DAM CONSTRUCTION FLAWS AND THE RECEDING LAKE VICTORIA - UGANDA

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ABSTRACT

Most Dam construction undertakings in Africa have often been done haphazardly due to limited objective assessment and prediction of water inflows and outflows. In Uganda, miscalculations and technical errors resulting from the construction of a second dam (Kiira) parallel to the old Nalubaale dam on River Nile has forced Lake Victoria water level to drop by about 2 meters between 2002 and 2005. A 1.3 kilometer canal constructed before the old dam diverts some water to the new dam in such a way that the two dams in combination utilize the same water drop from Lake Victoria. Daniel Kull 2006, approximates severe drop in Lake Victoria water level in the period 2004-2005 to 55% water over release from the two dams, and 45% to drought. While the agreed sustainable out flow about 500 m^3/s, Uganda has been releasing an average of 1100 m^3/s in the month of December 2005. The current events also pose severe threat to the flows of river Nile. The visible impacts range from destruction of the Tilapia fish breeding grounds and a severe decline in power generation by about 69% (from 265 MW in 2003 to 185 MW in 2006). In order to attain the sustainable outflow and keep the lake level at its already worrying state, one of the dams needs to be shut down. This paper reviews flaws and impacts of this dam 'investment', controversies surrounding the cause of severe drop in the lake level and presents responses to the problem. It is anticipated that this may advice proposed dam projects on the River Nile.

INTRODUCTION

Lake Victoria is the second largest freshwater Lake in the world with a total surface area of 68,800 km^2 and has a catchment of 193,000 km^2. The lake is shared between Kenya (6%), Uganda (43%) and Tanzania (51%). The lake and its basin lie in the Inter-tropical Convergence Zone (ITCZ) endowed with high rainfall amounts ranging between 1200mm and 1700mm annually. The abundant natural resources the lake is endowed support livelihoods of about 30 million inhabitants found in the basin. These resources namely; water; fisheries and biodiversity make the lake an important socio-economic resource to the East African Region (Lake Victoria Basin Commission, 2006).

Before the construction of Owen Falls Dam (re-named Nalubaale) in 1954, the outflow from the lake through River Nile was naturally controlled by Ripon Falls. With the construction of the

dam, Ripon Falls was submerged. An "Agreed Curve[1]" was therefore developed to dictate the amount of water released from the Lake by the dam. Up to 2000, not all the water being released by Nalubaale dam was being utilized for hydropower production. Therefore in order to adhere to the agreed curve out flows, sluice gates were used to spill out excess water.

The need for more power in Uganda resulted in a parallel dam (Kiira dam extension) being added one kilometer from the existing Nalubaale dam to generate 200 MW of power. A 1.3 km canal above Nalubaale dam diverts water to Kiira dam in such a way that the two dams in combination control the Lake Victoria water outflow. Kiira dam extension was built to utilize the excess water being spilled by the sluices of Nalubaale dam. Construction of Kiira dam extension started in 1993 and between 2000 and 2002 the dam extension was fully operational with three turbines. The two dams (Nalubaale and Kiira referred to as Owen Falls Dam Complex in this paper) utilize the same "head" (water drop) from Lake Victoria.

The flaws of Kiira dam extension stem from incomprehensive analysis of existing 100 year time series hydrologic data of Lake Victoria. It was a limitation to base the design of the dam on only the higher average flows experienced in the period 1965-1998, neglecting other trends of out flows and most important the climate factor. The dam project did not heed to caution by World Bank that if the low inflows experienced by the lake the in period before 1961 reoccurred, the operation of dam extension would not be sustainable. This resulted to out flows beyond the permitted sustainable levels thus contributing to 55% drop in Lake Victoria level by approximately 2 meters as of 27th December 2005.

The most articulated effects of the drop in the lake level are various and these range from: Acute electricity power shortages that have affected both national and local revenues; Impediment to use of hydraulic and civil structures related to water use on the shore lines such as docks and water works facilities and alteration of the zonation of the lake ecosystem leading to destruction of fish breeding grounds.

The process of understanding and attempting to address the severe drop in the lake level has been controversial. While the government of Uganda blames the drought as the principle cause of the problem, studies by independent experts and Civil Society Organizations both in Uganda and the other two countries sharing the lake hold dam operations in Uganda to be the major cause of the problem. The efforts of Civil Society Organizations in empowering the general public with dam operation information are likely to make the government accountable.

