Influence of Physiochemical Parameter on Fishing Efforts among Fisher Folks in Kisumu Municipality, Kenya

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Abstract

The purpose of this study was to investigate influence of physicochemical parameter on fishing effort in Kisumu Municipality, Kenya. Cross sectional descriptive survey design was used in this study. Households were the unit of analysis. From a study population of 15,179 households, a minium sample of 384 household heads were used, proportionatesampling and systematic sampling were used to select households according to location of study area. Purposive sampling were also used to get key informants. Primary data on socioeconomic factors, dissemination channels affecting utilization of research findings and physicochemical parameters trends affecting fishing effort were collected through questionnaires, key informant interviews, Focus Group Discussions, field observation, and photography. The quantitative data were analyzed using descriptive statistics to establish relationships. Qualitative data were analyzed by creating patterns and themes. Finally, logistic regression analysis were used to establish influence of physicochemical parameteron fishing effort to answer the research questions. The regression output shows physicochemical parameter as measured by number of fishers, turbidity, BOD, and pH are not significant influencer of fishing effort ie Number of fishers (ß=-.158, p.05), Turbidity (ß=.452, p.05), BOD (ß=-.954, p .05) and pH (ß=-.103, p .05). However, temperature (ß=-.1.231, p<.05) was a significant predictor of fishing effort. In conclusion turbidy, BOD, pH do not influence fishing effort where as temperature does.The study reconmended that the Kisumu Municipality authority responsible for public health and sanitation should put in place proper waste management mechanism, expansion of sewage system plant to reduce nutrient load happening to the lake through river Kisat and Waigwa. It should also create public awareness to protect the lake.

***Key words**: Fishing effort, physicochemical parameter, pollution, Fisher folks*

Introduction

Globally, the natural environment has been threatened by the human activities which involve extraction of its resources and pollution. This has affected both the terrestrial and aquatic environment which support organisms, to some extend biodiversity are threatened. The Lakes, Reservoirs and Rivers are among the most extensively altered ecosystem on the earth. Transformation include changes in morphology of Rivers and Lakes, Hydrology, Biogeochemistry of Nutrients and toxic substance, ecosystem metabolism and storage carbon, loss of native species, expansion of invasive species and disease emergences (Stephen *et al*., 2011). The key drivers of this threat to the global environment are (a) population growth (b) pollution of our natural environment (c) climate change and (d) over exploitation of our renewable and non-renewable resources (David *et al*., 2006). Much remains to be done to engage the global citizens to reverse

this threat to our environment through dissemination/ utilization of research findings or doing further research on how to create awareness on degradation of environment to reverse the process.

Population growth has been the main driver in environmental degradation/modification, at the moment it has become difficult to understand and predict how environmental changes will interact since many parts of the earth have been polluted in one way or the other (Novine *et al*., 2010). In Asia which has been experiencing high population growth which has also come with its own demands and challenges. Among the demand and challenges are demand for more fire wood, more Agricultural land to grow more food, increase sanitation challenges due to increase of more informal settlements and processing of waste generated has been a problem. Apart from this, more nutrient enrichment of water bodies has been taking place from untreated sewage discharge, and erosion of nitrogen fertilizers which are used in Agricultural activities. In China particularly, 47% of the wet lands are manmade composed of rice paddy and fish ponds (Wolfgang *et al*., 2013). This has led to Algae bloom in the water bodies which is a health risk to the surrounding population. The question is, are the people of China aware of this emerging challenges of environmental degradation and what are they doing to address it? Probable various research done on environmental issues are not reaching the people to use them to address these challenges. A similar situation is taking place right here in Kenya particularly Lake Victoria Kenya where serious degradation of environment is taking place, just like China the public need to be involved and educated to conserve the environment to reverse this trend.

In South America which covers an area of 17.8 million km^2 environmental degradation is still a big problem, the population of the continent has been growing very fast and currently stands at 381 million people. The end result has been environmental degradation where more and more waste products are not being managed properly and nutrient enrichment is taking place in water points resulting in Algae bloom (Wolfgang *et al*., 2013). This is particularly experienced in Brazil which is a good example where there has been growth of Agro-industries and urbanization which has resulted in discharge of waste water without treatment into rivers and water reservoirs. The occurrence of toxic cyanobacterial bloom has been registered in 11 out of 26 Brazilian states from North to South. These blooms occur mainly in reservoirs but there are records of occurrence in several coastal lagoons, natural lakes, rivers and estuaries. In general, there is little information about cyanotoxin analysis or toxicity test done with cyanobacteria bloom material. The consequences of toxic cyanobacteria bloom occurrence are underestimated or undiscovered by different authorities responsible for the environment and water quality control, the management actions, preventive plans and remedial measures are usually only implemented when a serious event occurs. It is common to observe that these actions are restricted to a few weeks surrounding the event, depending on the media attention for the case (Ingrid, 2005). In Brazil just like China very little is done to address the degradation going on and probably due to lack of access and awareness of research findings which have been generated to reverse the process. In this case lack of dissemination of environmental

research findings has led to low awareness of effects of environmental degradation and its impact to the environment and population health and this need to be addressed. A similar situation of what is happening in Brazil is happening in Lake Victoria Kenya and this formed the basis of this research; to find out why research information generated has not been disseminated /utilized to conserve the environment.

Lake Victoria is the second largest fresh water Lake in the world with surface area of 68,000km^2 (Linda *et al.,* 2003) and it is shared by three East African countries namely Kenya, Uganda and Tanzania. Kenya occupy 6 % of water mass, Uganda occupy 43 % of water mass and Tanzania which has the largest share of 51 % of water mass (Regional Frame survey Report, 2012). The Lake has a catchment area of 193,000km^2 (Uganda 30,880 km^2 , 16%; Kenya 42,460km^2 , 22%; Tanzania 84,920km^2,44%; Rwanda 21,120 km^2 , 11%; Burundi 13,510km^2 , 11%) with a rapidly growing population of over 35 million people World Bank, (2009). The Lake is relatively shallow with a maximum depth of 69m (Johnson *et al.,* 2000). The implication of high population growth is more of socioeconomic activities which is degrading this ecosystem due to high demand of the environmental resources which is a source of livelihood. As a result of this degradation taking place more dissemination and utilization of environmental and fisheries research findings is needed to utilize this resource in a sustainable way.

