Evaluation of Community Adaptation to Climate Change in Homa Bay County, Kenya

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Abstract- Climate change remains a major challenge to Homa Bay County whose main sources of livelihoods include fishing and fish trade, fish processing and agricultural production. The objectives of this study were to establish the potential of households to adapt to climate change and to evaluate adaptation strategies to climate change impacts in Homa Bay County, Kenya. The study adopted cross-sectional survey and evaluation research designs. Both qualitative and quantitative data were collected from male and female farmers in Homa Bay County. A sample size of 384 farmers was randomly selected and used in the study. Quantitative data analyses were done using SPSS package. The results reveal that there exist potential for households to adapt to the changing climate in the study area. The major factors influencing adaptation include lack of economic resources; availability and access to technology; levels of information and skills; social infrastructure; role of institutions; and equity in resource allocation. The local community response strategies include tree planting 335 (95%), planting more vegetation 245 (70%), changing and or diversifying crops 153(43.5%), rehabilitation of water storage structures 119 (34%) and paying more attention to weather forecasts. The main barriers to these coping strategies include lack of knowledge 207 (54%), insufficient funds 150 (39%) and lack of tools 27 (7%). The study proposes the use of short, medium and long-term adaptation measures for sustainability. These findings are important in strengthening local adaptation strategies and developing suitable policy frameworks to address the issue of resource mobilization in Homa Bay County.

Index Terms- Climate Change, Adaptation Strategies, Response Measures, Household Vulnerability, Climate Change Impacts, Livelihoods

I. INTRODUCTION

Adaptive capacity greatly influences the vulnerability of communities and regions to climate change effects and hazards (Downing *et al*., 1999; Kates, 2000). At the individual level, adaptive capacity can be seen as a different resource that one can draw upon in such times of need, such as time, money, belief in efficacy, knowledge, entitlements, personal networks, social and institutional support (Grothmann and Patt, 2005). The resources required for adaptation include the social, health, educational and financial. These are available to a rural community, together with the formal and informal social networks and government programs or policies, such as assistance during drought (Mulwa, 2008). Considerable attention has been devoted to the characteristics of households, communities or regions that influence their ability to adapt and/or their priority for adaptation measures (Kelly and Adger, 1999). These characteristics influence the occurrence and nature of adaptations and thereby circumscribe the vulnerability of systems and their residual impacts. With regard to climate change, the vulnerability of a given system or society is a function of its physical exposure to climate change effects and its ability to adapt to these conditions (Appendi and Liverman, 1996). Deficiencies in adaptive capacity like economic resources, technology, institutions, and lack of equity in allocation of power and access to resources within a community, region or nation results in low adaptive capacity and increased vulnerability to climate change impacts.

According to Kelly and Adger (1999), natural and human systems including agriculture, forestry, settlements, industry, transportation, human health, and water resource management have adapted to spatial differences in climate. Many systems are particularly vulnerable to changes in the frequency and magnitude of extreme events or conditions outside the coping range.

Adaptation types have been differentiated according to numerous attributes which include distinctions such as purposefulness and timing, autonomous or spontaneous adaptations and planned adaptations usually undertaken before impacts are apparent (Bryant *et al*., 2000). Although an impressive variety of adaptation initiatives have been undertaken across sectors and regions, the responses are not universally or equally available (Rayner and Malone, 1998). McGregor points out that the viability of crop insurance depends heavily on the degree of information, organization, and subsidy available to support it. Similarly, the option of changing location in the face of hazard depends on the resources and mobility of the affected part and on the availability and conditions in potential destination areas (McGregor, 1993).

Studies have shown that over 50% of Australian and British respondents indicated that they either strongly agreed or tend to agree with the statement that it is their responsibility to help to do something about climate change (Reser, *et al*., 2012). While responsibility for tackling climate change is more often placed at governmental and international levels, there is also evidence that the British and European public is aware of the need for wider collective and individual involvement in responding to climate change (Querol, *et al*., 2003; Lofstedt, 1996). The results of a study on Climate Change and Crop Agriculture in Nile Basin of Ethiopia which measured impacts and adaptation options indicated that the five major constraints to adaptation included lack of information (43%), lack of access to credit (22%),

shortage of labor (16%), shortage of land (11%), and poor potential for irrigations (8%) respectively (Meseret, 2009).

As Bibbings (2004) notes, the public accepts in theory that responsibility for environmental problems should be shared between society, business, industry and government but perceives that, in practice, nobody is living up to their side of the bargain (Lorraine, 2006). This shows that inaction by others may not be a disincentive for taking pro-environmental action among majority of the respondents (Adeniyi, 2011).

