



Bujagali Hydropower Project

Uganda A Case Study



(Under construction November 2009)

Bujagali Hydropower Project

Uganda

A Case Study

This case study is produced as part of the programme and activities of the:

Uganda- UK Schools Linking Partnership (U-UKSLP)

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Introduction

The Bujagali Hydropower Project is a scheme to increase the electricity supply to the national grid of Uganda. The power plant and associated dam is currently being constructed on the river Nile, a few kilometres downstream from where the river leaves Lake Victoria.



The electricity demand in the country in recent years has been growing by approximately 8% annually. This currently represents an increase in demand of about 30-40 MW per year. Domestic consumption of electricity in Uganda is low. The 2002 census reported that only 7.7% of households used electricity for lighting (37% of urban households and 2.6% of rural households). The census also reported that the national network reached 33 of the 54 districts within the country. When the demand for electricity is high, the country's generating capacity is not sufficient to meet the demand, hence the need to increase the electricity generating capacity to meet this shortfall in supply.

Electricity Generation in Uganda

Until 2000, all of Uganda's electricity came from hydroelectricity generated by the Nalubaale Power Station at Owens Dam (built 1949-54) which is at the outlet of Lake Victoria where the river Nile emerges. The Nalubaale Power Station is rated at 180 Megawatts (MW). In 1993 work started on the Owen Falls extension project. A new canal was cut and major construction completed in 1999. The first power from the new Kiira Power Station began in 2000, it is rated at 200 MW. The plan was to jointly run the plants in combination at 300 MW and at full capacity of 380 MW at peak demand times.

Electricity generation in Uganda showed an abrupt decline in 2006 as water levels in Lake Victoria dropped. The combined output of the two power stations was reduced to between 135-140 MW, leaving a large shortfall in electricity supply. This gap was to some extent bridged by the opening of three new thermal power plants running on diesel, but the electricity produced in this way is expensive. The total output of these three thermal power plants is approximately 150 MW. The remainder of the supply comes from sugar cane waste (approx 17 MW) and smaller hydro-electric schemes (approx 14.5 MW).

In total Uganda has a regular supply of grid electricity of approx. 305 MW, still 75 MW short of the 380 MW peak demand.

There is a further demand on the supply of electricity produced in the country. Uganda has a long term agreement with neighbouring countries. It has agreements to supply 30 MW of electricity to Kenya during off peak hours, 9 MW to Tanzania and 5 MW to Rwanda.

As a result of the demand for electricity exceeding supply there are periods of time when “loadshedding”, or the switching off of the electricity supply to certain parts of the grid, occurs.

Potential Electricity Generation

It has been estimated that Uganda’s hydrological resources have the power potential of 2500 MW. This is drawn from large scale projects contributing 2000 MW, mainly concentrated along the Nile, with numerous small schemes (0.5-5.0 MW) scattered around the country.

Some of the smaller projects in various stages of implementation include:

- Mobuku II (in western Uganda) - 13 MW (expected 2009)
- Mpanga (on the eastern edge of Queen Elizabeth National Park) - 18 MW (2010)
- Buseruka (in Hoima east of Lake Albert) - 9 MW (2010)
- Ishasha (in Kanungu near Bwindi National Park) - 5.5 MW (2010)
- Paida in the Nebbi district - 3.5 MW (2010)
- Mazibi in Kabale district - 1 MW (2011)
- Kikagati (Isingiro near the border with Tanzania) - 10 MW (2011)
- Waki (in Hoima north of Buseruka) - 6 MW (2012)

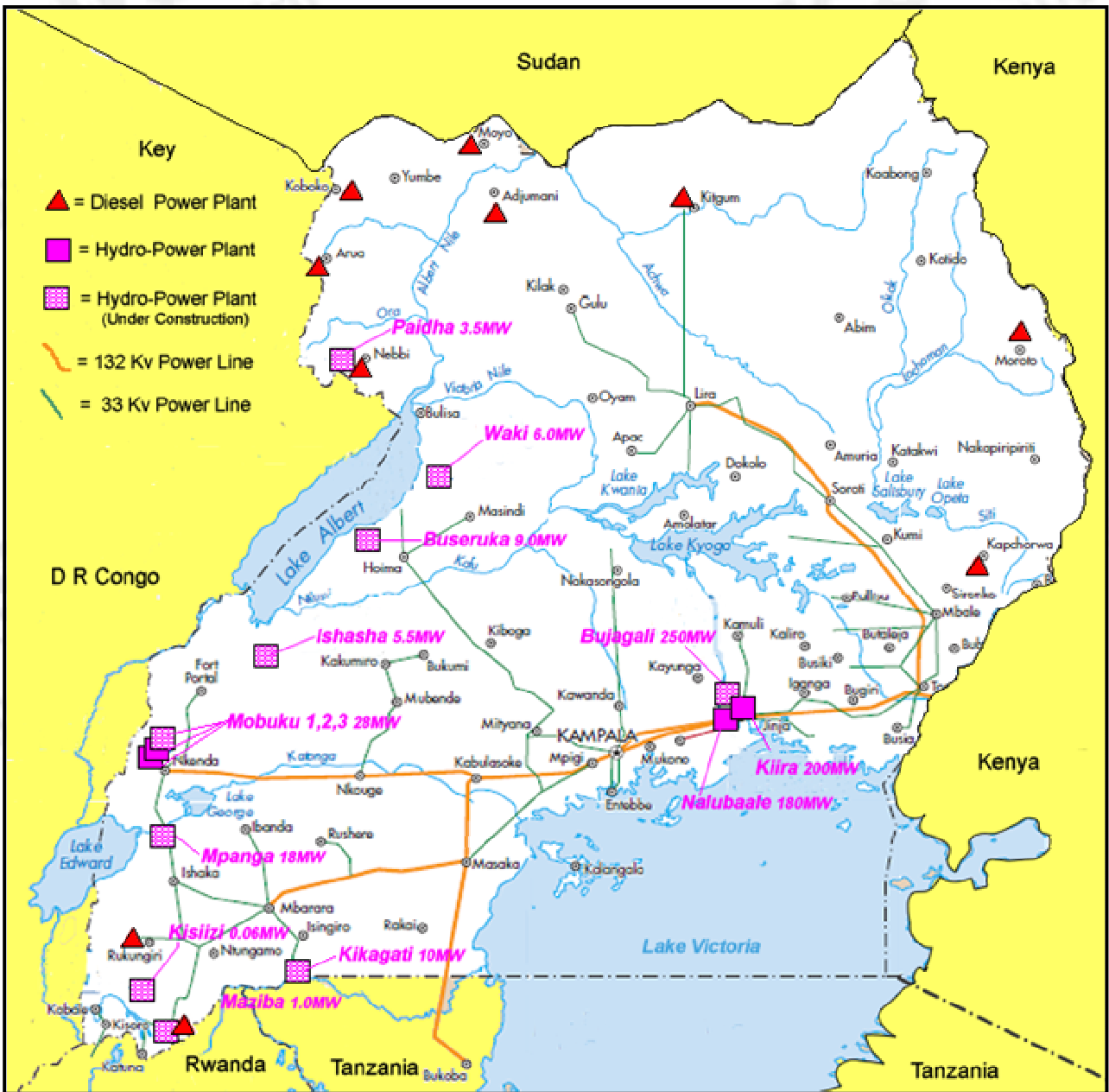
It was however the sites at Karuma and Bujagali Falls that were the preferred options for the development of large scale hydro-electric power plants. The 200 MW project for Karuma Falls stalled in early 2009 when the developer, a Norwegian company, Norpack Power Ltd, failed to get financing for the project. It was the Bujagali project that has moved forward and is now being implemented, although it did face difficulties in its early development.