Globally an enormous amount of information and data has already been generated, and will continue to be generated in physical, chemical and biological aspects such as limnology, hydrology, climatology, ecology, biochemistry and many more, all of which contribute to a better understanding of the state of the lakes, reservoirs and other lentic water bodies. There is also a growing number of studies on the managerial aspect of aquatic, terrestrial and riparian ecosystems including water quality, sediment quality, shoreline environment, inflowing and outflowing water systems extending to upper watershed tributaries. A needed component not yet produced is a means of compiling and utilising holistically, practically-synthesized information and data on such thematic and disciplined subjects (Research centre for sustainability and environment, Shiga University and International lake Environment committee Foundation, 2014).

In Kenya the quantity of data and research on Lake Victoria and its drainage is overwhelming. The number of research done to generate knowledge is estimated at about 405 (LVBC Knowledge management Portal, 2013). The key thematic areas which have been researched on are aquatic plants, parasites of fish, different species of fish, water budget, invertebrates, human socio-economic activities, pollutants discharged in Lake Victoria and climate change effect on Lake Victoria Basin, just to mention a few. These environmental and fisheries research findings are important to the people living and working within the Lake Victoria Basin depending on their socio-economic activities. The research question in this study was what is the influence of physicochemical parameter on fishing effort. So this study therefore sought to determine the influence of physico chemical parameters on Fishing Effort

Research Methodology

This study was conducted in Kisumu East

District which is located on the western region of Kenya in Kisumu county at $34^0$42' 49" E to 34^0 46' 47" E and 00^0 06' 14" S to $00^0$01' 13" S. It is one of the three Districts found in Kisumu County namely Kisumu west, Kisumu East and Nyando. Kisumu East District has two divisions Winam and Kadibo. It has twenty locations namely; Kondele, Kolwa Central, Kolwa west, Kolwa East, Kisumu South West, Kisumu Central, Kisumu East, Kisumu North, Kajulu East, Kajulu West, Miwani, Kawino North, Kawino South, West Kochieng, East Kochieng, Komura, Bwanda, Katho and Kanyagwal. The study area falls between at 34^0 35' 52" E to $34^0$47' 22" E and $00^0$09' 27" S to 00^0 02' 55" S. The size of Kisumu East District is 559.2km^2 (ROK, 2009).

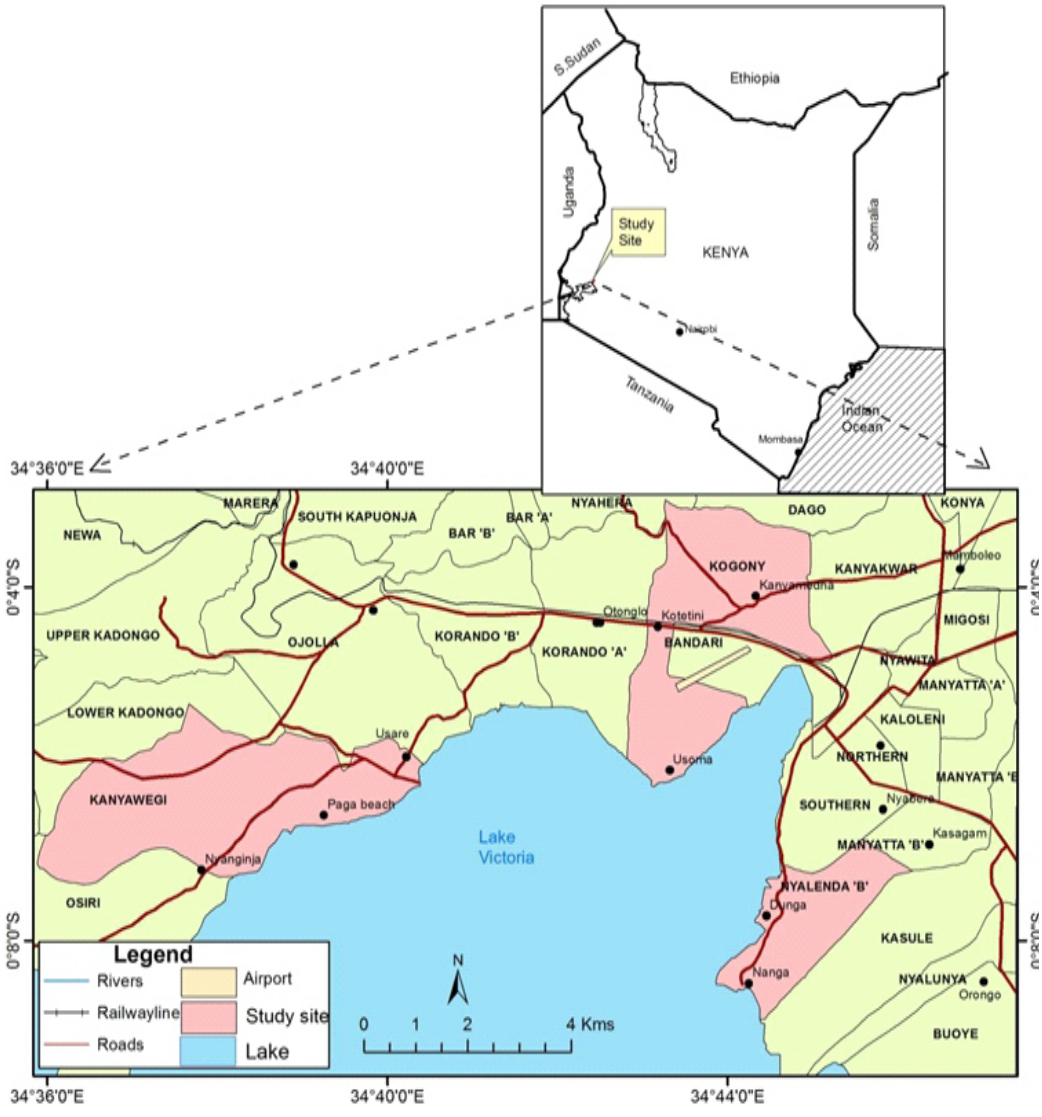

Figure 1: Map of Kenya Showing the study area Kisumu Municipality.