In Kenya, effective smallholder response to drought has shifted from traditional planting strategies to employment diversification (Downing *et al*., 1989). Poor and landless households have limited resources, yet failure to adapt can lead to significant deprivation, displacement, morbidity, and mortality. Subsistence farmers do not have the same adaptation options as commercial producers (Downing *et al*., 1997). Not only is there rarely only one adaptation option available to decision makers (Burton and Cohen, 1993) but also rarely do people choose the best responses among those available that would most effectively reduce losses often because of an established preference for, or aversion to, certain options (Rayner and Malone, 1998). Adoption of adaptive measures is constrained by other priorities, limited information and access to resources, adaptation costs, and residual damages or economic or institutional barriers (Bryant *et al.*, 2000; de Loë and Kreutzwiser, 2000, Mayaya *et al.*, 2014). In most cases local coping and adaptation strategies employed are event specific and the strategies are based on local knowledge and innovations (Bhusal, 2009). In this study, factors responsible for household vulnerability to the impacts of climate change in Homa Bay County were evaluated and subsequent recommendations given.

II. Materials and Methods

2.1 Study area

Homa Bay County lies between latitude $0^o15'$ South and $0^o 52'$ South, and between longitudes 34^o East and 35^o East (Figure 2.1). The County covers an area of approximately 4,267.1 Km^2 inclusive of the water surface. The county is located in South Western Kenya along Lake Victoria where it boarders 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 (GoK, 2013). This study was carried out in all the eight sub-counties of Homa Bay County namely; Ndhiwa, Homa Bay Town, Mbita, Suba, Karachuonyo, Rangwe, Kasipul and Kabondo Kasipul; 19 divisions, 116 locations and 226 sub locations. Based on projections from the 2009 Kenya Population and Housing Census, Homa Bay County had an estimated population of 1,038,858 persons consisting of 498,472 males and 540,386 females by the end of the year 2012. The County's Poverty rate for 2009 stood at 49.6% (Wiesmann *et al*., 2014). The main economic activities in the County include fishing and fish trade, fish processing, agricultural products: Maize, Millet, Cassava, Sunflower and sand harvesting (KNBS, 2013).

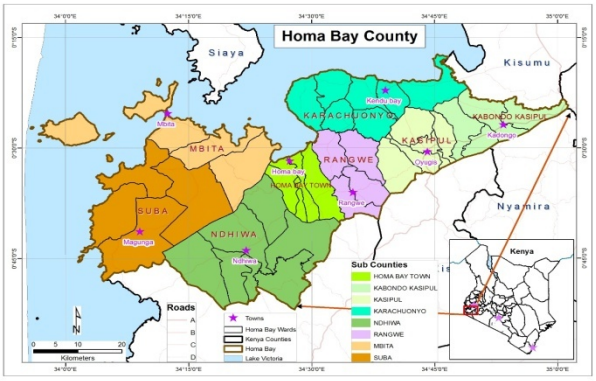

Figure 2.1: Map of Homa Bay County
Source: GoK, 2013.

2.2 Research design and sampling strategy

This study adopted a cross-sectional survey and evaluation research designs. The information required for this study was both qualitative and quantitative and was gathered from male and female farmers in Homa Bay County. The questionnaire was first piloted on a small sample of the population in an area with similar characteristics but not within the study area, in order to establish the reliability of the instrument. Questionnaires were used to gather information responses to impacts of climate change in the study area. The respondents were requested and assisted to fill the questionnaires. A face to face interview schedule on the subject of responses to impacts of climate change were conducted with some of the participants sampled for the study. The interviews were semi-structured, allowing participants to freely express their experiences and attitudes in their own language. Focus group discussions were held in four different areas within the county. The study explored the sources of information, adaptation strategies and the barriers to taking action on climate change effects. The study adopted a mix of quantitative and qualitative methods which made it possible to pool the strengths of different methods through triangulation (Gilbert, 2006; Cloke *et al.*, 2004)

A sample size of 384 farmers were randomly selected and used in the study. Quantitative data analyses were done using SPSS statistical package. The analysis of the sample was done according to the total sample, major geographic regions, gender, age brackets, level of education, poverty index and occupation categories. For qualitative data a coding frame was developed through a consultative process with the research assistants based on the research questions, and was further extended through open coding of a selection of the transects. Once the coding process was completed for all transects, the researcher identified which themes were most prominent across the transects and selected and grouped together all the quotations relating to each research question, so that they could be compared and analyzed together.

