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Original Research Article

Indigenous Local Knowledge in Climate Change Adaptation by Smallholder Farmers in Lake Victoria Basin, Kenya

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Abstract

The developing world, Kenya included is already grappling with extreme climate related events and such events pose a serious threat to agricultural production and particularly to the smallholder farmers. In Kenya, about 11% of arable land could be affected by climate change, including a reduction in cereal production, which is about 16% of the agricultural Gross Domestic Product (GDP). To avert this situation, adaptation to the effects of climate change is critical and of concern in developing countries particularly in Africa where vulnerability is high because the ability to adapt is low. However, a number of socioeconomic and culture specific factors of the farmer could be influencing the ability of the farmers to adapt to the effects of climate change. This informed the purpose of this study which investigated the influence of indigenous local knowledge on climate change adaptation by smallholder farmers in Homabay County, Kenya. The study employed cross-sectional survey design in which data was collected from smallholder farmers in one survey round. Quantitative data was collected from 398 smallholder farmers, while 48 key informant interviews and 12 focus group discussions were used to collect qualitative data to buttress information from farmers. Data was analysed using frequencies, percentages, cross-tabulations and chi-square at 0.05 significance level. The study established that indigenous local knowledge influences individual values and choices of climate change adaptation strategies. The study recommended the need to document the indigenous knowledge indicators across communities and how it has been used in climate change adaptation at household level. The study also recommended integration of indigenous knowledge with modern scientific knowledge in climate change policy documents at national and county levels for appropriate climate change adaptation.

Keywords: Climate change adaptation, Homabay County, Indigenous local knowledge, Smallholder farmers

INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) provides that all parties must formulate and implement national or regional programmes containing measures to facilitate adequate adaptation to climate change (Article 4.1.b of UNFCCC, 2007). It lists specific domains in particular need of adaptation, namely coastal zones, water resources, agriculture, and areas affected by drought and desertification, as well as flood (FAO, 2007). The farms, pastures and forests that occupy 60 per cent of the earth's surface are progressively being exposed to threats from increased climate variability and, in the longer run, to climate change (FAO, 2007).Floods, droughts and extreme weather events, for instance, are already putting social and economic relations under stress in many areas, while changes in such sectors as energy and forestry are transforming the world of work for countless women and men throughout the world (ILO, 2018).

Sub-Saharan Africa (SSA) has been identified as one of the regions that are most vulnerable to the impacts of climate change (Bryan et al., 2013; IPCC, 2014). Climate change is seen as one of the major factors limiting Africa's efforts to achieve food security because of the continent's dependency on rain-fed agriculture and the low capacity of smallholder farmers to adapt to climate change (IPCC, 2014; Phirri et al., 2016). It is projected that SSA will witness increases in temperature, changes in rainfall intensity and distribution and a rise in incidences of extreme weather events (e.g. droughts and floods), pests, weeds and disease epidamics (FAO, 2015; Connolly-Boutin and Smit, 2015). Research has shown that Africa is vulnerable to climate change due to poverty, inadequate technology, economic challenges, weather extremes and poor governmental agriculture policies (Lobell et al., 2011).

In Kenya, agricultural production contributes about 25.4 per cent of the country's Gross Domestic Product (GDP) directly and another 27 per cent indirectly through its links with agro-based industries and the service sector (FAO, 2015). While Kenya already experiences an increase in rainfall variability, 75% of the agricultural output remains dependent on rain-fed small-scale agriculture (Herrero et al., 2010). The majority of the population lives in rural areas, with smallholder rain-fed agriculture as the main economic activity (Bryan et al., 2013; Barasa et al., 2015b). It is projected that about 11 per cent of arable land could be affected by climate change, including a reduction of cereal production, which is about 16 per cent of agricultural GDP (FAO, 2005). Averting the challenge of climate change requires that farmers adapt by making changes in farming and land management decisions that reduce the negative consequences associated with the changing climate (Jarvis et al., 2011). The changes pose significant risks to all communities including smallholder farmers in Lake Victoria basin and the landscapes they depend on for livelihood, subsistence, and physical and spiritual being (Hanna, 2007). Climate change is a major economic challenge in the Lake Victoria Basin (LVB) and is likely to exacerbate existing poverty levels given its implications with respect to agriculture and food security, water resources, natural resources including ecosystem goods and services as well as its adverse effects on human health (Mogaka et al., 2006; Mugisha et al., 2007). The 2010 National Climate Change Response Strategy (NCCRS) recognized the importance of climate change impacts for Kenya's development (RoK, 2013). Thus, proactively addressing climate change and its impacts urgently is pro-growth strategy for the longer term that responds to Kenya's aspiration for sustainable socio-economic development in order to achieve the Sustainable Development Goals (SDGs) and Vision 2030.

