IMPACTS OF LAKE VICTORIA LEVEL FLUCTUATIONS TO LIVELIHOODS MISSUNGWI DISTRICT CASE STUDY

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ABSTRACT

Lake Victoria experienced drastic levels changes in 2005 causing great inconveniences to lakeside communities. This study investigated effects of these changes on livelihoods through questionnaire surveys, focused group discussions, interviews and analysis of fish catches, diseases, crops, and lake levels data. Results indicate recession of levels had various socio-economic impacts. The changes caused severe water shortage due to drying up of shallow wells and a remarkable increase in prevalence of schistosomiasis because of increased utilization of lake water. There was no evidence for impact of level changes on malaria and diarrhea. Decline of water levels caused decline in fish catches due to retreat of water from breeding sites. However receding waters created a new land for cultivation which helped to boost Maize and sweet potatoes production. The results emphasize on ensuring stability of lake levels to avoid negative impacts on livelihoods and to maintain ecological integrity of the lake.

***Key words**: Lake Victorial, socio-economic impacts, fisheries, water related dieseas, water supply*

1. INTRODUCTION

Lake Victoria is an important resource in east Africa which have attracted almost a third of population in the three countries Kenya, Uganda and Tanzania to its shoreline. Population growth around the Lake is significantly higher than the rest of Africa and Lake Zone is one of the most densely populated regions on earth. During each decade, population growth within 100 km buffer zone around the lake outpaced the continental average which reflects growing dependency and pressure on lake's resources (UNEP, 2006). The lake supports more than 30 million people in Kenya, Tanzania and Uganda

Communities around Lake Victoria depend very much on the lake resources for their livelihood. The lake provides a more stable source of income which unlike agriculture the only other alternative is not affected by erratic rainfalls. Unlike agricultural crops fish has more stable market and may be available for selling all year round. About 4 to 5 million people are employed in the fishing industry in Lake Victoria (LVFO, 1999). The lake provides water to all major towns on its shore including Mwanza, Bukoba and Musoma in Tanzania, Kisumu in Kenya, Jinja in Uganda and hundreds of villages on its shoreline. Fish catches in the lake is an important source of income for individuals, companies, local government and the central government. It is estimated that the annual value of fish produced from the lake is over 600 million US$ of which 217US$ is in foreign exchange (LVFO, 1999). Kebe and Tallec (2006) noted that fishing contributes to employment of the population making a living (or subsistence) directly or indirectly from fisheries products (selling, processing, handling, sale or repair of canoes). Lake Victoria is also an important ecosystem for biodiversity. Fresh water in the lake supports a number of plants and animal life including, phytoplankton, invertebrate fauna and the fishery some of which are only found in the lake (Katunzi, 2003).

Water level is an important factor which influences the ecosystem function of the lake (Jewit 2002). The history of water level variations in the lake has two distinct periods with strikingly different level regimes. In 1961 water levels in the lake rose suddenly for more than 2 meters following unusually high rainfall all over east Africa. This change in level resulted in flooding of ports and lead to reconstruction of raised platforms for ship docking in ports such as Mwanza. The minimum level recorded in the lake was in 1923 and the maximum was in 1964. Since attaining highest levels in 1964, levels have been decreasing gradually with occasional remarkable rises during el-nino years. The decline in water level is normally attributed to several factors including drought, watershed management and excessive outflow. It believed that level changes in the lake are mainly influenced by hydro-meteorological factors. (LVBC, 2006). Prolonged droughts may therefore have significant effects of lake levels.

Decline of water levels is a major threat in Lake Victoria which is resulting in losses amounting to millions of dollars every year (LVBC, 2006). The communities that depend on the lake have also been

affected through changes in availability of domestic water, decline in fish catches, reduced crop production and increase in prevalence of water related diseases (LVRLAC, 2006). Although the impact of lake level changes on fisheries, aquatic plants and organisms have been studied in depth in (Kairu, 2001; Jewitt, 2002;USDA, 2005; LVBC, 2006) the socio-economic impacts of water level changes have not received much attention. The main objective of this study was to investigate the impacts of Lake Victoria level changes to local people around the lake. Specifically the study looked at how extreme low water levels from 2004 to 2006 could have influenced the availability of domestic water, fish catches, crop production and prevalence of water related diseases in rural settings. The study also characterized the societies around the lake establishing their means of livelihood and how they have been affected by lake level changes. Livelihood is defined as adequate and sustainable access to income and resources to meet basic needs including adequate access to food, potable water, health facilities, educational opportunities, housing and time for community participation and social integration Frankenberger (1996). Sustainable livelihood is a livelihood that can cope with and recover from the stresses and shocks and maintain or enhance its capabilities and assets both now and in the future without undermining the natural resource base (Chambers and Conway, 1991).

2. STUDY AREA

The study area, Missungwi District is located in Mwanza region, Tanzania on the shores of Lake Victoria. It is bordered to the west by Mwanza city, to the east by Kwimba district, to the north by Magu and by Shinyanga Region to the South, and Geita, Sengerema districts to the Southwest (URT, 2004). The district lies between 2^0 and $3^030'$ South of Equator, $31^045'$ to $33^030'$ East of Greenwich. Its altitude ranges from 1000 to 1500 masl. The total area of Missungwi district is 2,553 km^2 of which 175 km^2 are under Lake Victoria waters (URT, 2004). According to the 2002 Tanzanian National Census, the population of Missungwi district was 256,133 with 125,380 males and 130,753 females. Out of this 20,604 live in Missungwi town which is an urban centre (URT, 2004).