The study adopted a cross-sectional descriptive design. The unit of analysis was the households and the respondents were household heads. The secondary data for the fishing efforts, fisheries from the year 1997 to 2011 were used to demonstrate relationships and develop future predictive fishing efforts.From a study population of 15,179 households, a minium sample of 384 household heads were used, proportionatesampling and systematic sampling were used to select households according to location of study area.Purposive sampling was used to sample 9 Key informants who are not fisher folks and are knowledgeable about the situation within LVB. These includedone for each group; Fishery officer, Kenya Wildlife Services, Agricultural officers, Area chief, leader of BMU, NGO, CBO and Minister of Fisheries in Kisumu County Government. Questionnaires, interviews, focus group discussion, and observation were used to collect primary data on socioeconomic factors affecting the utilization of environmental and fisheries research findings among the fisherfolks.The quantitative data on the influence of channels of dissemination of environmental and fisheries research findings on its utilization among the fisher folks was analyzed using descriptive and inferential statistics to generate the percentages, bar graphs and establish relationships between the two variables.

Findings of the Study

This section presents the findings on the influence of physiochemical parameter on fishing efforts and among fisher folks in Kisumu Municipality, Kenya.As a result of the degradation taking place in the lake, the respondents were asked what were the status of water quality in the lake ; 5.36% of the respondents said it was clean, 92.09% said it was dirty and 2.30% said they had no idea. What the majority of the respondents were say in layman languge is that the water is dirty which in scientific terms translated into the turbidity of the lake was poor and this was as a result of siltation of the lake and raw sewage which lead to blue green algae which was affecting the lake (Figure 3). This findings also demonstrate that they are aware of the challenges the lake is facing currently. This concurs with the studies of Fredrick *et al*., (2011) where the communities around river *Kisat* and Molasses were clear in their mind that their water have been polluted by efflent from the two sources.

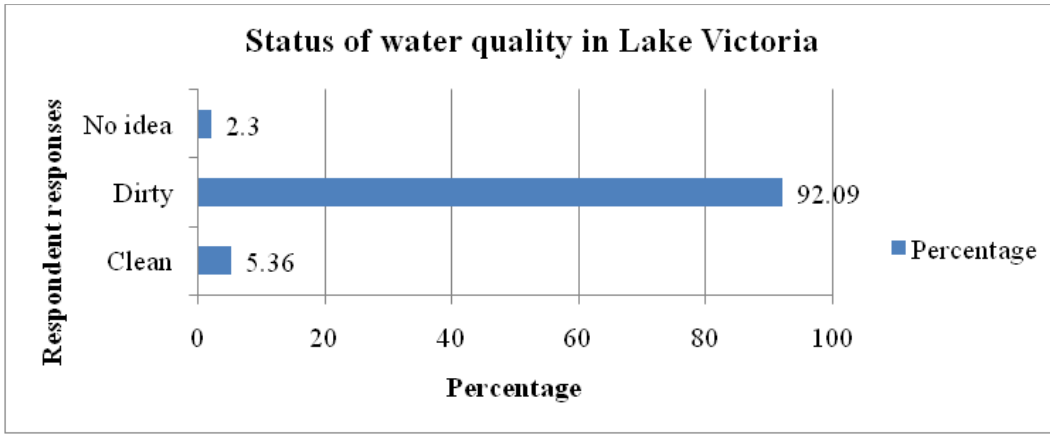

Figure 2: Status of water quality of Lake Victoria

When the respondents were pressed further to give reasons for saying why the water is dirty. 58% of the respondents said it was due to continous pollution, 21% said the water has bad taste/turbidity is poor/presence of blue green algae, 12% said water not safe for domestic use and 9% had no idea (Figure 4). This finding was interesting in the sense that the majority new what is affecting the lake. This concurs with (Wandiga *et al*., 2006; Ochola, 2006; Fredrick *et al*., 2011; Joyce *et al*., 2009) studies that stated Lake Victoria has deteriorated to a point that it is no longer able to support aquatic life in the same quality and quantity of the past 40 years. The major driving force behind water quality deterioration is population increase, deforestation, poor agricultural practices, overstocking, discharge of raw sewage and industrial waste getting into the lake.

