

# **IMPACTS OF LARGESCALE HYDROPOWER DEVELOPMENT ON THE WATER LEVEL OF LAKE TURKANA AND COMMUNITY LIVELIHOODS**

## **ABSTRACT**

The most profound effects of climate change are felt by the most vulnerable groups, including over 300,000 people that directly depend on Lake Turkana for their livelihoods. In Turkana County, such impacts have been experienced in the last few years, leading to a humanitarian crisis in the area due to shorter rain periods and prolonged dry spells. Lake Turkana, the largest desert lake in the world, the northern-most lake in Kenya's Rift Valley and a World Heritage Site, is often seen as a cushion against such adverse climate phenomena, at least to the residents living adjacent to it. However, the cushioning effect of the lake to the local communities is increasingly becoming compromised. The development of an 1870MW hydropower dam across the Omo River and associated irrigation scheme by the Ethiopian government, the main source of the lake's water, threatens the lake's existence entirely. Recent studies predict up to a 20-metre decrease in water levels (the lake's normal level is 30m), and over 50% reduction of water surface coverage if the planned irrigation schemes are fully implemented. While there is no doubt that climate change coupled with existing political, environmental and economic development challenges in Turkana will have profound effects on the ability of the people to access food, water, health and security, the combined impacts of climate change and loss of the lake have not been determined. In order to shape future policy and political direction that is crucial in averting an impending environmental catastrophe, there is an urgent need to understand the socio-economic impacts of the predicted loss of the lake amongst the local people in the face of climate change. This study aims at evaluating the livelihood risk associated with

the planned development of power infrastructure across Omo River and climate change on the communities directly depending on it. Specifically, the study will (a) establish the current levels of dependence on the lake for food, water, livestock pasture and other basic products and services; (b) determine if alternative sources of livelihoods exist if the lake was to reduce drastically; and (c) Determine the level of awareness on developments affecting the Lake ecosystem. Structured questionnaires, interviews and focussed group discussions will be used in the survey. Results of this study will provide the much needed link between human needs, environmental integrity and policy needs in order to safeguard not only the future of Turkana people but also the lake's ecological integrity.

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## **CHAPTER ONE**

### **1.1 Background Information**

Sustainability of Lakes has become an issue of concern in today’s environment. Threats such as pollution and unsustainable developments affecting the lakes are some of the major threats.

Already, Lake Chad, once the sixth largest lake and the great Aral Sea have fallen victims of

shrinking due to uncontrolled withdrawals for economic purposes such as irrigation. In Kenya, Lake Turkana is treading towards the same direction. Lake Turkana is currently the world's biggest permanent desert lake (Kolding, 1993). Many tribes in this arid region depend the lake's fisheries to compliment their traditional pastoral livelihood (Kaijage and Nyaga, 2009). The lake is also regarded as an area of high conservation importance, supporting over 350 native and migratory bird species and the world's largest remaining population of the Nile crocodile (Bennun and Njoroge, 1999). Because of its high faunal diversity and the area's paleoanthropological importance, two of the lake's islands and Sibiloi National Park on the Eastern Shores have inscribed as UNESCO World Heritage Site (UNESCO, 2016). The lake's ecological function is currently threatened by multiple economic activities across its hinterland. One of the biggest threat to the lake is the development of hydroelectric power generation (the Gibe Dams) and large-scale irrigation scheme along the Omo River, regarded as the Lake's umbilical cord. The Omo River supplies 90% of the lake's water. The Gibe III Dam, is one of the tallest dams in Africa (Allibhai, 2014), with Gibe IV already under construction. The Gibe dams will reduce Lake Turkana's water levels and affect the lake's flood cycle, which will likely impact the timing and success of fish breeding and migration (Avery, 2012). By April 2014, over 6,400 hectares of land had been cleared for sugarcane and cotton plantations in the lower Omo Valley. These irrigation schemes have been projected to consume substantial amounts of the Omo River's flow and could lead to reduction of the lake level of averagely 30 meters (Avery, 2012). These changes in flow regime are expected to impact fish communities, through eliminating spawning and nursery areas in the watershed and altering food web dynamics through changes in species composition and basic limnological function (Bigler et al, 2002). In addition to dam impacts, changing climate conditions have been speculated to also have a certain

degree of impact on the lake ecosystem (Velpuri and Senay, 2012), with precipitation predicted to decrease due to changing climate. The effects of changing flow regime due to dam development and climate change may have a compounding impact of the fisheries of the lake. As a result, fish resources will become increasingly less abundance. Because of the community's over-reliance on fish, the impacts to their livelihood is unknown.

## **1.2 Statement of the problem**

In decades, there has been no paradigm shift in the effects of large hydro and have in fact been agents of abuse to human rights, the environment and an unnecessary costs economically. A recent letter by the 272 undersigned organizations concerning the Green Climate Fund and large hydropower in March 27<sup>th</sup>, 2017 claims that with the current climate change situations, it is difficult to maintain the river and lake flows eventually drying them and losing the generation capacity of the dams, regardless of the enormous amounts of capital invested in such projects. Lake Turkana is the largest permanent desert lake in the world. It lies in a low, closed basin in northwestern Kenya and southwestern Ethiopia. As a closed lake, the influx from rivers and evaporation from the lake's surface determine water-level fluctuations. Of the three rivers that contribute to Lake Turkana—Omo, Turkwel and Kerio—the Omo River, which flows from the Ethiopian highlands, contributes more than 80 per cent of the lake inflows (Ricketts and Johnson, 1996). Approximately 300,000 people depend on this Lake for survival. With the series of dams being built along the Omo River in Ethiopia, the levels of water in the Lake have been predicted to decline over time, especially due to escalated impacts of climate change.

Ethiopia continues to be the mastermind behind large hydropower dams in Africa, and is as well constructing the Grand Renaissance Dam set to be the tallest dam in Africa. This continues to oppress the citizens of the affected countries in terms of accessibility to these water sources.

The Omo- Gibe Integrated River Basin Development Master Plan forecast that by the year 2024, 32% of the Omo inflow to the lake would instead be utilised to meet water demands (Woodrooffe et al, 1996) The African Development Bank studies showed that this high level of abstraction would lead to a significant and permanent drop in lake level (Avery, 2009; & Avery, 2010), with significant impact on the Lake Turkana fisheries.

Ethiopia generates 99% of its electricity from hydropower (Davis et al. 2013). Such hydropower dependency is risky in the face of an increasingly volatile climate, especially given the projections of decreased rainfall and higher frequency of droughts in East Africa (Williams and Funk 2011). The predicted increase in hydropower variability increases the vulnerability of the national energy system.

The emerging concern is that major developments are commencing without prior environmental & social impact assessment (ESIA), and without engagement with key stakeholders, including people in Kenya (Avery, 2012). This raises a great concern in regard to public participation in decision making particularly in matters pertaining environment and conservation.

Building of this dams also projects issues regarding accessibility of land whereby the people around the Omo River Banks will no longer be free to cultivate and collect water.

Failure to involve the affected communities in decisions regarding the developments along this Lake has a great impact on the level of preparedness in case of decrease water level in Lake Turkana as well as a violation to the right of public participation.

### **1.3 Significance of the Study**

Lake Turkana provides the communities around with ecosystem services that promote their wellbeing. The study was therefore important in helping us understand what is at stake and provide alternative livelihood sources if the worst-case scenario occurs. If the predicted shrinking of the Lake happens, there will be violation of the sustainable development goals and this will act as a hindrance in achieving some of these key goals such as SDG 7 which promotes life below water by conserving water bodies for sustainable development, SDG 10 reduced inequalities by ensuring the voices of the communities in the marginalized Turkana region are heard and SDG 1 and 2 respectively; zero hunger and poverty both in Turkana and along the Omo River in Ethiopia by providing alternatives that will ensure the unsustainable development through building the hydropower dams and the irrigation systems is done in a manner that respects the communities that survive and feed off the Lake.