This paper reviews flaws and impacts of this dam 'investment' to advice proposed dam projects on the River Nile. The paper accounts for contribution of the Owen Falls Dam Complex to severe drop of Lake Victoria. It also highlights most recognized effects, and responses to the problem.

[1] The Agreed Curve outflow is the natural flow which would occur, with or without drought conditions, if the Owen Falls dam was not built (with Ripon Falls being the natural control). This was based on agreements in 1949, 1953 between Egypt and Britain and again in 1991 between Uganda and Kenya.

CONTRIBUTION OF NALUBAALE AND KIIRA DAM COMPLEX TO SEVERE DROP IN LAKE VICTORIA

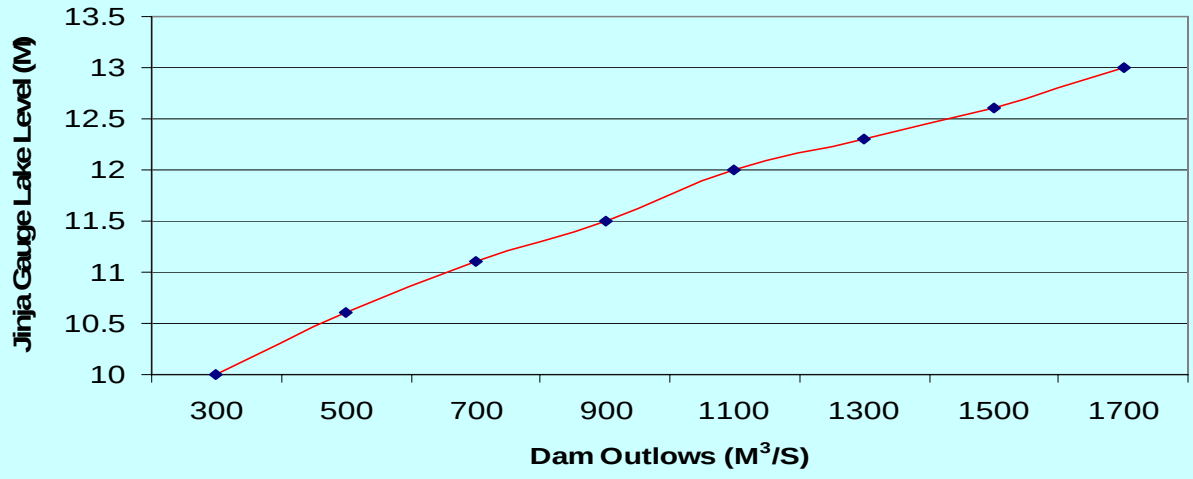
Daniel Kull's 2006 report, ***"Connections between Recent Water Level Drops in Lake Victoria"*** provides a comprehensive analysis of the impacts of both dam operations in Uganda and drought on Lake Victoria's water levels. This paper emphasizes outflows resulting from the operation of the dam complex.

In summary, the report cited above gives a detailed account of the contribution of both drought and over release of the water by the dams. The report provides detailed analysis of the annual water balances of the lake under different scenarios; namely; *No drought, Mild drought, Strong drought and Severe drought scenarios*. A non-drought year was analyzed along with mild, strong and severe drought year scenarios. The report concludes that; "Lake Victoria level drops occurring in 2004 and 2005 were about 45% due to drought and 55% due to over-releases from Nalubaale and Kiira" (Daniel Kull, 2006).

With the construction of Owen Falls Dam (Nalubaale) in 1954, Ripon Falls which naturally regulated the outflows from Lake Victoria was submerged. A mathematical equation called the "Agreed Curve' (Figure 1) was developed basing on agreements in 1949, 1953 between Egypt and the British Colonial Government on behalf of Uganda, and again in 1991 between Uganda and Kenya. The Agreed Curve policy was intended to ensure that water releases by the Nalubaale dam correspond to the natural flow of the river Nile before damming. Adherence to the Agreed Curve meant that this would dictate outflows from the lake and therefore fluctuations in rainfall determined how much water would flow out of the lake, as would be in a natural state. Dam operators adjust the outflow based on a water balance of the lake computed every ten days (World Bank, 2002). Not all the water being released by Nalubaale dam was being utilized for hydropower production. In order to adhere to the Agreed Curve out flows, sluice gates were used to spill out excess water.