Reference

Energy Profile of Uganda – Encyclopaedia of Earth

http://www.eoearth.org/article/Energy_profile_of_Uganda#Environmental_Impacts

Electricity Generation Sites and Network Grid in Uganda



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Electricity Generation and Supply in Uganda – World Bank Uganda

<http://siteresources.worldbank.org/EXTINSPECTIONPANEL/Resources/UGA35424.pdf>

History of the Bujagali Hydropower Project

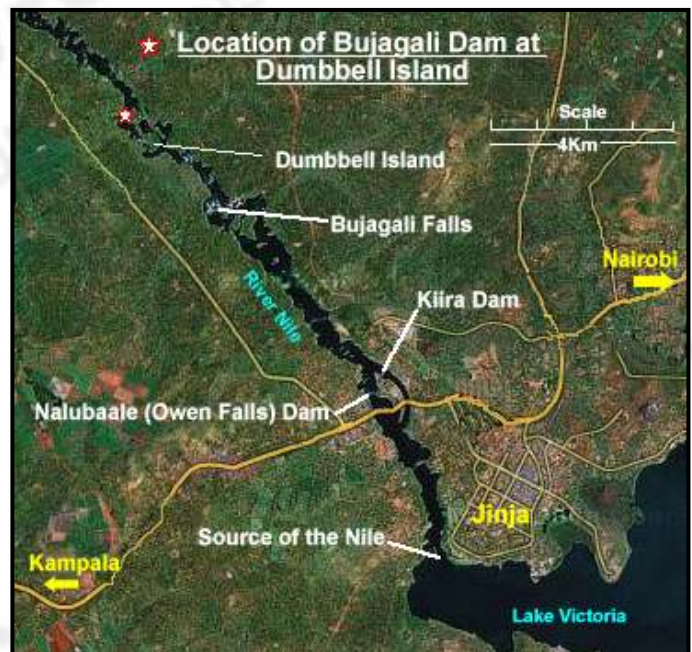
In the mid 1990s the American company AES, through AES Nile Power Ltd (AESNP) was awarded the contract by the Ugandan government to build the Bujagali dam and power house, the World Bank supported the project financially. However by 2002 an independent auditor reported that the Power Purchase Agreement between the parties was too costly and AESNP pulled out. There was also considerable opposition from the environmental lobby.

After this withdrawal the Government of Uganda initiated an international bidding process,- Bujagali Energy Limited (BEL) was selected as the preferred bidder. BEL is a project-specific partnership of SG Bujagali Holdings Ltd., a wholly owned affiliate of Sithe Global Power and Industrial Promotional Services (IPS). IPS is a division of the Aga Khan Fund for Economic Development.

The construction of the dam and power house at Bujagali started in June 2007. Financing of the project comes from loans from the World Bank, the European Investment Bank and the African Development Bank. Salini, an Italian company, was selected as lead construction contractor.