Research at the community and household level has provided insight into particular adaptation strategies and impacts (Below et al., 2012; Vermeulen et al., 2011), but remains unclear to what extent these strategies are influenced by indigenous local knowledge at household level. Although the farmers in Kenya like in any other African country have a low capacity to adapt to changes in climate, they have, however, survived and coped in various ways over time. Better understanding of how they have done this is essential for designing incentives to enhance private adaptation. A number of studies have shown the value of indigenous people's observations of changes in climate-related weather patterns (Green and Raygorodetsky, 2010), ocean phenomena (Fineup-Riordan and Rearden, 2010), phenology (Egeru, 2012) and fire behaviour (Mason et al., 2012). Their knowledge of ecological patterns can help reconstruct historical baselines (Thornton and Scheer, 2012). Traditional ecological knowledge of ecosystem health and species distributions can contribute to culturally appropriate climate change adaptation (Girot et al., 2011). Traditional water related knowledge, water harvesting and storage have allowed indigenous people to survive in arid lands and cope with drought for millennia (Johnstone, 2012). Therefore, supporting the coping strategies of local farmers through appropriate public policy and investment and collective action can help increase the adaptation of measures that will reduce the negative consequences of predicted change in future climate.

Response to the impacts of climate change requires integration of different knowledge systems and decision making processes in order to improve understanding of the issue and manage risk (Gilligan et al., 2006). Traditional ecological and local knowledge contribute insight, which is important in understanding environmental and social change (Riewe and Oakes, 2006). Traditional ecological knowledge emphasizes knowledge accumulated over a long time about an area or species (Gilchrist et al., 2005). It is influenced by the duration the farmer has stayed in a particular area and the farming experience. Indigenous or traditional knowledge has been defined as institutionalized local knowledge that has been built upon and passed on from one generation to the other by word of mouth (Osunade, 1994; Warren, 1992). The knowledge set is influenced by the previous generations' observations and experiment and provides an inherent connection to one's surroundings and environment. Therefore Indigenous Knowledge is not transferable but provides relationships that connect people directly to their environments and the changes that occur within it, including climate change (Woodley, 1991).

The IPCC Assessment report of 2007 noted that indigenous knowledge is an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change (IPPC, 2007). This was reaffirmed in the IPCC report of 2010 which indicated that indigenous or traditional knowledge may prove useful for understanding the potential of certain adaptation strategies that are cost-effective, participatory and sustainable.

Local climate and weather forecasting knowledge can provide information and insights that canbe used for successful climate change and variability adaptation at the local level (Chisadza et al., 2015). The strength of indigenous knowledge makes it a critical element that needs to be taken into account by the national weather forecasting systems. Many studies comparing indigenous with modern weather forecasting knowledge have confirmed a positive correlation between the climate and weather indicators used by indigenous and by modern science (Chisadza et al., 2015; Ziervogel and Opere, 2010). These studies inevitably recommend the co-production of weather and climate knowledge by these two knowledge systems to create a system which benefits from the accuracy of the modern systems as well as from the local relevance of traditional systems (Weatherhead et al., 2010; Mugabe et al., 2010; Kalanda-Joshua et al., 2011).

Local or indigenous knowledge can be beneficial or problematic in the context of climate change adaptation. Siedenburg (2008) analyzed local knowledge about agro-forestry practices in the context of rapid environmental change in the Shinyanga Rural District of Tanzania. He found that some smallholder households do not actively foster the re-generation of key farm-based natural resources, and he concluded that variations in local knowledge may be a key determinant of their use of this practice. In contrast, existing indigenous knowledge of rain-water harvesting technologies is an important asset for designing and implementing irrigation technologies in the future (Mbilinyi et al., 2005).