The Agreed Curve policy was adhered to until 2000. However after the commission of Kiira dam extension between 2000 and 2002, disparities started appearing between expected and observed water releases.

Figure 1: Agreed Curve for Water Release at Owen Falls Dam



Kiira Dam Extension

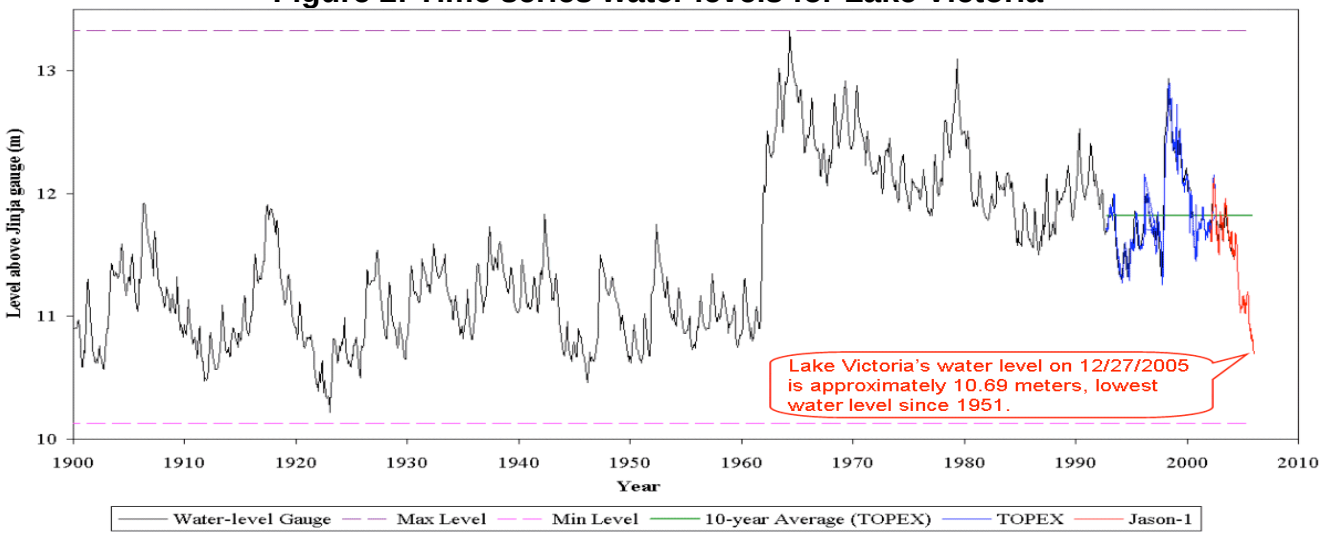
The need for more power in Uganda resulted in a parallel dam (Kiira dam extension) being constructed one kilometer from the existing Nalubaale dam to generate 200 MW of power. A 1.3 km canal above Nalubaale diverts water to Kiira in such a way that the two dams in combination control the Lake Victoria water outflow. Kiira dam extension was built to utilize the "excess" water being spilled by the sluices of Nalubaale dam. Construction of Kiira dam extension started in 1993 and between 2000 and 2002 the dam extension was fully operational with three turbines. The two dams (Nalubaale and Kiira) utilize the same water drop from Lake Victoria.

Kiira Dam Extension Design Flaws

The over design of the Kiira dam extension resulted from incomprehensive analysis of historical hydrological data of Lake Victoria water levels and neglecting future impact of climate. Daniel Kull 2006, observes that, the design and cost-benefit analysis were based on the higher average flows experienced after 1961. The contractor assumed a 99% probability for the continuation of the higher flows. This assumption was supported by a break-even analysis that showed that only a 61% probability for the high flows to continue was needed for Kiira to produce a net benefit. Caution was however given that "Kiira would not be economic if the low in-flow observed before 1961 returned and continued" (World Bank, 1991).

The design decision was based on the higher flows of 1965-1998, neglecting the lower pre 1961 flow shown in Figure 2. The contractor assumed that it was more likely that the higher post 1965 inflow pattern would continue as opposed to a reversion to the pre 1960 low flows. The dam contractors also seem to have not factored in the likely impact of climate change in their cost benefit analysis, yet at the inception of this project in the early 1990s; the climate change problem was already a global concern.