The climate in Missungwi is characterized by bimodal rainfall pattern, with short rains falling from October to December and the long rains from March to May. Average annual rainfall is 930 mm. (URT, 1997). Temperature in the area is to some extent influenced by Lake Victoria, and it ranges between 25 and 28^{o}C. On average the temperature peaks between September and December and deeps to lowest temperatures (11 to 20^{o}C) during dry season from June to August (URT, 2004). The study was conducted in 13 villages in Missungwi district selected according to their proximity to the lake or vulnerability of their means of livelihood to lake level changes.

3. METHODOLOGY

The study involved collection of qualitative data through house holds questionnaires, interviews, transect walk, informal interviews with key informants and focused group discussions. Statistical data was gathered from Missungwi district authorities to describe trends of fish catches, cases of water related diseases, crop production and livestock. In addition data on lake levels, rainfall and area under cultivation was also gathered. Diseases data was gathered from Missungwi district hospital and a total of 140 questionnaires were administered.

The key informants interviewed included the District Water Engineer (DWE), District Agriculture and Livestock Development Officer (DALDO), District Fisheries Officer (DFO), District Health Officer (DHO), Village Chairpersons, and Village Executive Officers.

Focused group discussions were conducted in one selected village, with the participants drawn from two sub-villages (*vitongoji*) namely Mwajombo and Nyahiti based on various demographic factors. The focus of discussion was on the following issues: indicators which enables villagers to know that lake levels are changing, livelihood activities and whether the incidences of water related disease such as malaria, diarrhea and schistosomiasis had been increasing over time or not. Others issues covered were time of the year when food is a problem and why, age groups (e.g. infants, youths, adults, or elderly) most affected by shortage and possible explanations for this.

Transect walk was carried out using two routes walking with key informants. The first route run from lake shore to the east of Mwajombo village and the second one from Chole to Kigongo and Bukumbi sub villages using a canoe. Information was gathered through observations and by questioning the accompanying informants. Information noted included grazing land, water sources, land under cultivation, uses of water for irrigation and livestock watering.

The data collected were analyzed using the Statistical Package for Social Scientist (SPSS) version 11.0 and Microsoft Excel spreadsheet. The data from household questionnaire were coded and entered in the SPSS and then analyzed using frequency tables, percentages and cross tabulations.

4. RESULTS

4.1 Rainfall pattern and Lake level variations

According to household questionnaires majority of the people 73.6 % believed that there was water shortage in 2006 related to drop in lake levels. There was somewhat low percentage of people who indicated that there was also a shortage in 2005 (18.6%) and even less 5.7%, 1.4% and 0.7% in 2004, 2003 and 2002 respectively. The results strongly suggest a link between decline in lake levels and water shortage felt by local people. It may be noted that although droughts (below average rainfall) was experienced in Tanzania for three consecutive years prior to 2006 (Fides, 2008) acute water shortage was only felt in 2006 when levels dropped sharply. This also suggests the important role of the lake in shielding people against droughts. The results tends to suggest that if there was no drastic change in water levels water shortage would have not been felt so strongly as the case was in the lake region in 2006. A drastic change in water level in Lake Victoria was reported by Lake Victoria Environmental Management Project (LVEMP), (LVEMP, 2006). Further analysis indicates a seasonal variation in lake levels corresponding closely to rainfall pattern. The lake levels peak in June after the long rains and continuously drop to lowest between October and November. On average the range between maximum and minimum level is 0.4m (Figure 1).

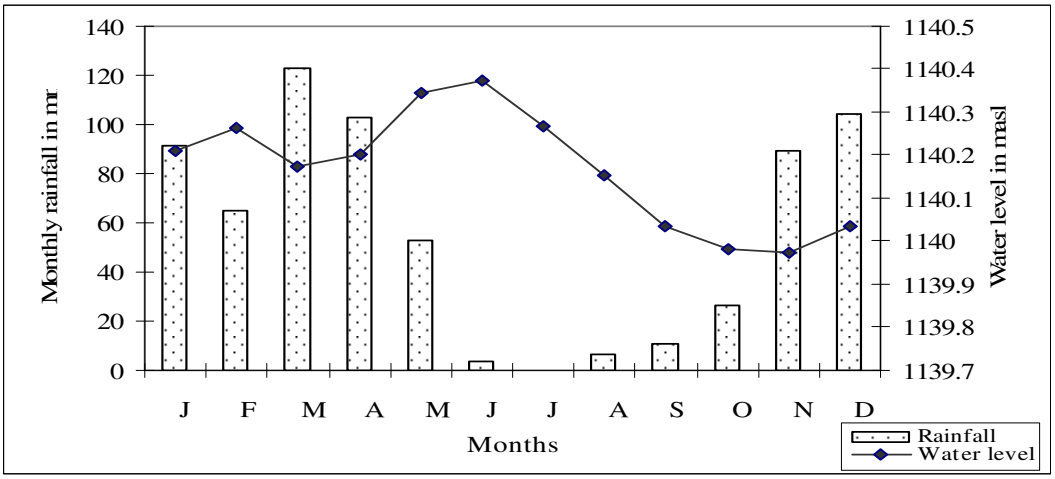


Figure 1: Seasonal variation of rainfall (Missungwi) and Lake Victoria lake levels (Mwanza south)

