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# ASSESSING SIGNIFICANCE OF COMMUNITY DOCUMENTED CLIMATE IMPACTS AND ADAPTATION PREFERENCES AND OPTIONS IN THE LAKE VICTORIA REGION, TANZANIA

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**Abstract**
*The study was conducted in Ukerewe Island in the Lake Victoria, Tanzania in order to ascertain the communities' awareness on climate change impacts and adaptation/coping strategies. The methodology involved randomly selected 420 people mostly farmers and fishermen who were interviewed and involved in focus groups. It was observed that communities were aware of the changes in climatic parameters consequently impacting their livelihood. The most significant impacts were scarcity of water and poor crop production which received 100% support of the respondents. Other impacts included the change of water quality of the Lake Victoria (94.5%) and loss of biodiversity (35.7%). On the non-climatic factors, the major concern was on population growth (98.3%), loss of soil fertility (96%) and deforestation (84.8%). Of the suggested adaption options, provision of alternative food crops and fertility improvement to increase production were highly supported with highest total score of 48 on an arbitrary total assessment scale of maximum of 50. This was also observed on fish farming activities. The observations highlighted gender-based labour division imbalance where women and children were shown to shoulder the burden. It can be concluded that communities in the Lake Victoria region are affected by multiple impacts related to climate and also those not related to climate. Under various impacts communities set their own coping and adaptation strategies based on importance to livelihood. However, there is a need for proper guidance on how adaptation strategies are being executed.*

**Key words:** *Climate change, Adaptation strategies, Livelihood, Lake Victoria communities*

## Introduction

Adaptation and coping methods have been embraced by different communities for lessening impacts of climate change. This is based on different communities' need for survival, economically or socially, and because climate change impacts act against human survival strategies, adaption strategies are necessary for communities' resilience. At community level, the success of adaptation strategies are always based on lessened climate impacts to communities. Since climate change is impacting on

basic society's needs, it is now the most recognised global challenge for both sustainable livelihood and economic development (Desanker and Magadza, 2001; Beg *et al.,* 2002; Adger *et al.,* 2003; Byg and Salick 2009; Ahmed *et al.,* 2009; Turner and Clifton 2009; Tibesigwa *et al.,* 2016). Depending on the nature and characteristics of the society, there are different valuations of the impacts of climate and therefore different adaptation priorities and approaches (Tibesigwa *et al.,* 2016).

The capacity of a given community to adapt is dependent on complex interaction of factors such as level of awareness, availability of infrastructures, etc. However, it is known that adaptation or coping strategies may result to positive or negative consequences (Niemeyer *et al.,* 2005) since they are commonly resulting from uncontrolled consequences of the climate change impacts on communities. Therefore, the knowledge on adaptation/coping strategies is necessary for a country to manage risks associated with climate change (Niemeyer *et al.,* 2005; Ford *et al.,* 2011). Since climate change impacts have been more pronounced in developing countries due to less adaptive capacity, it is important to have correct information for correct adaptation or coping strategies. Unfortunately, most developing countries have less information in relation to levels of climate change impacts and hence the vulnerability of many systems is not known.

In Tanzania, climate change and its impacts have been officially documented and communicated to the public (URT 2003). Information on adaptation/coping strategies to climate change in different localities in Tanzania remains weakly documented and analysed for proper establishment of the sources of the observed impacts. Meanwhile, there are other factors like population growth and resource scarcity which add to the generally observed impacts in developing world which have not been screened out due to the fact that, population increase in developing world, where major livelihood activities are dependent on natural resources has significant feedback impacts on the environment. All these (climatic, population and economic) impacts are rarely separated from one another.

The Lake Victoria region in Tanzania is similarly experiencing climate change impacts which are threatening communities' livelihood. The Lake Victoria Communities are witnessing changes of weather patterns and consequences due to such changes (Stager, 1998; Awange *et al.,* 2007; Tungaraza *et al.,* 2012). Such consequences include ecological and environmental changes which have shown adverse impacts on local communities' livelihoods such as loss or changes in biodiversity, loss of irrigation and portable water, emergence of new diseases, etc. (Verschuren *et al.,* 2002; Awange and Ong'ang'a 2006). Other changes include: changing rainfall patterns, increased temperature and prolonged drought (URT 2003; Awange *et al.,* 2008). It is factually observed that, the impacts of climate change to communities in the area are of different magnitudes depending on the location in the region and community's livelihood.