While the importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, little has been done to incorporate this into formal climate change adaptation strategies (Nyong et al., 2007) by smallholder farmers at local levels. Climate change cannot be divorced from sustainable development as sustainable development may be the most effective way to frame the mitigation question and a crucial dimension of climate change adaptation and impacts (Swart et al., 2003; Cohen et al. 1998). Incorporating indigenous knowledge into climate change policies can lead to the development of effective mitigation and adaptation strategies that are cost-effective, participatory, and sustainable (Robinson and Herbert 2001; Hunn 1993). However, incorporating indigenous knowledge into climate change concerns should not be done at the expense of modern/ western scientific knowledge. Indigenous knowledge should complement, rather than compete with global knowledge systems (Nyong et al., 2007).

In Kenya, UNEP (2008) observed that indigenous communities recognize that to be able to cope with the natural disasters, they have to monitor the environmental conditions, including the weather, to be able to make meaningful prediction and take appropriate actions. However, it is reported that in many Kenyan communities the Indigenous Knowledge (IK) is likely to be lost due to limited documentation and condemnation of its ability in natural hazard management (RoK, 2004). Based on this and given the variation on indigenous knowledge, the study investigated the influence of indigenous knowledge on climate change adaptation by smallholder farmers at household level. The study hypothesised that analysis of the role of technical traditional knowledge on the choice of climate change adaptation strategies is important in predicting particular adaptation behaviour of households in response to changes in climate. Knowledge of climate patterns will help farmers to develop adaptation strategies to cope with these climatic changes and improve their agricultural production. This knowledge that is accumulated over a long period of time as a result of experience by smallholder farmers can be termed as indigenous local knowledge.

METHODS AND MATERIALS

The Study Area

The study was carried out in Homabay County. The county is characterised by a rapidly growing population, high population density, falling food production and low resilience to climate change. It is within the Lake Victoria basin which is experiencing erratic weather as a result of perceived effects of climate change and variability. Most households in the study area rely on primary production for their livelihoods, which include rain-fed smallholder farming and fisheries, practices that are highly vulnerable to environmental degradation and effects of climate change. Poverty is prevalent in the county with about 48% of the population living below poverty line (KNBS and UNICEF, 2013). This is slightly higher than the national average of about 45%. Addressing population growth, environmental degradation, and climate change together should be a top priority if Homa Bay County is to achieve sustainable development.The county has varied agro-ecological zones giving rise to different land uses. These zones include Upper Midlands 1 (UM1), Upper

Midland 3 (UM3), Upper Midlands 4 (UM4), Lower midlands 2 (LM 2), Lower Midlands 3 (LM3), Lower Midlands 4 (LM 4) and Lower Midlands 5 (LM 5). This is representative of Kenya's agro-ecological zones, making Homabay County suitable for the study.

Homa Bay county lies between latitude 0º 15' South and 0º 52' South, and between longitudes 34º East and 35º East. The county covers an area of 4,267.1 Km^2 inclusive of the water surface which on its own covers an area of 1,227 Km^2. The county is located in South Western Kenya along Lake Victoria where it borders Kisumu and Siaya Counties to the North, Kisii and Nyamira Counties to the East, Migori County to the South and Lake Victoria and the Republic of Uganda to the West. The county is divided into six administrative sub-counties namely; Rachuonyo south, Rachuonyo north, Homa Bay, Ndhiwa, Mbita and Suba sub-counties (RoK, 2013).

Research design and data collection procedure

The study employed cross-sectional survey design to collect information from the respondents according the study objectives. Surveys are important in research and have been found to be effective in describing characteristics of population under study (Kathuri and Pals, 1993; Fraenkel and Wallen, 2000). This design therefore was appropriate for this study because the study involved description of the characteristics of the smallholder farmers as they relate to their ability to adapt to the effects of climate change. Given the nature of the objectives, the study was based on mixed methods approach (Creswell, 2014). Mixed method approach involve the collection, analysis and integration of both quantitative and qualitative research methods within a single research study in order to answer research questions (Creswell and Plano, 2011). The combination of qualitative and quantitative approaches occurred at different stages of the research process, such as formulation of research questions, data collection and data analysis.

A sample of 398 smallholder farmers was randomly selected to provide information for the study. The study employed both quantitative and qualitative data collection approaches.A structure questionnaire was used to collect quantitative data from the respondents. The qualitative data collection data approaches included Key Informant Interviews (KII) and Focus Group Discussions (FDGs). Data was analysed using frequencies, percentages, chi-square test of agreement and cross-tabulations.