The study aimed at coming up with recommendations and strategies to favour both the needs of both the people of Kenya and Ethiopia, without compromising the future existence of Lake Turkana, and advise on ensuring the rights of the affected are respected in terms of consultation in decision making and showcase what is at stake if the Lake is lost, and advise the concerned on preventing another catastrophic repeat of the Aral Sea and Lake Chad predicament.

### **1.4 Scope of the study**

Due to accessibility, the study was limited to villages around Kalokol, the main fish center around Lake Turkana. Funding and field logistics only allowed for a ten-day data collection period. The main variables focused on in the study based on the objectives were sources of



income, other alternatives apart from the Lake, actions if the lake was to reduce its water levels, what services the communities receive from the lake and what developments they know of.

## **1.5 Objectives of the study**

### **1.5.1 General Objective**

The principle objective of this project was to understand the impacts of the construction of the Gibe dams to the surrounding communities via an integrative study of people's livelihoods, levels of dependence on the lake and opportunity costs of the construction of the dams in Kenya's Turkana County. We focused on addressing three inter-related questions each with their own subset of hypotheses:

### **1.5.2 Specific Objectives**

The specific objectives of the study are:

1. To evaluate the level of community dependence on the lake for food, water and other basic products
2. To evaluate existing livelihood alternatives of the people around Lake Turkana if the Lake was to reduce its water levels drastically.
3. To determine the level of awareness on developments affecting the Lake

## **1.6 Research Hypotheses**

1.  $H_{01}$ : The communities residing around Lake Turkana depend entirely on Lake Turkana for basic provisions.
2.  $H_{02}$ : Communities residing around Lake Turkana have limited livelihood alternatives offered by prevailing climatic conditions.
3.  $H_{03}$ : The level of awareness on developments affecting the Lake is low

## CHAPTER TWO

### 2 Literature Review

#### 2.1 Dependence on the lake

Approximately 200,000 people rely on Omo River (Avery, 2012) below the dam for different forms of subsistence to sustain their livelihoods including flood recession agriculture, but still many of these ethnic groups live in chronic hunger. Same time, most critics state that the Gibe III dam may worsen their situation since it will lead to decrease in water levels where most indigenous people rely on recessional cultivation of food along the riverbanks, as well as livestock herding, for survival. These constructions, Gibe III dam, and the associated decrease in water levels and seasonality of flows in the Omo River threaten the continuation of the only two options for survival in this arid environment (livestock herding and irrigation), therefore leaving behind no other alternatives for survival (Velpuri et al, 2012). The people adjacent and living in close proximity with the project area are part of the Southern Nations of Ethiopia, a highly diverse group of people. Eight distinct Ethnic groups, indigenous communities, remain affected by the dam and might face severe impacts if the constructions continue: they include; the Mursi, Bodi (Mekan), Muguji (Kwegu), Kara (Karo), Hamer, Bashada, Nyangatom and Daasanach. The magnitude of the impact that the dam and possible irrigation projects induced by the dam will have on the water level of Lake Turkana is controversial (Velpuri et al, 2012). Surveys conducted around the lake including a hydrological study conducted for the African Development Bank in November 2010 concluded that the filling of the dam will reduce the lake's water level by two metres, if no irrigation will be undertaken. Irrigation would cause a further

drop in the lake level. Friends of Lake Turkana, a Kenyan organization representing indigenous groups in northwestern Kenya whose livelihoods are linked to Lake Turkana, had previously estimated that the dam could reduce the level of Lake Turkana by up to 10 meter affecting up to 300,000 people. This could cause the brackish water to increase in salinity to where it may no longer be drinkable by the indigenous groups around the lake (Kolding, 1993). Currently, the salinity of the water is about 2332 mg/L, and it is estimated that a 10-meter decrease in the water level of Lake Turkana could cause the salinity to rise to 3397 mg/L. This creates a big risk where the raising salinity could also drastically reduce the number of fish in the lake, which the people around Lake Turkana depend on for sustenance and their livelihoods (Yongo et al, 2010). According to critics, this "will condemn the lake to a not-so-slow death. Most indigenous communities around lake Turkana depend on the lake for their food crops, livestock grazing and watering, and fishing and being so, any impacts to the lake's ecosystem would disrupt the economy, leading to an increase in conflicts in the area. Considering the unstable state of peace in Northern Kenya, such damage to the local economies would invoke a threat to regional stability (International Rivers).

## **2.2 Livelihoods around Lake Turkana**

Lake Turkana is the world's largest permanent desert lake and the world's largest alkaline lake and by volume, it is the world's fourth-largest salt lake. The Lake Turkana basin covers over 130,000 square kilometres, which is shared in near equal proportions between Kenya and Ethiopia, but also encroaching into South Sudan near the Ilemi triangle, and extending into Uganda in the west near Mount Elgon (Avery, 2014). The Kenyan population around Lake Turkana is huge where approximately one million people live in the former Turkana, Samburu and Marsabit Districts that border Lake Turkana, areas which have long been neglected and have

received little Government investment overtime (Oba, 1992). The area is insecure, with constant livestock rustling, and the people are amongst the nation's poorest (Oba, 1992). These surrounding communities depended on pastoralism which is a livelihood extremely well suited to these arid lands but all this has been undermined by rising population challenges, insecurity, land fragmentation, restrictions in mobility, and absence of adequate governmental support for the livestock marketing (Oba, 1992). Alternative livelihoods have developed, including crop production and fishing, but to a limited extent (Marshall, 1990). In some places today, up to 75 % of the food input is external food aid. 12 In the 40 years since 1969, the population of Turkana District increased four-fold (Ogutu-Ohwayo, 1997). By the year 2050, the national population will be treble the 2010 population. Numerous tribes depend increasingly upon the lake's fishery due to the unsustainable nature of their traditional livelihood of pastoralism in this arid region

### **2.3 Awareness Level**

Meaningful public consultations are a critical component of major public development projects where for project-affected people, the consultation process is often their single opportunity to interact with project authorities and bring their concerns and needs to the negotiating table. Too often, consultation processes use a one-way flow of information – from the project authorities to the people – and the information is often decorated with verbal promises but scant on discussion of potential risks. A meaningful consultation process will include mechanisms to ensure that participation of affected peoples results in sufficient information sharing, mitigation of their risks and compensation for their losses. Such a process should allow for regular sharing of information, and ensure that information is distributed and concerns are collected in a manner

that reaches a critical quorum of affected people. Processes should not be unduly rushed by the project's schedule, but allow sufficient time for affected communities to understand, react and consult with outside experts if needed (International Rivers, 2009). The communities around Turkana are marginalized and are often denied the right of public participation. Public participation in deliberations which lead to important project planning and development decisions is characteristic of the hydropower planning system in many countries (Gilpin 1995). River basin developmental activities such as construction of dams/reservoirs, irrigation development, regulation of river flows, or land cover change often result in either a positive or negative impact on the hydrology of the river basin. Such activities require impact assessment to be performed before the developmental plans are commenced. However, most of the basins in developing countries, where basin developmental activities are currently being carried out, are ungauged (Sivapalan, 2003).

## **CHAPTER THREE**

### **3 METHODOLOGY**

#### **3.1 Study Area**

##### **3.1.1 Location, Geography and Socio-economic status**

Lake Turkana straddles the two biggest counties (area) in Kenya: Turkana County to the West and Marsabit County to the East. The lake is approximately 60km from Lodwar, the County Headquarters of Turkana, and 70km to Marsabit, the County headquarters of Marsabit County (Owen, 1982). A small portion of the lake's northernmost tip is in Ethiopia. The lake lies between latitudes 3° 41.028' South and 3° 39.564' South and longitudes 35° 49.342' east and 36° 41.097' east. It has a maximum length of 290 km and a maximum width of 32 km. Its surface area is 6,405 km<sup>2</sup>, while the average depth is 30.2 m. The deepest part of the lake is 109m. The lake has three islands: North, Central and South, two of which gazetted National Parks and World Heritage Sites (Borona, 2014). On the eastern shores is Sibiloi National Park, another world heritage site. Several small towns are found around the shores of the lake including Loyangalani, Kalokol, Eliye Springs, Ileret and Fort Banya.