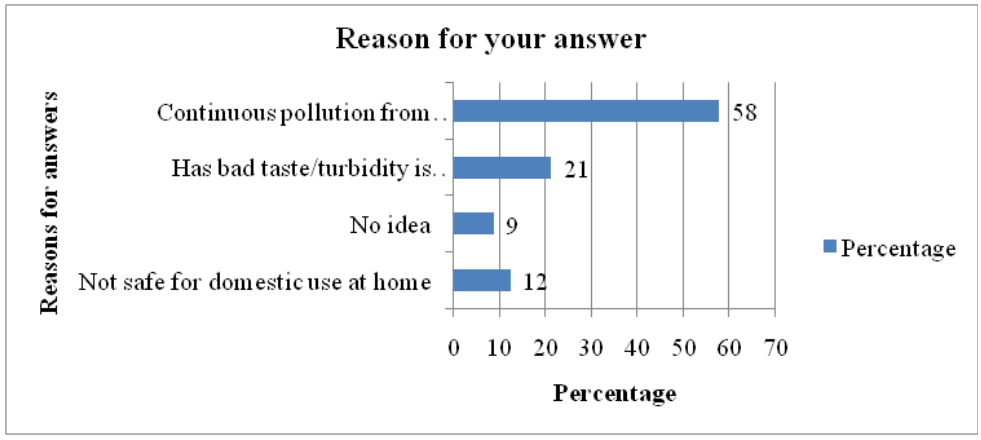

Figure 3: Reasons on status of water quality of Lake Victoria

When respondent were asked to state the indicators of lake degradation; 9% said at times they get dead fish floating/ fish tasteless/taste funny, 64% bad odour/turbidity poor/taste bad, 14% said continous presence of blue green algae, 6% had no idea and 7% outbreak of water born diseases. From this findings 94% of the respondents knew indictors of degraded lake which is very encouraging (Figure 5). This concurs with FGD in Paga, Usoma and Dunga beaches where the participants mentioned the same indicators. They went further to state that not much is being done to protect the lake currently interms of allocation of resoures by both the Central Government and County Government to protect it.

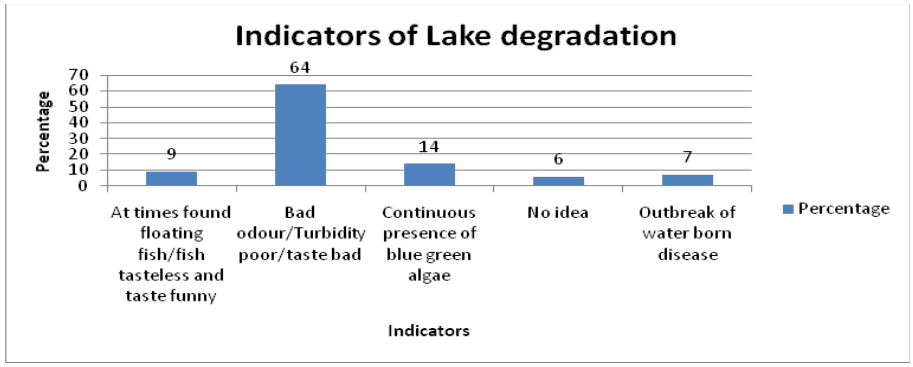

Figure 4: Indicators of degradation of Lake Victoria

When the respondents were asked further to state the status of water quality in the next 15 years the majority 68% said it will be dirty, 28% said it will be clean and another 4% had no idea how it will be (Figure 6). From this finding it demonstrate what the majority of the people think about how the lake will be in the next 15 years. If we go by what the respondents are saying then the lake will be heavily polluted. This again concurs with what was discuss in FGD where the participants said the lake is dying as we are watching since the government is not allocating enough resources to protect the lake and culture of corruption is making the problem worse. This was also mentioned by Madam Boera of KMFRI Kisumu.

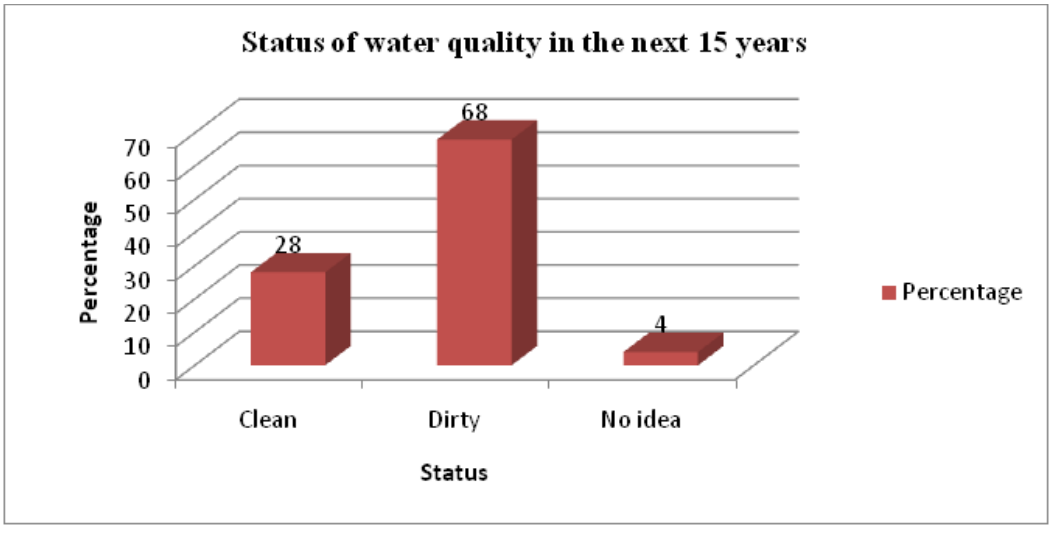

Figure 5: State of water quality in the next 15 years

When respondents were asked the reason why they think the water will be dirty in the next 15 years; 48% felt that Government is not doing enough to improve the water quality, 45% felt it will be clean if the Government take action against pollutants and create awareness about the importance of the lake being clean and 7% had no idea (Figure 7). Current what is going on around the lake is unchecked pollution from surrounding industries, discharge of raw sewage through river *Kisat* and *Waigwa*, blasting and making of ballast near the lake especially on the side of *Paga* beach and erosion is taking place on these places. All this lead to siltation of the lake. When the participants say the lake is dirty what they have in mind is the turbidity of the lake is poor which is brought as a result of erosion and presence of blue green algae. From one of the participants in FGD in Usoma Beach said when they go fishing in the lake they get used syringes, cotton wool, condoms and plastics from the lake. They cited Jaramogi Odinga Oginga Teaching and Referal Hospital and other Hospital as polluters of Lake Victoria. This demonstrate medical waste are finds its way in the lake which is very unfortunate. In the same FGD another participant mention Molasses plant, Swan Millers and match Box company discharge its waste in the lake and they wonder what is the Government doing to stop this pollution. All this is damaging the water quality of the

lake and hence destroy suitable condition where aquatic life can thrive well. The end result, this affects the quality and quantity of fish which are found in the lake. In sum total this reduce the fish found in the lake and hence the fishing effort. Once the fishing effort of the fisherfolks has been affected their economic status is affected too.