III. Results and Discussion

3.1 Potential of households to adapt to climate change impacts in Homa Bay County, Kenya

In order to determine the households potential to adapt to climate change effects in Homa Bay County specific focus was

directed to the following variables: demographic characteristics; economic resources; availability and access to technology; levels of information and skills; social infrastructure; role of institutions; and equity in resource allocation.

3.1.1 Economic Resources

To determine the levels of economic resources within the county, the respondents were asked to state land ownership and the findings revealed that 69.3% household heads owned land while 30.7% were landless. The respondents were then asked to state their levels of income and the findings revealed that 46. 7% of the households were poor while 53.3% were between medium to high income groups. This is in line with the 49.6% poverty incidence determined during 2009 population census as reported in Wiesmann *et al*. 2014. When asked to state their employment status, the findings revealed that 73.4% household heads were not formally employed while 26.6% were engaged in gainful formal employment. Distribution of household assets among households is a proxy indicator for the wealth status of the respective households. Whether it is expressed as the economic assets, capital resources, financial means, wealth, or poverty, the economic condition of nations and groups clearly is a determinant of adaptive capacity (Burton *et al*., 1998; Kates, 2000). It is therefore widely accepted that poverty is directly related to vulnerability (Chan and Parker, 1996) and therefore a rough indicator of the ability to cope in the face of changes in climate (Dow, 1992).

Generally it is usually the poor who are among the most vulnerable to famine, diseases, malnutrition, and hunger. This is partly due to the insufficient financial power that would enable them to diversify and engage in multiple sources of income. The poor are also characterized by poor housing quality and little community organization. Kelly and Adger (1999) demonstrate the influence of poverty on a region's coping capacity by indicating that poor regions tend to have less diverse and more restricted entitlements and a lack of empowerment to adapt to changes. Material poverty adversely affects the poor, eroding their wellbeing, security and development potential. The type of material used for the floor of a dwelling often serves as a useful indicator of housing quality from both a wealth and health perspective. It is a proxy for wealth status because floors are typically given lesser priority for investment than walls and roofing (Wiesmann *et al*., 2014).

Lack of technology has the potential to seriously impede a nation's ability to implement climate change adaptation options by limiting the range of possible responses (Scheraga and Grambsch, 1998). Adaptive capacity is likely to vary, depending on availability and access to technology at national and county levels. Many of the adaptive strategies identified as possible in the management of climate change directly or indirectly involve technology including warning systems, protective structures, crop and animal breeding, irrigation, settlement and relocation or redesign, and flood control measures among others.

3.1.2 Information and Skills

On examining the various trusted sources of information, it was established that radio was the main source of information 300 (78%) followed by Television 162 (42%), Newspapers 103 (27%) and school 93 (24%) while one out of ten people mentioned NGOs, workshops and conferences, chiefs and neighbours (Figure 3.1).

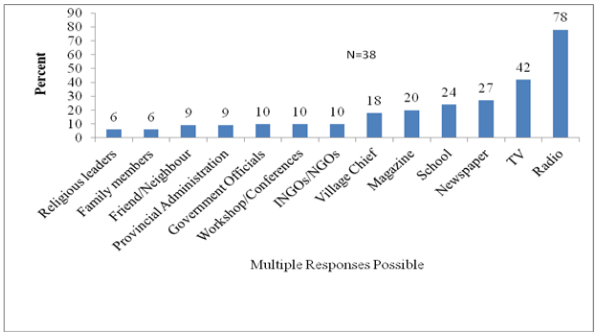

Figure 3.1: Sources of trusted information

Further analysis indicated that TV coverage was least in Karachuonyo 4 (7.5%), highest for the Government officials 80% and those aged 55-59 (70%). Proportionally, it was found out that more male 87 (35.4%) than female 44(31.9%); more urban 28 (45.9%) than rural 103(31.9%) and more of the employed 45 (44.1%) than the unemployed 86 (30.5%). More males than females could be reached through TV (35.4%), radio (88.2%), neighbours 11.8%, weather reports, newspapers and provincial administration/chiefs while the reverse was true for family and school. More urban than rural residents could be reached through Radio, TV, Neighbours and Newspapers with the reverse also true for family, weather report, provincial administration/chiefs and schools.

When asked where they find information about climate change, the interviewees indicated Ministry of Environment Water and Natural Resources, Ministry of Agriculture Livestock and Fisheries, National Environment Management Authority (NEMA), University libraries, Journal articles, research institutions, internet, colleges offering environmental courses and the Meteorological Department. Among them the most trusted sources of information include NEMA, meteorological department, elders, Kenya Forest service (KFS), Institutions like Jomo Kenyatta University where they offer these courses and United Nations bodies like United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP) and the World Agro-forestry center, University research departments, The Government of Kenya.