### **3.1.2 The people**

Six Major ethnic groups live adjacent to the eastern side of Lake Turkana. These are the Daasanch, Gabbra, Turkana, El molo, Rendille and the Samburu (Macpherson, 1984). The Daasanach are traditionally a pastoral people but in recent years they have turned into agropastoralism and fishing. Gabbra is the major tribe located at North Horr. Other minor tribes include Turkana, Boran, Wata, Somalis. The Gabbra live in the Chalbi desert of northern Kenya, between Lake Turkana and Moyale and Marsabit, extending into the Bula Dera plain east of the Moyale-Marsabit road, and the Mega escarpment in southern Ethiopia. They share portions of this area with the Boran, Rendille, Samburu, Daasanach and Turkana (Macpherson, 1984). The Gabbra are primarily pastoralists. The Gabbra culture is entwined with their care of camels. A mixture of tribes is found at Loiyangalani namely, the Rendille, Samburu, Turkana. The Rendille are ethnic group inhabiting the Kaisut Desert of Kenya. They are nomadic pastoralists. The Samburu are semi-nomadic pastoralists whose lives revolve around their cows, sheep, goats, and camels (Kaijage, 2009). The main ethnic group at Elmolo Bay are the Elmolo tribe with around 800 people only from this tribe. The tiny population's main livelihood is fishing from Lake Turkana and face the hugest threat of extinction once the Lake deteriorates. The main study group in this study is the Turkana around Kalokol and its surrounding. This tribe mainly does fishing and pastoralism. Other communities that have settled around Turkana to venture into various businesses such as boat making include the Luo, Kikuyu, Kisii and Luhya.



### **3.1.3 Natural Resources**

#### **3.1.3.1 Wildlife**

The lake is renowned for supporting a large population of the Nile crocodile *Crocodylus niloticus* and water turtles. Large mammals that range along the shores include the endangered Grevy's zebra *Equus grevyi*, Burchell's zebra *Equus quagga burchellii*, the Beisa Oryx *Oryx beisa*, Grant's Gazelle *Nanger granti*, the Topi *Damaliscus lunatus jimela* and the Reticulated Giraffe *Giraffa camelopardalis reticulata*. Carnivores include the African Lion *Panthera leo* and Cheetah *Acynonyx jubatus*. The cushioned gerbil *Gerbillus pulvinatus* is also reported. The lake is recognized as an Important Bird Area (Bennun and Njoroge, 1999), and hosts regionally threatened species such as African skimmer *Rhyncops flavirostris*. Other birds include white-breasted cormorant *Phalacrocorax lucidus* and Heuglin's bustard *Neotis heuglinii* found to the east of the lake region.

#### **3.1.3.2 Fisheries**

The lake holds about 50 fish species, including 11 endemics, such as the cichlids *Haplochromis macconneli*, *H. rudolfianus* and *H. turkanae*, the barb *Barbus turkanae*, the robber tetras *Brycinus ferox* and *B. minutus*, the Rudolf lates *Lates longispinis*, and the cyprinid *Neobola stellae* (Abel et al, 2008). Non-endemic species include Nile tilapia, bichirs, the elephant fish *Mormyrus kannume*, African arowana, African knifefish, *Distichodus niloticus*, the Nile perch amongst others (Wik et al, 2016).

### **3.1.4 Study Sites**

This study will be conducted in the communities surrounding lake Turkana, in the upper regions of Kenya. Lake Turkana happens to be the largest desert lake in the world and it is located The survey will be carried out in seven villages or camps in three wards in the area around Kalokol.

(villages in brackets): Turkana North- Lake Zone Ward, Kataboi location (Lokitoe Angaber); Turkana Central, Kalokol Ward, Kalokol location (Kalimapus, Kalokol, Natirae, Imprezza Beach, Daraja Beach); Kangatothe Ward (Longech). The sites are considered relevant to the interests of the study because of their proximity to the lake and the main economic activities are influenced by the lake.

### **3.2 Sampling Design**

Purposive sampling was used to determine the villages and camps to be sampled. We used existing roads and tracks as transects, households to randomly to administer questionnaires. A minimum of ten questionnaires was done in each village as this was the viable number of realistically possible number of households that could be sampled given the time and the number of researchers involved in the study.

### **3.3 Data Collection Methods**

#### **3.3.1 Semi Structures Questionnaires**

Semi structured questionnaires were used to obtain social-economic information from the households and the respond's interaction with the lake. Themes within the semi structured questionnaires were used to guide the whole exercise. They included sections on household characteristics (demographics), household resources, sources of income, and sources of food, lake conservation aspects, and awareness of threats facing the lake.

#### **3.3.2 General observation and photography**

This was used to profile people's behaviour and their interaction with the environment within the landscape. This method captured information deemed important which had earlier not been anticipated during the preparation stage. In addition, photography captured various coping

strategies used by the people when environmental conditions are tough, besides documenting people and resources that were mentioned during the questionnaire administration.

### **3.3.3 Focused group discussion**

Several Focussed Group Discussions were carried out as a means of verification on the information gathered from questionnaires. Focused Group Discussions were done opportunistically when we encountered a group of people who were willing to participate.

### **3.3.4 Secondary data**

Secondary data was sourced from publications, verbatim from personnel of Friends of Lake Turkana (FoLT) and Kenya Marine and Fisheries Research Institute (KMFRI) and other knowledgeable persons from the area. Information was sourced from various libraries, including National Museums of Kenya, Kenyatta University and personal libraries.

### **3.3.5 Data Analysis**

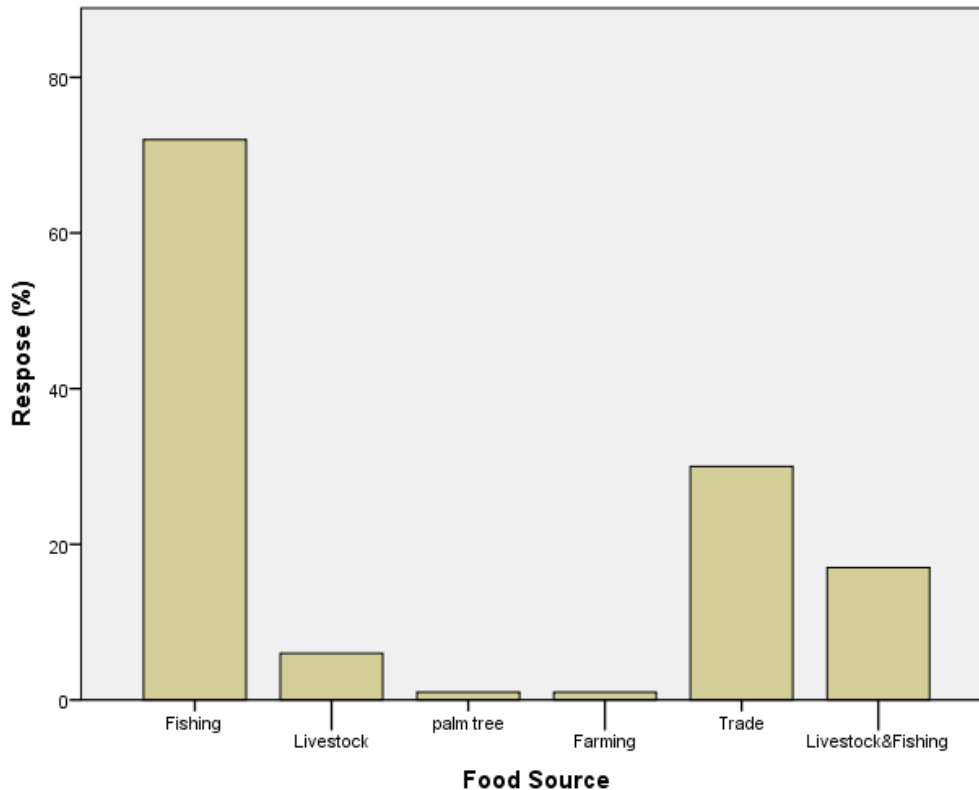
Averages, modes and percentages were computed from the quantitative data using Statistical Packages. For qualitative data, a series of steps is followed to analyse the general observations, comments and views of respondent. The first step was to identify the main themes, and involved a thorough analysis of the descriptive responses given by the respondents to each question which is done to understand the ‘meaning’ communicated. From these responses, broad themes that reflected the meaning were developed, which became the basis for analysing the text of the unstructured interviews. The second step involved classification of the responses under each theme, which is achieved through reviewing all the transcripts of the interviews while classifying the responses under the different themes.