Figure 2: Time series water levels for Lake Victoria



Data Source:
Historical water level gauge data from Jinja, Uganda (near Lake Victoria's outlet).
Satellite radar altimeter data from USDS/NASA/UMD at:
http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/

U.S. Department of Agricultural (USDA)
Foreign Agricultural Service (FAS)
Production Estimates & Crop Assessment Division (PECAD)

The fact that lakes and rivers are susceptible to some hydrological cycles, demands that the longest time series hydrologic data of lake Victoria should have been used for hydrologic statistical analysis for the design of Kiira dam extension. “As the number of samples grows, the accuracy typically improves” (Maidment, 1993).

At the early stages of receding lake levels in 2002, the World Bank’s Investigation Panel concluded that: “the Owen Falls complex (Nalubaale and Kiira extension) is over-designed and incapable of full capacity” (World Bank, 2002). This resulted to over release of water, a situation Daniel Kull 2006 links to 55% contribution to the low water levels of the lake.

Over Releases above the Agreed Curve by Owen Falls Dam Complex

Accounts by hydrologic engineers, journalists and high ranking public servants as summarized below, point to the conclusion that over releases from two dams in Uganda as a primary cause of the severe drops in Lake Victoria in recent years.

Daniel Kull 2006, observes that; during the 3 days of provided data, the estimated lake level at Jinja was about 11.24 m Nalubaale alone was releasing an average of 712 m^3/s. But in addition, at the same time Kiira was also releasing an average of 658m^3/s, such that for the lake level of 11.24 m, a total of average of 1370 m^3/s was being released. This is a full 630 m^3/s over the Agreed Curve (an over-release of 85%). In other words, this is almost double the prescribed release for the given lake level. This supports the conclusion that over-releases have contributed to lake level drops.

On March 1, 2005, a Ugandan engineer, Hilary Onek (who is also an MP for Lamwo County, Kitgum) claimed that over 1400 m^3/s was being released from Nalubaale and Kiira combined (Onek, 2005). On that date, the observed lake level was about 11.05 m (USDA, 2005), which according to the Agreed Curve, requires an outflow of 653 m^3/s. The total releases from the dams were thus on this day more than double the agreed release for the observed lake level.

The *Lake Victoria Policy Brief December 2005*, as quoted in Mugabe and Kisambira (2006), indicates that during November 2005 the average combined dam releases were about 1100 m^3/s. During that month, the average Lake Victoria level was approximately 10.8 m (USDA, 2005), indicating an Agreed Curve prescribed release of about 550 m^3/s. http://grdc.bafg.de

According to the WREM Hydraulic Model Study (2005b), at lake levels around 11.1m, combined (both dams) maximum hydropower production would result in total outflow of about 1460 m^3/s. It would thus appear, based on the analyzed flow data for August 2004, March 2005 and November 2005, that dam operators have been maximizing hydropower production, which is in violation of Uganda’s agreement with Egypt.

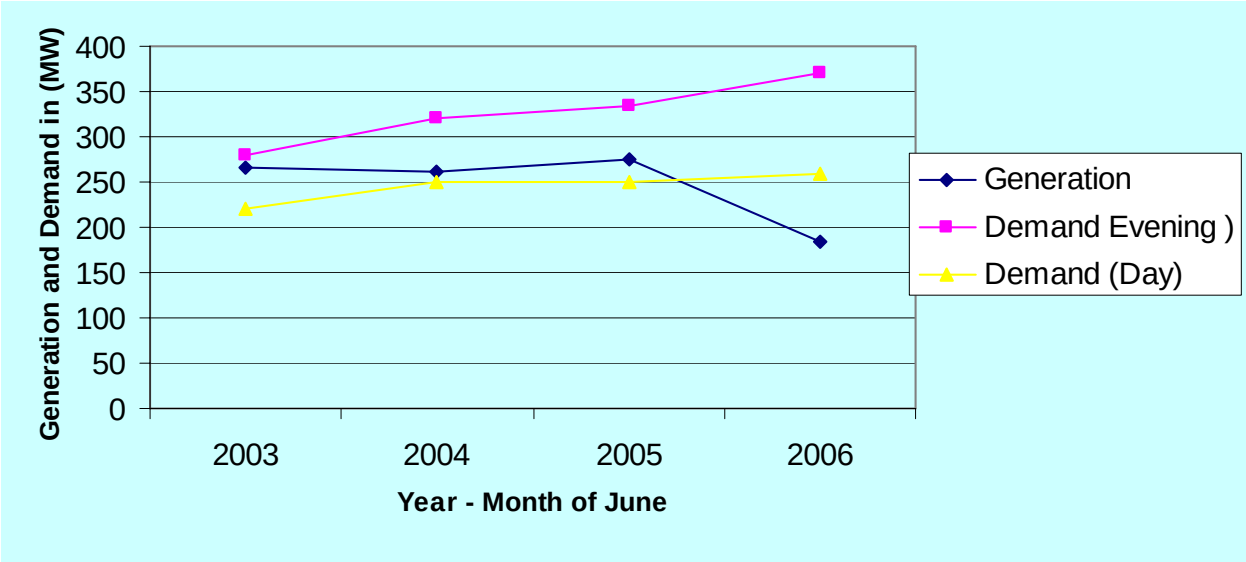
HIGHLIGHTS OF EFFECTS OF THE REDUCED WATER LEVELS