The respondents were asked to state their level of formal education. The results showed that 22.4% had attained primary level of education, 36.7% secondary, and 33.8% tertiary while 7% had no formal schooling. Basic capacity enhancement contributes to the improvement of adaptive capacity of local societies, by enhancing their basic capacity in terms of technologies, programs, financing, and human resources that is typically present in regions and sectors. Both integrated adaptation and basic capacity enhancement have other benefits even if the actual situation differs from projected climate change and its impacts and should be promoted systematically and consistently, with a long-term perspective.

Electronic information and communication tools play an important role in the development of a nation. They provide easy access to information enabling dissemination of content and

national languages that may be relevant for development. About 73.9% of residents in Homa Bay County own radio 15% own TV. Successful adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess them, and the ability to implement the most suitable ones (Fankhauser and Tol, 1997). In the context of climate variability and change, this idea may be better understood through the example of the insurance industry: As information on weather hazards becomes more available and understood, it is possible to study, discuss, and implement adaptation measures (Downing, 1996).

Building adaptive capacity requires a strong, unifying vision; scientific understanding of the problems; an openness to face challenges; pragmatism in developing solutions; community involvement; and commitment at the highest political level (Holmes, 1996). Lack of trained and skilled personnel can limit a nation's ability to implement climate change adaptation options (Scheraga and Grambsch, 1998). In general, countries with higher levels of human resources are considered to have greater adaptive capacity than developing nations and those in transition (Burton *et al*, 1998; Magalhães (1996) includes illiteracy along with poverty as a key determinant of low adaptive capacity to climate change in northeast Brazil. Such findings have prompted Gupta and Hisschemöller (1997) to conclude that it is important, therefore, to ensure that systems are in place for the dissemination of climate change and adaptation information nationally and regionally and that there are forums for discussion and innovation of adaptation strategies at various levels.

3.1.3 Infrastructure Facilities

To determine the resources required and available in the county for use in adapting to climate.6% indicated finances, 18.2% education, 18.2% Knowledge, 13.5% support from government, 7.8% information while 4.7% mentioned support from NGOs as below (Figure 3.2).

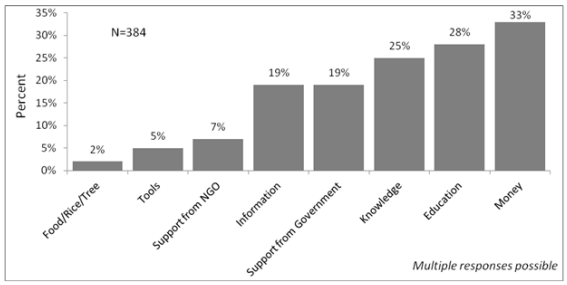

Figure 3.2: Resources required to help people adapt

Adaptive capacity is likely to vary with social infrastructure (Toman and Bierbaum, 1996). Some researchers regard the adaptive capacity of a system as a function of availability of and access to resources by decision makers, as well as by the vulnerable subsectors of a population (Kelly and Adger, 1999). Nations that depend solely for example on hydroelectric power for industries will have increased vulnerability during times of drought.

Common social and institutional enablers and constrainers influence adaptive capacity by providing opportunities or constraints to adaptation, including preparedness for climate risk. These include the kind of social, health, educational and financial services available to a rural community, including formal and informal social networks and government programs or policies, such as drought assistance. Due to inherent institutional deficiencies and weaknesses in managerial capacities to cope with the anticipated natural event, it would be extremely difficult for a country to reduce vulnerability to climate change (Ahmed *et al*., 1999).

3.1.4 Economic Equity

Economic inequality is viewed as a social and economic burden and especially when linked to poverty they threaten the core values as articulated in Kenya's constitution 2010. Economic inequalities exist with Homa Bay county standing at position 43 countrywide with an index of 0.42 as measured by the Gini Coefficient (Wiesmann *et al*., 2014). Other inequalities exist in areas of education in which gender disparities stands at 0.32 against a national average of 0.23. Interestingly for Homa Bay County the female participation in economic activities 77% is higher than male participation 76.5% Weismann, 2014. This can be explained partly by women's role in small-scale agriculture. A growing rate of female participation in economic activities can be a strong indication of improvements in gender mainstreaming policies and practices, equal employment opportunities , women's empowerment, and involvement of the total population economic and national development potential Wiesmann *et al*., 2014.

