

A Look at the Social and Environmental Opportunities Brought by Climate Variability and Change in Kenya

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Abstract

Climate variability and change will definitely stress the rural livelihoods and especially the agropastoral communities in various ways which include, but not limited to, reduction of harvested produce and death of livestock. It is very important for communities to understand the actual and anticipated changes that may affect their livelihood systems to enable them make informed choices in tackling the adverse impacts. Understanding the factors that make a certain community vulnerable and managing climate related risks opens opportunities for the communities to overcome the challenges hence increase their resilience. This paper presents empirical findings on the opportunities associated with climate variability and change that the agropastoral community in Kieni can pursue to adapt better. House hold survey, key informant interviews and focus group discussions were used to gain insight into what the community has in terms of resources and the opportunities perceived as a result of changing and variable climate. The study revealed that 91% of the agropastoral community are aware of the opportunities brought by climate variability and change. Those opportunities were seen in livelihood diversification including poultry farming, dairy goat farming and dairy cow farming; social and environmental entrepreneurship mainly in agribusiness; technological innovation and development; land use and land management; improved farm production practices; financial and market services; employment and in education. Of the 350 households who were aware of the opportunities, only 67% had taken up one or more, 33% of those households did not utilise any of the perceived opportunities. The research revealed that despite being the majority who perceived opportunities brought by climate variability and change; female headed households had a lower uptake level (48%) as compared to male headed households (52%). Some of the barriers that hinder utilisation of these opportunities include lack of financial capital, lack of knowledge and technological awareness, old age(because majority of the young people have migrated to urban areas in search of employment),health problems, unreliable water supply and hindering market services and credit facilities.

Keywords: Livelihoods; climate variability and change; opportunities; Adaptation

1 Introduction

The fifth report by the Intergovernmental Panel on Climate Change (IPCC) working groups I,II and III provides a detailed report on impacts of climate variability and change which include serious and pervasive effects on the natural and social environment (IPCC, 2014). The future risks that would possibly arise from the changing climate are not only discussed in the report but also highlights the existing opportunities that actors can take advantage of to build their own resilience and that of their ecosystems (Klein *et al.* 2014).

Climate variability and change will definitely stress the rural livelihoods and especially the agropastoral communities in various ways which include, but not limited to, reduction of harvested produce and death of livestock. These stresses will cause both negative and positive impacts to these communities (Cordona *et al.* 2012). This therefore means that communities must be able to make informed choices on risks and stresses associated with climate variability and change (Klein *et al.* 2014; Bryan *et al.* 2011; Preston *et al.* 2011).

Risk is defined as a probability or a chance that an event will have adverse (ecological, sociological and economic) consequences. Risks stems from vulnerability of communities to extreme climatic events (Klein *et al.* 2014). Vulnerability is highly associated with lack of preparedness on the part of the communities and societies experiencing it combined with exposure of the community to a stimuli and their capacity to cope with or recover from the effects of a climate event (Adger, 2006, Wisner *et al.* 2004, Turner *et al.* 2003).

Different ecosystems and communities are vulnerable to climate change impact. However, vulnerability varies from one community to another due to different underlying factors such as socioeconomic status, a fragile environment, lack of or low technological knowhow, suppressive political system, poor governance, weak financial systems and low education. The bottom line is understanding the factors that make a certain community vulnerable and managing climate related risks opens opportunities for the communities to overcome the challenges hence increase their resilience (Klein *et al.* 2014; Hall *et al.* 2012; Adger *et al.* 2009). Community resilience can therefore be built through enhancing social economic and political opportunities for increased human security, safety, and prosperity.

While the fact that climate is changing around the globe is indisputable, it is generally agreeable that the question now is how to specifically adapt the environmental and livelihood systems to anticipate the changing climatic conditions and building resilience (TUC, 2009; IISD, 2003; Magombo *et al.*, 2011). This means that communities must be able to appreciate their challenges and innovatively create solutions to overcome them. These communities must therefore be able to capitalize on adaptation opportunities and opportunities arising from climate variability and change in order to build their resilience (Klein *et al.* 2014).

According to the fifth IPCC report, there exists opportunities brought by climate variability and change (IPCC, 2014). This means that building capacity of vulnerable communities could help them adapt better.

2 Opportunities arising from Climate Variability and Change

According to IPCC (2014), opportunities are factors that make it easier to plan and implement adaptation actions; that expand adaptation options; or that provide ancillary co-benefits.

Opportunities in climate variability and change can be categorized into two: (i) adaptation opportunities and (ii) potential benefits of climate change or adaptation options (Nobel *et al.* 2014). The recognition and uptake of these opportunities can go along way into enhancing the adaptive capacity of communities.

Adaptation to climate variability and change entails taking actions that would reduce communities' vulnerability; creatively and innovatively identifying and utilizing opportunities brought by the changing climate and empowering communities to be able to anticipate, respond to climatic events and rebuild their livelihood systems (IPCC, 2012; Tompkins *et al.*, 2010). Adaptation opportunities vary from region to region, nation to nation, community to community and household to household depending on their capacities (*very high confidence*) (IPCC, 2012). This means that each community is unique and the biophysical, social and institutional capacities of each and every community must be scrutinized individually to help these communities seize the opportunities presented by climate variability and change (Klein *et al.* 2014). The enabling factors for adaptation include empowering vulnerable communities to help them make informed choices in relation to adaptation, sharing knowledge between communities and scientists/experts to help in integration of indigenous knowledge into climate science, nurturing local innovations and technologies and creating innovative ways of sharing information on climate change.