## CHAPTER FOUR

### 4.0 RESULTS

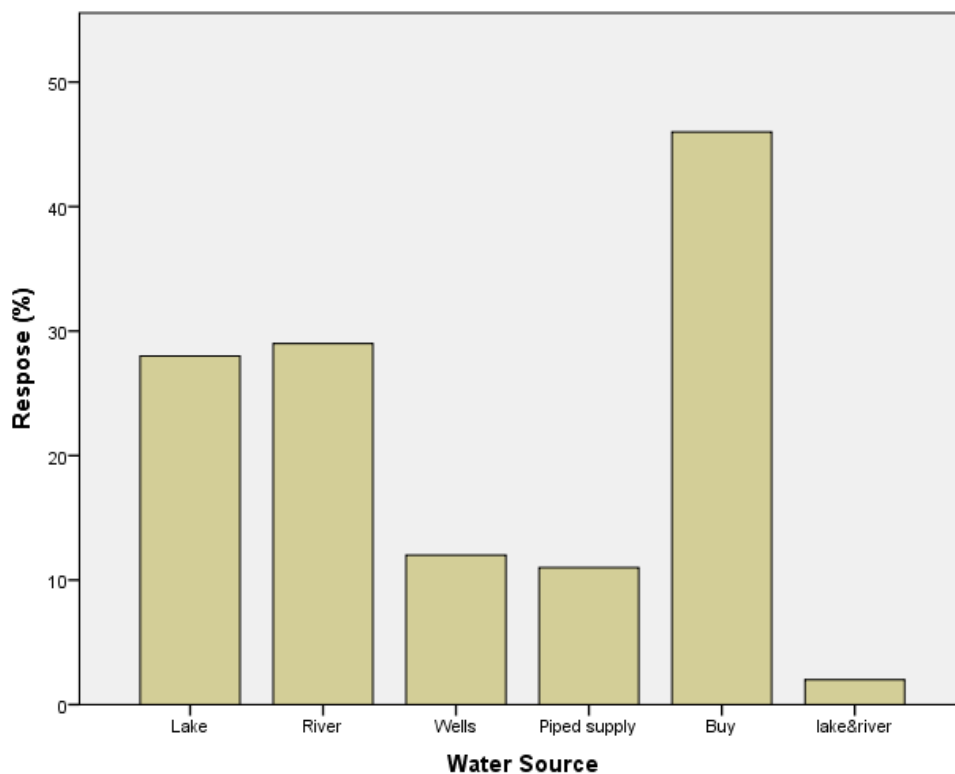
#### 4.1 Dependence on the Lake

From our results, the communities' dependence on fishing as a food source was significantly higher ( $>70\% \pm 0.5$ ) than any other activity. A good percentage of the population also engaged in trade as a means of obtaining food ( $25\% \pm 0.5$ ) but less expected, only a few individuals as shown in the graph were involved in farming. Interestingly, a few individuals were involved in more than one means of sourcing for food where a combination of fishing and livestock keeping was shown to be an important source of food. Livestock keeping, independent of fishing, was not shown to be a key source of food. Livestock keeping, independent of fishing, was not shown to be a key source of food in these communities ( $< 5\% \pm 0.5$ ). Palm tree was also considered as a source of food but by a very small portion of the population.



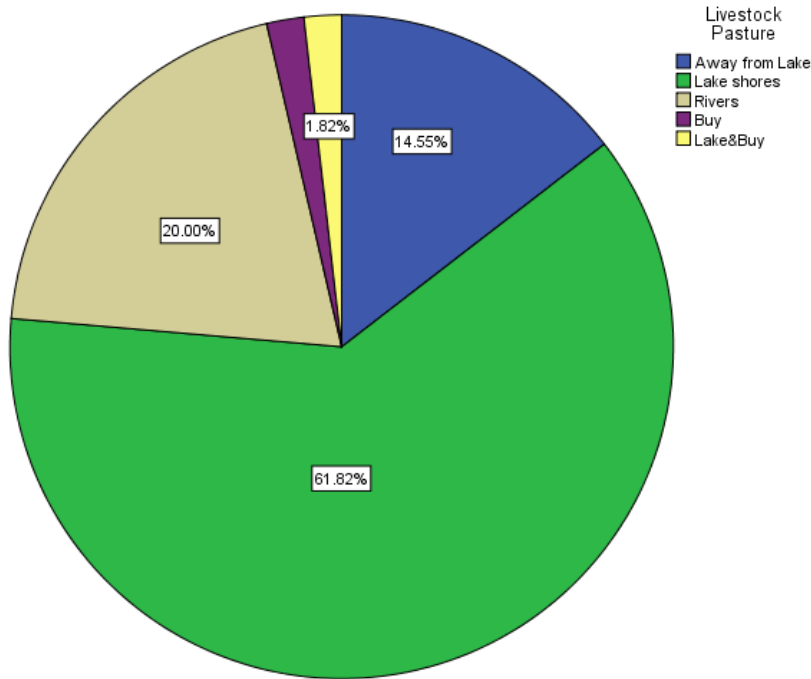
**Figure 1: A percentage comparison on the main/key sources of food for the communities surrounding Lake Turkana**

Though an averagely good population of the people depends on the lake as a water source (29%  $\pm$ 0.5), our data also showed that most of the people around the Lake buys water from other sources (>40 %  $\pm$ 0.5) as opposed to fetching water from rivers and lakes. All the same, a slightly higher population of people, to that dependent on Lake water, depended on water from rivers (30%  $\pm$ 0.5) and where as wells and piped water were mentioned to be important water sources, they were not significantly used by a big population of people. Also, a very small number of individuals used both rivers and the lake as water sources.



*Figure 2: A percentage comparison of the key water sources for the communities around the Lake*