RESULTS AND DISCUSSION

Chi-square was used to test the relationship between indigenous local knowledge and choice of climate change adaptation strategies. The factors analysed included length of time of stay in the study area, length of time taken in practising agriculture and climate change experience, and experience in water accessibility problems. The cases were first analysed descriptively using percentages and frequencies before chi-square test was done.

The study sought to understand the extent to which the duration of time the farmers had stayed in the study area had influenced their knowledge of climate events and how this had helped them adapt to climate change. Most of those who had stayed in the area for more than 30 years indicated that they had used their past experiences of climate regimes to predict the likely climate events. However, most farmers indicated that climate variables had become very much unpredictable that it had become very difficult for them to be very sure of the predicted events. Egeru (2012) also observed that indigenous knowledge is being challenged by a number of factors including unreliable seasons, short return period of climate variability events; break down in social inclusion systems and a low mastery of indigenous knowledge among younger community members. The most common indicators mentioned during focus group discussions were wind patterns and cloud cover where one respondent pointed out that heavy rains were predicted when winds were constantly blowing from west to east. The results are presented in table 1.

To determine the relationship between the duration of stay in the study area and knowledge of climate regimes chi-square test was run. The results are presented in table 2.

The Chi-square test statistic, $\chi^2(3, N = 398) = 355.57$, $p<0.05$ indicate that there is a significant relationship between the length of time stayed in the study area and accumulation of knowledge about climate events. The longer the time of stay of a person in a particular environment, the more the knowledge accumulated about that environment which is important in responding to environmental challenges. This knowledge influences the smallholder farmers' preparedness towards changing climatic events. It enables the respondents in the study area to cope with impending water shortages due to drought and application of various adaptation strategies to counter low crop yields and poor livestock production. This implies that indigenous local knowledge on climate events has a positive influence on climate change adaptation.

On whether there is a relationship between farming experience and the amount of knowledge on climate regimes gathered, farmers were asked if they agree that farming experience enhances knowledge accumulation which is vital for climate change adaptation. The results of the study indicated that 33.67% strongly agree, 46.73% of the respondents agree, while 5.78% of the respondents strongly disagreed as shown in table 3. Most of the respondents who agreed that farming experience

Table 1. Influence of length of stay in the study area on knowledge of climate events

	Frequency	Percentage
Little extent	38	9.55
Undecided	16	4.02
Great extent	256	64.32
Very great extent	88	22.11

***Source*:** Field survey data, 2018

Table 2. Chi- Square Test Results on the relationship between duration of stay and knowledge of climate events

	Value	df	Pr > ChiSq
Pearson Chi-Square	355.57	3	<0.05

Table 3. Whether farming experience enhances indigenous knowledge

Farming experience results in accumulation of knowledge about climate events	Frequency	Percentage
Strongly agree	134	33.67
Agree	186	46.73
Not sure	25	6.28
Disagree	30	7.54
Strongly disagree	23	5.78

***Source*:** Field survey data, 2018

Table 4. Chi-square test results on the relationship between farming experience and indigenous knowledge

	Value	df	Pr > ChiSq
Pearson Chi-Square	288.005	4	<0.05

enhanced their knowledge of climate regimes in the study area were those who had practiced farming for more than 7 years and therefore had clear knowledge of climate variability in the study area. Farmers who have spent many years in farming are more equipped with local knowledge in adaptation to climate change. This corroborates a study by Defiesta and Rapera (2014) who reported that the number of years of experience in farming is highly correlated with the level of knowledge and skill related to adapting to climate change and climate variability using technology.

Chi-square test was run to determine the relationship between farming experience and indigenous technical knowledge. The results are presented in table 4.

The test statistic, χ^2(df = 4, N = 398) = 288.005,p<0.05 indicate a statistically significant relationship between farming experience and accumulation of indigenous local knowledge. This implies that the experience farmers have in farming enables them to acquire knowledge on climate events and this facilitate climate change adaptation. The longer the time taken in farming as an activity, the more the knowledge and skills acquired for improved agricultural production. Experienced farmers perceive climate change better as they are exposed to past and present climatic conditions over their life span (Mburu et al., 2015) and hence higher chances of adopting various strategies to cope with climatic changes. Farmers with more farming experience are more likely to perceive long-term changes in rainfall variability, an increase in average temperature, and a decrease in average rainfall (Bryan et al., 2013).

