years? Where 1 is no probability and 5 is high probability

13). Why do you think flood events are dangerous for the community?

a) they are unpredictable

b) there is a scarce presence of adequate protections (dams, embankments reinforcements,

c) people adopt wrong behaviors

d) there is bad management by local authorities

14). what do you think would be the causes of floods in the area where you live? (Rate on a scale from 1 to 5, where 1 is no probability and 5 is a high probability).

a) Flooding of a major river b) breakage of the banks c) flooding of minor streams/rivers

d) Heavy rainfall e) poor farming practices

15). In your opinion, what factors can contribute to a similar event? (Rate on a scale from 1 to 5, where 1 = Not Important, 2 = Slightly Important, 3 = Of Average Importance; 4 = Important, 5 = Very Important)

• Incorrect management of the territory

• the lack of defense works (embankments)

• the characteristics of the soil

• poor farming practices

• deforestation

• modification of the course of rivers and watercourses

• bad luck

• climate change

• little interest of public administrators

16). How well informed do you feel about flood risk in your neighborhood? (Rate on a scale from 0 to 5, where 0 is not informed and 5 is very informed).

17). Do you feel well prepared to face a flood event? a. Yes b. No c. Do not know

18). Have you attended any training related to flood risk? • Yes• No. I don't know

19). How difficult is it to forecast flood on where and when it will occur? (Rate on a scale from 0 to 4, where 0 = very easy and 4 = extremely difficult)

20). Compared to early years do you think that today the management system of this type of

A risk is improved? a)Yes b)No c)I do not know

21). How much confidence do you have in the information on flood risk coming from? (Rate on a scale from 0 to 3, where 0 is "none at all", 1 is "not very much", 2 is "fair amount" and 3 is "great deal")

a) National government

b) County Government

c) CBOs

d) Non-governmental Organization

22). According to you, who is responsible for preparing you for flood disaster? a. I am completely, b). I am primarily, c) the government and I equally. d) the government is primarily, e) the government is completely

23) In your own opinion has SLMT influenced the flood risk in the community you reside from? On the scale of 1-5 rate i) not influenced ii) slightly influenced iii) moderately influenced, iii) highly influenced iv) extremely influenced

APPENDIX V

EVALUATE THE STRATEGIES FOR MITIGATING FLOOD RISKS IN WESTERN REGION, KENYA

Informational strategy for mitigating Flood Risks 1) Do you belong to any **project group**? □ YES □ No □ I don't know

2) **which one?** Name:____

3) If yes how has your group membership improved your understanding of SWCs

□ Demonstration of use □ sharing knowledge □ training by project staff □ other specify

4) If you do not belong to any group what are the reasons?

□ Lack of interest □ lack of time □ lack of info □ group problems □ lack of money □ lack of labor on farm □ lack of permission from spouse

5) How does your lack of membership to a farmers' group affect your understanding of flood risk? i) not affect ii) slightly affect, iii) moderately affect iii) highly affect iv) extremely affect

6) Have you made any modification to the Soil and Water Conservation Technologies **(SWCs)** contrarily to what was taught □ yes / □No □I don't know

7) Which ones, please list them-- ………

8) What do you do with the extra harvest

□ Domestic supplies □ farm supplies □ school fees □ Social commitment □ entertainment

9) Have you increased your farm size to accommodate the technologies: □ YES □ NO□ I dont know

If no, why? □ limited land □ lack of money □ lack of labor □ lack of benefits □

□ lack of benefits from technology □ spouse decision other specify

10) Has the adoption improved your living standards? □ yes □ No □ I don't know

If yes how? □ Able to pay school fees □ domestic supplies □ farm supplies □ Social commitments □ entertainment

11) Are there any technologies you plan to abandon: □ YES □ NO□ I don't know

If yes why? Please mention Technology and reason for abandoning

12 What is the government effort in management and practice of SWC in the community you reside?

13. what are the most used strategy for mitigating flood risks please choose from the list

a) Active community participation b) Government effort for SWC c) NGO involvement in SLM & SWC d) Mainstreaming of technology to farmers e) all of the above.