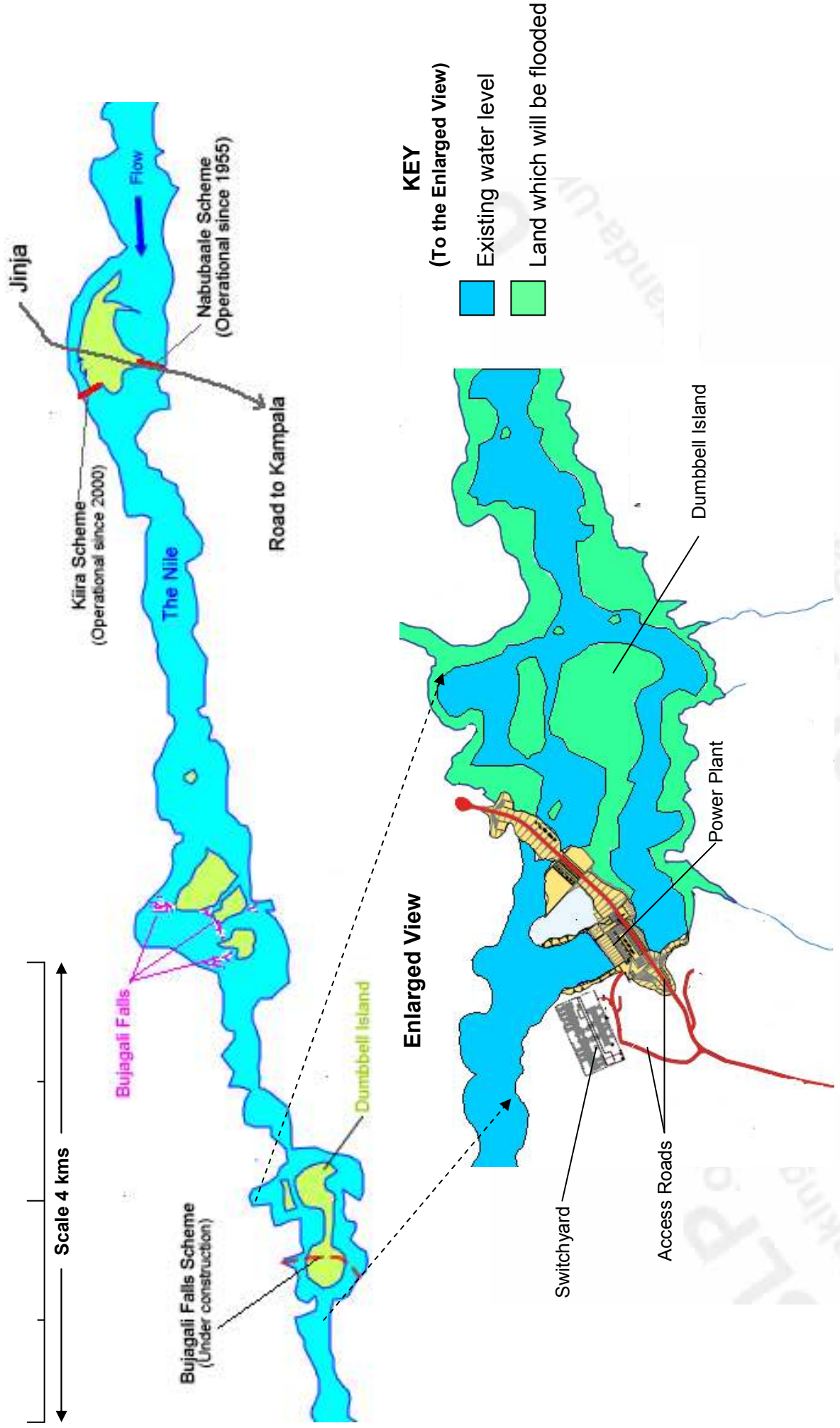
The Location of the Bujagali Hydropower Project

The location of the Bujagali HP Project is at Dumbbell Island, which is about 8 kms downstream from where the Nile leaves Lake Victoria. Water flowing out of Lake Victoria passes either through the Nalubaale or Kiira Powerhouse. The Nile is the only outlet from Lake Victoria so these two powerhouses control the outflow of water from the lake and hence the amount of water released further down the river. Currently water then flows over the falls at Bujagali and then onward passing by Dumbbell Island.



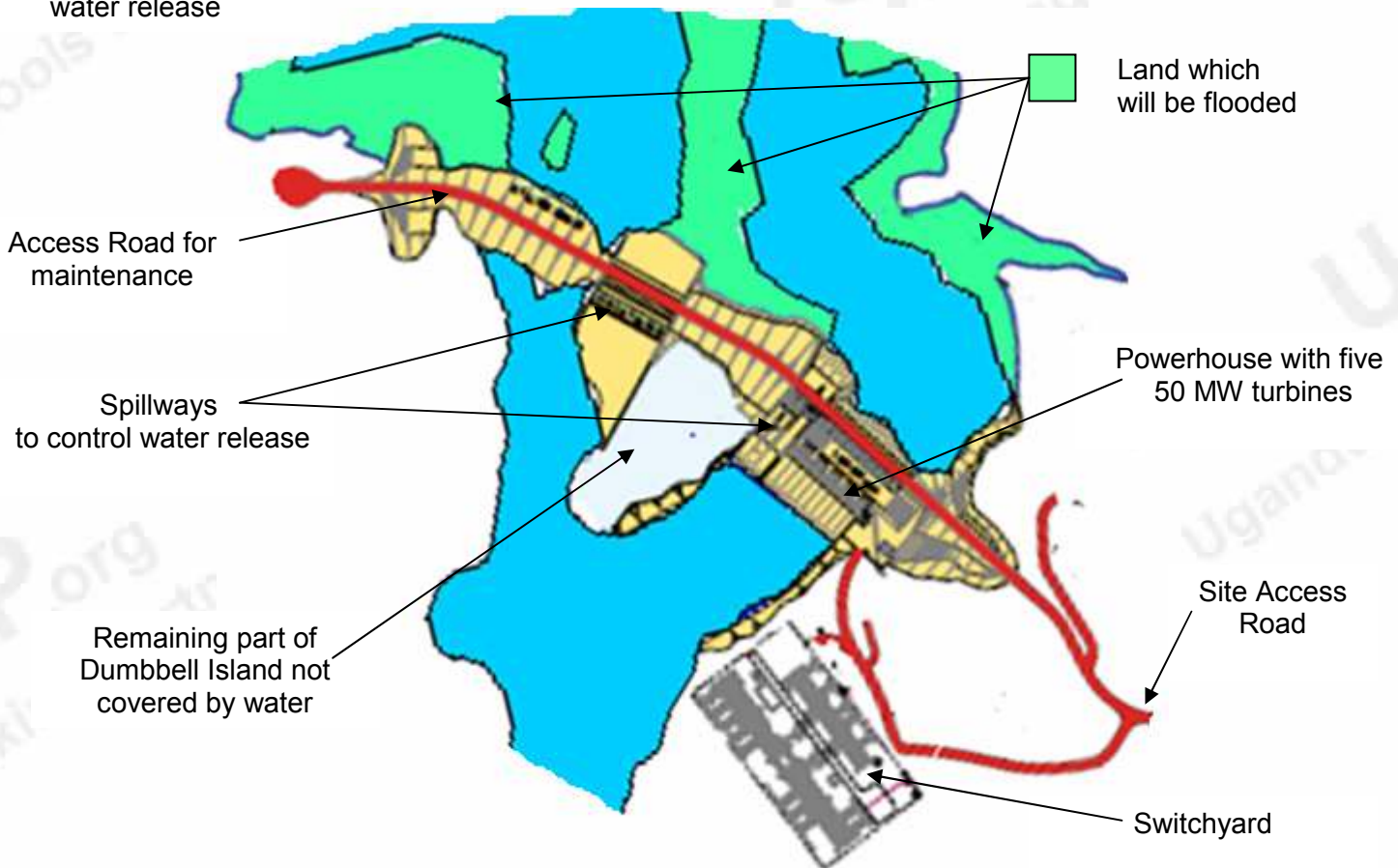
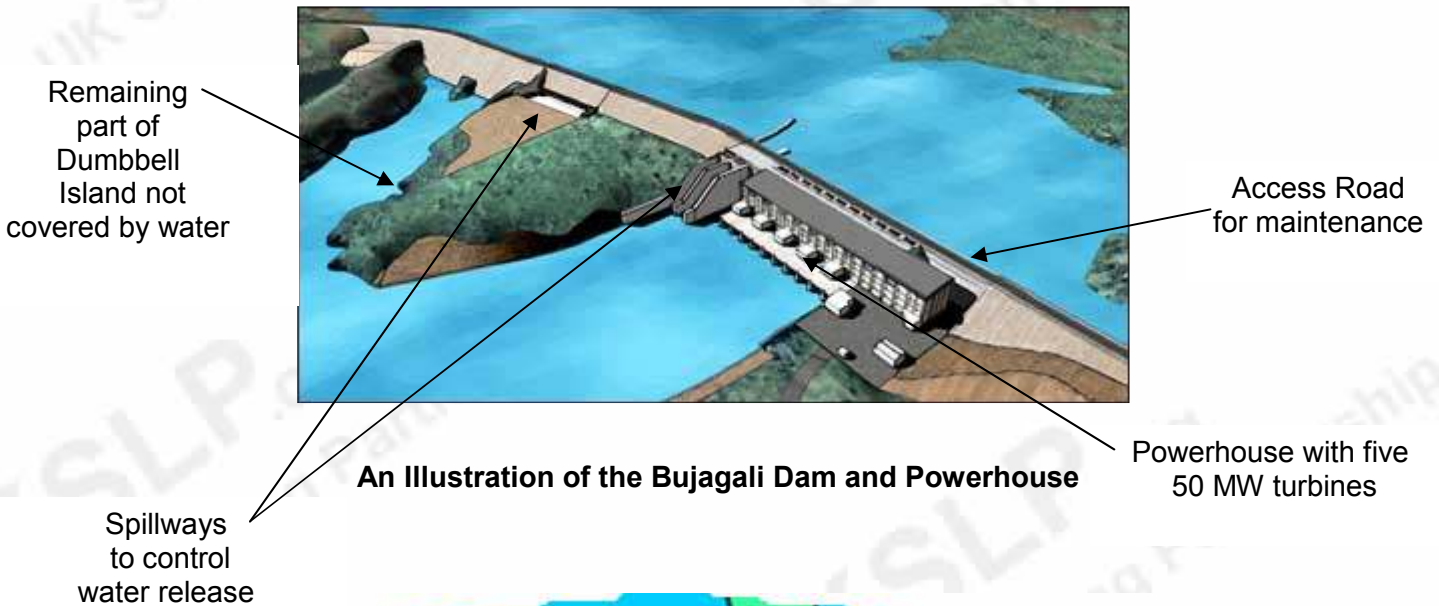
Once the Bujagali scheme is completed the water will pass through the new powerhouse, however the falls at Bujagali will be covered by the rise in water level created by the dam.