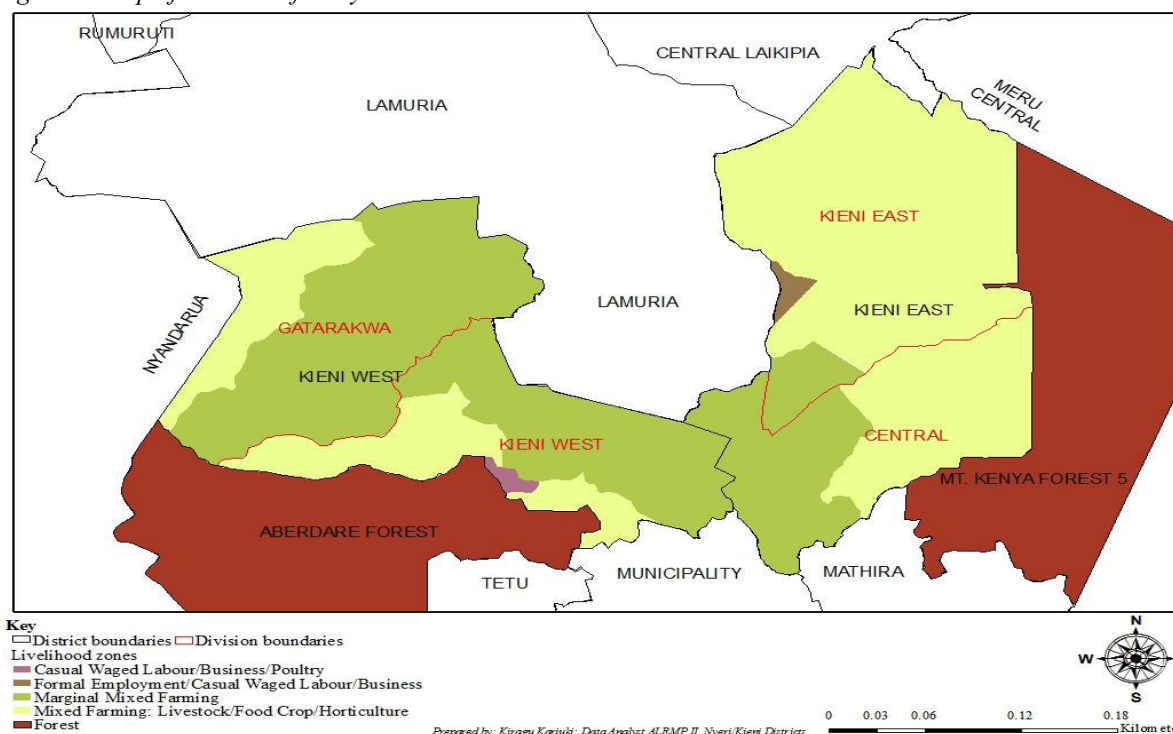
The agropastoral communities in Kieni are vulnerable to climate related risks due to persistent droughts, frostbites and invasive diseases such as maize lethal necrosis disease, *mucoïd enteritis/ mucoïd enteropathy* and pests such as millipedes and caterpillars which invade crops causing massive destruction. However, a range of opportunities exist that the communities can exploit to enable them adapt better. This study was conducted to determine the community uptake of opportunities brought by climate variability and change for agropastoral communities in Kieni. The analysis was done both at the household and community levels.

3 Methodology

3.1 The study area

The study was conducted in two administrative wards of Kieni Sub County; Narumoro and Mweiga. In Narumoro the research covered Ndiriti, Kabandera, Murichu, Kamburaini and Tigithi sub-locations. Narumoro sub-location was not covered because it is peri-urban and the parameters of the research targeted only rural agro-pastoral communities. In Mweiga, the research was conducted in Bondeni, Kamatongu, Njengu and the rural areas of Amboni sub locations. The selected study location falls under semi- arid zones in Kenya and receive annual rainfall of between 550mm and 950mm. The area falls under agro-pastoral livelihood cluster and depends largely on agriculture and livestock production which is currently under threat from effects of climate change and variability (GoK, 2013; NDMA, 2014). Other forms of livelihood systems include casual labour, small enterprises, formal employment, horticulture and forest based livelihood (see fig. 1). The impact of climate change on the production system of the area has adversely affected the well being of the community with increasing incidences of insecurity; human-wildlife conflict; and, high food prices being experienced. A study done by Kenya Food Steering Group (KFSSG) between October and December 2013 indicated that food security situation in Kieni is stressed (GoK, 2013).

Figure 1: Map of the area of study



Map Source: NDMA (2014). National Drought Management Authority (NDMA); Nyeri County- Kieni Sub-County Drought Monitoring Bulletin for June 2014.

3.2 Data collection

In data collection, we took a random sampling method approach. Cochran's sample size determination formula was applied to get the household sample size (Yamane, 1967; Cochran, 1963).

Cochran's sample size determination formula:

$$n = \frac{N}{1 + N(e)^2} \text{ where;}$$

n is the sample size
N is the population size
e is the sampling error
 * 0.05 is the assumed margin of error

Individual households were randomly selected. A household in this case was taken to be people who live together and feed from the same pot. Semi structured questionnaires, focus group discussions (FGDs), and in-depth interviews were used to collect information in the study area.

The population size of the two administrative locations is; 6620 for Narumoro and 5260 for Mweiga. A total of 383 household were identified using the Cochran method, above. Questionnaires were administered to these households along with 20 in-depth interviews conducted with community members and experts in the area between June 2015 and May 2016. The household questionnaire was designed to capture the following information:

- i. Demographic characteristics i.e. *gender, age, education level and time lived in the area*
- ii. Perceived opportunities associated with climate variability and change
- iii. Livelihood systems in the area
- iv. Barriers to uptake and utilisation of the opportunities associated with climate variability and change.

The data collected was analysed and coded, then processed using Census and Survey Processing System (CSPPro). The quantitative data was summarised using descriptive statistics, frequency tables and mean, minimum and maximum values. All qualitative data was analysed according to researcher's subjective understanding of the data.

4 Results and discussion

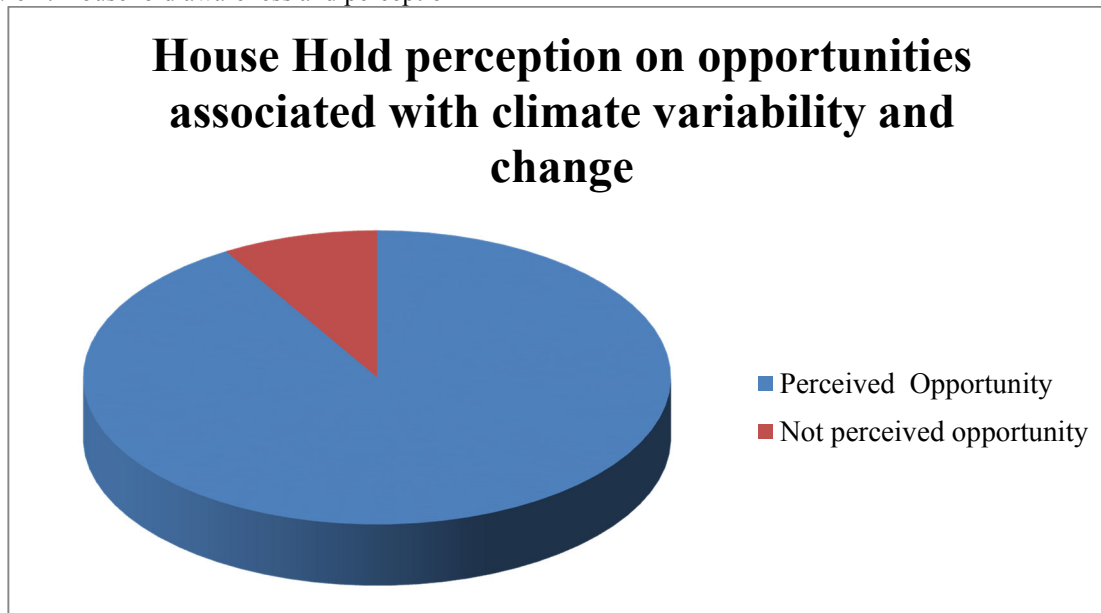
This section discusses the findings on opportunities brought by climate variability and change as reported by the agropastoral community in Kieni.

4.1 Adaptation opportunities and options

For Kieni agropastoral communities, a range of opportunities exist that the communities are already exploiting. There is much more that they are yet to take up to enable them adapt better. In this study, both the ancillary benefits and adaptation opportunities are investigated and discussed.