Like other communities in Tanzania and Africa in general, the Lake Victoria communities largely depend on natural resources for their livelihoods. Although

climate change has affected the Lake region, there have been limited analyses of the impacts of climate change on the communities. Little is known about sustainability of communities' coping strategies. Therefore this study aimed at assessing the communities' adaptation/coping strategies to climate change specifically to (i) ascertain the coping and/or adaptation strategies; (ii) evaluate the sustainability of adaption/coping options adopted as instantaneous response to climate change impacts and (iii) communities' preferences to suggested adaption options.

## Methodology

### *Study Area*

The study sample communities were three villages in the island of Ukerewe, at the middle of the Lake Victoria (Fig. 1). The Island is centrally located in the lake Victoria between latitude 1° 30' and 2° 20' S and longitude 32° 30' and 33° 30' E) in Mwanza region, Tanzania. The three villages involved in this study were Hamkoko, Busiri and Muhula with populations of 5,286, 3,349 and 4,026, respectively (Ukerewe District Council 2012). Administratively, Ukerewe is a district with an estimated human population of about 345,147 in an estimated area of 640 $km^2$ of land, which makes it one of the most densely populated districts in the country (NBS and Office of Chief Stastitian Zanzibar 2013).

The district has bimodal rain pattern with an annual total average rainfall ranging between 900 mm and 1200 mm distributed in two seasons namely, short rainfall season (October/November – January) and heavy rainfall season (March – May). The average temperature trend for daytime is between 21°C and 28°C. Humidity is low with a minimum of 35% during the end of the dry season and maximum of 60% at the end of the wet season.

The major economic activities are Agriculture, fishing and livestock keeping. Recently (in 2000s), fishing activity became a major economic activity for communities along the lake shore with Nile perch dominating fish export trade (Ukerewe District Council 2012). According to Ukerewe District Council report (2007), the gross domestic product (GDP) for Ukerewe district is estimated to be 130,000 Tanzanian shillings (ca US$ 100) per capita.