Well perceived effects of the drop in water levels are various and can range from: Acute electricity power shortages that have affected both national and local revenues; impediment to use of Hydraulic and civil structures related to water use on the shore lines such as docks and water works facilities and alteration of the zonation of the lake ecosystem leading to destruction of fish breeding grounds

Hydropower Shortages

The Construction of Kiira dam extension led to unsustainable outflow from the lake, which drastically led to decline in hydropower production by about 69% (from 265MW in 2003 to 185 MW in 2006). Figure 3 shows a strong inverse correlation between the decline in power generation and a steady increase in demand for electricity.

Figure 3: Negative correlation between Hydropower Generation and Demand



Power shortages characterized by load shading have led to decline in revenues from electricity generation, to local consumers and from foreign exchange earnings through export to Kenya and Tanzania with a suspension of a 30 MW supply contract to Kenya and erratic supply to Bukoba.

The tip of the iceberg on the local economy is summarized by Sylvia Juuko in the New Vision daily News paper of Saturday 3rd December 2005 quoted below, "Electricity consumption in August and September recorded a 2.4% decline hitting Umeme[2] earnings from power distribution. This resulted to a slump of Umeme's earnings by 2.9%. Umeme earnings declined from US$ 8.36 to 8.14 million (Bank of Uganda's Monthly Economic Review Report for November 2005).

[2] Umeme is a Company responsible for marketing hydro electricity power in Uganda.

Impediment to use of Hydraulic and Civil Structures on the shoreline

Fisher folks who used to land their fish catch on the shorelines now dock in the lake. Figure 4 (a) and (b) shows less useful fish landing structures constructed to ensure good fish quality. This has increased the cost of production and undermined income of fisher folks (Lake Victoria Basin Commission, 2006).

Transportation has been affected as vessels can no longer dock at ports due to shallow waters as shown in Figure 4 (a).

Figure 4(a): Majanji fish landing site, Uganda left on dry land due to lowering of lake level. www.eac.int/lvdp/lake_victoria_waterlevels_apr_06.pdf

Figure 4(b) Disrupted shoreline infrastructure like this small dock. (Photograph courtesy USDA Foreign Agricultural Service.); http://www.fas.usda.gov/

Docking facilities at Jinja, Mwanza and Port Bell require expensive modifications in order to continue to use them. These costs affect national budgeting and divert resources away from social expenditure. Similarly expensive plans are being prepared to extend water intake works at Kampala, Jinja and Kisumu.

Alteration of Lake Ecosystem Zonation

The decline in water levels has altered the natural zonation. The three zones namely; shoreline, littoral and pelagic areas are each meant to support a particular type of biodiversity and human activities. The most productive fish breeding areas have thus been exposed to various conflicting activities shown in Figure 5. These activities range from collection of water for domestic purposes, livestock watering to car washing, thus lowering the quality of water at the shorelines.

Figure 5: Conflicting uses facilitated by shallow shorelines as a result of low lake levels. (Lake Victoria Basin Commission 2006); www.eac.int/lvdp/lake_victoria_waterlevels_apr_06.pdf

RESPONSE TO THE PROBLEM

The response to a drop in Lake Victoria's water level has been controversial. While the public has tried to demand accountability from government, the government on its part has perused a defensive approach that has been characterized by controversial statements given by top government officials.