It is frequently argued that adaptive capacity will be greater if social institutions and arrangements governing the allocation of power and access to resources within a community, nation, or the globe assure that access to resources is equitably distributed (Ribot *et al*.,1996; Kelly and Adger, 1999). The extent to which nations or communities are entitled to draw on resources greatly influences their adaptive capacity and their ability to cope (Adger and Kelly, 1999). Some people regard the adaptive capacity of a system as a function not only of the availability of resources but of access to those resources by decision-makers and vulnerable subsectors of a population (Kelly and Adger, 1999). In the case of technological innovation, Cyert and Kumar (1996) show that differential distribution of information within an organization can impose constraints on adaptation strategies. Differentiation in demographic variables such as age, gender, ethnicity, educational attainment, and health often are cited in the literature as being related to the ability to cope with risk (Chan and Parker, 1996; Burton *et al*., 1998.

3.2 Adaptation strategies to climate change impact practiced in Homa Bay County, Kenya

Adaptation strategies employed by households to respond to climate change impacts in Homa Bay County were determined and evaluated. The study first established the strategies the households have used and barriers in response to the changing weather then went further to establish where the power to act on the changing weather lay. The strategies were critically evaluated in terms of effectiveness and efficiency.

The respondents were first asked if people in their community had done anything in response to the changing weather in which 352 (92%) responded affirmatively while the rest 32 (8%) responded to the contrary. Among those who indicated that nothing had been done by their community, about

30% were from Suba sub-county, 29% of those aged 70 years and above, the poorest group. More female than male and more urban than rural respondents indicated that something has been done by their community. Most of them said their work had been affected by the weather changes and community response has been in terms of tree planting 335 (95%), planting more vegetation 245 (70%), changing and or diversifying crops 153(43.5%), rehabilitation of water storage structures119 (34%) and paying more attention to weather forecasts. Others responses included talking to friends and neighbours, praying, reducing water consumption and irrigation canals as shown in the figure 3.3 below.

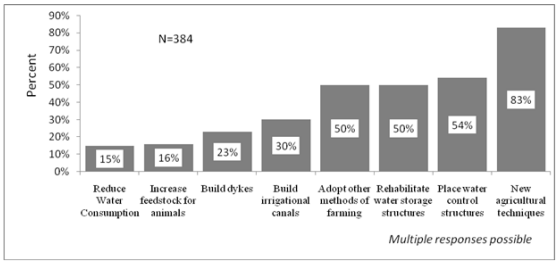

Figure 3.3: Actions in response to the changing climate

People have taken adaptive measures over the history of time to utilize the given climate conditions of their surroundings in the best possible way. When asked if they had done anything to prevent climate change in the past one year at the time of this study, a number of the key informants mentioned joining committees to give information on activities that need attention; Some respondents indicated that they had adopted use of biological farming methods to minimize overreliance on chemical based agriculture, tree nursery establishment and planting trees and use of energy saving stoves, and awareness creation in the communities to reduce on tree cutting for firewood. Other responses included having managed to plant many seedlings of trees and also minimizing the use of charcoal as main source of fuel.

The residents of Homa Bay indicated that if at all weather changes were to get worse they would resort to reforestation 296 (77%), changing and or diversifying crops 188 (49%), and rehabilitating water storage structures 159 (41%) and water control structures 146 (38%) respectively. Others said they would talk to friends and neighbours 63 (16%), build dykes 62 (16%) while about 13% do not know what to do (Figure 3.4).

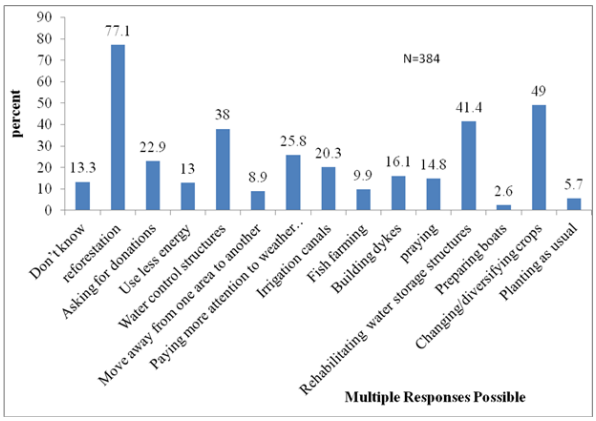

Figure 3.4: Respondents proposed actions with worse climatic conditions

A study conducted in Nepal among 113 interviewees to determine the local peoples' perceptions to climate change, its impacts and adaptation measures (Bhusal, 2009), found that local coping and adaptation strategies were event specific and the strategies were based on local knowledge and innovations and included practicing vegetable farming instead of cereal crops and crop diversification to earn more income while other strategies included forest protection, and utilization of marginal lands by planting trees and grasses. In a similar study (Meseret 2009), indicated that most commonly observed responses of farmers towards temperature and precipitations changes showed that 56.8% of the selected households had no adaptation strategy, 20% changed crop varieties, 13.3% planted trees while 2.9% put into practice soil conservation techniques. Regarding adaptation to change in rainfall patterns, about 42% had no adaptation strategy. Soil conservation schemes (30.4%) was the most commonly adapted strategy followed by use of different varieties of crops (11.1%), planting early and harvesting water for irrigation purposes among others.