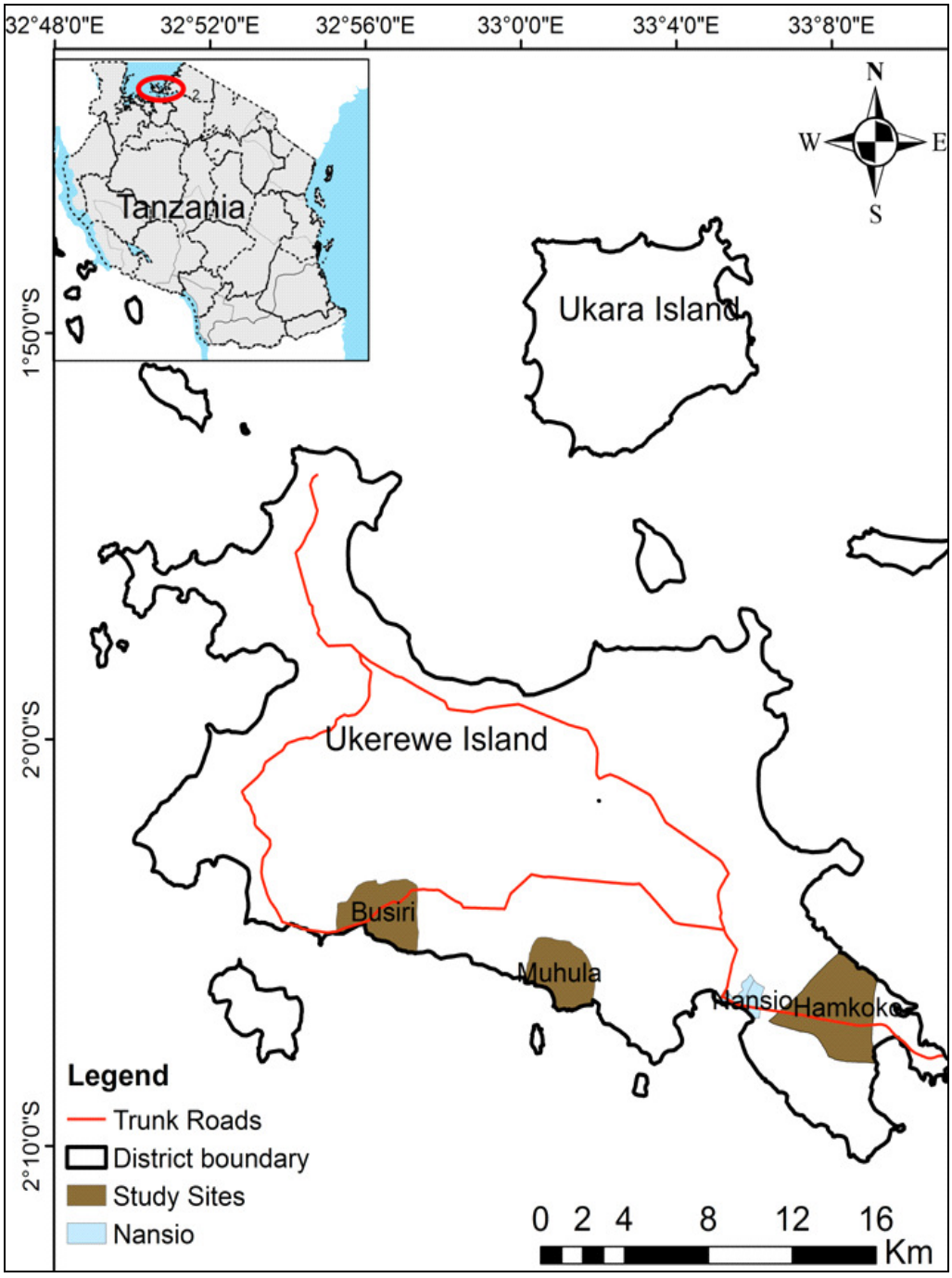


Fig. 1: Ukerewe Island in the Lake Victoria showing three study communities: Hamkoko, Muhula and Busiri villages.

***Data Gathering***

This study focused on community knowledge and experiences on the climate of the island, experienced changes, impacts and coping strategies. Data collection included information on household surveys and participatory rural appraisals (PRAs). In the household

survey a total of 420 (140 per village) respondents mainly heads of the household were interviewed collecting information on demographic characteristics; socioeconomic status, crop and livestock management, food consumption patterns and expenditures, coping responses to climate shocks, perceptions of climate change, adaptation options undertaken, and constraints to adaptation. Several PRA sessions were conducted with villagers mainly by focus group discussions over a period of eighteen months, where narrative stories from individuals were documented by video and text recording. Gathered information on the impacts of climate was authenticated by physical evidence, discussions among members and information from government offices. Documented information included:

- Listing of incidences to support existence of climate change in the area.
- Narrative documentation from communities' understanding of the impacts of climate changes on communities' livelihood
- Long-term baseline reference for climate change evidence explored in relation to different age groups.
- Adaptation strategies and prioritization for their livelihood i.e. climate impact considered to have highest impacts to individuals

Climatic and non-climatic impacts to communities' livelihood were identified from a list of impacts whereas the prioritization of adaptation strategies was done by ranking individual's preferences from a list where sustainable coping and adaptation strategies were isolated from various adopted activities. The evaluated for adaption preference among community members. Ten (10) randomly selected community members were asked to assess similar strategies by scoring along an arbitrary selected scale of 1–5 to indicate how they perceive the suitability/acceptance of the suggested strategies (dimensions). The average and corresponding variance was calculated for each of the strategy in order to establish closeness or agreement among the scored values.

***Gender Consideration***

A special consideration was to evaluate gender-related climate impact. This was done by identifying major activities which are mostly affecting women and children within communities. Two major identified activities were water and fuel wood access. A tallying system was employed for identifying the extent of the need in relation to family sizes. Family level use of both wood and water were estimated by interview and physical verification methods for a period of 16 hours (0600 hrs – 2200 hrs) per family visit where the total use of water and wood for cooking were documented per family together with respective family size. The family size per household was arbitrarily composed with no age classification.