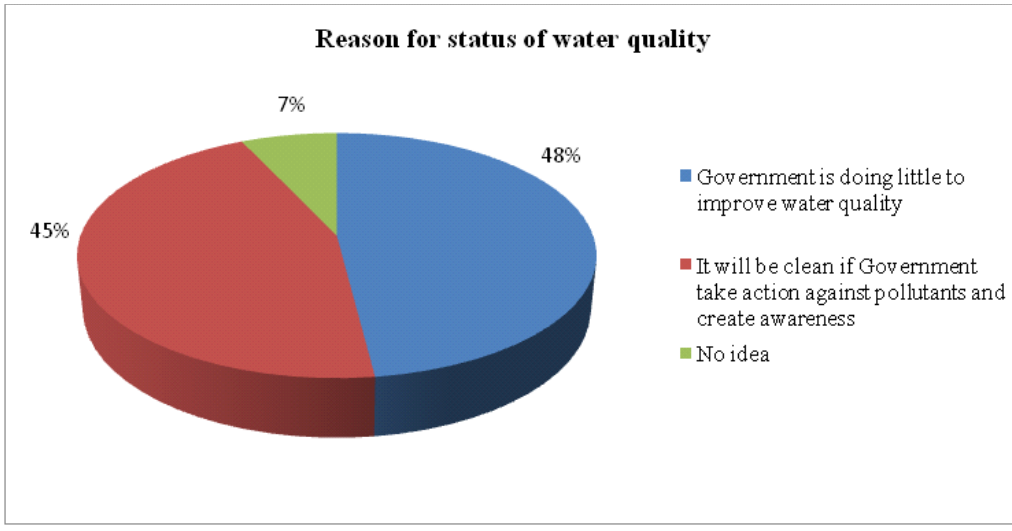

Figure 6: **Reasons for the status of Lake Victoria water in the next 15 years**

As explained elswhere in this study, Lake Victoria plays a very important role in international development. This starts from Kenya, Uganda, Tanzania, Ethiopia, Sudan and Rwanda (Kelley, 2009). It suport many socioeconomic activities and as a result of these activities the lake has been degraded by its inhabitants interms of water quality and other physicochemical parameters. When the respondents were asked have the number of fishers in the lake increased? 60 % of the response said Yes, 39% was No and 1% had No idea (Figure 7).

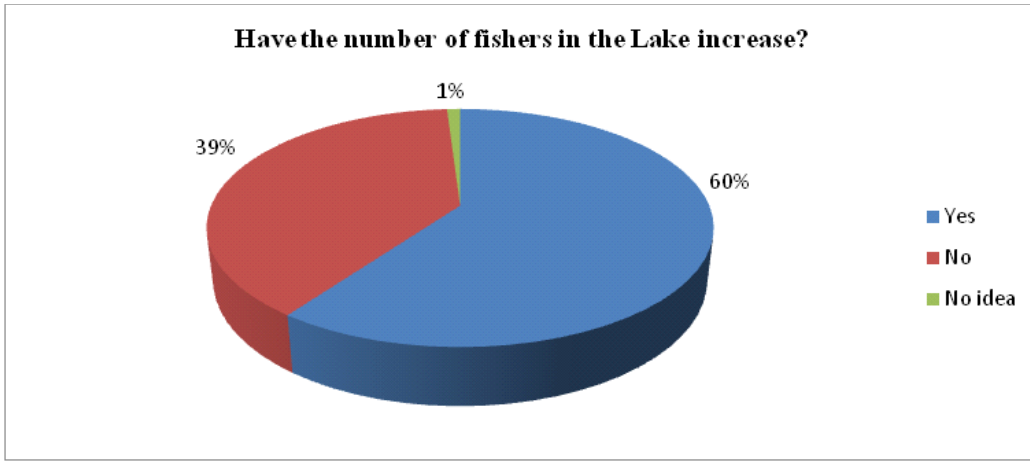

Figure 7: Number of fisher in Lake Victoria

That finding demonstrate that the respondents have an idea that more and more people are venturing into the lake and this is a source of concern for most of them and has led to degradation of the lake as explained elswhere in this study. When the respondents were asked further why are more and more people venturing into the lake, 34% of the respondents were of the view that most people see the lake as a source of income, 58% of respondents think unemployment was a factor and 8% had no idea (Figure 8).

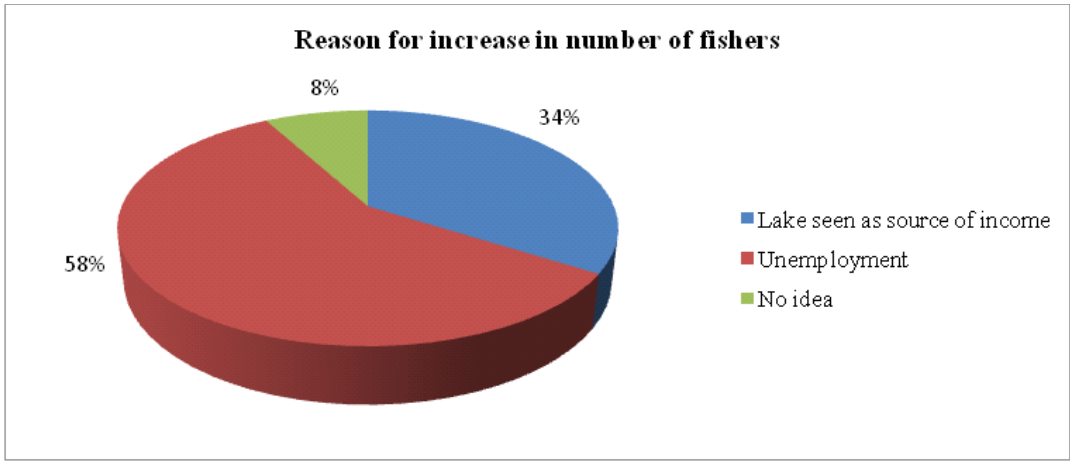

Figure 8: Reason for increase in fishers

When the respondents were asked have the volume of fish caught in the lake decreased? 95 % of the respondents said Yes and 5 % was No (Figure 10). This is quite serious and this resonate with the thinking of the people around the study site and beyond. This concurs with the information which came out in FGD in *Paga* beach, *Usoma* and *Dunga* Beach. Most of the participant felt that fish catch is decreasing and this is demonstrated by the fact that fish price is going up. Other studies from Lake Victoria agrees with what the respondents said, that its now recognised that fish catch from the lake is on the decline at a time when the demand for fish is on the increase due to population growth (Rutaisire *et at*., 2009).