Majority of the key informants said that the responses required for climate change adaptation include engagement of the County government through the environment ministry where government must protect forests from destruction, conducting baseline surveys to establish the extent of impacts, planning meetings and mobilizing groups, collect and compile data and information, provision of materials for awareness creation and engaging the media to ensure wider audience reach regarding climate change awareness and adaptation.

The results revealed that all sectors from maize to sugarcane to fishing have realized they must do things differently to cope with this new and harsh reality of climate change. The need to dig water reservoirs to store water for irrigation and for cows to drink is inevitable. The results also showed that most people had lost hope in farming in Homa May County due to the dry weather patterns. Other key informants indicated that the weather patterns had changed they needed to adapt to the changes to stay afloat. The earlier practice where runoff water would be let to go to waste has been abandoned and is now harvested and stored for use during the dry season.

The key informants had realized the need to come up with progressive strategies such as embracing the use of indigenous seeds which are resistant to drought since the exotic seeds cannot withstand the extreme weather. Without politicizing the whole

issue, the need to conserve water catchment areas and also reduce the cost of gas and use of electricity will drastically reduce charcoal burning and sustain the environment.

3.3 Barriers in responding to the impact of weather changes

In determining the barriers to taking action to respond to the effects of climate change, 207 (54%), 150 (39%) and 27 (7%) said lack of knowledge, insufficient funds and lack of tools respectively as shown in Figure 3.5. People may not adapt, or adapt incompletely, for a variety of reasons or obstacles that impede adaptation. Common social and institutional enablers and constrainers influence adaptive capacity by providing opportunities or constraints to adaptation, including preparedness for climate risk. These include the kind of social, health, educational and financial services available to a rural community, including formal and informal social networks and government programs or policies, such as drought assistance.

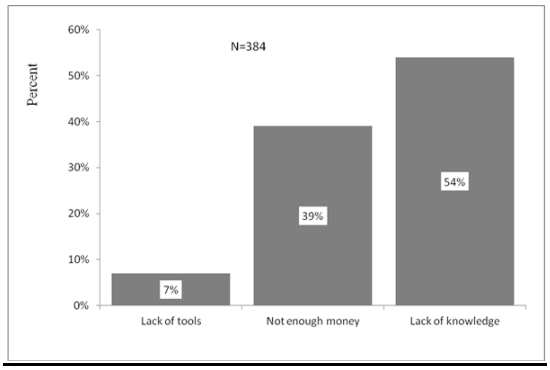

Figure 3.5: Barriers in responding to the impact of weather changes

Qualitative research highlights a prevailing belief amongst the public that they can do little to influence political processes and that their concerns and opinions are irrelevant to policy-makers (Bibbings, 2004b; Macnaghten and Jacobs, 1997). The results of a study on Climate Change and Crop Agriculture in Nile Basin of Ethiopia which measured Impacts and Adaptation Options (Meseret, 2009) indicated that the five major constraints to adaptation included lack of information (43%), lack of access to credit (22%), shortage of labor (16%), shortage of land (11%), and poor potential for irrigations (8%).

3.4 Power to act on the changing weather

The respondents were further asked if they knew any individual, organization or government department that is working to respond to the changing weather and their responses were that 245 (63.8%) responded affirmatively while 100 (26%) responded contrary with 39 (10.2%) not knowing. When asked who has the most power to respond to the changing weather (42%) mentioned the national government followed by the people of Homa Bay (18%) and the respondents themselves (16%) while another (4%) mentioned God as indicated in Figure 3.6 below.

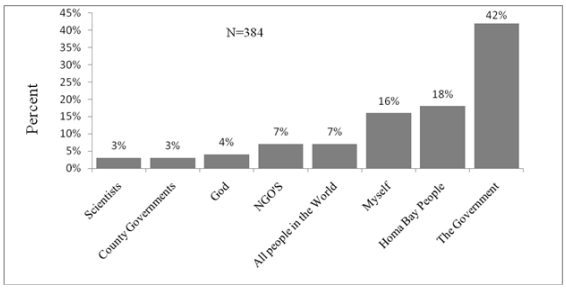

Figure 3.6: Power holders to changing weather

Responding to the issue of whose responsibility it is to deal with climate change; the key informants indicated that it is a multi-stake holder and a multi sectoral response strategy that can counter climate change and therefore all citizens, Governments, Non State Actors, NGOs, CBOs, PBOs) private sector organizations and networks across the country must be involved. Adaptation is not only a responsibility of national and local governments, but also directly related to the general public, corporations, and other actors in society although almost all the respondents 373 (97%) think the government is able to act to help cope with the problem of the changing weather in Homa Bay County.