Demand for Social Accountability

Indeed application of science in environmental flow management provides essential data for river system management. Such data and scientific interventions yield sustainable positive impacts only with deliberate engagement of the civil society and independent experts in soundly judging proposed water applications in rivers. This has been lacking throughout Uganda's experience in dam construction. The lack of public information on water releases by the dams and river flows has pushed the government to be on the defensive side against the demands of the civil society and independent consultants on the lowest water levels in Lake Victoria in the last 50 years. Emphasis should be focused on civil society empowerment through advocacy

The Civil Society in the country has not been empowered to undertake civic engagement to demand for appropriate reforms, transparency and accountability from government officials. In the case of the Kiira dam extension, the general public was excluded from the programme. The government missed the opportunity of engaging Civil Society in development processes as a prerequisite to democracy building and empowerment of citizens to take part in decision-making.

This situation is changing as driven by vibrant growth of non partisan print media, the radio and other electronic media in the country. The Civil Society Organizations (CSOs) notably the National Association of Professional Environmentalists (NAPE) has taken a lead on empowering the communities with information and advocacy skills through workshops, seminars, press

conferences, radio and television talk shows to hold government accountable to the public and independent experts in the implementation of dam projects in the country.

The Civil Society in Uganda is gradually realising the indispensable role it can play to promote development in country. This was seen during '*the Save Mabira Forest Crusade'.* The last resort actions this crusade is shown in figure 6. At the pick of the electricity power crisis which was largely blamed on the over release of the water by the over designed Kiira dam extension, the government with disregard of public concern wanted to convert Mabira forest for sugar cane growing. Mabira forest is a unique equatorial forest ecosystem replenishing Lake Victoria through conventional rainfall ranging between 1200 and 1700mm annually. The forest is a natural habitat to vast forms biodiversity including endangered migratory bird species. The forest is recognized as a national treasure.

The short messaging service, internet and radio programs were effectively utilized by CSOs to educate the public. This mounted a lot of pressure on the government and was climaxed by a public demonstration (Figure 6) held on the 12th May 2007. The government had to drop the idea

Figure 6: The Army containing a public demonstration which effectively achieved its objective of saving Mabira forest" from destruction. Photo taken on the on 12th May 2005.
Source: The New Vision News Paper Tuesday, 15th May, 2007;

Government's Response

The Government of Uganda has been sluggish in facing the reality of the dam flaws and instead gone on a defensive side characterized by conflicting statements from line government officials. Below are some of the mixed messages about the dam operation controversy:

For example, an article in the Sunday Vision on 4 January 2006 states that "The (Study on Water Management of Lake Victoria) report heaped the blame for the continued falling water levels on the over leasing of water to generate electricity at the two existing dams, Kiira and Nalubaale" (Tenywa, 2006).
In the same article, a top officer of the Electricity Regulation Authority denied that the dams were at fault, blaming instead global warming. He said: "The new dam (Kiira) is supposed to

replace the old dam (Nalubaale), which has become obsolete" (Tenywa, 2006). The article reports that the sluice gates at Nalubaale had been closed, and all flows were now going through Kiira, "which then rules out the arguments of over leasing of water."

On 5 January 2006, the Minister of Water, Lands and Environment, is reported to have said that the Government was considering closing one of the dams in order to maintain water levels (Nyanzi and Nandutu, 2006). This confirms that both Nalubaale and Kiira are still in operation.

Conclusion

Since the full commissioning of the Kiira Dam Extension in 2002, the over release of water by the Owen Falls Dam Complex rendered the Agreed Curve less useful, thus contributing to over 50% drop in water level of approximately 2 meters. The dam flaws were a result of: incomprehensive analysis of the time series hydrologic data of the lake and absence of climate factor in the design process. To address this problem the following actions are required:

- The Republic of Uganda should reduce water releases at Jinja and move towards the Agreed Curve release policy. The Directorate of Water Development charged with this responsibility is already engaging dam operators.
- Emphasis should be focused on civil society empowerment through advocacy activities. This is vital in making government accountable to public.
- Access to public information on water release at the dams and the general river flows should be availed to the public to feed external expert advice in to river Nile management process.
- Comprehensive analysis of all available time series data on Lake Victoria is required. The likely effect of climate should be considered because climate change is a reality and quite unpredictable.

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