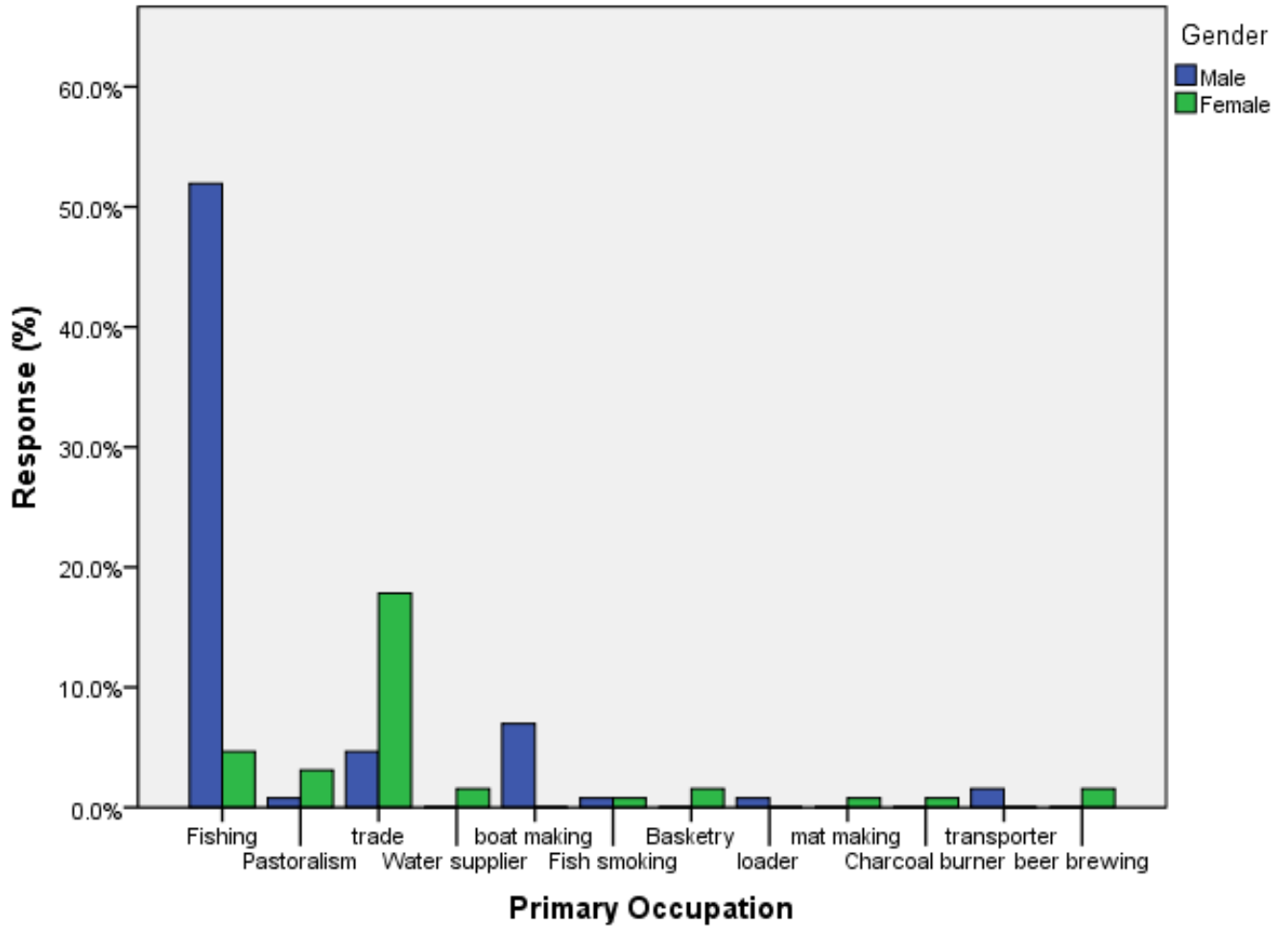
Apart from peoples' direct dependence on the Lake for food and water, more data showed that a significantly big population of the respondents (62%  $\pm$ 0.5) used the Lake shores as their only sources of livestock pasture although regions around rivers were also mentioned (20%  $\pm$ 0.5) as frequently used though by only a small population of the respondents. Regions away from the Lake were also showed to be used by 14% ( $\pm$ 0.5) of the population as a pasture source where as a very small percentage of the people would buy pasture for their livestock..



*Figure 3: A pie chart showing a comparison of different sources of livestock pasture for communities around Lake Turkana*

#### **4.2 Livelihood Alternatives**

As earlier hypothesized, fishing was shown to be the main primary occupation of most of the respondents respective or irrespective of gender ( $>50\% \pm 0.5$ ) but significantly more males were more involved in fishing than females (**CHI SQUARE**). Our analysis also showed trade as the second most occupation with close to 20% ( $\pm 0.5$ ) of the respondents engaging in it but of great interest is the result that significantly more females than males mentioned trades as their primary occupation (**CHI SQUARE**). Both boat making and transportation were occupations dominated by males where as basketry and beer brewing was dominated by females.



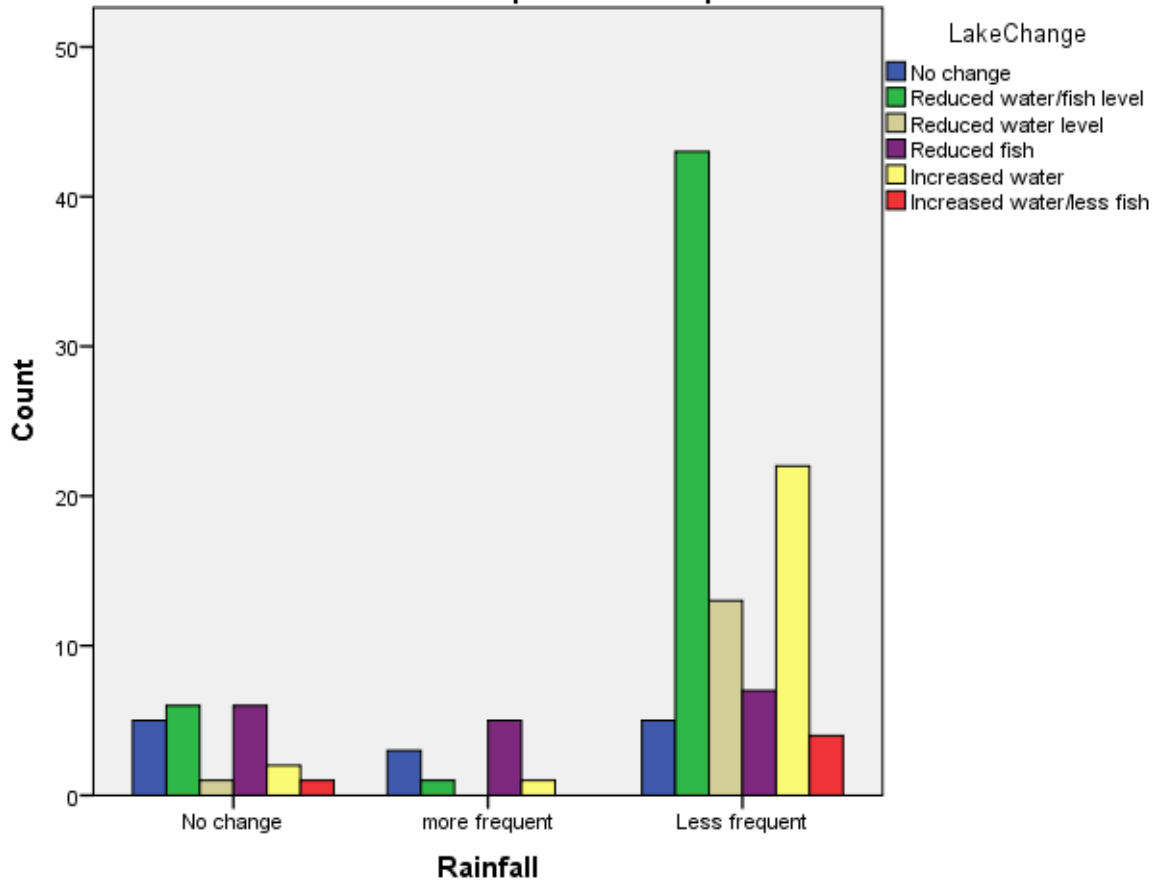
*Figure 4: Primary occupation by study respondents around Lake Turkana*

A chi square test was done to determine the relationship between rainfall patterns over the past ten years and the changes observed in the Lake. The results showed less frequent rain was highest where changes in the Lake had been observed to be less water and less fish in the Lake. We concluded there was a significant difference;  $X^2(10, N=125) = 33.376, p < 0.001$ . **PM**