A Diagram to Show the Bujagali, Nalubaale and Kiira Hydropower Schemes on the Upper Reaches of the Nile River in Uganda



The Dam and Powerhouse

The dam is to be a 28m high earth-filled structure with spillways and a powerhouse that will have five 50 MW turbines, hence a total projected output of 250 MW of electricity. The location of the dam is at Dumbbell Island.



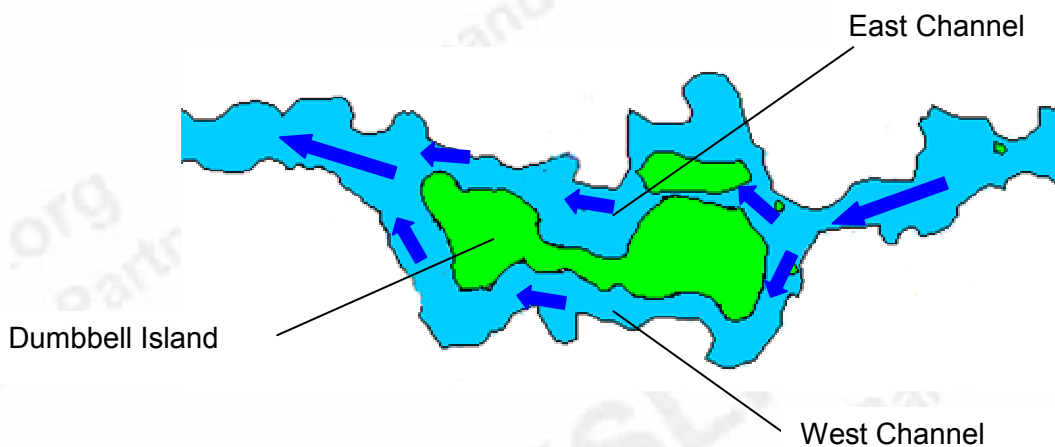
The dam will create a reservoir that will extend upstream to the tailrace of the Nalubaale and Kiira facilities. The reservoir will be 388 ha in surface area comprising of the existing 308 ha surface of the Victoria Nile and 80 ha of newly inundated land. The amount of newly inundated land is comparatively small as the reservoir waters will be contained within the steeply incised banks of the river. The total land take for the newly inundated and site for permanent facilities will be 125 ha, with a further 113 ha during construction.

In order to interconnect the powerhouse with the national grid, BEL on behalf of the Uganda Electricity Transmission Company Ltd (UETCL) will connect the new switchyard at Bujagali to a new substation at Kawanda north of Kampala, a distance of about 70 kms. This in turn will be connected to the existing substation at Mutundwe 17 kms away to south east of Kampala. There will also be two transmission lines each of about 5 kms in length linking Nalubaale and the existing Tororo transmission line.