4.2 Awareness and Perception of opportunities which come with climate variability and change

Figure 2: Household awareness and perception

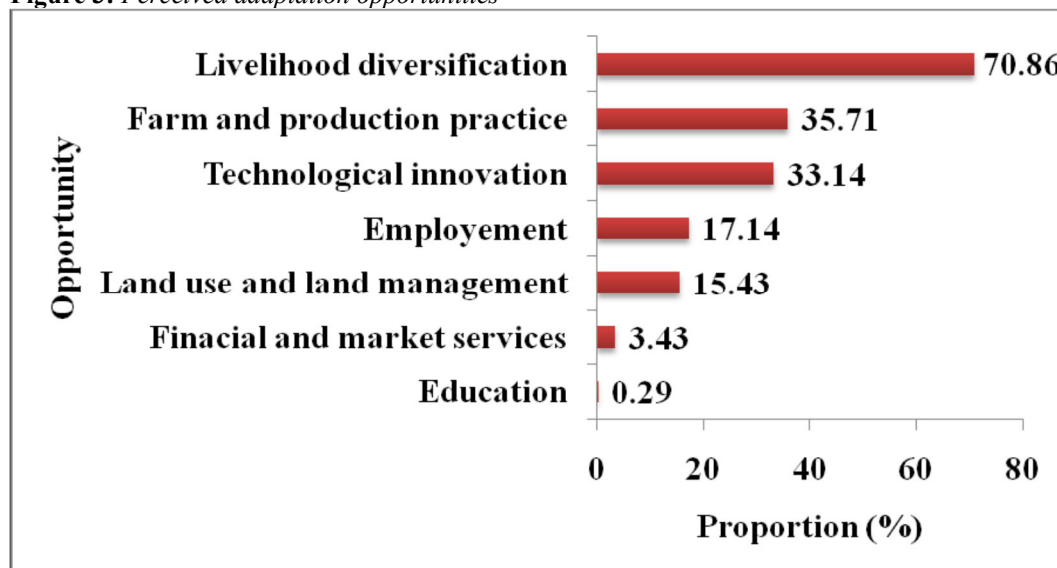


Source: Field work, 2015

Of the 383 surveyed households, 91% reported to have awareness about climate variability and change opportunities. Only 9% of the households surveyed reported that there were not aware of any opportunities which come with climate change. These households perceived climate variability and change as a negative situation and hence all the events associated with it are seen to be devastating. A number of them felt helpless in the face of climate variability and change and termed it God's way of punishing humanity for all their misdeeds.

The results are discussed under seven thematic groups: local livelihoods diversification; technological innovations and development; land use and land management; farm production practices; financial and market services; employment and education. The approach for analysing and categorising the adaptation options was borrowed from a typology done in Canada on classifying and characterisation of agricultural adaptation strategies to climate change (Smit and Skinner, 2002).

Figure 3: Perceived adaptation opportunities



Source: Field work, 2015

4.3 Opportunities in local livelihoods diversification

This section discusses the perceived livelihoods diversification opportunities in poultry farming, dairy cow farming, dairy goat farming, and social and environmental enterprises.

4.3.1 Poultry farming

The communities in Kieni reported that they were aware and had perceived a potential in rearing of poultry. Out of the 351 households that reported to have seen any opportunity in climate variability and change, 23% reported an opportunity existed in the rearing of both indigenous chicken commonly known as “*kuku wa kienyeji*” and the exotic type majorly for eggs and meat. Some community members were already taking advantage of the fact that poultry keeping does not involve a lot of capital and does not depend heavily on rainfall patterns which had become erratic over time. It was reported that the market for poultry products was expanding and that the farmers were taking advantage of it to diversify their livelihoods and to increase their incomes. The increased income had supported various households in food, health, education and development. However, the key informant interviews revealed that there were a number of bottlenecks associated with income generated by the farmers. For instance, the local NDMA Information Officer and the chairlady for REKAKA – a community based organisation in Narumoro said that there was need to train the community on financial management, how to save, entrepreneurship and investments to help the agropastoral community maximize on the returns that they make from their novel climate smart innovations.

With the increased uptake of poultry keeping, there exists a major opportunity for farmers to cross breed the local chicken with improved breeds such as Kenbro to improve the weight and egg production of the hatched chicks. The Kenbro breed of chicken is a dual purpose breed suited for both meat and egg production. These are free range birds suited for the semi arid areas and can withstand difficult environmental conditions. This breed of chicken grows faster than the indigenous ones maturing at 10 to 14 weeks for meat and egg-laying at 25 to 27 weeks. Kenbro chicken and their eggs fetch higher prices in the market. For example Kenbro eggs go for US\$ 0.15 a piece while a hen or cock can fetch as much as US\$ 5-10 (ALRMP, 2011).

4.3.2 Dairy cow farming

The dairy farming subsector is very important for the agropastoral community in Kieni and indeed in Kenya. This sector contributes 70% of total milk production in Kenya (Karanja, 2003; Ngigi *et al.*, 2006; IFAD, 2006; GoK, 2008 and USAID, 2010).

Our study revealed that of the households reporting an awareness of the livelihoods opportunities availed by climate change and variability, 22% perceived dairy farming as an opportunity that can be exploited to help them cope better with climate variability and change. This was also triangulated during the focus group discussions held with Kigama commercial village and REKAKA CBO on 2nd June, 2016 where discussants confirmed to have found dairy cow farming more profitable. This is further supported by a research done by Ngigi in 2003 which showed that small-scale dairy farming was very profitable. When probed further, the discussants revealed that due to climate variability and change, reduced land resources and increased population, dairy farming is showing great potential for the communities in the semiarid regions. Many perceived dairy farming as a potential employer. Other studies done concur with this perception (Staal *et al.* 2008; USAID, 2010; Mawa *et al.* 2014).

Our study revealed that the greatest potential is perceived to be in the intensive dairy farming system as opposed to the traditional grazing system. However, most of the community members who are already utilizing this opportunity preferred to stock one to three cows. This is a decision that was influenced by the increased fragmentation of land, diminishing pasture due to climate change, high cost of stocking, rearing and maintaining dairy cows.

4.3.3 Dairy goat farming

Out of the surveyed households, 5% perceived an opportunity in dairy goat farming. They attributed this to the growing demand for goat milk due to its nutritional value. The discussants in Kiambo and REKAKA FGDs triangulated this information by revealing that goat milk is highly recommended by doctors for people suffering from HIV/AIDS, diabetes and those allergic to cow milk. Research conducted recently supports this (Mburu *et al.* 2014; Shivairo *et al.* 2013 and Kipserem *et al.* 2011). The study revealed that the Alpine breed of goats has high potential in the production of milk. The study done by Mburu *et al.* in 2014 showed that a pedigree Alpine breed starts to produce milk at the age of 2 years and can give an average of 2.6 litres of milk per day. The study also revealed that the price of goat milk was relatively higher compared to cow milk. The farm gate price was between US\$ 1-1.5 per litre. The discussants further revealed that goat rearing requires little resources and hence were very popular among women in the area.