4.2 Means of livelihood

The communities around the Lake Victoria in Missungwi engage in farming, livestock keeping, and fishing. Farming was the major economic activity, providing income and food. In fact, of the 140 households within the thirteen villages surveyed, 113 households (or 80.7%) engage in farming. Table 1 describes the sources of livelihood of head of households in the surveyed area. In this area fishing was not a major economic activity with only a few people (7%) of respondents engaged in this activity as the main source of livelihood. Livestock keeping is also another important activity in which the local communities engage. Most of the people practice both farming and livestock keeping 43%. Other means of livelihood include fish vending (1.4%), business (6.4%) and employment in public or private sectors (6.4%).

4.3 Combined impact of lake level recession and droughts on agriculture

The impacts of lake level recession and droughts can not be discussed in isolation because to a large extent recession is attributed to prolonged drought As pointed out in section 4.2 agriculture is the main source of income and food for the lake shore communities in Missungwi district. Crops grown in the area include maize, sweet potatoes, and cotton, sorghum, millet, paddy, cassava and horticultural products. Horticultural crops are grown in the lake buffer zone where water is available all year round while the rest of crops are rain-fed. Production of horticultural products depends on some form of irrigation using lake water. Due to high cost of pumping most farmers fetch water by buckets to irrigate crops. This is an important source of income and a coping mechanism for effects of droughts.

Table 1: Sources of livelihood for Communities around the Lake Victoria in Missungwi District

No.	Source of Livelihood	Frequency	Percentage of Household	Cumulative Percentage
1	Farming	22	15.7	15.7
2	Business	9	6.4	22.1
3	Fishing	7	5.0	27.1
4	Livestock keeping, farming & fishing	35	25.0	52.1
5	Formal Employment	9	6.4	58.6
6	Farming & Livestock Keeping	43	30.7	89.3
7	Farming & Fishing	13	9.3	98.6
8	Fish mongering	2	1.4	100.0
	Total	**140**	**100.0**	

Source: Field survey March – April, 2007

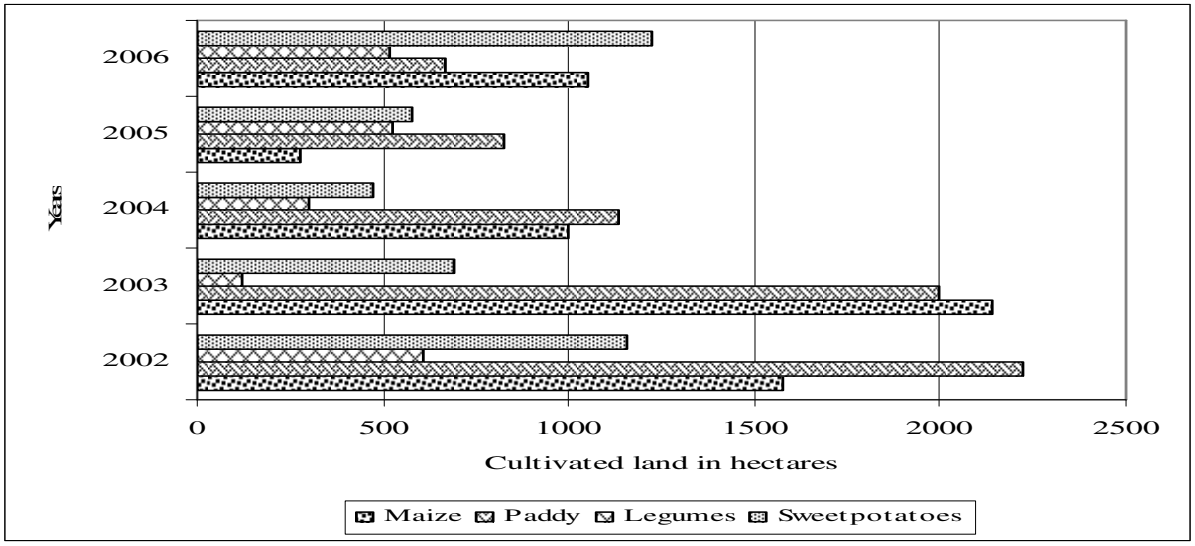
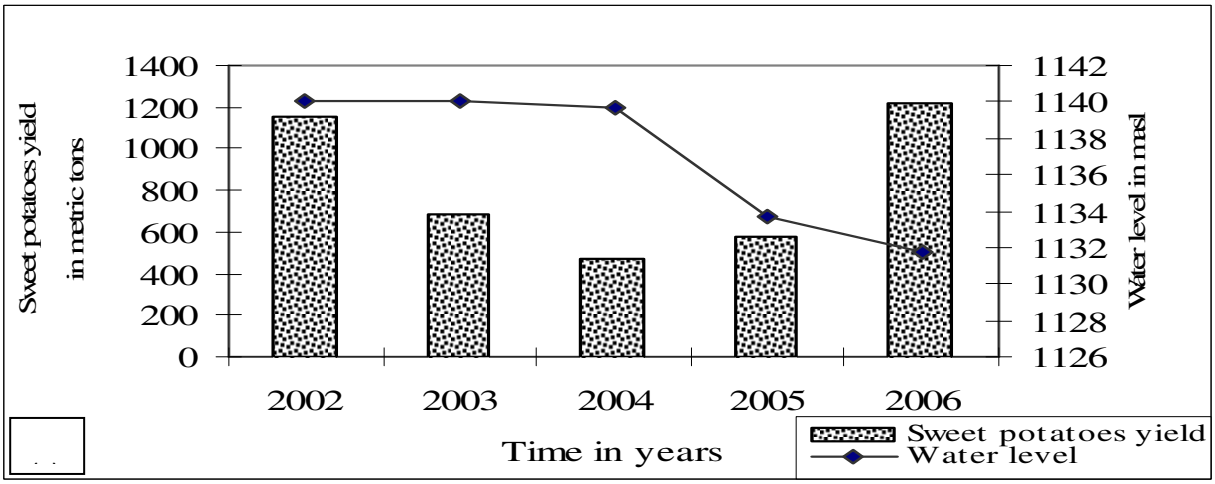