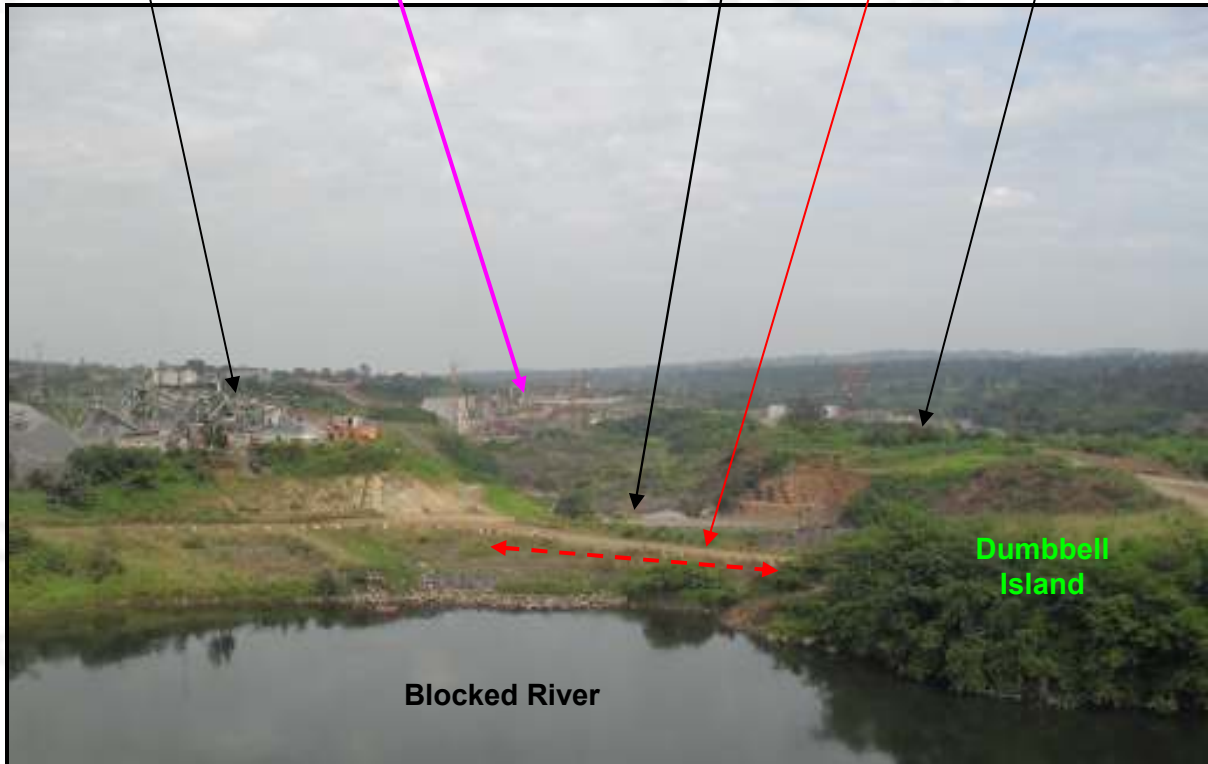
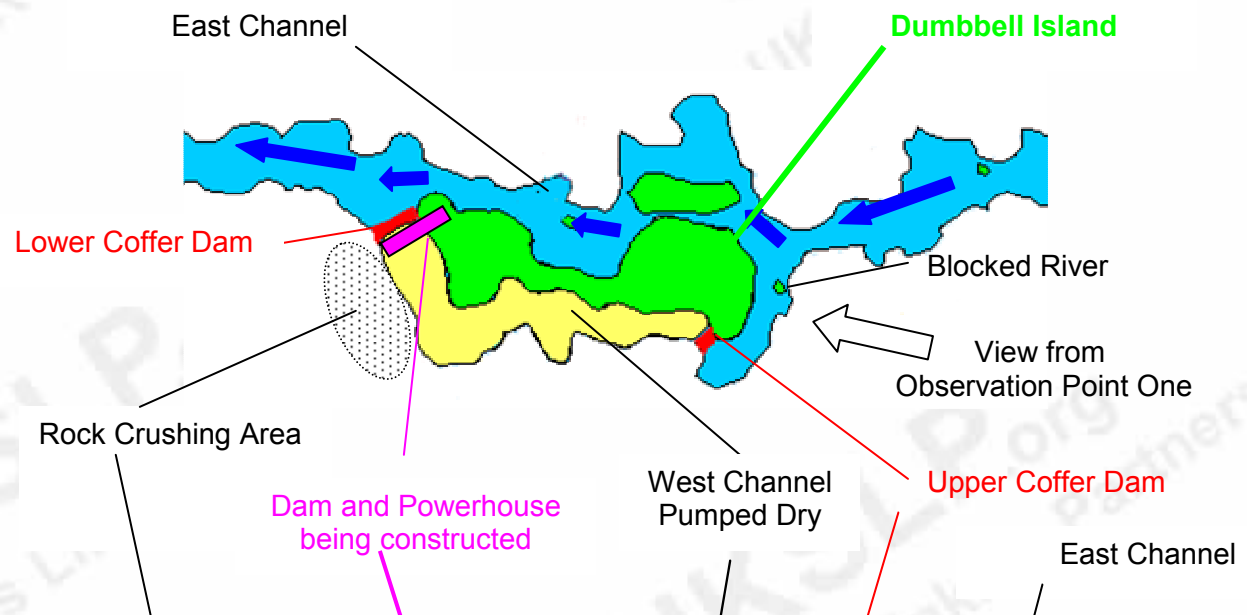
The estimated cost for the construction of the dam and powerhouse at Bujagali is approximately US\$ 800 million with a further \$US 62 million for the interconnection project.

Construction of the Dam and Powerhouse

Building a structure such as envisaged in the Bujagali Hydropower Project is a massive engineering task. The construction of the facilities at Dumbbell Island is taking place in a number of phases. Originally the waters of the Nile flowed on both sides of Dumbbell Island through a channel to the east and to the west.



The first task was to block off the west channel by making two temporary dams - the Upper and Lower Coffe Dams. These dams were built by firstly pouring in very large rocks into the river followed by smaller rocks until the river was blocked and its flow stopped. The water between these two Coffe Dams was then pumped out creating the area where the powerhouse could be constructed. Having blocked the west channel all the water of the Nile now flowed along the east channel.



