Scholars Journal of Agriculture and Veterinary Sciences **e-ISSN 2348–1854**
Sch J Agric Vet Sci 2017; 4(7):267-272 **p-ISSN 2348–8883**

(An International Publisher for Academic and Scientific Resources) DOI: 10.36347/sjavs.2017.v04i07.003

An Assessment of Vulnerability and Risks of Climate Change and Possible Solutions to Enhance Resilience to Adapt To the Change in Meru County, Kenya

Lucy Karega Njeru, PhD
Department of Agricultural Economics and Extension, University of Embu, P. O. 6-60100 Embu, Kenya

***Corresponding Author**
Name: Lucy Karega Njeru
Email: lucykarega@gmail.com

Abstract: Kenya like other sub-Saharan African countries face uncertainty and potential risks of climate change and have been integrating climate considerations into various legal and governance instruments for some time. Notably, there has been progress made in planning and implementing policies, projects and programs in key economic sectors in order to align Kenya with the international community's approach to promote climate resilience thereby reducing the negative impact on the environment and on people's lives and livelihoods. The research assessed the climate change vulnerability and risks in Meru County and focused on 20 stakeholders from each of the sampled Sub County namely Igembe North, Igembe Central and Igembe South. The research was guided by two objectives and a stakeholders' questionnaire was used to solicit the data that was required for the product. The collected data was cleaned, coded and analyzed using SPSS version while frequency tables and percentages summarized and presented the quantitative results. The results showed varied risks faced in Igembe in the context of climate change, for instance food and water insecurity which was very dominant. The findings showed that majority of the people (91.7%) most vulnerable to climate change were the small holder farmers, (88.3%) children and (78.3%) female headed house-holds. The result also indicated that the major possible solution to enhance resilience to climate change was agroforestry practices (95.7%) and community capacity building and sensitization (81.7%). These findings will contribute to the policy-makers, development practitioners and governments' efforts of finding more innovative ways of creating targeted interventions for promoting climate resilient livelihoods through enhancing community coping strategies and participation of marginalized groups in policy issues.
Keywords: Climate Change, Vulnerability, Risks, Resilience, Adaptation

INTRODUCTION

Climate change represents one of the world's greatest human development challenges. Global temperatures and sea levels are rising and will continue to do so throughout the 21st century. Human activity, particularly deforestation and the burning of fossil fuels, is driving this change by increasing atmospheric concentrations of carbon dioxide and other greenhouse gases (GHGs) [4]. As a result, the world is experiencing greater weather extremes, changes in rainfall patterns, heat and cold waves, and increasing droughts and floods. These phenomena have a negative impact on the environment and on people's lives and livelihoods. According to [5], marginalized groups in the poorest regions are particularly affected, even as they are least responsible for these changes. As such, short-term disasters and the longer-termeffects of climate change can threaten people's abilities to lead long and healthy lives, to be knowledgeable, to have a decent standard of living, and to participate in community life with dignity and self-respect. Climate change not only threatens efforts to reach the Sustainable Development Goals (SDGs), but could also lead to major reversals for certain groups in terms of income, health and education outcomes, while increasing global inequities. Climate change responses can also perpetuate inequality if not carefully designed [3].

The effects of climate change and related disasters have the potential to adversely impact the majority of Kenyans given that about 75% of the population depends directly on land and natural resources for their livelihoods [1]. In recent years, there has been increased attention to climate change due to its impacts on the lives of Kenyans. This has been mainly due to an increase in intensity and frequency of extreme climate events such as severe droughts and flooding. These extreme events have had negative socio-economic impacts on almost all sectors in the Kenyan society such as health, agriculture, livestock, environment, hydropower generation, and tourism thus impacting negatively on the objectives set out in the Government's Vision 2030 development plan.

The degree to which climate change affects human development depends on levels of both risk and vulnerability. Vulnerability is different from risk. Whereas risk is about exposure to external hazards over which people have limited control, vulnerability is a measure of people's capacity to manage such hazards to

prepare for, cope with, and recover from them without long-term, potentially irreversible losses of well-being [10]. When for instance, tropical cyclones and floods strike a city like Mombasa, they expose the whole city to risks. However, people's vulnerabilities are concentrated among those living in the overcrowded, makeshift homes of the slums along the coastal region. In any country, the processes by which risk is converted into vulnerability are shaped by the underlying state of human development, including inequalities in income, opportunity and political power that marginalize the poor *et al*. [1], High levels of economic dependence on agriculture, lower average incomes, already fragile ecological conditions, and location in areas that face more extreme weather patterns are all vulnerability factors.