## Results and Discussion

***Peoples' Knowledge on Climate Change***

The results show that majority of respondents (93%) indicated that, the area used to experience much more rainfall frequencies than it is today. This historical account was supported by especially aged people of over 70 years old during group discussion sessions. It was indicated that, in the past the rain season covered months of March, April,

May, July, September, November and December whereas the Island experienced periods of dry weather in January, February, June, August and October. All three communities reported changes in rain patterns associated with decreased number of rain days but with frequent occurrence of high downpours. This is in line with rainfall data reported by (Tanzania Meteorological Agency) TMA for the Lake Victoria region (URT 2003; Lyimo and Kangalawe 2010; Tungaraza *et al.,* 2012).

Very few (17%) respondents indicated existence of climate change by an increase in average temperature, an obvious report, since from communities' perspective, it is difficult to associate climate change in reference to temperature at this tropical climate, where one cannot notice temperature changes over time to substantiate the occurrence of permanent temperature changes. Nevertheless, the association of climate change with rising in average temperature have been reported elsewhere (Lyimo and Kangalawe 2010; Bryan *et al.,* 2013; Medugu *et al.,* 2014).

***Impacts of the Climate Change***

It was observed that communities indicated knowledge of existing climate change impacts in the area although some listed impacts were not related to climate effects. The eventual analyses of both climatic and non-climatic impacts to communities appear in Table 1 and 2 respectively. Scarcity of water and poor crop production were ranked by 100% of respondents as the main problem facing the communities (Table 1). Similar findings has been reported elsewhere (Medugu *et al.,* 2014). The change of water quality of the Lake Victoria also ranked high with a support of 94.5% of respondents indicating it to be part of climate-influenced effect. The lowest support was on the impacts of climate on the diverse fish species availability in the Lake Victoria, where only 35.7% supported it to be influenced by climate change. The lake water quality has been affected similarly as showed by the recession of the lake water level. This has been partly ascribed to poor rainfall in the region (Nicholson 2000; Nicholson and Yin 2001). However, the supporting number fell due to the fact that some village communities (Hamkoko and Muhula) were not entirely dependent on the lake as a source of portable water. The low evidence of climate influence on the Lake Victoria biodiversity can be clarified by the fact that fishing is the most popular activity providing daily needed food. Among communities, there have been documented evidences of increasing fishing pressure and increased predation by non-native fish species like the nile perch (Ogutu-Ohwayo 1990; Witte *et al.,* 1992) thus, excludes climate as the major cause of decreasing fish species. However, based on previous observations, it has been reported elsewhere (Kaufman *et al.* 1996; Ficke *et al.,* 2007) that climate change significantly affects Lake Victoria ecosystems. The necessary analysis is to exclude the influences of human activities from climate related impacts, which was not undertaken in this study.

Table 1: Various climate impacts documented by interviewed community members

| Climate Impacts | No. of positive responses | % of supporting respondents |
|---|---|---|
| Changes of spatial and temporal distribution of rainfall | 356 | 84.8 |
| Scarcity of portable water | 420 | 100.0 |
| Disappearances of some fish species | 200 | 47.6 |
| Changes of Lake Victoria water quality | 397 | 94.5 |
| Poor crop production | 420 | 100.0 |
| General loss of biodiversity indicated by the disappearance of some organisms | 150 | 35.7 |

Total respondents = 420

Table 2: Non-climatic factors impacting communities in the region

| Documented impacts | No. of positive responses | % of supporting respondents |
|---|---|---|
| Population growth | 413 | 98.3 |
| Deforestation | 212 | 50.5 |
| Loss of soil fertility | 407 | 96.9 |
| Pollution problem (eutrophication) | 356 | 84.8 |
| Over fishing | 411 | 97.9 |

Total respondents = 420

Generally, all non-climatic factors were supported by more than 50% of all respondents (Table 2). This implied that non-climatic factors featured to have significant impacts among community members. This scenario can be explained by the fact that, some non-climatic factors may be classified being secondary effects of climatic factors. Incidences of community members shifting from agriculture to charcoal making were verbally reported. In fact, charcoal making has increasingly become a way for fast income generation than agriculture. With increasing such deforestation, there are likely consequences on soil fertility. Fishing has gained popularity and attracted large population in the region due to its resistance to climate change effect. The need for engagement in fishing activities has encouraged illegal fishing methods, which have consequently accelerated overfishing.