14) Do you attend project meetings as institutional strategy for mitigating Flood Risk?

□ YES □ NO.□ I don't know If you don't attend project meetings what are the reasons:

□ Lack of time □ not interested □ lack of money □ communication barrier

□ unsuitable venue □ lack of information

15) Are there other strategies that you have not adopted? Please mention them

16) Do you intend to adopt them in future? □ Yes □ No □ I don't know

If yes why?

□ high yields □ soil fertility □ more income □ labor availability □ increased control of floods

17 Access of Extension Services for mitigating Flood Risks) Do you receive any extension advices: □ Yes □ No □ I don't know

18) If yes how often? □ Never occasionally □ S/times □ always □ everyday

19) Do the extension officers have preferences for whom to give information? □ YES □ NO□ I don't know

20) If yes who do they prefer giving advice to □ Man □ Woman □ both

21) what is mainly the gender of the extension officers? □ Male □ Female

22) What areas of knowledge do they emphasize on; □ Sustainable land management technologies □ soil erosion control □ pest and diseases management □ crop varieties □ Soil fertility management □ Flood Risk

23. On the scale of 1-5 how do you rate the Technologies adopted in the area? i) not adopted ii) slightly adopted, iii) moderately adopted, iv) highly adopted v) extremely adopted

APPENDIX VI

INTERVIEW GUIDE FOR KEY INFORMANTS

1. What are the type and existing sustainable land management technologies employed by farmers in the study area?
2. What is the popularity of SLMT in study area?
3. What is the prevalence flood Risk in the study area?
4. What disaster experience do they have and the social trust in the organization dealing with floods?
5. Are there pertinent strategies for mitigating flood risks in the study area
6. Are the Socio- economic factors enhancing flood risks in the study area?
7. Does the farm characteristic influence flood risks in the study area?
8. Does the training of farmers have any impact to the attendees in relation to adoption of the SLMT in the study area?

APPENDIX VII

INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION

1. What is the existing Sustainable Land Management Technologies adopted in mitigating floods in flood prone areas?
2. What is the prevalence of flood risk to farmers in the study area?
3. What governance actors guide on SLMT and Flood risk control in the section?
4. Do people have a social trust in the institutions guiding them in the study area?
5. What is the level of disaster experience in terms of SLMT and flood risk control?
6. Are there benefits and ranking acquired in the use of SLMT and flooding effects?
7. Do farmers receive any training on SLMT, and what are the challenges encountered during the training activities
8. Are there SLMT adopted and those not adopted? Those not adopted what could be the reasons?
9. What are the challenges in adoption of the SLMT and ranking in terms of the benefits

10. What are the strategies for mitigating floods in the community you reside from?

APPENDIX VIII

RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 585353

Date of Issue: 08/September/2022

RESEARCH LICENSE

This is to Certify that Ms.. Betty Nasambu Opilo of Masinde Muliro University of Science and Technology, has been licensed to conduct research in Busia on the topic: IMPACT OF SUSTAINABLE LAND MANAGEMENTTECHNOLOGIES ON FLOOD RISK IN WESTERN REGION, KENYA for the period ending : 08/September/2023.

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APPENDIX IX

AUTHORIZATION LETTER FROM UNIVERSITY

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 056-30870
Fax: 056-30153
E-mail: directordps@mmust.ac.ke
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P.O Box 190
Kakamega – 50100
Kenya

Directorate of Postgraduate Studies

31st August 2022

Ref: MMU/COR: 509099

Betty Nasambu Opilo
CDS/H/01-53874/2019
P.O. Box 190-50100
KAKAMEGA

Dear Ms. Opilo,

RE: APPROVAL OF PROPOSAL

I am pleased to inform you that the Directorate of Postgraduate Studies has considered and approved your PhD proposal entitled: "***Impact of Sustainable Land Management Technologies on Flood risk in western Region, Kenya***" and appointed the following as supervisors:

1. Prof. Samuel Soita China - SDMHA - MMUST
2. Dr. Nicodemus Omoyo Nyandiko - SDMHA - MMUST

You are required to submit through your supervisor(s) progress reports every three months to the Director of Postgraduate Studies. Such reports should be copied to the following: Chairman, School of Disaster Management and Humanitarian Assistance Graduate Studies Committee and Chairman, Department of Disaster Management and Sustainable Development. Kindly adhere to research ethics consideration in conducting research.