View from Observation Point One

With the West Channel blocked off and the water pumped out, the powerhouse and dam in that section could then begin to be constructed in the river bed.

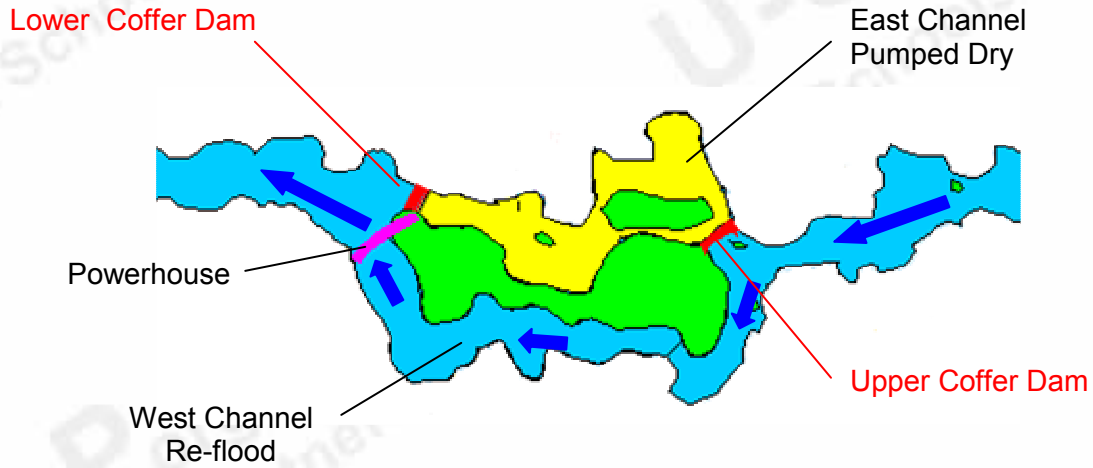


Construction of the Powerhouse Emerges Out of the West Channel River Bed - October 2008



A Year Later the Powerhouse with the Turbine Housings Being Constructed - October 2009

When all the facilities have been constructed on the West Channel, the Coffers Dams on this channel will be opened up and water allowed to flow. The East Channel will then be closed off with the building of two further Coffers Dams and the East Channel pumped dry. The facilities on the east side will then be constructed.



Once the facilities on the East Channel are completed, the Coffers Dams will be removed and the water will begin to back up, the scheme will then come fully into operation.



The Switchyard being Constructed - October 2009

The Case for the Scheme (As presented by Bujagali Energy Ltd.)

a. Economic and Social Benefits

The Bujagali Hydropower Project will produce substantial benefits for the Ugandan national economy and local communities near the site. In addition to direct benefits - new jobs, lower electricity costs, etc. - the project will stimulate increased economic activity, producing important "macro" benefits for the national community.

b. National benefits for Ugandans

When completed, the project is expected to provide a significant boost to the Ugandan economy by sharply reducing the country's current power deficit and significantly reducing the present use of expensive and polluting oil fired thermal power generation. The Bujagali Hydropower Project will support economic growth and job creation as well as enhance the competitiveness of Ugandan goods both regionally and internationally. The project is also expected to meet the anticipated near-term increase in energy use in Uganda, estimated at 30-40 MW per year.

The project's principal macro benefits for Uganda include:

- New supply of clean, reliable energy*
- Lower electricity costs*
- Reduced electricity rationing*
- Increase in economic investment and national income*
- Increase in export revenues*
- Possible support for rural electrification programs*
- Income from the sale of carbon credits*

c. Improving Local Communities

The facility is benefiting the residents and economies of local communities near the project site. New jobs, primarily unskilled and semi-skilled, are creating employment opportunities for Ugandan workers. In addition to improving the local economy, we're committed to preserving the heritage and cultures of nearby villages. Meetings with the Kingdoms of Buganda and Busoga are helping us identify actions needed to fulfil that commitment.

An estimated 1,000 - 2,000 workers will be employed at peak times during the four-year construction period. In recruiting workers, our project team is giving preference to local residents living in the area near the project. This increase in employment will stimulate the local economy, leading to investment in new and existing businesses and additional job opportunities for local residents.

Bujagali Energy Limited is committed to providing additional sustainable benefits, primarily for the local region affected by the project. Our Community Development Action Plan supports long-term development initiatives on both sides of the river: Wakisi Subcounty (west bank) in the Mukono District and Budondo Subcounty (east bank) in the Jinja District.

We hope to invest as much as \$2.4 million in community action initiatives. The major features of our community development plan include:

- *Improve local facilities, such as:*
 - *Enhanced water supply*
 - *Better schools*
 - *Enhanced health care facilities*
- *Support sustainable economic development through:*
 - *Enhanced job creation and worker training*
 - *Improved agricultural productivity and marketing*
 - *Promotion of other business activities*
 - *Enhanced fishing activity*
 - *Support for vulnerable people*
 - *Tourism initiatives*

Further assessment and additional consultations with community leaders and the affected villages are planned before these initiatives are finalized.

d. Environmental Responsibility

At Bujagali Energy Limited, we take environmental stewardship seriously. We fully appreciate the importance of the Victoria Nile River and its environs as an invaluable natural resource. That's why we're committed to preserving and enhancing the area near the hydropower project for current and future generations.

The following highlights some of the environmental mitigation and monitoring measures currently planned or underway:

- *Alternative water supplies (groundwater wells, piped water, etc.) for villages with restricted access to the river*
- *Native vegetation planted on islands and riverbanks in the new Bujagali reservoir and downstream*
- *Water quality monitoring during and after construction*
- *Monitoring of fish stocks in the new reservoir and the downstream river, and the re-stocking of native fish species, if necessary*
- *Environmental measures -- e.g., enrichment planting of forest reserves and islands -- and support of Kalagala Sustainable Management Plan*
- *Alternative raft launching and exit facilities for white water rafting enterprises*
- *New tourism facilities in the Bujagali area (cultural heritage facilities, dam visitors centre, picnic site, etc.)*
- *Traffic management, environmental monitoring and management programs to minimize the effects of construction*

We're also considering additional public and private initiatives designed to protect the Kalagala Falls reserve.