Figure 2: Cultivated area in (hectares) by crop in Missungwi District



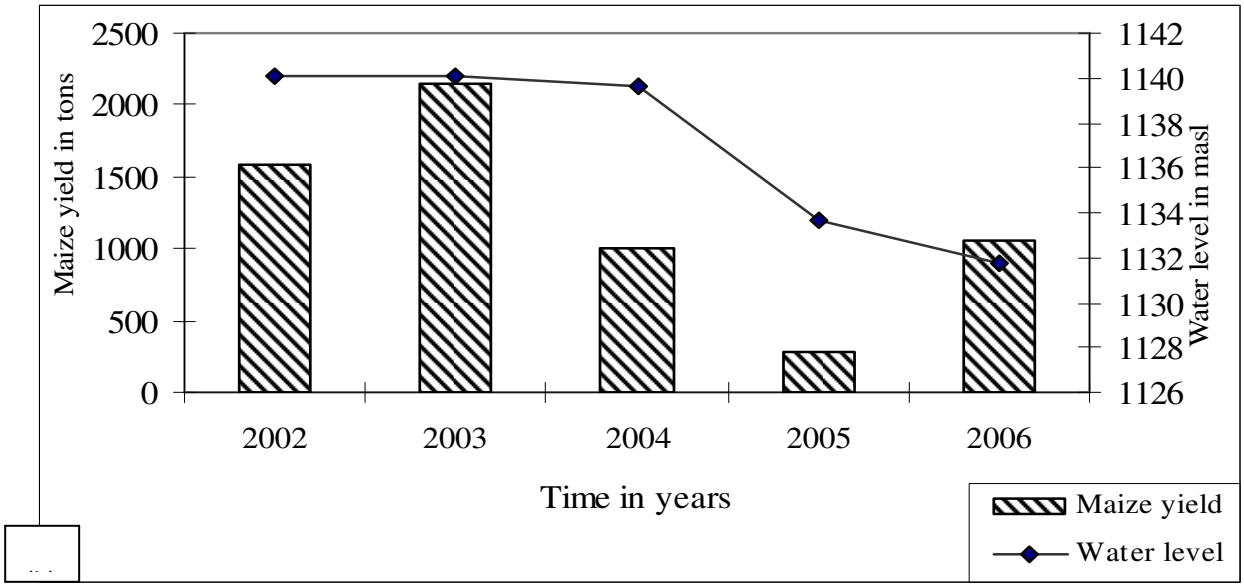


Figure 3: Annual production of Sweet potatoes (a) and Maize (b) in Missungwi district

During study period (2002-2006) farming activities were affected by both drought and recession of lake levels. Rain-fed Agriculture was hit by prolonged drought between 2003 and 2006. Data gathered from DALDO Missungwi shows declining production of maize, paddy and sweet potatoes between 2002 and 2005 and a sudden increase in 2006 Figure 2.

Low production in food crops coupled with recession of lake levels eventually lead to invasion of the ample land created by receding waters in Missungwi. The beach in Missungwi is gently sloping and slight changes in lake levels create a huge portion of land which is well watered. Analysis of data collected indicates that farmers in Missungwi used this portion of land for agriculture and boosted their production. Statistics gathered from DALDO office in Missungwi shows acreage for maize and sweet potatoes increased four times and two times respectively in 2006 (Figure 2) resulting in increase in proportional increase in production of these crops (Figure 3).

A combined effect of drought and excessive draw down of the lake lead to invasion of the protected lake buffer zone which is important for maintain fish breeding sites and water quality (Katunzi, 2003). During a field survey, fish experts expressed much concern on pollution of the lake by agricultural activities like these which may result in severe depletion of fish stocks especially the indigenous types preferring to breed in shallow waters. It was also noted that buffer zone agriculture is prohibited by law but people fail to comply because of lack of reliable means of getting food and income. It is therefore important to help the buffer zone communities to adopt means of obtaining food and income away from the protected area if ecological integrity of the lake is to be realized. The study results suggest that excessive draw down of the lake should also be avoided and law enforcement increased to protect the lake ecosystem. These measures are considered important since in the near future, because population growth is going to put enormous pressure on the lake and impacts can be devastating.