Key among the activities that the Government can implement is stopping deforestation 173 (45%), planting more trees 134 (35%), giving out money to the people 65 (17%) and initiating irrigation schemes 12 (3%). The responses indicate that the respondents are aware that forests play an important role as sources of wood and non-timber products and as regulators of water flows and in addition, natural forests are key biodiversity hot spots (Weismann, *et al*., 2014).

Adaptation measures are normally related to the activities of national and local government agencies, but they also relate to the daily lives of citizens, and the activities of businesses. It is therefore important that a broad range of actors act with an awareness of their relationship and roles in the respective adaptation policies, plans, and measures. Efforts should therefore be made to clarify the responsibilities of departments in order to gather information relating to climate change, and to promote the adaptation measures in individual sectors in an organized way.

Over the past century, forest cover in Kenya has been reduced to about 2.4% of the total land area with Homa Bay county having a paltry 1.0% forest cover covering total area of 31 km^2 (Wiesman, *et al.*, 2014). The decline of forest cover in Kenya is a reason for concern, especially in view of the vital function forests play in protecting water resources. The protection, preservation and sustainable use of these forests is important for the County's natural resource base, and poses both challenges and opportunities for inter county collaboration (Wiesman, *et al.*, 2014).

Studies on strategies and responsibility for mitigation indicate that respondents believe that national governments, the international community, and the industrial corporate sector bear a strong responsibility for taking action to combat climate change. But the Australian multiple response data suggested that individuals and families are viewed as having almost equal responsibility to take action in the context of climate change. It is noteworthy that in response to the question of whether they felt a sense of urgency to change their behaviours to help to reduce

climate change, 41.9% of British and 35.6% of Australians responded affirmatively. Over 50% of both Australian and British respondents indicated that they either strongly agreed or tended to agree with the statement that it is their responsibility to help to do something about climate (Reser, *et al.*, 2012).

While responsibility for tackling climate change is more often placed at governmental and international levels, there is also evidence that the British and European public is aware of the need for wider collective and individual involvement in responding to climate change (Querol, *et al*., 2003; Lofstedt, 1996). When asked explicitly whether they felt they could help stop global warming, two-thirds of British people agreed they could (DETR, 1997). Furthermore, a BBC (2004) poll found that 85% of the British public say they 'would be prepared to change the way they live in order to lessen the possible impact of global warming'.

Bibbings (2004) posits, the public accepts in theory that responsibility for environmental problems should be shared between society, business, industry and government. However, it is perceived that, in practice, nobody lives up to their side of the bargain (Lorraine, 2006). When the respondents were asked to respond to the statement as to whether it is not worthy for them to do things to help the environment if others don't do the same, most (90%) of the respondents either disagreed or strongly disagreed with this statement. This shows that inaction by others may not be a disincentive for taking pro-environmental action among majority of the respondents (Adeniyi, 2011).

3.5 Proposed short and long term adaptation strategies

Adaptation prevents or moderates harm or exploits beneficial opportunities, by making changes in natural or human systems in the context of climate change impacts. The impacts of climate change are already occurring, and because they are projected to become even more severe in the future, it is essential to undertake short-, medium- and long-term adaptation measures. In this respect the respondents were asked to list short and long term adaptation strategies and rank them.

3.5.1 Short term climate change adaptation strategies

Short-term adaptation measures are those that are required immediately in order to prevent and moderate impacts that are already experienced. When asked on what they do to respond to the changes in weather patterns, majority indicated resorting to planting trees (94%), new agricultural techniques (83%), placing water control structures (54%), rehabilitation of water storage structures (50%) and adopting other methods of farming (50%) respectively. Suggested ways of keeping cool during hot weather included bathing often 3% and acquiring air conditioning equipment 2%. Of more concern is the group that suggested planting as usual 7.3%. Other responses centred around water management strategies including building irrigation canals 30%, building dykes 23% and reducing water consumption 15% as shown in Figure 3.7.