Discussions were held and continue among numerous local, national and international stakeholders -- environmental and other non-government organizations, community leaders, government officials -- about the effects of the project and possible mitigation actions. This continued public consultation process will help us finalize an effective and innovative mitigation program to protect and enhance the Victoria Nile River environment.

A detailed description of the program is included in the Social & Environmental Assessment report that was filed with the Government of Uganda (National Environmental Management Authority) and prospective project lenders in December 2006.

e. Global Benefits

The Bujagali Hydropower Project will reduce the emissions of greenhouse gasses in Uganda. Hydropower electricity does not cause emissions of the greenhouse gas CO₂. Most electricity that is currently used in Uganda is generated by diesel and fuel oil

generators, that emit considerable volumes of CO₂. The electricity produced by the Bujagali Hydropower Project will replace the diesel and fuel oil electricity and hence reduce CO₂ emissions that contribute to global warming.

The Social and Environmental Assessment (SEA)

A Social and Environmental Assessment has been prepared by the Canadian company R.J. Burnside International on behalf of Bujagali Energy Ltd (BEL) for stakeholder review and comment. This leads on to an integrated Social and Environmental Action Plan (SEAP) that will be updated and maintained throughout the life of the project.

The Social and Environmental Action Plan will be a 'living' document that is revised regularly as project development proceeds. The SEAP is designed to define the specific responsibilities of Bujagali Energy Limited, its contractors and sub-contractors, as well as any third parties, where applicable, to the efficient and responsible management of social and environmental activities associated with the project. It will form one basis for BEL's covenants with its lenders as well as provide a vehicle to demonstrate its compliance with regulatory requirements.

As updates are prepared, the SEAP will be consulted upon regularly with affected stakeholders. Progress on the contents and implementation of the SEAP will be publicly reported upon, as well, at regular intervals on a go-forward basis.

References

Social and Environmental Assessment Report - Executive Summary

<http://www.bujagali-energy.com/docs/HPPWEBVersion/HPP%20Exec%20Summ.pdf>

Bujagali Newsletter Project Newsletter produced by BEL publicising activity of the Social and Environmental Program

<http://www.bujagali-energy.com/docs/newsletter/BEL%20Newsletter%20Jul-09.pdf>

World Bank promotional video for the project

www.youtube.com/watch?v=dHT648Q667o

Case against the Scheme (As presented by International Rivers)

The government of Uganda, with help from the World Bank and African Development Bank, is constructing a 200-megawatt dam near Bujagali Falls on the Nile, just downstream from two other large dams. The costly dam's power will not meet the energy needs of most Ugandans, will drown a treasured waterfall, and could harm Lake Victoria, the world's largest tropical lake.

By drowning Bujagali Falls – a spectacular series of cascading rapids which Ugandans consider a national treasure – the dam will submerge a place with great cultural and spiritual importance for the Busoga people. The project will also directly affect the livelihoods of about 6,800 people, impact fisheries, and submerge highly productive agricultural land and islands of high biodiversity. Some villagers have already been resettled for the project, with poor results.



Bujagali Falls

Local environmentalists say the costly dam will harm Uganda's chances to pursue more sustainable energy alternatives, and point out that this project will do nothing to help the 95% of Uganda's population who are not connected to the national grid. NGOs are pressing for the development of renewable energy sources, a sustainable fuel wood program, and improved efficiency to reduce the very high levels of waste in the

existing system. The dam project's costs have skyrocketed, and the dam is now expected to cost US\$860 million, plus another \$74.7 million for transmission lines.

Groups are also concerned about the dam's impact on the health of Lake Victoria, which supports millions of people and extensive biodiversity. The lake, has suffered a dramatic drop in its water level in large part because two existing dams released more water than would naturally have flowed out. As a result, the lake level dropped to record lows in recent years, causing energy shortages and economic disruption (nearly all of Uganda's electricity comes from the two existing dams). Although Uganda needs more energy, it does not need another economically disastrous dam. The Bujagali project could be a costly mistake if river flows prove insufficient to support its turbines – a situation that could result from climate change.

References

New Power Transmission Lines Threaten Tourist Facility

<http://www.eturbonews.com/12609/new-power-lines-threaten-tourism-business-uganda>

The Last Descent

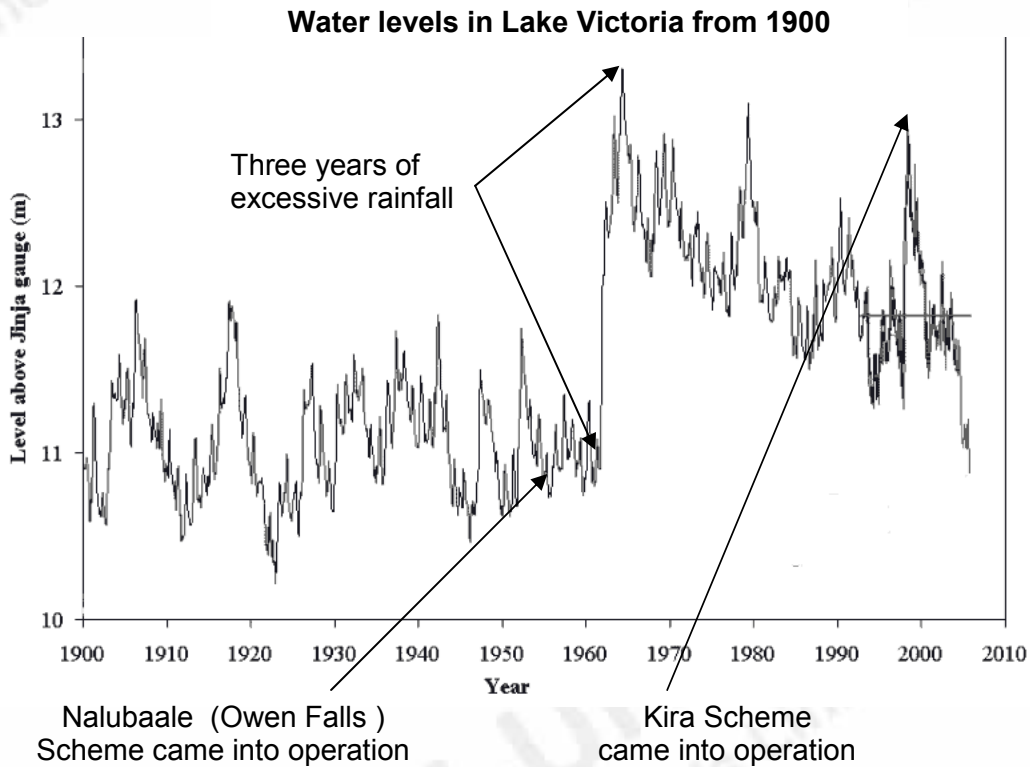
<http://www.youtube.com/watch?v=hNJqTEP-wt0>