4.3.4 Social and environmental entrepreneurship

Out of the 351 households who reported to have seen livelihood opportunities in climate variability and change, 13% reported social and environmental enterprises as a great opportunity. When prompted further, the community revealed that on farm innovations and diversification summed up for the foreseen business opportunities. These forms of social and environmental enterprises were in agribusiness. Agribusiness can be seen as carrying out agricultural activities with a business perspective. The agribusiness should be designed and intended to earn

revenues for the farmer as well as make profit. It may include farming itself, value addition such as processing fruits into packed juice and marketing of the farm produce (Bairwa *et al.* 2014; Baruah, n.d). In Kenya, the government through the National Agribusiness Strategy of 2012 has cited agribusiness as a key strategy in realisation of the country's Vision 2030 and for achieving the national food security goal. The Nyeri County Government with the help of the World Bank has set aside a total of 295 acres of land to be used as an agribusiness park in Kieni. Agribusiness has massive potential in unlocking youth unemployment in Kenya. There is huge potential for growth in agribusiness because of increased demand for raw and processed food due to rapid urbanisation, high population growth and for export markets (GoK, 2012). However, the country still has a challenge in incentivising young people to take up farming as a form of gainful employment.

4.4 Opportunities in Technological innovation and development

This section presents the various subsectors as cited by the agropastoral community in Kieni. They include opportunities in aquaculture/ fish farming, greenhouse farming, access to weather and climate information and water conservation.

4.4.1 Aquaculture

The agropastoral communities in Kieni reported that fish farming offered a great opportunity for vulnerable communities to respond to climate variability and change. The subsector was also recognised as one that can help many rural families combat food insecurity. In the FGDs held with farmers group in Ndiriti, in December 2015, and REKAKA CBO in June 2016, the discussants termed fish as one of the cheapest way of accessing protein for their families. Worldwide, fish and other aquatic sources of food provide important nutrition and minerals to 4 billion people and forms more than 50% of the animal protein for poor people (FAO, 2014; World Bank, 2010).

The aquaculture subsector of the economy is currently recognised as one that has much potential especially in the fight against food insecurity (ACP and EU, 2011). The Government of Kenya, through the Economic Stimulus Program (ESP) of 2009 under the 'Fish Farming Enterprise and Productivity Program' has invested heavily in fish production. This programme has seen tremendous growth in the quantities of fish produced. For example in the year 2000 only 1,000 metric tonne of fish was produced in Nyeri County as compared to 12,154 in 2010 (Economic Stimulus Program (ESP) Report, June 2010). In 2013, Nyeri County was ranked the best fish producer from ponds in the entire country with 21,800 metric tonnes in 2012. This means that there is great potential for fish farming. In the country, a positive trend is registered in adoption of aquaculture with the number of ponds increasing from 7477 fishponds in 2007 to 28,000 in 2010 (ESP Report June, 2010;FAO,2005). The government initiative in stimulating fish production offers an opportunity for promoting rural enterprise that can help agropastoral communities respond to climate variability and change.

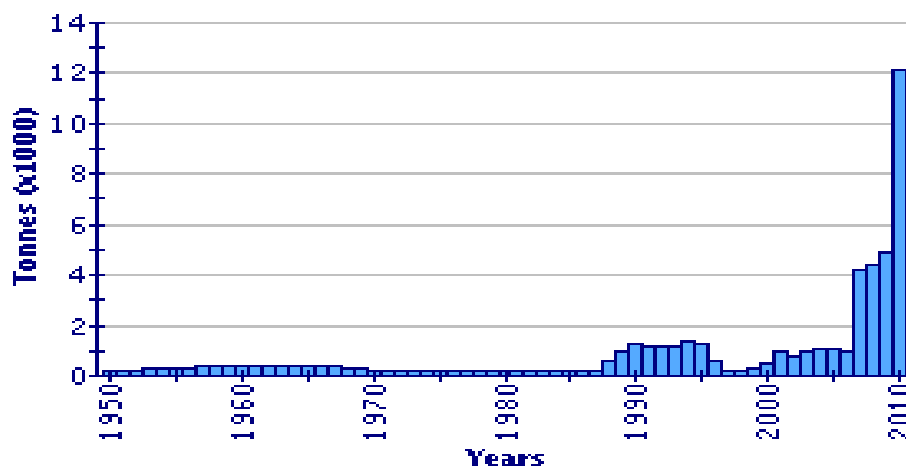


Figure 4: Aquaculture production since 1950 in Kenya
Source: FAO, 2005; Fishery Statistics, Aquaculture production

4.4.2 Greenhouse farming technology

Greenhouse farming technology was reported as an opportunity brought by climate variability and change by 22% of the total households who reported to be aware of perceived livelihood opportunities.

Despite the high start-up costs, greenhouse farming was highly favoured because the farmers felt that they can control the microclimate, pests and diseases. Greenhouse farming takes up a very small portion of the land but has higher yields than open field farming. The farmers reported that high value crops such as tomatoes, capsicums, strawberries and eggplants were preferred. "These crops mature faster and have got high demand in the market", said one of the FGD participants. During the FGDs, it emerged that greenhouse farming was particularly very popular with the unemployed youth and women who have recognized the financial opportunities

in greenhouse technology.

The advantages given in favour of greenhouse farming are: i) a farmer can be assured of all year round production of quality agricultural produce ii) the technology produces up to six times more per unit area iii) it is environmental friendly and makes organic production of food possible iv) one is able to manage pests and diseases with ease v) has little or no pesticide residuals.

4.4.3 Access to weather and climate information

The community in Kieni reported that there is an opportunity in the provision of climate information services. When asked whether and how they receive climate information, 98% said through the weather forecasts on radio or televisions for the few households which own one. They also cited that the information broadcasted was not focussed to their specific area but to the region and at best to the county level. Therefore, Kieni farmers felt that they can never prepare adequately with such unfocussed climate information. The community lamented that there was a huge gap in climate information sharing, understanding and application. A research done in East African Countries in 2011 had revealed that there was a missing link in technical advisory services that is given by scientists to enhance proper understanding and hence applications of climate products such as seasonal weather forecast, monthly weather forecast and agro-climatological services (Kadi *et al.* 2011). This means that, although the Kenya Meteorological Department (KMD) compiles climate information and then releases them to different Deckadal Crop and Weather Bulletins, the agropastoral communities in Kieni are still struggling to get adequate climate information services.

The agropastoral community in the study area expressed a very keen interest in collaborating with climate information service providers to ensure that local climate information is disseminated using the right form and channels and hence benefit them.

4.4.4 Water conservation and rain harvesting

The community in the study area reported to have perceived water conservation as a great opportunity brought by climate variability and change. In the FGDs, the discussants revealed that the reason the community was highly vulnerable was due to lack of adequate clean water for domestic and agricultural use. The discussants noted that during the rainy seasons there were huge runoffs which could be collected and stored in dams for use during the dry season. There were various methods which could be used to harvest rain water right from the homesteads such as gutters placed on the roof of the houses which then directed the water to storage tanks. Runoff water could be collected using constructed water pans and diversions of road side culverts. On the farms, ponds could be dug to store the water.