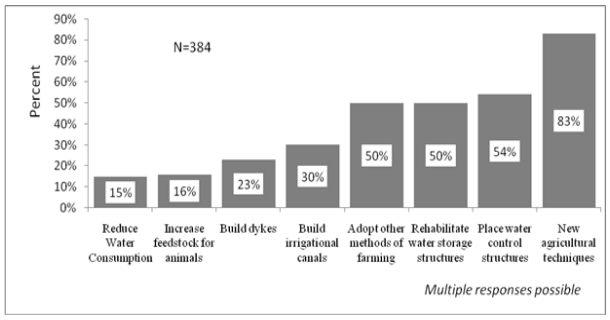

Figure 3.7: Possible responses to the changing weather

During the next few decades, it will be essential to initiate and encourage to the greatest extent possible and as quickly as possible, urgent adaptation and recovery measures for impacts that have a high likelihood of arising from climate change already occurring despite mitigation efforts. These would include introduction of heat-resistant crop varieties and promotion of appropriate cultivation methods, to address the declining crop quality and yields. Others would include crisis management arrangements and improvements in early warning systems, to deal with sea-level rise and with rising damage in confined areas and from intense rainfall events; installation and augmentation of independent electrical generation equipment for water purification plants to respond to power outages caused by the increase of natural disasters.

The Key informants indicated that it is essential to initiate and encourage urgent response measures to prevent or mitigate short-term impacts that are already occurring and are likely to arise from climate change. They said that it is essential to initiate urgent efforts to prevent and/or mitigate short-term impacts, and also to give higher consideration to measures where socioeconomic benefits are clearly superior in terms of cost to majority of the people. As the impacts of climate change are already occurring, it is important to strengthen existing response measures in individual sectors and take short-term adaptation measures. The respondents further revealed that it is vital to indicate basic approaches to adaptation, based on the current state of discussions about adaptation measures and the latest scientific knowledge to make national and local government departments responsible for adaptation. Efforts should be put in place to consider, plan, and implement adaptation measures in a coherent way.

From the focus group discussions, it came out that some adaptation measures are appropriate in the short-term including enhancing crop varieties and adjusting planting and harvesting dates by farmers. They also indicated that there is need to increase conservation of drought-resistant crop varieties by adopting water-conserving farming practices and promoting crop diversification. They further recommended that national and county governments should help set up a much-needed early-warning system for climate risks that will include educating farmers in the use of drought-tolerant seeds, plants and trees, as well as expand eucalyptus plantations for charcoal. The discussants also recommended scaling-up risk-transfer mechanisms for farming communities, restoration of degraded pasture lands, installation of air-conditioning systems in buildings and enforcement of building codes standards.

3.5.2 Long term climate change adaptation strategies

Long-term adaptation measures are those meant to prevent and mitigate projected future impacts. Response measures are necessary to enhance adaptive capacity to prevent and mitigate possible impacts, by assessing the risks of impacts that may occur in the medium and long term, and by controlling the impacts, reducing vulnerability, and strengthening resilience. These will include transforming the agricultural production system itself into a more resilient system to climate change. Among the longer term adaptation strategies are integrated farming, embracing insurance and banking and providing incentives for relocation.

Key informants indicated that there is need to ensure that we integrate individual sectors improve basic capacity enhancement. Long term strategies should also provide convenience and environmental improvements that can be expected to offer larger synergies than measures that aim only at adaptation. These may include improvements of river and sea embankments, functional improvements of existing facilities; land-use regulations and incentives in affected areas; strengthening of measures to prevent outbreaks of infectious diseases; development of global food supply-and-demand systems that consider climate change impacts based on existing projection methods; and systematic water supply development to cope with recent recurrent droughts. In order to ensure the safety, security, and sustainable development of the society, it is therefore essential to implement not only initiatives for the long-term mitigation of climate change, but also policies to adapt to climate change. Parallel with this, it is essential to start planning the medium- and long-term adaptation measures, while assessing the future risks of climate change based on the latest scientific research.

IV. Conclusion and Recommendations

The people of Homa Bay County have limited resources to adapt to climate change and this will further limit their capacity in the face of the magnitude of future hazards. Local adaptation strategies employed in Homa Bay County (tree planting, planting more vegetation, changing and or diversifying crops, rehabilitation of water storage structures, and paying more attention to weather forecasts) were effective but not sufficient and therefore not sustainable. Although communities in Homa Bay have used these strategies to adapt to climate change, the magnitude of future hazards may limit their capacity. It was revealed that the use of short, medium and long term strategies in adapting to climate change will enhance sustainability. It is recommended that local adaptation strategies be strengthened through improved extension services, training and research and developing suitable policy frameworks to address the issue of resource mobilization in Homa Bay County.

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