***Adaptation Strategies to Climate Change Impacts***

Diverse adaption strategies against climatic and non-climatic impacts on livelihood were suggested by communities as summarised in Table 3 A and B, where each of the impacting factors are listed against suggested adaptation strategies. As observed, some strategies were suggested at multiple climatic impacts. Irrigation schemes were suggested to be an ideal adaptive strategy against poor spatial and temporal rainfall, which was suggested as an adaptive remedy for crop production decline. This is because the strategy addresses an underlying support for agriculture which is a necessary activity for every family's livelihood. This need for a single strategy over multiple indicative impacts was also

observed on the lack of energy source (wood) of a non-climatic factor and declining forest cover of the climatic factors where the introduction of biogas digesters was a suggested strategy similar to the need for alternative energy as suggested when considering non-climatic factors. The two basically, expressed the difficulties to accessing energy sources. The Loss of biodiversity of the climatic factors and Population growth of the non-climatic factors were also suggested to have similar strategies, related to human population control as the major factor driving the two indicative impacts. Obviously, human activities of various types are the major contributors to ecological destruction affecting biodiversity. It is therefore correct for the communities to consider population increase to be a cause of biodiversity problem.

Table 3: Suggested coping and adaptation strategies against climatic and non-climatic impacts illustrated by indicative impacts

A. Climatic Impacts

| Indicative impact | Suggested strategies |
|---|---|
| Spatial and temporal distribution of rainfall | Irrigation schemes |
| Scarcity of portable water | Boreholes |
| Disappearances of some fish species | Fish farming |
| Periodical changes of the Lake Victoria water level and its quality | Boreholes |
| Crop decline and emerging crop diseases and pests | Irrigation schemes |
| Declining forest cover | Biogas |
| Loss of biodiversity | Population control |

B. Non-climatic Impact

| Indicative impact | Suggested strategies |
|---|---|
| Population increase | Education, relocation |
| Lack of energy source (wood) | Tree planting, alternative energy source |
| Loss of soil fertility | Alternative food crops, fertilization |
| Pollution problem (eutrophication) | Boreholes |
| Over fishing | Controlled fishing, fish farming |

From the rearranged suggested strategies by communities (climatic and non-climatic), preferential assessment for adaptation strategies are shown in Tables 4. The total scores indicated that alternative food crops and fertility improvement were highly supported with highest total score (48) support among community members. This was also observed on Fish farming activity with similar total score of 48. Close to these two were irrigation schemes, scoring a total of 47 points and boreholes for water sources with a score of 41 points. Other scores include tree planting for energy source (36), Education and population relocation (30), controlled fishing (30), Introduction of biogas technology (18) and population control (17). The consistence of the given scores was measured using calculated variance values for each of the assessed dimension. The values indicated that preference for alternative food crops and

soil fertility improvement had the lowest (0.18) variance followed by irrigation schemes which had the variance of 0.23. The introduction of fish farming variance was 0.4 whereas provision of boreholes for water sources had a variance of 0.5. The highest variance was on controlled fishing activities (2.67) and community education and relocation of the population.

The variance values inform that, adaptation strategies of the communities should focus on techniques that will increase food provision. This is addressed by the high support scores and consistence of responses as shown by the lowest variance value on the support to having alternative food crops and ways of improving soil fertility. In other words, availability of food is the major problem recognized by the communities such that food providing activities are fundamental of the livelihood. This is also the case for communities' acceptance of irrigation schemes and fish farming techniques. It is alternatively noted that communities highly disfavoured strategies like population control and introduction of biogas. The concept of controlled fishing activities was of high variance due to communities' perception, where the scientific reasons underlying the control is not understood among communities. Control measures over fishing activities are considered interfering with communities' daily activities of fishing. The fact is that, the Lake Victoria region fishing practices has changed with communities opting to coping strategies which are sometimes unacceptable, unsustainable and detrimental to the lake ecology. These include poison fishing and unauthorised fishing gears, which on the long run will destroy the lake fishery. Population control measures were disfavoured, very likely due to cultural norms where family size is linked to social security. Opting to biogas for energy source is not a new idea. The idea has been existing (but well-known for high unaffordable costs among communities (Kileo and Akyoo 2014; Shane *et al.,* 2015). Whenever this idea is introduced there is a reflection of installation costs.