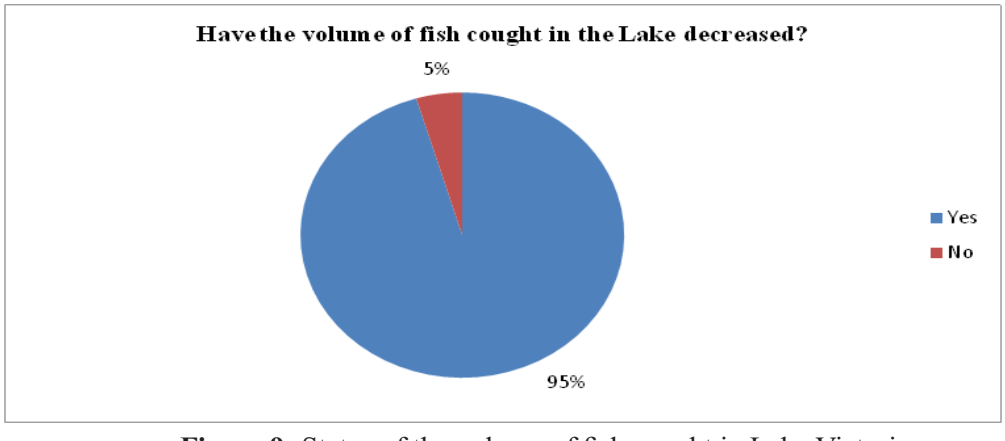

Figure 9: Status of the volume of fish cought in Lake Victoria

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When the respondents were asked to give reasons for the decline in volume of fish catch; 1.79% respondents mentioned breeding sites for fish are being destroyed, 26.28% mentioned the lake has been polluted from many sources, 42.35% mentioned more fishers in the lake, 15.56% mentioned the use of illegal fishing gears in the lake and 13.78% had no idea (Figure 11). This findings demonstrate the reality of what is happening in the lake. When one moves around Usoma beach alot of sand havesting is taking place which is destroying breeding site of fish (Plate 1). On Paga beach side one can see many quarry are locate around this area (Plate 2). This has been neccessitated by construction boom in Kisumu county. When it rains erosion takes place and all the soil are washed into the lake. The question which one might ask why are NEMA approving projects like this which are near the lake? Is this corruption at play?

Plate 1: Sand harvesting in Usoma beacher
(Source: Researcher, 2016)

Plate 2: Quarry site near Paga beach
(Source: Researcher, 2016)

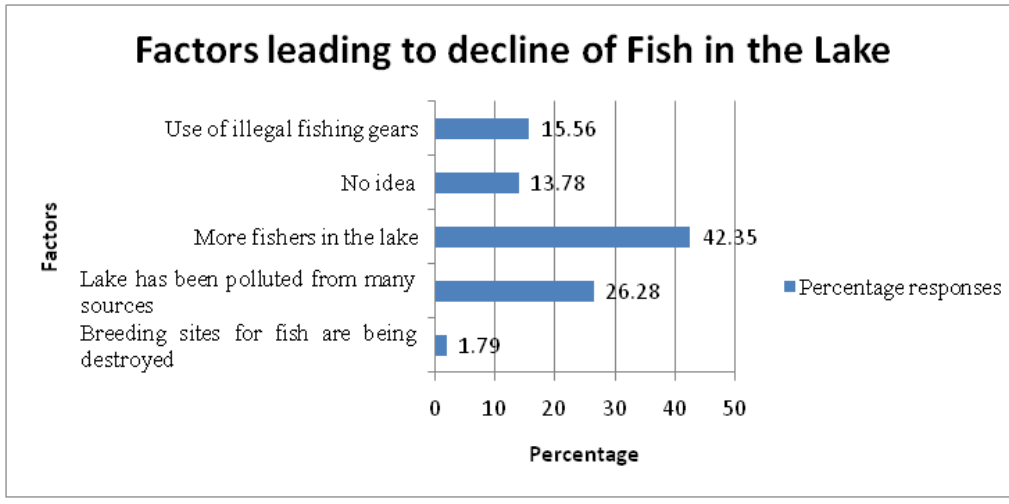

Figure 10: Factors leading to pollution of Lake Victoria

This finding information concurs with what Mr Okumu of Agriculture Sector Support Kisumu who suggested on why the fish catch in the lake is on the decline. He mentioned that pollution and erosion from the highlands is affecting the lake. He also mentioned that increase in the use of illegal gears such as *Amuok* where the illegal nets are less that four inches are spreading for almost one kilometer and are joined by two boats. This gears sweeps the adult fish which are parents, juvenile fish and the fingerlings which are still growing. This are the fish one see being sold in the market places around. Sometimes he also feel ashamed as he eats the parent fish and the fingerlings. But the question he ask what can we do? Poverty and unemployment is driving people to do the unexpected. This findings also concurs with Mr John Kisoti of Fisheries Kisumu. He gave it a different dimention, he said illegal fishing has been going on but fisheries Ministry function was devolved from the National Government to County Governmentand and they have little control , illegal fishing has increased in the lake and its difficult to control at the moment. The five counties (Migori, Homa bay, Kisumu, Siaya and Busia County) Government which surround the lake do get financial allocation for taking care of the lake resource from the National Government but County Government for reasons best know to themselves are not availing the funds to take care of the lake. Another reason is the political class in the five County Governments, the Member of County Assemble (MCA) view the population of the fishers who leave around the lake as source of votes. When the ministry of fisheries arrest the fisher men for using illegal fishing gears, they quickly run to the MCAs who quickly intervene and ask why are the Ministry of fisheries officials jeopardizing their chance of re-election in the County Government? This happens because the MCAs are also blackmailed by the fisher men who tell them if you do not protect our interest we shall not vote you back in the County Assembly. The other problem is lack of adequate staff to monitor the activities of fisher men in the lake. What the ministry of fisheries do is to work with BMU to try to reduce the use of the illegal nets in the lake.