According to [8] coping strategy is the response to actual or expected climatic conditions or their effects that have a negative impact on human development. It is a broad concept that can be used to describe a variety of ways to reduce vulnerability. Adaptation to the negative impacts of climate change generally takes place in two ways: anticipatory (before impacts take place) and reactive (as a response to initial impacts). Adaptation measures can be implemented by public and private actors. Action therefore must be taken now by all national and international stakeholders to find sustainable win-win solutions to adapt to the effects of climate change. Efforts must simultaneously be made to curb future risks through emission reductions, while ensuring sustainable, climate-resilient growth and greater energy access for the poor. It is therefore against this background that this research sought to carry out an assessment of climate change vulnerability in Meru County.

Statement of the Problem

Kenya's economy relies heavily on agriculture with smallholder agriculture accounting for over 75% of total production and 70% of marketed agricultural produce. Continued improvement on the productivity of this sector is therefore necessary for increased production. However, despite Government efforts to make agriculture more productive and profitable to small holder farmers, these farmers are not able to fully exploit the agricultural potential as they are faced with various risks due to negative impacts of climate change. Reducing negative impacts of climate change on the environment and on people's lives and livelihoods is a major challenge because of the high level of vulnerability for most Kenyan.

There are several factors that influence climate change vulnerability among the smallholder farmers in Kenya for instance, household's level of income, gender perspective, level of education; age differences and policy issues among others. In Meru County for instance, majority (88%) are smallholder farmers and the factors named above (income, gender perspective, education level; age differences and policy issues) play a pivotal role in influencing their vulnerability to effects of climate change. However, information on these factors in the County are poorly documented and understood, which make it difficult for Kenyan leaders and their development partners to formulate innovative strategies for promoting climate resilient livelihoods through enhancing community coping strategies and participation of marginalized groups in policy making in the County. This study will provide the missing information, which can be used to make informed decision on how to improve climate resilient livelihoods for the marginalized groups.

Purpose of the Research

To promote climate change resilient livelihoods through enhancing community coping strategies in Meru County.

Objectives of the Research

The research was aimed at achieving the following objectives:-

- To assess the vulnerability and risks faced by the Meru County in the context of climate change
- To identify possible solutions to address the issues that will enhance the resilience of local communities to adapt to climate change.

RESEARCH METHODOLOGY

Description of the Study Area

The research was carried out in three Sub Counties in Meru County. These were:- Igembe North, Igembe Central and Igembe South. These are the main producer of Khat (Miraa), but it is ironically ranked among the areas with the highest level of poverty, unemployment, acute child malnutrition and illiteracy levels in the County. Cases of climate change for instance change in rainfall pattern, prolonged drought, landslides, large gully formation have been experienced in the region in the last 3 years.

Research Design

This research adopted descriptive survey design which is simple to execute and can yield important information about a phenomenon. According to Kothari (2008), the design concentrates more on conditions which have already existed, practices which are held, and processes which are on-going as well as new trends. The design can create a detailed description of a phenomenon thus, it was appropriate to assess climate change vulnerability in Igembe region**.**

Target Population and Sampling Procedure

This project targeted in Igembe region who included:-County Government officials, private sector,development practitioners and farmer representatives. Twenty of these stakeholders were sampled from each of the three Sub-Counties to give a

total of sixty respondents who acted as a target population for this preliminary study for the project. Kendall (2007) confirmed that a target population is the one the researcher uses to generalize the study results. Relevant data for the research was solicited by use of a semi structured questionnaire which was duly completed by the stake-holders.

Instrumentation and Data Collection Procedures

A self-administered questionnaire with information on an assessment of climate change vulnerability in Meru County, developed by the researcher with open and closed-ended items, was used for the main stake-holders in the agricultural sector in Meru County. The questionnaires' content validity was ascertained by five extension experts while a pilot test involving 30 stake -holders was conducted to determine its reliability, which was 0.83α. This was above the 0.70 minimum acceptable for educational research at a significance level of 0.05 set a priori.

Data Analysis

Immediately after the data was collected questionnaires were examined for completeness, cleaned and then coded using SPSS software. Analysis was done by both quantitative and qualitative techniques and frequency tables, charts and percentages were used to summarise and presents the results.