Cross tabulation of measures adopted by farmers to adapt to climate change and farming experience revealed a significant relationship(X^2 (12) = 65.13, P<0.05). The number of years spent in farming correlate with the number of years that the households will have experienced climate change effects. This implies that farmers who have spent more years in farming will have experienced more problems of climate change and as such have accumulated more knowledge on climate variability and change and have developed ways of coping with them. On the other hand, less experienced farmers may not garner enough knowledge on climate variability hence not able to effectively apply coping mechanisms. The results are shown in figure 5.

Household heads were also asked to report on whether their experience on changes in water accessibility had helped them to come up with mecha-

Table 5. Farming experience by measures to cope with climatic changes

Farming experience in years	Climate change adaptation measures					
	Changing planting date	**Planting short season crops**	**Planting drought resistant crop varieties**	**Planting trees**	**Water harvesting**	**Total**
	16	8	12	16	25	77
1-3 years	2.44%	1.22%	1.83%	2.44%	3.8%	11.7%
	17	10	22	35	6	90
4-6 years	2.59%	1.52%	3.35%	5.3%	0.91%	13.7%
7-10 years	25	20	24	42	13	124
	3.81%	3.05%	3.66%	6.40%	1.98%	18.9%
>10 years	93	56	59	139	18	365
	14.18%	8.54%	8.99%	21.19%	2.74%	55.6%
Total	151	94	117	232	62	656
	23.02%	14.33%	17.83%	35.36%	9.45%	100%

Source: Field survey data, 2018

Table 6. Relationship between experience on water accessibility changes and knowledge gained in coping with the problem

	Frequency	Percentage
Little extent	48	12.06
Not sure	26	6.53
Great extent	216	54.27
Very great extent	108	27.14

Source: Field survey data, 2018

Table 7. Chi-square test results on the association between experience on changes in water accessibility and local knowledge

	Value	df	Pr > ChiSq
Pearson Chi-Square	218.08	3	<0.001

nisms to cope with water problems. The changes reported by farmers on water accessibility in the last ten years included decline water volumes and drying up of some rivers, drying up of wells and excess water during floods. Most farmers reported that these changes having been experienced consistently for a long time provided them with skills to tackle water problems in the study. On the extent of the amount of skills acquired as a result of the experience on water accessibility problems, 12.06% of the respondents indicated that they had gained to a little extent, 54.27% to a great extent, 27.14% to a very great extent, while 6.53% of the respondents reported that they were not sure if they had acquired any skill out of the experience (table 6).

To determine association between the experience on changes in water accessibility and local knowledge acquired in coping with water problems in the study area, chi-square test was conducted as depicted in table 7.

The test statistic, χ^2(df = 3, N = 398) = 218.08,p<0.05 indicate that experience of water accessibility changes in the study area enabled households to acquire knowledge and skills to come up with strategies to cope with water accessibility problems which is good for climate change adaptation. Water accessibility problem was commonly found in poor households, practicing small scale farming in the study area. Prolonged droughts was one of the major factors mentioned that is causing water problems in the study area and therefore households had developed particular indigenous knowledge to cope with water shortages. Among the interventions included use of drought animals especially donkeys to transport water, construction of wells, roof-water harvesting using earthen pots and construction of water pans to store water during rains. However, those households with grass-thatched houses were not able to practice roof-water harvesting.

CONCLUSION

The study revealed that smallholder farmers had experienced increase in temperature, declining humidity and precipitation and this was affecting agricultural production in Homabay County. The study established that perceptions of climate change by smallholder farmers is majorly determined by the farmers' experience. The farming experience had enhanced indigenous local knowledge of farmers on climate events. Those who had been practising farming for a long time perceived long-term changes in temperature, precipitation and rainfall variability. The study also revealed a significant relationship between length of stay in the study area and accumulation of climate knowledge by the smallholder farmers. The longer the time of stay in a particular environment, the more the knowledge accumulated, which is important in responding to environmental challenges. The study concludes that perceiving that the climate is changing increases the probability of uptake of certain adaptation strategies by smallholder farmers.

RECOMMENDATIONS

1.The study recommended the need to document the indigenous knowledge indicators across communities and strengthening of indigenous knowledge among the younger community members in the study area and how it has been used in climate change adaptation at household level.

2. There is need to integrate indigenous knowledge of climate events with modern scientific knowledge for better forecasting by the meteorological department. This will enhance climate change adaptation at local levels.

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