BMU do not have the capacity, technical know how and the will to control the use of illegal nets in the lake as most of the fisher men who operate in the lake are either their brothers, brother-in-law and friends and cannot prevail on them or take action against them. This explains why their is continuous degradation of the lake. As a result of this the fish harvested and species has been on the decline. When the respondents were asked if there is a decline in the number of fish species in the lake; strangely 92.82% of the respondents response was Yes, 5.90% was No, and 1.28% had No idea (Figure 11).

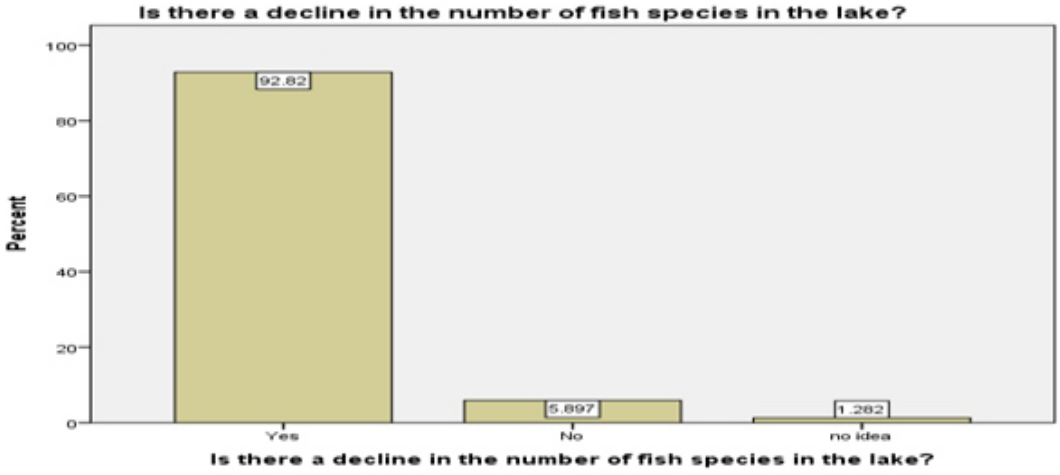

Figure 11: Status of fish species in Lake Victoria

When the respondents were asked to state some of the fish species which were on the decline, they mention them as follow; *Ningu, Osoga, Othore, Seu, Mumi, Kamongo, Sire, Omena, Fulu, Okoko, Ngege, Sima, Fwani,* and *Omena.* (Table 2) below shows list of the fish species with scientific names, english names and local names in Kenya, Uganda and Tanzania. This concurs with Wakwabi *et al*., (2006) where over 60% of *haplochromine* species have greatly diminish in number or completely eliminated.

Table 1: List of Fish species in Lake Victoria

Scientific Name	English Name	Local Names K {Kenya}, U {Uganda}, T{Tanzania}
Lates niloticus	Nile perch	mbuta (K), mputa (U), sangara (T), chengu (T)
Rastrineobola argentea	sardine	dagaa (K,T,U), omena (K), mukene (U)
Oreochromis niloticus	tilapia	nyamami (K), ngege (K,T,U), perege (T), sato (T)
Oreochromis esculentus	tilapia	ngege (K,T,U), perege (T), sato (T)
Oreochromis leucostictus	tilapia	ngege (K,T,U), opat (K), perege (T), sato (T)
Oreochromis variabilis	tilapia	ngege (K,T,U), mbiru (K,T), perege (T), sato (T)
Tilapia zillii	tilapia	ngege (K,T,U), sili (K), perege (T), sato (T)
Tilapia rendalli	tilapia	ngege (K,T,U), perege (T), sato (T)
Haplochromis spp.	haplochromine	fulu (K), furu (T), nkeje (U)
Bagrus docmac	catfish	sew (K), mbofu (T), ssemutundu (U)
Clarias mossambicus	catfish	mumi (K), kambale (T), male (U)
Protopterus aethiopicus	lungfish	kamongo (K,T), kambale mamba (T,U)
Synodontis victoriae	-	okoko (K), ngogo (T), nkolongo (U), gogogo (T)
Barbus altianalis	-	fwani (K), odhadho (K), kuyu (T), kisinja (U)
Mormyrus kannume	elephant-snout fish	suma (K), mbete (T), domodomo (T), kasulu (U)
Schilbe mystus	butterfish	sire (K), nembe (T), nzere (U)
Alestes jacksoni	-	osoga (K,T), nsoga (U)
Labeo victorianus	-	ningu (K,T,U)
Caridina nilotica	shrimp	

Key: K=Kenya, U=Uganda, T=Tanzania

Plate 3: Fish species of lake victoria
(Source: Researcher, 2016)

When the respondents were asked if they required more time to harvest one tonne of fish in the lake, 91.82% of the respondents mentioned they need more time, 1.54% need less time, 3.84% need sametime and 2.81% had no idea (Figure 12).