4.4 Impact of drought and lake level recession on livestock

Lake Victoria zone is famous in Tanzania for livestock and a -major source of beef. However prolonged droughts in recent times have seen pastoralists from Lake Zone migrating to wetlands in Mara and great Ruaha rivers in search of fodder and water. Extreme droughts lead to death of stocks from starvation, lack of water and drinking of poor quality water in stagnant pools as a result of water shortage. Pastoralists around the lake use the lake for watering heads especially in shallow bays. With prolonged drought there is a tendency for flocks to move towards the lake seeking for pasture and water. This was confirmed with data from DALDO office in Missungwi which shows 65% increase in livestock between 2002 and 2006 (Table 2). This is a rather high growth which can not be achieved without substantial migration.

Table 2: Livestock population data for 2002 and 2006 Missungwi District

TYPE	2002	2006	Percentage increase
Cattle	160,465	244,161	52
Goats	33,903	84,106	148
Sheep	12,827	12,576	-2
Total	**207,195**	**342,849**	**65**

Source: Field survey March – April, 2007

The study revealed that most of livestock keepers (67.1%) depend on the lake water for watering their flocks; 12.9% depended on ponds and 20% on streams. During droughts the Lake provides the only means for watering flocks leading to increase in number of flocks on shore. Another factor which attracts flocks near the lake is fodder. During house hold survey it was discovered that most of the people (40%) feed their flocks near the lake shore followed by highlands 31.4%, low lands (17.1%) and others 11.4%. Just like in agriculture, drought causes flocks to concentrate near the lake and may compromise with ecological integrity of the lake. Experts interviewed during field studies had the opinion that a lot of animals died during extended droughts prior to 2006 because of consuming unwholesome water in stagnant ponds infested with worms. This potential impact of droughts on livestock could not however be substantiated with data.

4.5 Impact of lake level recession on fisheries

Fisheries constitute a stable source of livelihood in the lake zone (Yongo *et al.,* 2006). Although the percentage of people who engage only in fishing is low (5% Table 1) most respondents combined fishing with other activities like livestock keeping and farming. About 9.3% of population practice farming and fishing and 25% combine livestock fishing, farming and fishing. Fish caught is both sold and used at home as protein source. The majority of subsistence fishermen do fishing for their own use and selling (83%) as compared to those who's main use is for selling (commercial fishers) 17%. This indicates the relative importance fishing as a source of food and income to Missungwi communities.

The main types of fish caught in the study area are (local names and botanical names in bracket) Nile perch (Sangara, *lates niloticus*), Nile-tilapia (Sato, *Oreochromis niloticus*) and Sardine (Dagaa, *Rastrineobola argenta*). There are 14 landing sites in Missungwi district including; Mwasongwe, Kigongo, Chole, Mwalogwabagole, Nyahiti, Sawenge, Mikuyu, Mitego, Nyabusalu, Mbarika, Lugobe, Mondo, Lubili and Ilalambogo. Fish data collected from Missungwi fisheries department (Figure 4) shows a continuous decline of fish catches (total of Nile-perch, Nile-tilapia and Sardine).

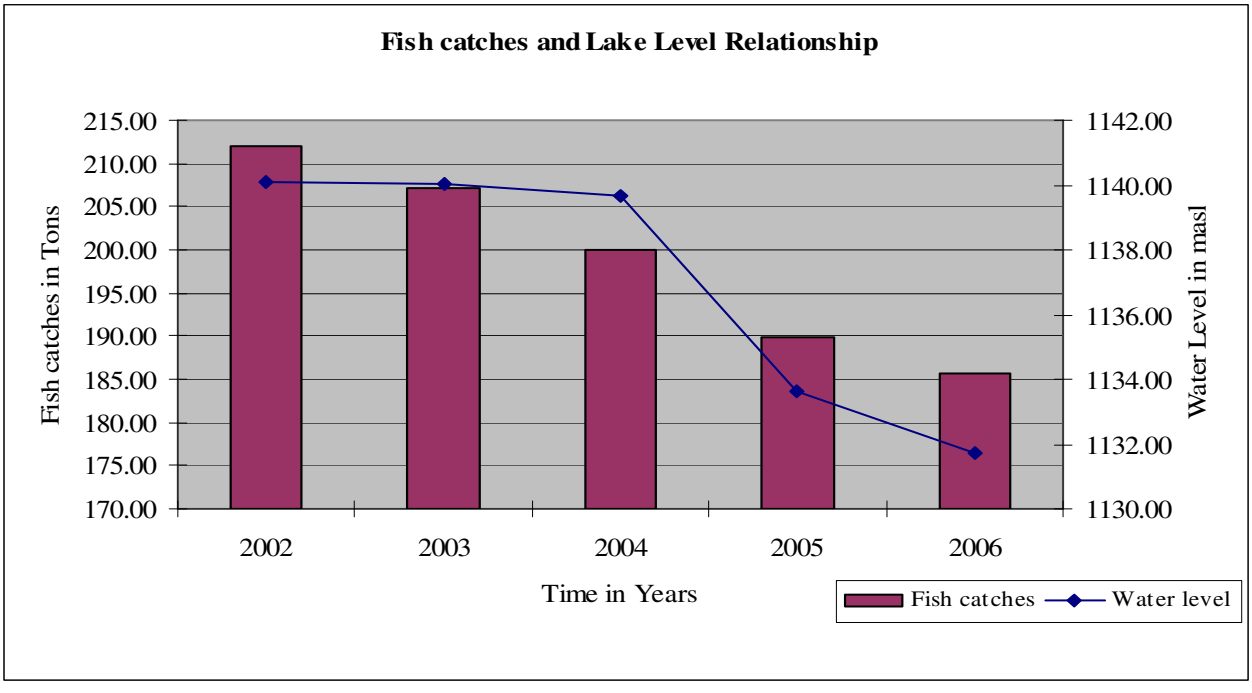


Figure 4: Trend of fish catches in Missungwi district total of Nile-perch, Nile Tilapia and Sardines.