4.5 Opportunities in Land use and Land management

This section addresses two major opportunities: irrigation and tree planting

4.5.1 Irrigation

Out of the households surveyed reporting an awareness of the perceived livelihood opportunities, 15% reported irrigation as a potential adaptation option in Kieni. Both low-cost technologies and the public irrigation schemes were seen as areas that can be exploited to help agropastoral communities secure their livelihoods. The National Irrigation Board has established irrigation projects in the area such as Ndiriti-Aguthi irrigation project, Githiru, Naromuro dam and Karemeno dam. The community however faulted the system and said that it was not reliable especially because the water levels were too low. Moreover, during the dry seasons when water is needed the most it is highly rationed or the supply is stopped altogether. The low cost irrigation which can be adapted by farmers on their small plots has a high potential to transform the subsistence farmers in the area into intensive producers of food. The Agropastoral communities in Kieni reported that the greatest disservice by the NIB was the lack of water conservation and rain harvesting technologies.

At the country level, the Kenyan government has taken food insecurity as a priority area and has rolled out several projects to enhance food security in the country. A good example is the Galana irrigation scheme in Tana River County. The total irrigated area in Kenya is about 80,000 hectares and both the public and small-scale irrigation is still short of the 300,000 hectares maximum potential (Purcell, 1997). It is also important to note that enhancing irrigated agriculture would go along way into building women's capacity and increase their earning power as they are the majority participants in subsistence farming (Ibid).

4.5.2 Tree planting

Tree planting offers an opportunity for the farmers to benefit in various ways including source of fodder for animals, as a source of edible fruits, and can be used as an alternative source of food in times of scarcity as well as a source of income (Oke and Odebiyi, 2007; Matocha *et al.* 2012). Trees are essential in the ecosystem because they serve as carbon sinks.

4.6 Opportunities in Farm production practices;

4.6.1 Diversification of crop type and varieties

The agropastoral community in Kieni identified crop diversification as a potential opportunity brought by climate

variability and change. Crop diversification means the addition of novel crops or a cropping system with crop rotation which recognizes the various returns from the crops that have been added value vis-a-viz the available or potential marketing opportunities (Bradshaw *et al.* 2011; Akinagbe and Irohibe, 2014). Individual farm level crop diversification may include having multiple production locations/sites and introduction of new varieties of crops or increasing the number of cultivated species and value addition processes (Brenda, 2011; Orindi and Eriksen, 2005; Wandel and Smit, 2000). Novel and improved crop varieties increase the plants' resistance to environmental stressors such as water and heat stress and invasive pests and diseases. Crops can also be improved in terms of nutritional value in order to benefit both humans' and animals' health.

In Kieni, specific crop diversification potential lay in fruit farming. About 7% of the households surveyed reported that farming of fruits such as macadamia; tomato fruits; pumpkins and improved variety of passion fruits have the highest potential. Macadamia nuts were termed the '*new cash crop*' of the region especially in Mweiga.

Planting of drought resistant crops such as sorghum and cassava was also highlighted as an opportunity in the face of climate variability and change.

4.6.2 Diversification of livestock types and varieties

Diversification in livestock production was also identified as an opportunity to enhance community resilience in Kieni. Bee keeping, rabbit farming and pig farming were seen to have the greatest potential.

4.7 Opportunities in Financial and market services;

4.7.1 Access to agriculture subsidy, extension services and credit

The household survey revealed that access to agricultural inputs and services at a subsidized price was seen as an opportunity to enhance resilience. Availability of fertilisers and other agronomic essentials at an affordable price was seen as the most important incentive in unlocking the agricultural potential in the area. Coupled with agricultural extension services, subsidised inputs help farmers implement and benefit from various agricultural practices they engage in (Dorward, 2009).

Access to credit facilities was also cited as an opportunity that can help farmers adapt better. Access to finance for agribusiness development is normally limiting in Kenya. This challenge is more pronounced semi arid zones where environmental uncertainties are deemed higher (Kadi *et al.* 2011). In Kieni the agropastoral community members have formed small societies in the form of '*community table banking*' where groups of likeminded people come together, contribute, save and loan money to one another. Table banking groups comprise of 15-30 individuals who contribute their modest income on a weekly or monthly basis depending with a group. These groups have a membership, leadership and governance structures that guides their operations. Through the FGDs with farmer groups in Kiambogo, Kigama, Ndiriti and Aguthi, it was revealed that many of the farmers groups in the study area were exploiting the opportunities in government policies such as the Youth Fund, Women Enterprise Fund and the Uwezo Fund to access credit to advance their agribusinesses. One of the CBOs in the area reported to have accessed 700 US\$ from Uwezo Fund which they used to start up a poultry farming business. However, a number of other farmers groups are yet to access the funds despite sending numerous applications to the relevant bodies.

4.7.2 Access to market

The agropastoral community in Kieni reported to have perceived an opportunity in marketing their agricultural products (crops and animals). They cited the formation of cooperative societies as a major step towards consolidating farmers' bargaining power and hence better prices for their produce. The Government's role in the regulation of agricultural market was seen as the most important to protect farmers especially from middlemen. Extensive research results reveal that there is a direct and indirect relationship between access to market and agricultural productivity (Ijaimi, 1994; Von Oppen *et al.* 1997; Kamara and Von Oppen, 1999; Freeman and Salim, 2002; Kamara, 2004).

4.8 Opportunities in Employment

Employment was seen as an opportunity to enhance resilience of the agropastoral communities in Kieni. From the household survey, 17% of the households' view that employment in various sectors of the economy could help the communities adapt better. Such employment would work by way of creating a fallback option during the dry seasons. The study revealed that though the community did not have the expert terms for green jobs or adaptation jobs, the opportunities they mentioned actually fall right within these categories. Examples of the jobs mentioned were in; development of canola and biogas energy (renewable energy), green house farming, fish farming, organic farming and conservation agriculture. The government of Kenya through the Vision 2030 and the County Integrated Development Plans hopes to achieve an annual growth rate of 10% per annum. This can only be achieved through transition to green economy as advocated for by the *Future we want* (UNCSD, 2012). Creation of green jobs is paramount for Kenya. In line with this the government has developed a green economy strategy that will support efforts aimed at addressing poverty and unemployment for many Kenyans (GoK, 2015).

4.9 Opportunities in Education

Education not only helps people improve their perceptions, knowledge and understanding of climate related risks but also enhances their socioeconomic status (Lutz *et al.* 2014). As important as this is, a small percentage (0.29%) of the agropastoral community in Kieni viewed education as key to climate adaptation and building of resilience in the area. Communities need to be aware of the risks that surround them in order to prepare and respond appropriately. Recent research conducted in El Salvador and Brazil, revealed that people who had low education levels were more likely to see their surrounding environment as risk free compared to those who had high education who were more aware of the environment risks (Wamsler, 2012). Formal education is seen to have a positive impact on the community's perception and understanding of the risks which exist; access to information related to risks and risk avoidance; coping mechanisms and knowledge and access to potential and available institutional support (Wamsler, 2012).

5 Utilisation of opportunities brought by climate variability and change

Out of the 350 households who reported to have spotted opportunities brought by climate variability and change, 67% had taken up one or more of the perceived opportunities. A sizeable number, 33% of the households were not utilizing any of the opportunities that they perceived. The research revealed that despite being the majority who perceived opportunities brought by climate variability and change; female headed households had a lower uptake level (48%) as compared to male headed households (52%) as shown in Table 1.