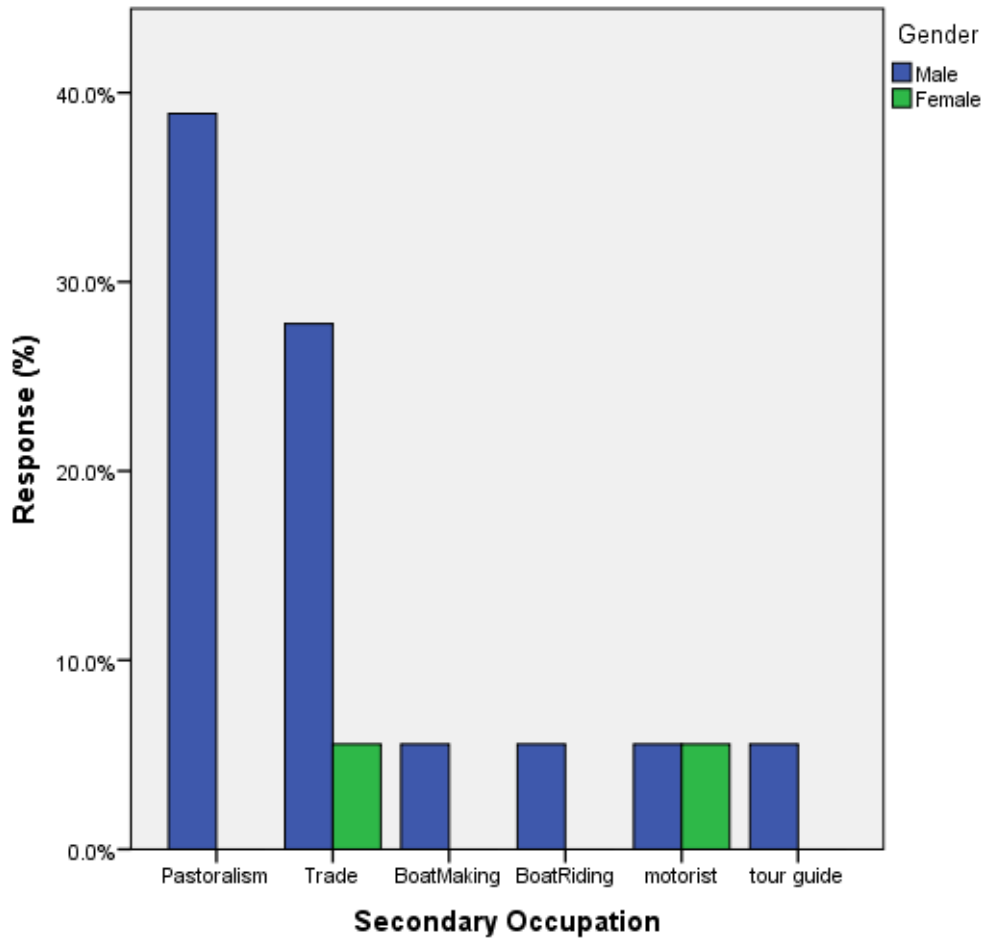
**WORKING ON THIS but the graph is wrong**



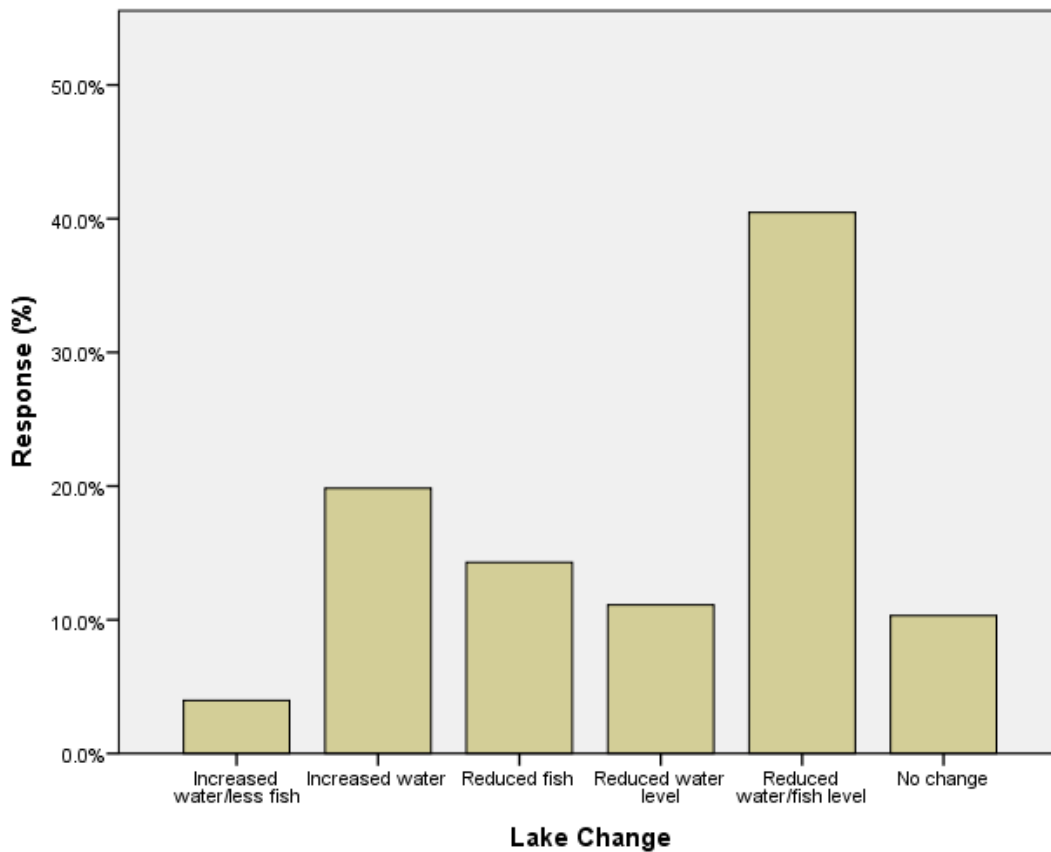
Chi Square Bar Graph



Even with the existing primary occupation, most of the respondents had corresponding secondary occupations where a big percentage were practising pastoralism (39%  $\pm$ 0.5) and trade (28%  $\pm$ 0.5) as a side occupation . Similar to the primary occupation, this varied with gender where males were significantly dominant in both of these categories (**CHI SQUARE**). Equal number of males and females were motorists for a secondary occupation where as only males were recorded to practice boat making, boat riding and tour guiding.