It is the policy and regulations of the University that you observe a deadline of two years from the date of registration to complete your PhD thesis. Do not hesitate to consult this office in case of any problem encountered in the course of your work.

We wish you the best in your research and hope the study will make original contribution to knowledge.

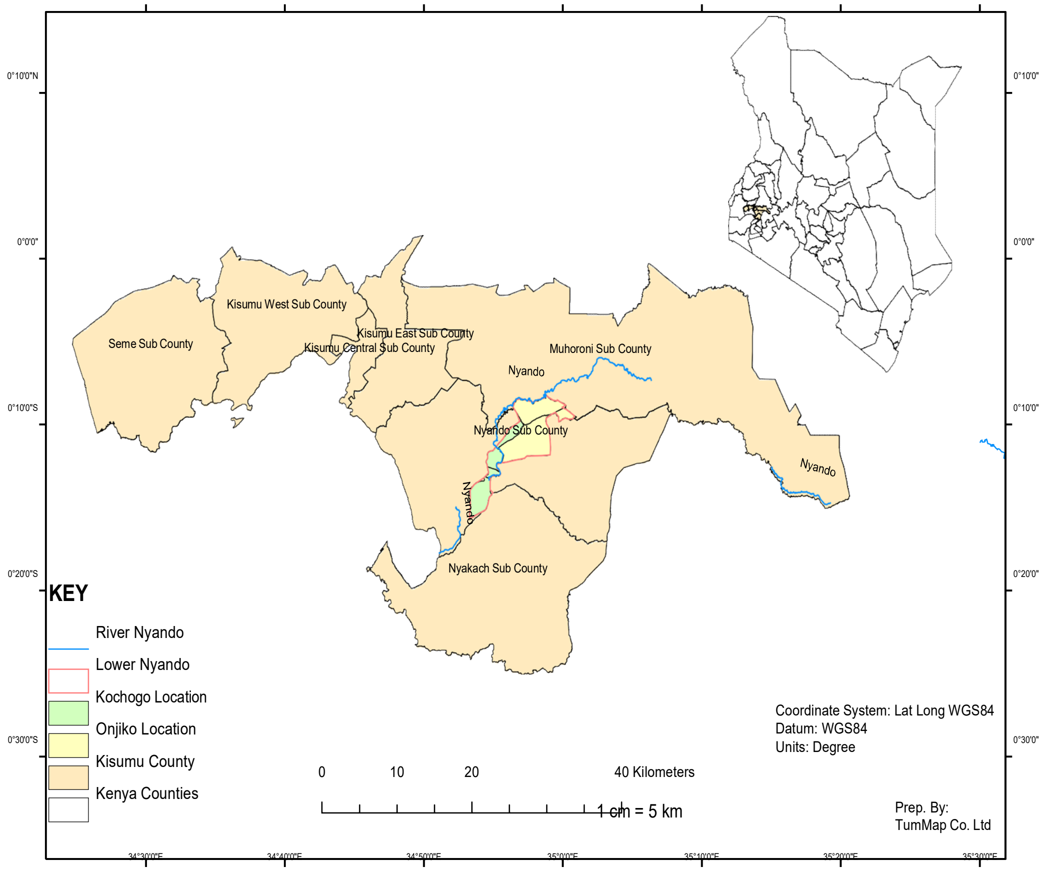
Yours Sincerely,

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY
DIRECTORATE OF POSTGRADUATE STUDIES
P.O. Box 190 - 50100, KAKAMEGA (K)
Date:.................... Sign:....................

Prof. Stephen O. Odebero, PhD, FIEEP
DIRECTOR, DIRECTORATE OF POSTGRADUATE STUDIES

APPENDIX X

ADDITIONAL MAP FOR LOWER NYANDO SUB-COUNTY



APPENDIX XI

ADDITIONAL MAP FOR LOWER BUDALANGI -SUB-COUNTY