Table 1: Perception on opportunities brought by climate variability and change per gender

	Taken advantage	Gender	
		Female	Male
Perceived opportunities	Yes	57.6	42.4
Taken advantage	Yes	48.1	51.9

Source: Field work, 2015

The study also showed that those with informal education level had low uptake of perceived opportunities brought by climate variability and change (See Table 2). Of the households that did report any opportunities that arise with climate variability and change, 70% had primary or informal education levels. An increase in the proportion of households that have not only perceived but taken advantage of opportunities is also noted.

Table 2: Perception and uptake of opportunities brought by climate variability and change based on education level

	Taken advantage	Education level				
		Informal	Primary	Secondary	College	University graduate
Perceived opportunities	No	6.1	63.6	30.3		
	Yes	9.6	33	44.4	13	
	Yes	5.1	35.3	46	12.7	0.9

Source: Field work, 2015

5.1 Barriers to uptake of opportunities brought by climate variability and change

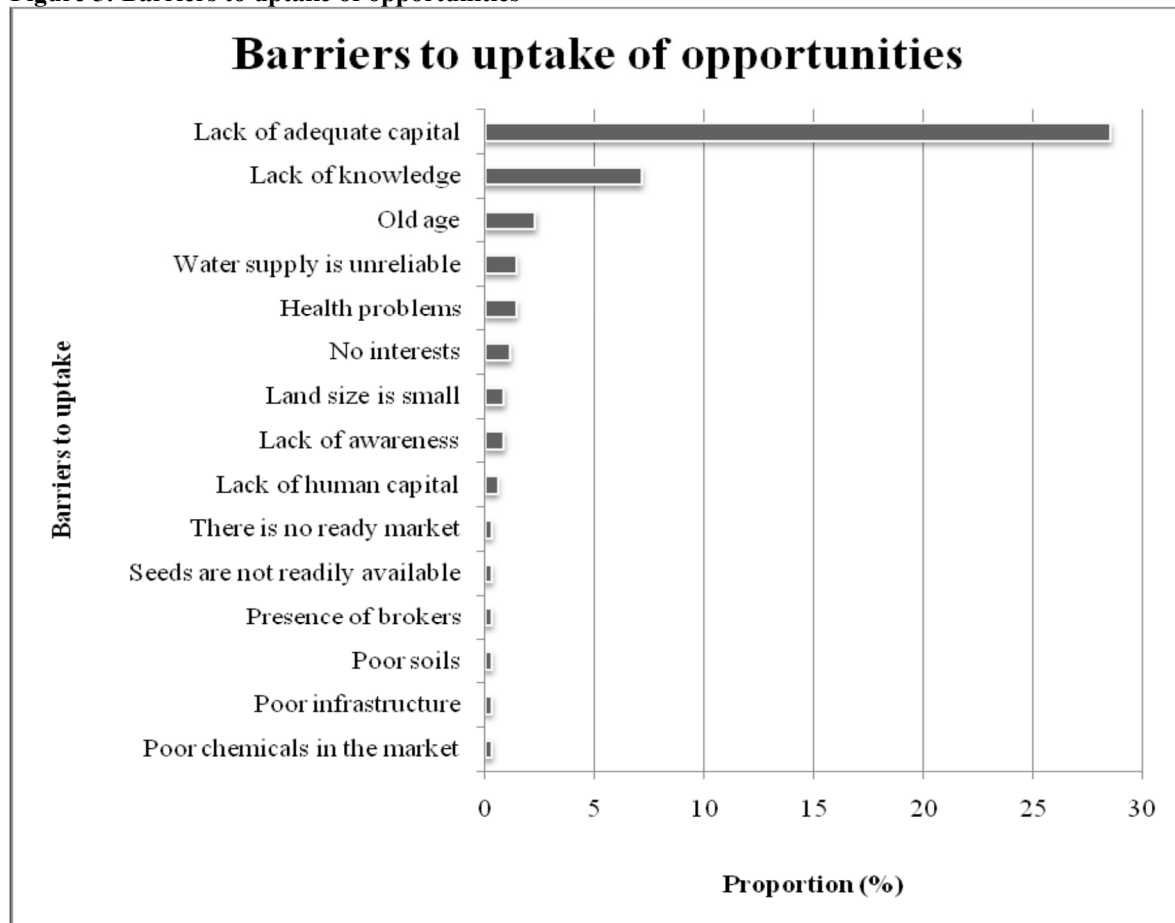
The research revealed a range of barriers that limit the agropastoral communities to pursue perceived opportunities brought by climate variability and change (See figure 5). This study shows that access to financial assets and services is considered a huge impediment in uptake of these opportunities. Lack of knowledge and awareness on opportunities brought by climate variability and change was also a huge barrier in uptake. Poor market and lack of credit facilities were also cited as a barrier. In the focus group discussions, the discussants vigorously lamented the presence of middlemen who they blamed for 'messing with the produce prices'. The community expressed their disappointment with the government for issuing empty promises on streamlining the market. Apart from the middlemen, the weights and measures of some farm produce, particularly potatoes, cropped up. The discussants in the FGDs reported that the government had issued a warning in 2014/2015 that the weight of potato bag should not exceed 50kg but the enforcement was poor. This made many farmers lose out because those who did not fill the ninety kilogram bag could not access the market.

Old age and health problems were also cited as barriers to uptake of climate variability and change opportunities. Further probing of those who cited ill health, a majority complained of cold related diseases such as frostbite, pneumonia, respiratory tract infection and arthritis (which scientifically is not caused by cold weather per se but may be attributed to the extreme weather conditions in the early evening through nights to morning hours).

Subjective perceptions and views also came out as a factor that limit uptake of the opportunities brought by climate variability and change. About 1.14% of those who spotted opportunities said they did not have interest

in utilising them. This means that different people have different perceptions that influence choices of adaptation.

Figure 5: Barriers to uptake of opportunities



Source: Field work, 2015

6 Conclusion and recommendations

This study examines how the agropastoral community in Kieni perceive opportunities brought by climate variability and change and their uptake. The study revealed that 91% of the surveyed community members are aware and perceive there are opportunities associated with climate change. Despite the plenty of opportunities available for uptake, it is clear that a good number of these community members have not taken initiative to utilise the opportunities available to them to help them adapt better. This means that in the absence of crucial assets such as natural and human capital, social networks, institutional and good governance, technology and general good health, communities may not be able to adapt to the changing and variable climate. It is therefore paramount that adaptation enablers such as education and awareness creation, capacity building, shared learning and promotion of local climate change innovations be enhanced to help rural communities make informed decisions on climate adaptation.

The study recommends improvement on market access, pricing of produce and policy enforcement from government especially on marketing of farm produce. For example, the law on the weight of a potato sack which was cut from 110kg to 50kg as stipulated by the International Labour Organisation as maximum packaging weight for agricultural produce should be upheld and enforced across the country. This will protect poor farmers against exploitation by the middlemen.