Table 4: Preferential suggestions on adaptation strategies scored by randomly selected community members

| | **Scores** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tested option measure** | i | ii | iii | iv | v | vi | vii | viii | ix | x | **Total** | **Average** | **Var** |
| Boreholes - water sources | 5 | 3 | 4 | 5 | 4 | 4 | 3 | 4 | 4 | 5 | **41** | **4.1** | **0.54** |
| Biogas | 1 | 1 | 4 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | **18** | **1.8** | **1.07** |
| Population control | 1 | 1 | 1 | 2 | 1 | 2 | 5 | 2 | 1 | 1 | **17** | **1.7** | **1.57** |
| Education, relocation | 3 | 1 | 3 | 5 | 2 | 1 | 4 | 2 | 5 | 4 | **30** | **3.0** | **2.22** |
| Tree planting for energy source | 4 | 3 | 5 | 3 | 3 | 4 | 4 | 5 | 2 | 3 | **36** | **3.6** | **0.93** |
| Alternative food crops, fertility improvement | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | **48** | **4.8** | **0.18** |
| Controlled fishing | 5 | 3 | 4 | 1 | 2 | 5 | 2 | 1 | 2 | 5 | **30** | **3.0** | **2.67** |
| Fish farming | 5 | 4 | 4 | 5 | 5 | 6 | 5 | 4 | 5 | 5 | **48** | **4.8** | **0.40** |
| Irrigation schemes | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 5 | 5 | **47** | **4.7** | **0.23** |

NOTE: i – x represent interviewee i – x

**Score key:**

| **1 – 1.99** | **2.0 – 2.99** | **3.0 – 3.99** | **4.0 – 4.99** | **5.0** |
|---|---|---|---|---|
| Not important | Less important | Somehow Important | Important | Highly important |

Water and wood were specifically investigated as two major (apart from food) family necessities within the communities in which women and children are daily involved in, so as to meeting family requirements. Fig. 2 shows estimated daily requirements of wood (A) and water (B) for different family sizes. The indication is that as the family size increases, so is the requirement for wood per family. Large numbers of surveyed families were at an average size of 4 and 6 persons per family. The highest wood consumption for families of 4 was 7 kg per day and the minimum was 4 kg per day. The wood consumption for families of 6 increased to 9 kg per day but also a minimum of 5 kg per day was observed. Water usage showed almost similar requirements trend with variations, depending on family set-up. The maximum water requirements were observed at family size of 6 where about 100 litres/day was used. A minimum water requirement was observed at family size of 3 persons. The similarity of the trends was due to the fact that same families were visited for both wood and water requirements. These trends present an observation of the burden shouldered by children (especially girls) and women who are daily required to supply the required quantities for families. From these observations, as the family becomes larger, there is a general increase of wood and water requirements. Water requirements can be observed to have no systematic trend of variation differing from wood requirement because, with families constituting more adults than children, few will depend on family supply of water. Therefore, with family size of 6 only three groups of water requirements (80, 70 and 100

litres/day) are observed as opposed to wood requirements at family size of 6 where the requirements were at 5, 6, 7, 8 and 9 kg/day. Logically this implies that wood for family cooking is the most pressing requirement putting women and young girls at constant responsibility. The best adaptation activity for families will need to provide such consideration since the communities have gender-based division of labour.