When the respondents were asked if they required more time to harvest one tonne of fish in the lake

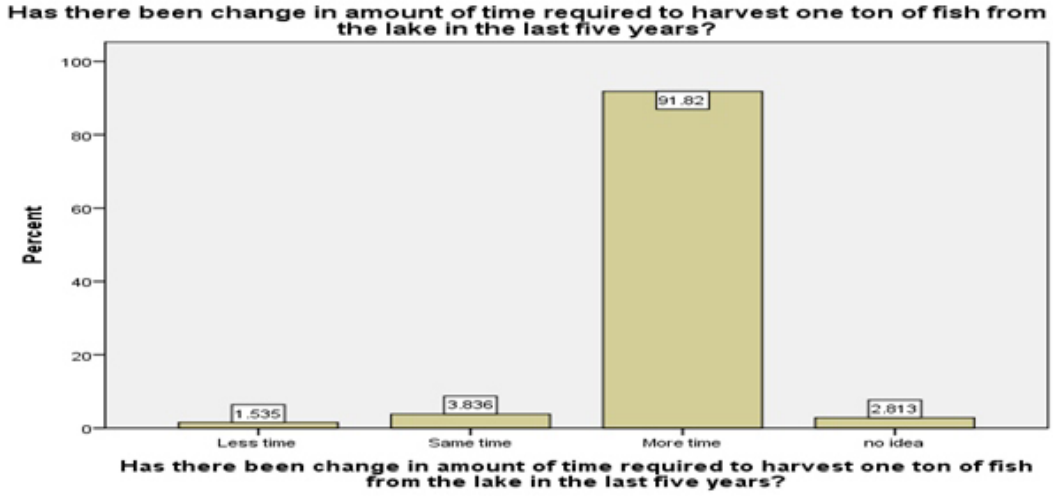

Figure 12: Time taken to harvest one tonne of fish

When the respondents were asked what distance they travelled to harvest one tonne of fish; 92.58% respondents said they travel long distances, 2.05% travel short distance, 2.56% travel same distance and 2.81% had no idea (Figure 14). This concurs with Fredrick *et al*., (2011) where most fishers have to travel for a distance of more than 10 km and beyond for fishing since this place are less polluted than near the shore of the lake.

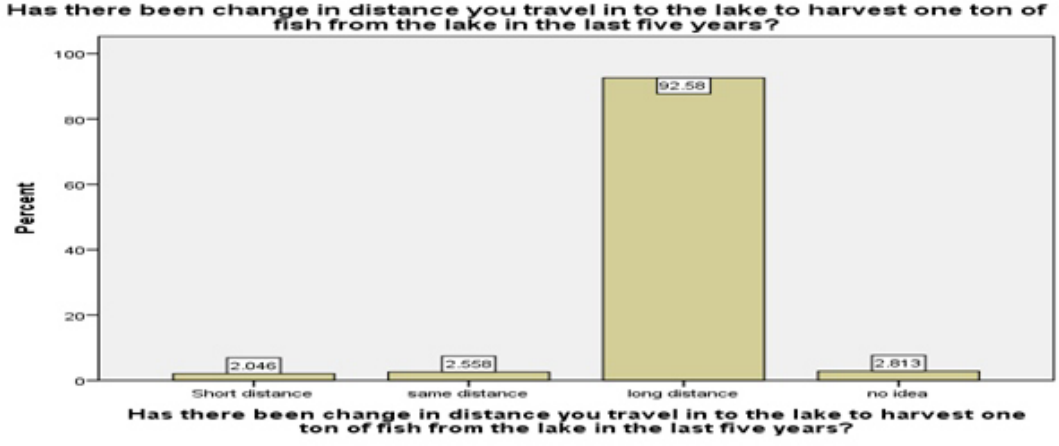

Figure 13: Distances covered to harvest one tonne of fish

This finding indicates that the fish stock in the lake is on the decline and most fishermen have to travel long distance and spend more time to get fish from the Lake, hence encouraging the use of illegal fishing gears in the lake to get whatever fish one can get from the lake.

When analysis was carried further, the results of the multiple regression analysis reveal that the relationship between the explanatory variables was strong (r = .991) (Table 15). They also indicate that the

Number of fishers (ß=-.158, p.05), Turbidity (ß=.452, p.05), BOD (ß=-.954, p .05) and pH (ß=-.103, p .05) are not significant predictors of fishing effort. However, temperature (ß=-.1.231, p<.05) was a significant predictor of fishing effort. The results further reveal that 98.3% (R^2 = .983) variation in fishing effort was explained by the independent variables and the proportion of that variance was significant, $F(5, 3) = 34.527, p < .05$. These results indicate that physiochemical parameters as measured by number of fishers, turbidity, BOD, temperature and pH influence fishing effort. What this translate to, the continous pollution of the lake is having a negative effect on fishing since either more fish are dieing or they are migrating away from places which have been polluted.

Table 2: Relationship between fishing efforts and physico-chemical parameters

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Models	**B**	**Std. Error**	**Beta**	**t-value**	**p-value**	**Tolerance**	**VIF**
(Constant)	6953210.3	1172995.11		5.928	0.01		
Number of fishers	-0.667	0.326	-0.158	-2.043	0.134	0.949	1.054
Turbidity	38904.98	29095.706	0.452	1.337	0.274	0.05	20.09
BOD	-11039.643	3620.12	-0.954	-3.05	0.055	0.058	17.203
Temperature	-251300.92	46869.68	-1.231	-5.362	.013*	0.108	9.253
pH	-4572.907	16722.947	-0.103	-0.273	0.802	0.04	25.05

r = .991, R^2 = .983, Adjusted R^2 = .954, F (5, 3) = 34.527, p< .05 *Significant at 0.05

Conclusion

The study concluded that turbidy, BOD, pH do not have significant influence on fishing effort where as temperature does. As much as the lake is experiencing changes in the physicochemical parameter the lake is still clean and this has not impacted much on fishing effort.

Recommendation

The Kisumu Municipality authority responsible for public health and sanitation should put in place proper waste management mechanism, expansion of sewage system plant to reduce nutrient load happening to the lake through river Kisat and Waigwa. It should also create public awareness to protect the lake.

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