There is also need to create a strategy that would incentivise the youth to take up farming as a form of employment. Training and awareness creation on rain harvesting and water conservation technologies should also be enhanced. This would help the community members to retain substantial amount of water even after the rains for their subsistence irrigation and domestic use. The study also recommends training in financial management, a saving culture and access to credit facilities for the agropastoral community in Kieni. This will help the communities to gain knowledge on how to invest the monies they receive from their various social and environmental enterprises hence building their resilience.

The study also recommends further research on the relationship between climate change and health especially on cold related diseases in Kieni. This would give insights on what majority of the agropastoral

community in the area believes to be health problems brought by changing climate.

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Conflict of interest

“The authors declare that there is no conflict of interest regarding the publication of this paper.”

References

- ACP and EU, (2011), Support to legislative development in Tanzania and Preparation of a draft Aquaculture policy in Kenya. Final Technical Report, Project Ref. N°: Ref. CU/PE1/UG/10/001; ACPII Fish and EU, Kenya
- Adger, W.N. (2006), Vulnerability. *Global Environmental Change*, 16(3): 268-281
- Adger, W.N., S. Dessai, M. Goulden, M. Hulme, I. Lorenzoni, D.R. Nelson, L.O. Naess, J. Wolf, and A. Wreford, (2009), Are there social limits to adaptation to climate change? *Climatic Change*, 93(3-4): 335-354.
- Akinngbe, O., and Irohibe, I. (2014), Agricultural adaptation strategies to climate Change impacts in Africa: a review. *Bangladesh J. Agril. Res.* 39:407-418.
- Bairwa, S.L., Kalia, A., Meena, L.K., Lakra, K. and Kushwaha, S. (2014), Agribusiness Management Education: A Review on Employment Opportunities. *International Journal of Scientific and Research Publications*. 4 (2): 2250-3153
- Baruah, B. K. (n.d), Agribusiness Management, its meaning, nature and scope, types Of management tasks and responsibilities. Department of Agril. Economics Farm Management Assam Agricultural University Jorhat – 785 013
- Bradshaw, B., Dolan, H., and Smit, B., (2002), Farm-level adaptation to climatic variability and Change: Crop diversification in the Canadian Prairies. Department of Geography *Simon Fraser University, Burnaby, B.C. V5A 1S6, Canada.*
- Bryan, E., Ringler, C., Okoba, B., Roncoli C., Silvestri, S., and Hererro, M., (2011), Adapating Agriculture to Climate Change in Kenya: Household and Community Strategies and Determininants. Report to the World Bank for the project “Adaptation to climate change of smallholder agriculture in Kenya” January 2011
- Brenda, B., (2011), Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change. *J. of Bioscience* Vol. 61 No. 3 American Institute of Biological Sciences. University of California. USA.
- Cochran, W.G., (1963), Sampling Techniques, 2nd Ed., New York. *John Wiley and Sons, Inc*
- Cordona, O.D., Van Aalst, M.K., Birkmann, J., Fordham, M., McGregor, G., Perez, R., Pulwarty, R.S., Schipper, E.L.F. and Sinh, B.T. (2012), Determinants of risk: exposure and vulnerability. In C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor and P.M. Midgley, (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation*, pp. 65–108. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, USA, Cambridge University Press.
- Dorward, A. (2009), Rethinking agricultural input subsidy programmes in developing countries. Food and Agriculture Organisation of the United Nations, Rome, 311-374pp.
- Food and Agriculture Organization of the United Nations (FAO), (2005), Aquaculture production. *Year book of Fishery Statistics* 96/2. Food and Agriculture organization of the United Nations, Rome, Italy.
- Food and Agriculture Organization of The United Nations (FAO), (2014), The State of World Fisheries and Aquaculture Opportunities and challenges. FAO, Rome.
- Freeman, H.A. and Salim S.S. (2002), Commercialisation of smallholder irrigation: The case of horticultural crops in semi-arid areas of eastern Kenya. In: Sally H and Abernethy CL (Eds.), Private irrigation in sub-Saharan Africa. Proceedings of the Regional Seminar on Private Sector Participation and Irrigation Expansion in sub-Saharan Africa, 22–26 October, 2001, Accra, Ghana, pp 185–192.
- Government of Kenya (GoK), (2008), Sessional Paper No.2 of 2008 on National Livestock Policy. Nairobi Kenya.
- Government of Kenya (GoK), (2012), National Agribusiness Strategy. Nairobi Kenya.
- Government of Kenya (2013), Kenya Vision 2030 Sector plan for Drought risk management and ending drought emergencies. Second medium term plan 2013-2017.

- Government of Kenya (GoK), (2015), Kenya Green Economy Strategy and Implementation Plan (GESIP), Nairobi, Kenya.
- Hall, J.W., S. Brown, R.J., Nicholls, N. Pidgeon, and R.T. Watson (2012), Proportionate adaptation. *Nature Climate Change*, 2: 833-834.
- IFAD (2006), IFAD Strategic Framework 2007-2010; Enabling the rural poor to overcome poverty. Executive Board-Eighty-ninth Session, Rome, 12-14 December 2006.
- Ijaimi A. (1994), Efficiency and equity effects of market access on agricultural productivity in Sudan: A case study of smallholders along the River Nile, North of Khartoum. PhD Dissertation, Department of Agricultural Economics, University of Hohenheim, Stuttgart, Germany.
- IPCC, (2012), Land Use, Land Use Change and Forestry. UNEP:WMO; 2000, Smith P, Wollenberg E: Achieving mitigation through synergies with adaptation. In *Climate Change Mitigation and Agriculture*. Edited by Wollenberg E, Nihart A, Tapio-Bostroöm M-L, Grieg-Gran M. London-New York: ICRAF-CIAT; 2012:50-57.
- IPCC, (2012), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Eds.)], Cambridge University Press, Cambridge, UK and New York, NY, USA, 582 pp.
- IPCC, (2014), Climate change 2014: Impacts, adaptation and vulnerability. Part B: Regional Aspects. Contribution of working group II to the *fifth Assessment Report of Intergovernmental Panel on climate change* (Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.E. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (Eds.)), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp.668.
- Kadi, M., Njogu, L., Mwikya J., and Kamga A. (2011), The State of C.I.S for agriculture and food security in East African Countries. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Working Paper No.5.
- Kamara, A., and Von Oppen, M., (1999), Efficiency and equity effects of market access on agricultural productivity: The case of small farmers in Machakos District, Kenya. *Quarterly journal of International Agriculture*, 38: 65-77
- Kamara, A. (2004), The Impact of market access on input use and agricultural productivity: Evidence from Machakos District, Kenya. *Agrekon*, 43:202-216.
- Karanja, A.M. (2003), The Dairy Industry In Kenya: The Post-Liberalisation Agenda. Paper presented at a Dairy Industry Stakeholder workshop held in Nairobi, Kenya (27th August, 2002)
- Kipserem, T., Sulo, T., Chepng'eno, W., and Korrir, M. (2011), Analysis of factors affecting dairy goat farming in Keiyo North and Keiyo South Districts of Kenya. *Journal of Development and Agricultural Economics*, 11: 555-560.
- Klein, R.J.T., G.F. Midgley, B.L. Preston, M. Alam, F.G.H. Berkhout, K. Dow, and M.R. Shaw, (2014), *Adaptation opportunities, constraints, and limits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 899-943.
- Lutz, W., Muttarak, R., and Striessnig, E., (2014), Universal education in key to enhanced climate adaptation, *Science*, doi/10.1126/science.1257975
- Matocha, J., Schroth, G., Hills, T., and Hole, D. (2012), Integrating climate change adaptation and mitigation through agroforestry and ecosystem conservation. In P.K.R. Nair and D. Garnty (Eds.), *Agroforestry-The future of Land Use*, Advances in Agroforestry. Springer, pp.105-126.
- Macharia, P.N., Lugadiru, J., Wakori, S., Ng'ang'a, L.W. and Thurania, E., (2009), Perception and Adaptation measures to climate change and variability by immigrant communities in semi-arid regions of Nyeri and Laikipia East Districts. *African Crop Science Journal*, Vol. 20, Issue Supplement s2, pp. 287 – 296
- Magombo, T., Kanthiti, G., Phiri, G., Kachulu, M. and Kabuli, H. (2011), Incidence of Indigenous and Innovative Climate Change Adaptation Practices for Smallholder Farmers' Livelihood Security in Chikhwawa District, Southern Malawi. ATPS, Research Paper No. 4. Nairobi, Kenya.
- Mawa, L., Kavoi, M., Baltenweck, I., and Poole, J. (2014), Profit efficiency of dairy farmers in Kenya: An application to smallholder farmers in Rift Valley and Central Province: *Journal of Development and Agricultural Economics*, 6:455-465
- National Drought Management Authority (NDMA), (2014), Nyeri County- Kieni Sub-County Drought Monitoring