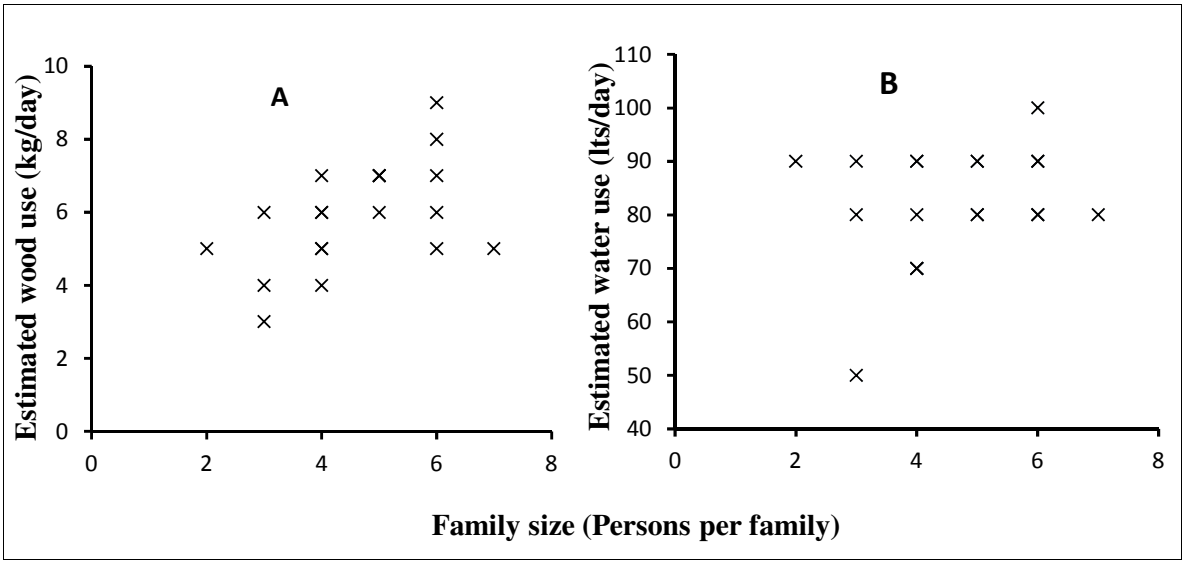


Fig. 2: Estimated wood consumption per family as source of energy (A) and water use per family (B)

The previous observed adaptation preferences of adaptation measures in Table 4 don't highlight the high need for wood fuel rather highlight needs for Alternative food crops, Fish farming, Irrigation schemes and borehole because of the fact that these measures directly affects the whole community. Those affecting women and children are not very much considered but, they are the most significant. This was also probably caused by the fact that children were not involved in the interview processes.

Undocumented options can also be seen in the region where due to wood shortage, coping strategies are now providing negative feedback where fruit trees like mango and orange are being used as sources of firewood. Although communities indicated understanding of the importance of such fruit trees, cutting of the trees has become inevitable because of lack of alternatives.

It is obviously observed that communities in the region are affected by multiple impacts related to climate and also those not related to climate. This study indicates that communities set their own coping and adaptation strategies based on the importance of the affected system or livelihood within their communities. Such adaptation strategies include shifting from agriculture to climate resistant activities like charcoal making and fishing, regardless of new environmental problems emerging from such shift. This implies that some coping strategies are not sustainable and have

been exacerbating environmental deterioration. It also includes activities like wrong or illegal fishing methods and fishing gears which have been accelerating the destruction of the Lake Victoria ecology. Safe adaptation or coping strategies options have been unsuccessful due to unaffordable cost involved. This has been observed on the introduction of biogas systems which was reported to be limited by huge initial costs and need for expertise.

## Conclusion and Recommendation

This study shows that Ukerewe communities perceive climate to be changing and are particularly concerned with changes in rainfall patterns. It was observed that such climatic changes are impacting their livelihood. The most significant impacts were scarcity of domestic and irrigation water, poor crop production, changes of water quality of the Lake Victoria and loss of biodiversity. In addition, climate change was reported to be exacerbating impacts caused by other factors such as population growth (98.3%), loss of soil fertility (96%) and deforestation (84.8%). It was further observed that, communities are taking measures to protect against impacts associated with the perceived climate change. Of the suggested adaption options, provision of alternative food crops, fish farming and fertility improvement to increase production were highly supported. However, many households face some challenges in adapting to climate change including lack of capital, limited land available and poor access to extension services. Nevertheless, there is a need for proper guidance on how adaptation strategies are being executed. The observations highlighted gender-based labour division imbalance where women and children have shown to shoulder large share of climate impacts burden.

This assessment has indicated that women and children are the two groups most affected by climate impacts since, in a search for survival strategy, adaptation and coping options involves more labour from these two groups. Therefore, successful adaptation strategies need to consider options aiming at women and children who are heavily shouldering the burden. In these communities, it is on access to food, water and wood fuel, preferentially.

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