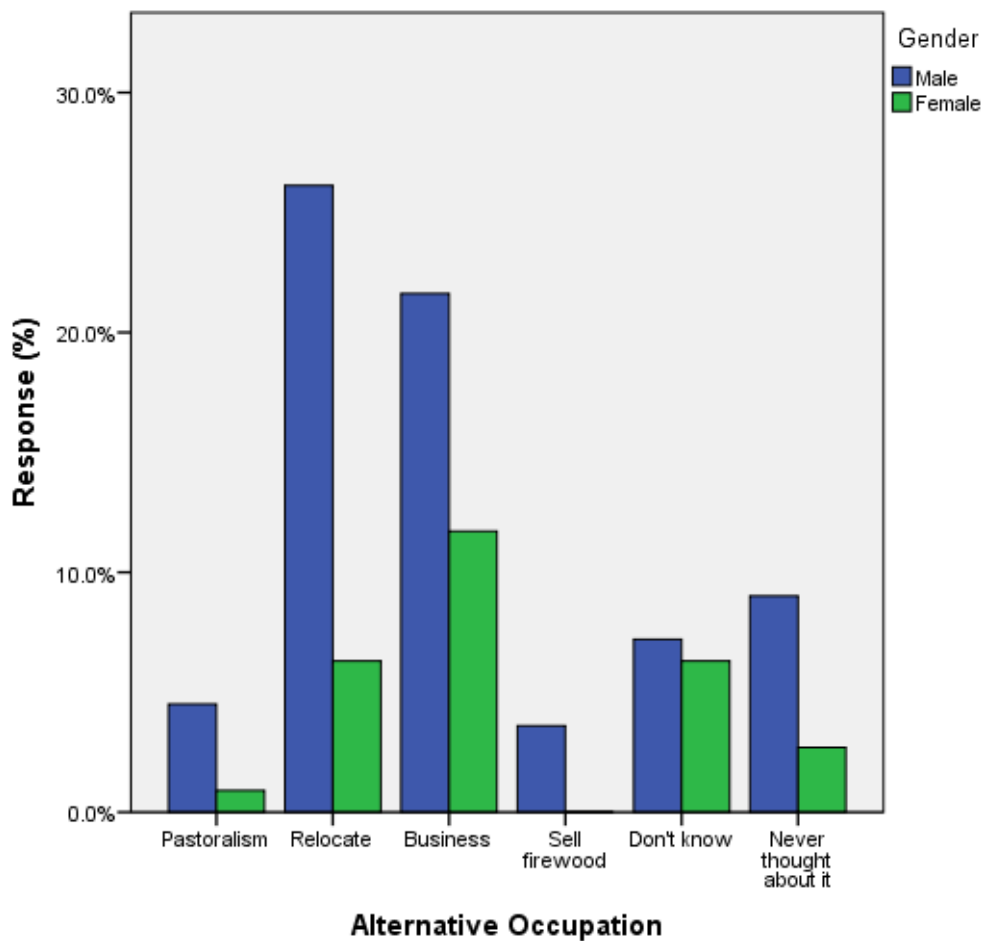


To show how the primary/secondary occupations might change with changes in the lake, we plotted a separate graph of evident lake changes and >40% ( $\pm 0.5$ ) of the respondents mentioned of possible reduced water levels and fish numbers in the lake. Similarly, >10% ( $\pm 0.5$ ) of the respondents had noticed reduced water levels and numbers of fish independently. Approximately 10% of the respondents had noticed no changes in the water levels where as <5% of the respondents said to have noticed rising water levels overtime.



**Figure 5: Observed changes in the Lake by the respondents around Lake Turkana**

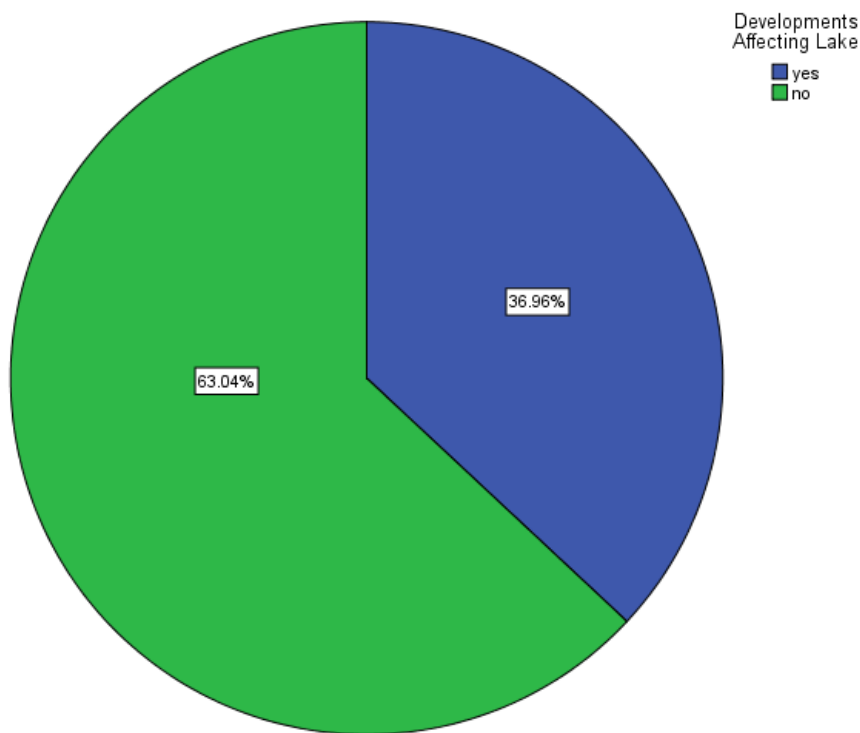
With the observed lake changes, most respondents were shown to be ready to relocate ( $>25\% \pm 0.5$ ) and start businesses ( $>20\% \pm 0.5$ ) whereas a small percentage would start selling firewood. Similar to above findings, the first two categories, relocation and businesses, greatly varied with gender where most males significantly opted for relocation (CHI SQUARE) and businesses (CHI SQUARE) compared to females.



*Figure 6: Alternative occupations that different individuals would take due to the lake changes; showing differences between gender.*

### 4.3 Awareness levels

Surprisingly and contrary to our expectation, a great percentage of the respondents ( $63 \pm 0.5$ ) had not heard of any form of developments that related to Lake Turkana but the rest of the respondents acknowledged having a certain level of awareness of the developments. All the same, their level of this knowledge was not measured.

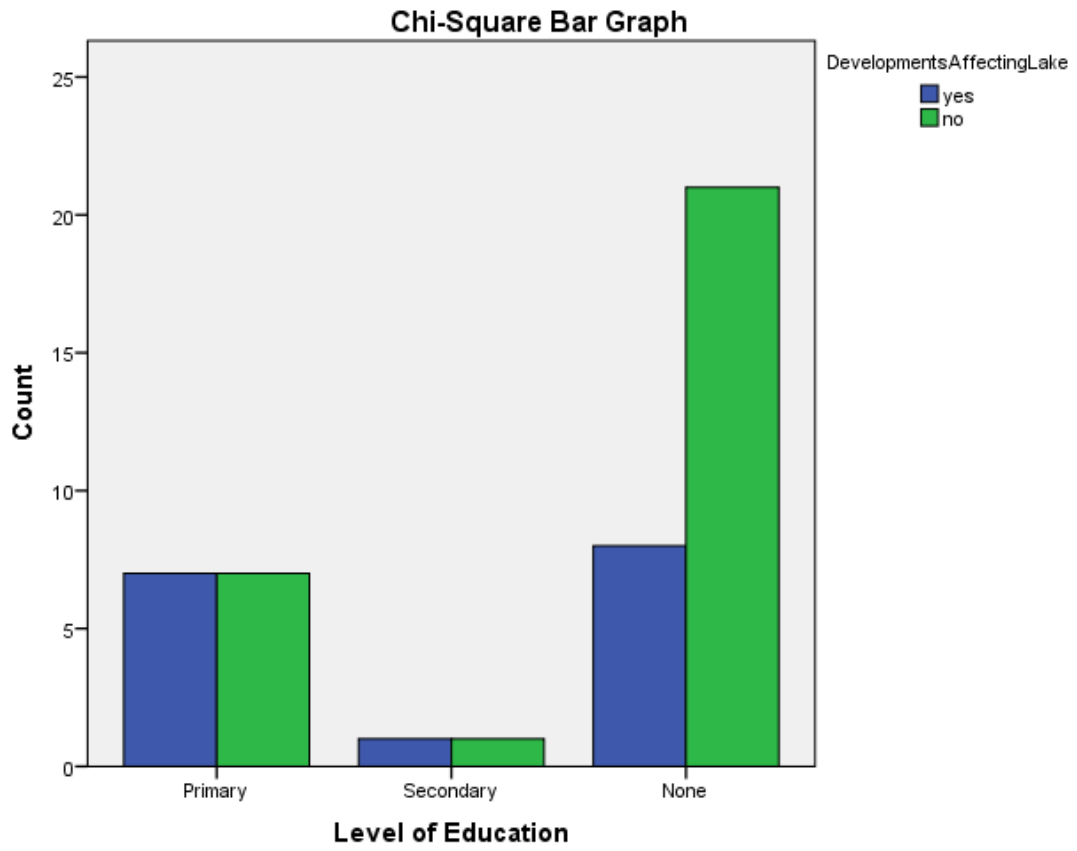


Our team of respondents was shown to be mostly comprised of people with low/no level of education ( $n=29 \pm 1$ ) as compared to those who had attended primary/secondary/tertiary level of

education (n=16) but accordingly to our results, education was not shown to in any way influence the peoples' knowledge of the developments  $X^2(2, N=45) = 2.261, p=0.32$ .