The decline in fish catches was concurrent with decline in lake levels suggesting a strong link between the two. Factors that could have contributed to this decline include reduced breeding and nursery sites, increased inconvenience at landings and drying up of landing sites. Retreat of water in shallow zones where most of the small scale fishing is mainly done could also have a very significant impact on fish catches. Kairu (2001) also noted that the very young fish of different species find shelter from predators, as well as food, in shallow waters. Retreat of water from shallow zone exposes this fish to predators and reproduction of stock can severely affected if sustained for low time.

4.6 Impact of drought and lake level recession on water supply

Main source of water for domestic use in the study area is un protected shallows wells. The water has a relatively poor taste. The results of the study indicates the following sources of domestic water supply with number of people depending on such sources in brackets; un protected shallow wells (37%), protected wells (25%), lake (28%), ponds (9%) and piped water (1%). Average water consumption established during house hold survey is 18 l/p/d. This rate is below the target set in the Tanzania National Water Policy (NAWAPO), (URT, 2002). The amount is also below 20-40 l/p/d which Butterworth and Soussan, (2001) found out as water consumption rate in the majority of rural areas of Africa. Gleick (1996) proposed a consumption rate of 50 l/p/d as minimum requirement for personal hygiene.

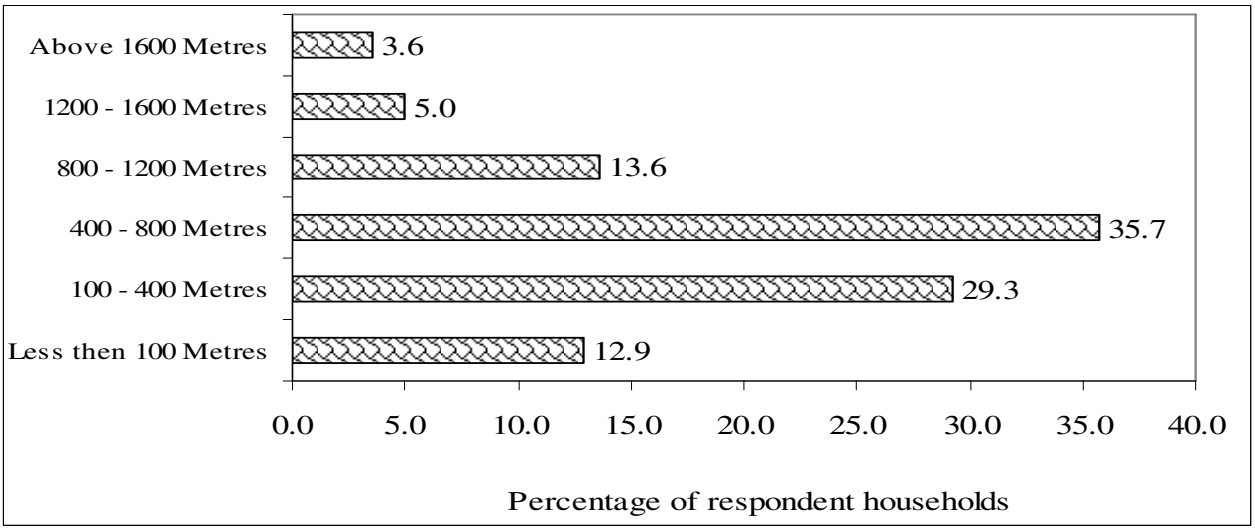


Figure 5: Distance traveled to fetching water in study area. (Field survey, 2007)

There is relatively short distance for fetching water (Figure 5) and less time spent due to influence of the lake on water supply in the study area. About 80% of people obtain water within 1km from their house hold and spends between 15 and 45 minutes fetching water (Figure 5). This indicates a high potential to achieve the NAWAPO target (25 l/p/d from a protected source within 400 m) if the existing sources are improved. Results of the study show that about 43% of the people in the lake shore communities in Missungwi obtain their water within 400m although majority of them get it from un protected shallow wells. Water supply situation deteriorates during dry season when yield in wells decreases causing excessive waiting time and diverting most of people to lake for their water demands to save time. The main group involved in fetching water is women (42%) as compared to men (3%). Among boys and girls, girls accounted for 16% of water fetchers as compared to only 1% for boys. This situation was expected due to culture of the local people in the study area.

During focus group discussions it was revealed that most people who are sufficiently close to the lake draw water directly from the lake for domestic uses because of salty taste of ground water. These people also use the lake directly for bathing and washing. The shallow wells in study area also dry up during dry season and when drought is experienced in the area leading to increased utilization of lake for domestic water supply. Most people in the study area use lake water (67%) and streams (21%) for domestic supply during dry season.