RESULTS

A respondent's age was important in determining the average age of stakeholders who participated in the research in the County. Most of the stakeholders 53.3% were 41-50 years while 26.7% aged between 31 and 40 years. 11.7% were 50 years and above with only 8.3% who had between 20 and 33 years of age. In terms of formal education, 38.3% had tertiary education, 43.3% had secondary education and 8.3% had primary education with the remaining 1.7% lacking formal education. The gender of the respondent was composed of 70% male and 30% female.

An Assessment of Vulnerability to Climate Change

Information on this section presents the main objectives of the research.

Objective One

To assess the vulnerability and risks faced by the Meru County in the context of climate change.The respondents were asked to indicate the major observable signs of climate change in the County and their responses are indicated in Table 1.

Table-1: Major Observable Signs of Climate Change in Meru County

Major observable signs	frequency	Percentage
Change in rainfall patterns	60	100.0
Heat and cold waves	39	65.0
Increasing drought	52	86.7
Environmental pollution	40	66.7
Cases of land-slides	20	33.0

Table 1 explains various climate change signs observed in Meru County as was stated by the respondents that included change in rainfall patterns, heat and cold waves, increasing draught environmental pollutions among others. This is in line with the study by [4] which confirmed that human activity, particularly deforestation and the burning of fossil fuels, is driving this change by increasing atmospheric concentrations of carbon dioxide and other greenhouse gases and as a results, the world is experiencing greater weather extremes, changes in rainfall patterns, heat and cold waves, and increasing droughts and floods.

The respondents further gave responses on various risks experienced in the County in the context of climate change as indicated in Table 2.

Table-2: Various Risks Experienced in Meru County in the Context of Climate Change

Climate risks	Frequency	Percentage
Increased food and water insecurity among the small scale farmers	59	98.3
Increased illiteracy levels	40	66.7
Increased poverty levels and inequalities	48	80.0
Health issues	52	86.7
Under nutrition	52	86.7
Conflicts between Small holder farmers and pastoralists	40	66.7

Table 2 indicated that food insecurity in terms of both livestock and crop products in the County was cited as a major risk as a result of climate change with majority of the respondents (98.3%) who indicated that climate change has led to increased food insecurity in the County for the last 3 years. This support the findings of the study by Adimo *et al.*[1], that underscored the fact that climate change causes new rain patterns, droughts and longer-term water shortages affecting rainfall, temperature and water availability for

agriculture and in vulnerable areas like some parts of Igembe North Sub-County, climate change has led to increased food insecurity

The respondents too were asked to give their take on the category of people who are most vulnerable to climate change in Meru County. Their responses are indicated in table 3.

Table-3: Category of People Most Vulnerable to Climate Change in Meru County

Most Vulnerable group of People	Frequency	Percentage
Small holder farmers	55	91.7
People with low education and incomes	40	66.7
Elderly with respiratory problems	43	71.7
Female headed house holds	47	78.3
Children and Expectant mothers	53	88.3
HIV and AIDS infected people	46	76.7

From Table 3 it is evident that agricultural production and food security which are paramount in eradicating extreme poverty and hunger are affected by climate change. It is also clear that women are vulnerable to climate change because the poor are most vulnerable to climate change risks, and women make up the majority of the world's poor. This support the findings from study by [5] which revealed that fact that women's traditional roles also as primary users of natural resources, primary caregivers and laborers put most of them at risk by climate change.

Climate change stresses pose additional burdens on subsistence activities such as water collection, taking care of the siblings while parents are away which may burden families enough to remove children from school [6]. Climate change also worsen health primarily through increased vulnerability to poor health due to reduced food and water security; water-borne diseases associated with reduced water quality due to drought, favorable conditions for the spread of vector-borne and air-borne diseases and the direct link between temperatures and heat stress

Objective Two

To identify possible solutions to address the issues of enhancing the resilience of local communities to adapt to climate change.

The respondents were asked to give their opinion on possible solutions that will enhance the resilience of local community to adapt to climate change. Their responses are indicated in Table 4.