		Education			
		Primary	Secondary	Tertiary	None
		Count	Count	Count	Count
Developments Affecting Lake	yes	7	1	0	8
	no	7	1	0	21

*Table showing interaction between the level of education of different individuals and their knowledge on the developments around Lake Turkana*



## CHAPTER FIVE

### 5.0 DISCUSSION

#### 5.1 Fishing as a livelihood source

Average per capita annual fish consumption in Kenya is estimated to be 5 kg, and the contribution of fish to overall protein intake is low at 7.6%, likely because many Kenyans do not regularly consume fish for historical or cultural reasons [FAO, 2007]. However, for communities along Kenyan lakes and coastlines, small-scale fishing is essential to overall household well-being as it provides both income and nutrient-rich food. Comparing our results with the above study, fishing has been shown to be the main predominant activities for the communities in close proximity with lakes maybe because of the simple reasons that these resources are easily available and open to all people for use. Similarly, in addition to the accessibility, fishing is a task that might not need a lot of skills hence many people can engage in it. And more in support to this, as traditional herding has suffered under scarce resources, Lake Turkana has become a more vital resource hence communities rely on the lake for fishing and water for household uses

According to estimates of the Food and Agriculture Organization (FAO), to feed the world in 2050, agricultural output originating from fisheries and aquaculture must increase by over 60 percent (FAO, In press). Meeting this target is a formidable challenge for the international community considering that an alarming number of people, mostly in developing countries still suffer from hunger and poverty. Also in Kenya, there remains to be a huge crisis in fish production considering the constantly rising human population and this has eventually led to



overharvesting of fish of both mature and undersized fishing in urge to feed the rising demand. And as our work shows, the fact that fishing is a leading activity around Lake Turkana may also mean that this might end up being a big threat to fish conservation. The fisheries sector generates employment for over two million Kenyans through fishing, boat building, equipment repair, fish processing, and other ancillary activities [FAO, 2013].

Kenya currently derives little economic benefit from its valuable marine fisheries that are primarily exploited by foreign fishing vessels. Though the lake might be key in provision of fish and products for the surrounding communities, both our work and other previous studies has shown that the local people depend on the lake for other important provisions such as water and pasture for livestock. Though our results showed that respondents mostly depended on buying water, there are higher chances that this water was always fetch from the lake as this is the only water resource around this region. Apart from people, livestock also depends on the lake and areas surrounding the lake for water and good pasture partly because the lake modifies the weather of the surrounding region making it good for pasture. The profitability of commercial fish farming operation is of paramount importance to all farmers. However, farmers must have access to well-balanced and cost effective feeds coupled with optimal on-farm feed management practices as a prerequisite to profitable production. Similarly, according to by International Rivers, 2010, the Turkana region has experienced a growing population in the last few decades while more frequent and prolonged droughts have reduced the natural resource base. Rainfed agriculture is not possible. Pasture resources for livestock have dramatically reduced, encouraging those closest to Lake Turkana to turn to fishing as an alternative livelihood.

## **5.2 Lake changes and impacts**

With our data and more studies showing increased dependence of people on the lake for fishing and other activities, fishing has predominantly taken the lead as the main primary occupation for the people but more data shows that there exists secondary occupations for most of the people since the primary occupations are not sustainable. Surrounding communities seem to acknowledge the fact the lake water levels has been declining which has in return led to a reduction in the amounts of fish harvest hence hugely affecting the main primary occupation. The Gibe 3 Dam under construction on the Omo River will affect the quantity of water flowing into Lake Turkana and could cause Lake Turkana's level to drop up to 12 meters (African Resources Working Group, 2009)

Six recognized, indigenous communities - Dassanach, El Molo, Gabra, Rendille, Samburu and Turkana - depend on the lake to support their fishing and herding livelihoods. Many also rely on the lake as a primary source of drinking water and water for household use. Though a small percentage of the respondents seem to have not noticed the reduction in water levels and fish amounts in the lake, it is evident that a big portion of the population are quite aware of the predicaments of reduction in water levels and as expected, this will be a real nightmare to the local people. Our data shows that although primary occupations vary, most of them have a huge dependence on the lake and hence there might not be other relevant occupations for survival.

A reduction in the lakes' water level comes with several predicaments to both the lake and the people where the salinity levels of the lake are expected to rise continually while same time, it is expected that the water quality might continue to decline. Despite Lake Turkana's high salinity level, many villages around the lake have no other source of drinking water for all or most of the

year. The lake has come under increasing threat due to climate change and the reduction of other minor inflows such as the Turkwel River. As the lake level falls, the water's salinity and temperature increase. These changes threaten the habitat, breeding grounds, and food sources for fish stocks. Though we have shown the lake shores to be key grazing areas, a smaller and more saline Lake Turkana would reduce the grazing areas along the lake's shoreline and considering the level of dependence on the lake by people, it could also increase health risks of the lake water used for human consumption (International Rivers, 2010).

The Gibe 3 Dam is expected to dramatically reduce Lake Turkana inflow from the Omo River through four factors (International Rivers, 2010), none of which have been sufficiently analyzed to date by project developers. The filling of the dam's massive reservoir would require several years, during which time the inflow to Lake Turkana would be reduced by nearly half. The filling is expected to take at least two years, but some believe it could take up to six years.

### **5.3 Public participation and awareness levels**

Though a study by Terri Hathaway, 2010, has shown that the local people are keenly aware of the ongoing issues in Lake Turkana and that they have shown great resistance towards these developments, our data shows that a big population of the people did not seem to know about these developments. Overtime, the issues surrounding Lake Turkana has turned political and this might have caused bias to the responses we got where people might be worried and be less willing to criticize these developments. Similarly, the above study was conducted in a different study area to ours and this might as well cause the difference.

The community members around the lake share a common message and they are opposed to the Gibe 3 Dam. Their communities, as earlier studied, have been passed over for years by the Kenyan government. They have no other options for their livelihoods and often no other water source besides the lake. Reduction of the lake levels, increased temperatures, and increased salinity is affecting the fish population and in response, reduced fishing incomes mean greater poverty. The last three years have been particularly hard as food levels have reduced, and many are chronically dependent on relief food and people are generally concerned about the next generation. From our study, the level of education was not proven to in any way influence the level of knowledge on the developments surrounding the lake and this might be partly because the indigenous population better understands this situation and have observed all these transitions overtime. All the same, public involvement in decision making has been minimal which has in turn led to a poor understanding of the phenomena. And this is contrary of what has been happening in recent years where public participation has become to be seen as a vital part of addressing environmental problems and bringing about sustainable development.

## **CHAPTER SIX**

### **6.0 CONCLUSIONS AND RECOMMENDATIONS**

#### **6.1 Conclusion**

This study revealed some interesting and important information that have an implication in both conservation of the lake and the livelihoods of the people surrounding the lake in respect to the observed lake changes. The conclusions are as below;

1. Most people mainly depend on fishing as their livelihood and although most males tend to engage in it more than females, females also engage in other activities that are primarily dependent on the lake.
2. Alternatives means of livelihood exists but importantly, most of these alternatives are connected/associated with the lake.
3. The lake has changed overtime and as shown, it is prevalent that there has been a recorded/noticed reduction in water levels.
4. There has been poor involvement of the local people in decision making come issues related to the lake which has in return led to a poor understanding and awareness of these issues by the local people.

## **6.2 Recommendation**

From the findings from this work, extended research needs to be done on the interactions between peoples' livelihoods and the changes occurring to the lake to help create a better understanding on what the lake shifts mean to the local people. Recommendations are as follows;

1. Local communities need to be more and better involved in all decision regarding the lake as they are directly involved in both the use and the conservation of the lake.
2. There's need for controlled direct use of the lake because combined with effects expected from the ongoing construction of dams in Ethiopia, more negative impacts to the lake are expected to be observed.
3. An Environmental Impact Assessment balancing between people's livelihood and the dams' constructions, combined with realistic research, need to conducted such science and livelihood sustenance are both used to help make better and conclusive decisions.
4. Negotiations between the Government and local people will be vital in helping both groups come into conclusive agreements on the use of the lake.

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## **APPENDICES**