Direct relationship between availability of water in shallow wells and water levels in the lake was difficulty to establish due to lack of monitoring wells. However period of critical water shortage in the area coincides with the timing of lowest lake levels and the two can not be considered totally independent. Most of people complained of critical water shortage in 2006 when both drought and low lake levels were experienced. Most probably drying up of shallow wells was also influenced by excessive low levels in the lake.

4.7 Impact of lake level recession on health

Receding lake levels could change the prevalence of water related diseases by enhancing breeding or exposure to transmitting vectors, deterioration of personal hygiene due to lack of enough water and increasing possibilities for contracting water borne diseases through use of unsafe sources of water. The most common water related diseases identified in the study area were diarrhea, dysentery, schistosomiasis and malaria. For purposes of analysis dysentery and diarrhea were combined.

Diarrhea is related to consumption of contaminated water or food. Diarrheal diseases including cholera usually happen in places with poor excreta management and personal hygiene. The tendency for large number of people using the lake directly for bathing while others draw water from the same for drinking and cooking can significantly increase the risk of contracting diarrhea.

Schistosomiasis is spread by snails which live in water and victims are normally infected while in contact with water. Increased contact with lake water has been associated with schistosomiasis infection for example Handzel *et al.,* (2003). Swimming, bathing, fishing, washing clothes, and fetching water from the lake increases the risk of infection Handzel *et al.,* (2003).

Malaria is spread by vectors that are strongly affected by environmental factors (Pattanayak *et al.,* 2003). *Anopheles gambiae* which spread malaria reproduce very well in water with near neutral pH as opposed to acidic one. Vegetated swamps tend to produce acidic water which create unfavorable environment for growth of mosquitoes. Further more Wandiga (2006) has shown that Papyrus found in many of the swamps in valley bottoms in East Africa excrete oil which inhibit the growth of *Anopheles gambiae*. When wetlands are cleared water collecting in puddles that are more open to sunlight have a more neutral pH which favors the growth of the vector. It may therefore be argued that decline in lake levels if accompanied by massive clearing of the swamps such as for agricultural activities may significantly increase the prevalence of malaria.

Investigation of the changes in cases of water related diseases was done using disease data collected from Missungwi district hospital. Data was collected for cases of malaria, diarrhea, dysentery and schistosomiasis.

Table 3 presents a local perception on the causes of water related diseases as captured in the questionnaire survey. The results show a high understanding of the real causes of the diseases indicating a well informed society.

Table 3: Local perception on causes of water related diseases

Description	Frequency	Percentage
Consumption of contaminated water	29	20.7
Poor environmental sanitation	41	29.3
Fetching water from lake	17	12.1
Poor handling of foods, fruits and vegetables	31	22.1
Not applicable	22	15.7
Total	**140**	**100**

Source: Field survey March – April, 2007

For example about 70% of the respondents believed that water related diseases are either caused by drinking contaminated water, poor environmental sanitation or poor handling of food, fruits and vegetables. Table 4 shows distribution of common water related diseases in the surveyed area as captured through questionnaire survey. The most common problem seems to be malaria which has a high prevalence 41%. There is also a fairly high rate of schistosomiasis (15%) as estimated from house hold survey.

Variation of cases of diarrhea, dysentery malaria and schistosomiasis were studied using data for annual cases reported at Missungwi district hospital. Results show no specific temporal pattern related to

lake level variations or droughts except for schistosomiasis (Figure 6). There is an increase in number of cases between 2002 and 2005 for all diseases but this seems to be largely related to normal population growth.

Table 4: Distribution of common water related diseases in study area

Diseases	Frequency	Percentage of household
Diarrhea	40	28.6
Malaria	58	41.4
Schistosomiasis (Bilharzias)	21	15
Dysentery	6	4.3
No cases	15	10.7
Total	**140**	**100**