- Bulletin for June 2014.
- Mburu, M., Mugendi, B., Makhoka, A., and Muhoho, S.(2014),Factors Affecting Kenya Alpine Dairy Goat Milk Production in Nyeri Region.Canadian Center of Science and Education. *Journal of Food Research*, 3:160-167
- Ngigi, S. (2003), Rainwater harvesting for improved food security: Promising technologies in the Greater Horn of Africa. Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association (KRA), Nairobi, Kenya.). In: Proceedings of 3rd International Conference On bearing capacity of roads and airfields. Longhorn ,Trondeihm, Norway. PP 743-756.
- Ngigi, S., Savenije, H., and Gichuki, F. (2006), Hydrological impacts of rainwater harvesting and management on dry seasons' irrigation water abstraction in upper EwasoNg'iro river basin, Kenya. Paper submitted to Agriculture, Ecosystems and Environment. In: Proceedings of 3rd International Conference On bearing capacity of roads and airfields Longhorn, Trondeihm, Norway, PP 743-756.
- Noble, I.R., S. Huq, Y.A. Anokhin, J. Carmin, D. Goudou, F.P. Lansigan, B. Osman-Elasha, and A. Villamizar, (2014),Adaptation needs and options. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 833-868.
- Oke ,D.O. and Odebiyi, K.A.(2007),Traditional cocoa-based agroforestry and forest species conservation in Ondo State, Nigeria. *AgricEcosyst Environ.*, 122:305-311.
- Orindi, V. and Eriksen,S.(2005),Mainstreaming adaptation to climate change in the development process in Uganda. *Ecopolicy Series 15*. Nairobi, Kenya: African Centre for Technology Studies (ACTIS)
- Preston, B.L., R.M. Westaway, and E.J. Yuen, (2011), Climate adaptation planning in practice: an evaluation of adaptation plans from three developed nations. *Mitigation and Adaptation Strategies for Global Change*, 16(4), 407-438.
- Purcell, R. (1997), Potential for small-scale irrigation in sub-Saharan Africa: The Kenyan example. In irrigation Technology Transfer in Support of Food Security. Proceedings of a sub- April regional workshop in Harare ,Zimbabwe -(14-17 April 1997). Water Reports. No. 14. Food and Agriculture Organisation of United Nations, World Bank, IPTRAD, Rome Italy.
- Shivairo, R., Matofari, J., Muleke, C., Migwi, P., and Lugairi, E. (2013), Production Challenges and Socio-Economic Impact of Dairy Goat Farming amongst Smallholder Farmers in Kenya.*J. of Food Science and Quality Management*, 17 :54-62.
- Smit, B. and Skinner,M. (2002), Adaptation Options in Agriculture to Climate Change: A Typology.Department of Geography, University of Guelph Guelph, Ontario, Canada
- Staal, S., Nin, P., and Jabbar, M.(2008), Dairy Development for resource poor. Part 3: Pakistan and India dairy development case studies. Available at <http://cgspace.cgiar.org>
- The International Institute for Sustainable Development (2003), Livelihoods and Climate change: Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty. Winnipeg, Manitoba Canada.
- Trade Union Congress (2009), Changing work in a changing climate: Adaptation to climate change in the UK- New research on implications for employment .London, UK
- Turner, B.L. II, R.E. Kasperson, P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, J.X. Kasperson, A. Luers, M.L. Martello, C. Polsky, A. Pulsipher, and A. Schiller, (2003), A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences of the United States of America, 100(14), 8074-8079.
- Tompkins, E.L., W.N. Adger, E. Boyd, S. Nicholson-Cole, K. Weatherhead, and N. Arnell,(2010), Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change*, 20(4), 627-635.
- UNCSD (2012),The Future We Want. United Nations.
- USAID, (2010) ,Consumer milk quality perception/preferences and an assessment of willingness to pay for quality.USAID dairy sector competitiveness program.[online] Accessed on 11/0/2016.available at http://pdf.usaid.gov/pdf_docs/Pdacs668.pdf.
- Von Oppen, Njehia M., and Ijiami A.(1997), Policy Arena. The impact of Market Aceso to Agricultural productivity: Lessons from India, Kenya and the Sudan. *Journal of International Development vol 9 pp 117-13*.
- Wamsler, C., E. Brink, and O. Rentala (2012), Climate change, adaptation, and formal education: the role of schooling for increasing societies' adaptive capacities in El Salvador and Brazil. *Ecology and Society* 17(2):2

- Wandel, J. and Smit, B.(2000), ‘Agricultural Risk Management in Light of Climate Variability and Change’, in Millward, H., Beesley, K., Ilbery, B., and Harrington, L. (eds.), *Agricultural and Environmental Sustainability in the New Countryside*, Rural Research Centre, Nova Scotia Agricultural College, Truro, pp. 30–39.
- Wisner, B., P. Blaikie, T. Cannon, and I. Davis (2004), *At Risk: Natural Hazards, People’s Vulnerability and Disasters*. Routledge, Abingdon, UK and New York, NY, USA, 471 pp.
- World Bank, (2010) ,*World Development Report 2010: Development and Climate Change*. The International Bank for Reconstruction and Development .The World Bank, Washington, DC, USA, 439 pp.
- Woznicki, S.,Nejadhashemi, A.and Parsinejad, M.(2015), Climate change and irrigation demand: Uncertainty and adaptation.*J. of Hydrology*,3: 247-264.
- Yamane, T. (1967), *Elementary Sampling Theory*. Englewood Cliffs, New Jersey, Prentice Hall,Inc.