Table-4: Possible Solution to Enhance Resilience to Adapt to Climate Change

Solutions to enhance resilience	Frequency	Percentage
House hold water supply and sanitation	44	73.3
Environmental protection	49	81.7
Health related interventions	46	76.7
Community capacity building	49	81.7
Diversification in agriculture	38	63.3
Reducing emissions from industries and agriculture	24	40.0
Adoption of agroforestry practices	55	95.7
Use of renewable energy	34	56.7

From Table 4, it is evident that adoption of agro forestry practices (95.7%), environmental protection (81.7%) as well as capacity building for community members are dominant issues of concern in enhancing resilience to climate change in Meru County. Others are health related interventions, house hold water supply and sanitation, use of renewable energy etc. This agrees with the findings of the study by *et al.* [2], that agro forestry practices and healthy forests are critical to food security and the sustainable livelihoods where an estimated 1.6 billion people globally, including about 60 million indigenous people are almost wholly dependent on them. It also support the findings of [7] that renewable energy provides opportunities for poverty alleviation and for satisfying the energy needs in rural and remote areas. It helps generate employment and creates local economic opportunities as well as curbing climate change and contributes to the protection of human health caused by air pollution.

The findings supports those of the study by [4] that capacity development is essential to climate change adaptation and mitigation efforts, as well as broader environmental sustainability activities at regional, national and sub-national levels. Examples of requisite capacities would be: to collect, assess and share climate change information, including meteorological and socioeconomic data on human development risks and vulnerabilities; to support new

public-private partnerships, and cross-border and regional cooperation; and to lobby, negotiate, and coordinate financial and technical assistance for promoting community resilience to climate change [8]. revealed that Integrated Water Resource Management(IWRM) frameworks address climate change impacts while linking to other sect oral and crosscutting topics. Adaptation is not just about physical infrastructure, but also about where it is created, who controls it, and who has access. The principles driving water sector reform, including related to allocation, pollution control, equity, environmental sustainability and economic development, can support better planning and management at national and local levels. Water levels can be within the limits of ecological sustainability and provides a coherent planning framework for all water resources hence agreeing with the study findings.

CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:-

i. There are varied risks faced in Meru County in the context of climate change; for instance food insecurity among the small holder farmers, increased illiteracy levels, increased poverty and inequalities, health issues and under nutrition particularly for children and elderly as well as conflicts between Small holder farmers and pastoralists.

ii. It was evident that majority of the people (91.7%) most vulnerable to climate change were the small holder farmers, this was followed closely by children (88.3%) and female headed house-holds (78.3%). Others were people with low education and incomes, elderly especially those with respiratory problems as well as HIV and AIDS infected people. This implies that agricultural production and food security that underpin the solution to extreme poverty and hunger are affected by climate change. The research also showed that women were vulnerable to climate change because the poor are most vulnerable to climate change risks, and women make up the majority of the world's poor.

iii. Climate change stresses posed additional burdens on subsistence activities such as water and wood fuel collection which may burden families enough to remove children from school.

iv. Climate change affected health primarily through increased vulnerability to poor health due to reduced food and water security; water-borne diseases associated with reduced water quality due to drought, favorable conditions for the spread of vector-borne and air-borne diseases and the direct link between temperatures and heat stress

v. Several interventions can be put in place to enhance the resilience of local community to adapt to climate change. This was evident from majority of the respondent (95.7%) who indicated agro forestry practices as a major intervention, followed closely by (81.7%) who argued that community capacity building and sensitization was pertinent. Others were house-hold water supply and sanitation, health related interventions and diversification in agriculture among others.

Recommendations to be adapted to Build Climate Change Resilience

Based on the study conclusions, the following recommendations were made:-

i. The County leaders should strengthen existing efforts to empower the vulnerable and marginalized groups like the small holder farmers, and provide targeted assistance through public and private services. New jobs for the poor can be created and should be sustained for economic growth.

i. Participatory policy planning is of paramount importance to include safer infrastructure, integrated water resource management, more sustainable access to public services and disaster risk management and preparedness thus the environment for school children can be better and to provide inputs needed for higher quality education.

ii. The stakeholders should ensure that campaigns to reduce child mortality, improve maternal health, and combat HIV/AIDS, malaria and other diseases are strengthened through heightened awareness, increased capacities, better public services, information sharing, new and proven technologies, and better targeted financing.

iii. Efforts to address climate change events should be enhanced by integrating issues of environmental sustainability and incorporating climate change partnerships while creating awareness around achieving the SDGs.

iv. The stakeholders should strengthen community capacity-building including environmental education for child-friendly schools and spaces, microenterprises for women, education for sustainable development, and vocational training.

v. The County Government should ensure employment of adequate number of agriculture extension officers and ensure better targeted financing geared towards farmer visit and trainings.

Recommendation for Further Research

In order to determine whether the situation is different in other areas, other researchers should replicate the study in order to come up with a more comprehensive program for assessment of vulnerability and risks of climate change and coming up with possible solutions to enhance resilience to adapt to the change in Kenya.

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