Source: Field Survey, 2007

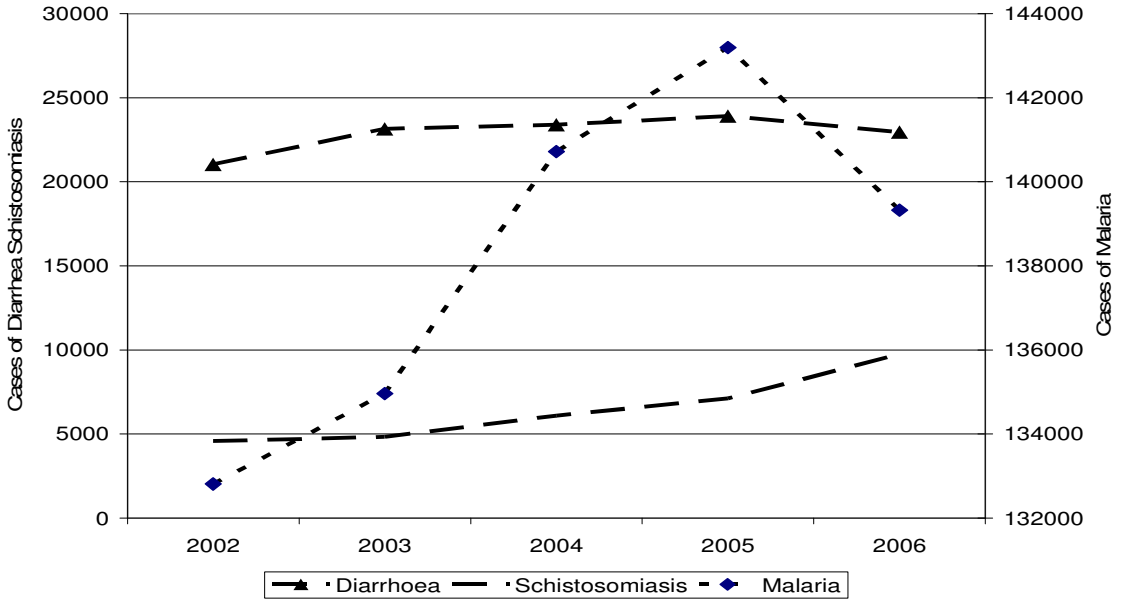


Figure 6: Variation of prevalence of water related diseases in Missungwi District s

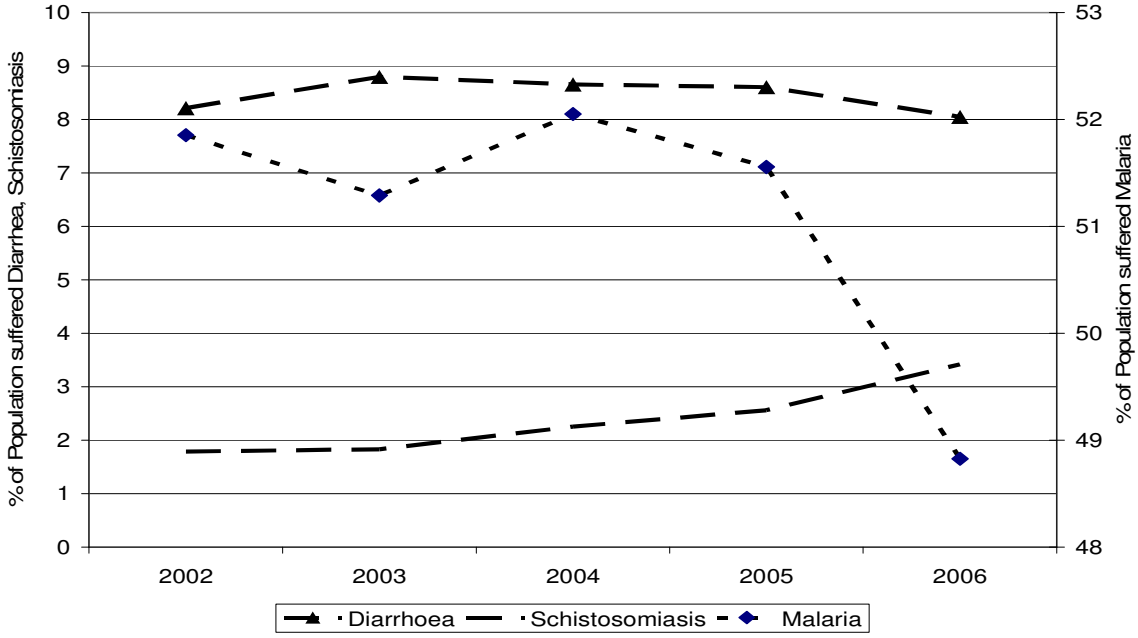


Figure 7: Variation of prevalence of water related diseases in Missungwi District s

To remove the effect of population growth, prevalence rates (cases per population) are used. When this is applied the increase in rates of infection of schistosomiasis becomes more evident as others show no relatively no change. (Figure 7). The prevalence rate of schistosomiasis seems to be increasing during the study period. Although the prevalence rate for schistosomiasis is low (1-4%) the increasing rate is alarming. As pointed out before increased contact with lake water would be responsible for increasing rate of infection. From what we know in the study area this trend could be influenced by water shortage from common sources including wells as a result of which people resort to fetching water in the lake and increase their exposure to infecting vectors.

CONCLUSIONS AND RECOMMENDATIONS

The objective of the current study was to identify and estimate the magnitudes of the potential impacts of Lake Victoria level changes to local communities around the lake. The study was motivated by drastic changes in Lake Victoria levels between October 2005 and February 2006. Questionnaire survey was conducted in 13 villages and involved 140 house holds. Results of the study suggest a direct relationship between decreasing water levels and prevalence of schistosomiasis, decrease in fish catches and drying up of shallow wells. The prevalence rate of schistosomiasis is low but it is increasing at fast rate. Increased utilization of lake water for domestic purposes and irrigation is thought to be a major factor behind this trend. Excessive draw down of the lake is also threatening sustainability of the fishing industry as it contributes to pollution of the lake and disappearance of breeding and nursery sites. Current data shows continuously declining fish catches. The subsistence economy around the lake is vulnerable to lake level variation and suffers severely with either droughts or excessive draw down of the lake. Lack of stable means of income (poverty) drives people to the buffer zone where production of vegetables with bucket irrigation has become common practice to supplement incomes. This practice is unsustainable as it compromises the ecological integrity of the lake. If the lake levels were to be controlled it would be desirable to maintain levels higher enough to cover the shallow breeding sites. This would discourage utilization of such areas for agriculture. Awareness raising and education campaigns followed by strict law enforcement are also recommended to protect the ecological functions and ecosystem service of the lake.

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