Report by Reuters on the increased costs and delay in the completion of the project

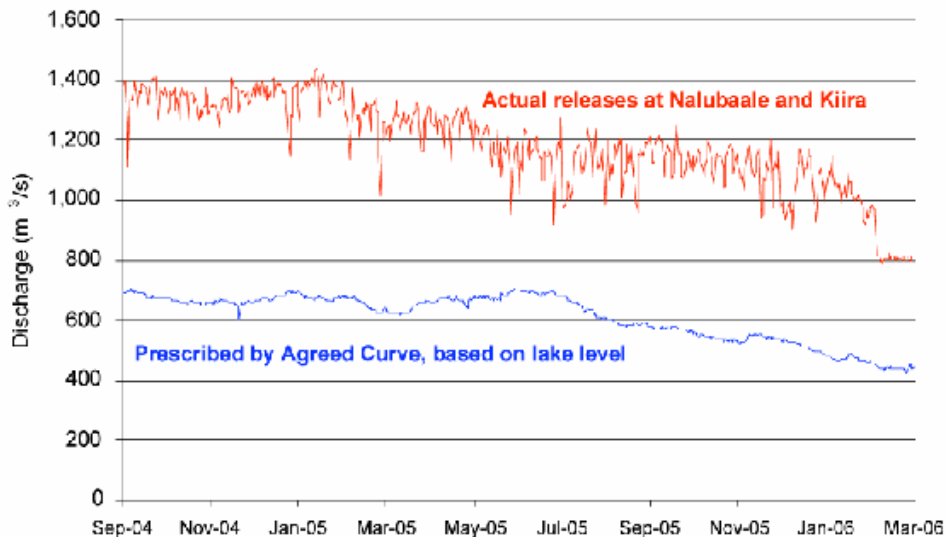
<http://af.reuters.com/article/topNews/idAFJOE59T0IJ20091030?pageNumber=1&virtualBrandChannel=0>

Historic Water Levels in Lake Victoria

The water level of lake Victoria is very sensitive to the amount of rainfall falling in its catchment area (most of the rainfall falls directly on to the lake) and the amount of water released through the Nalubaale and Kiira dams.



Concern has been expressed that more water has been released through the dams than is sustainable; this was particularly noted in 2005-06 when low rainfall occurred and the water level significantly dropped. At that time it became a political issue as the drop in water level was thought by some to be attributed to the drought alone, while others thought that at least 55% of the drop could be attributed to the excessive release of water.



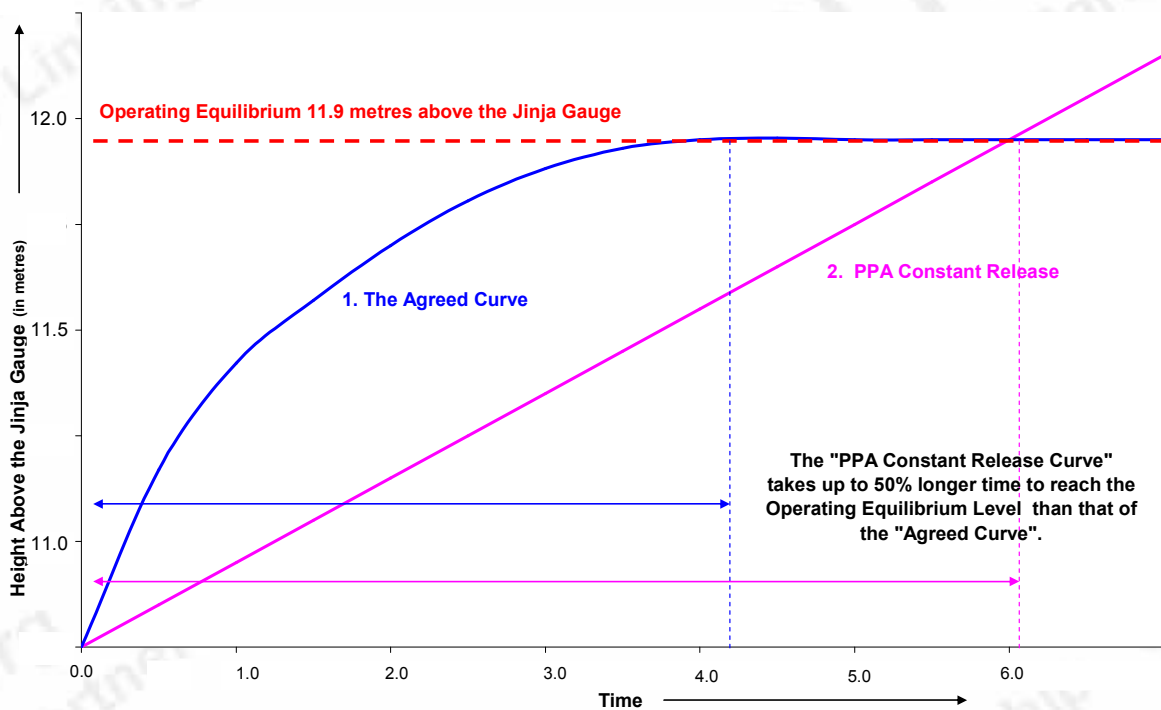
Graphs Comparing Actual Release Against Prescribed Release

The Management of Water Release from Lake Victoria

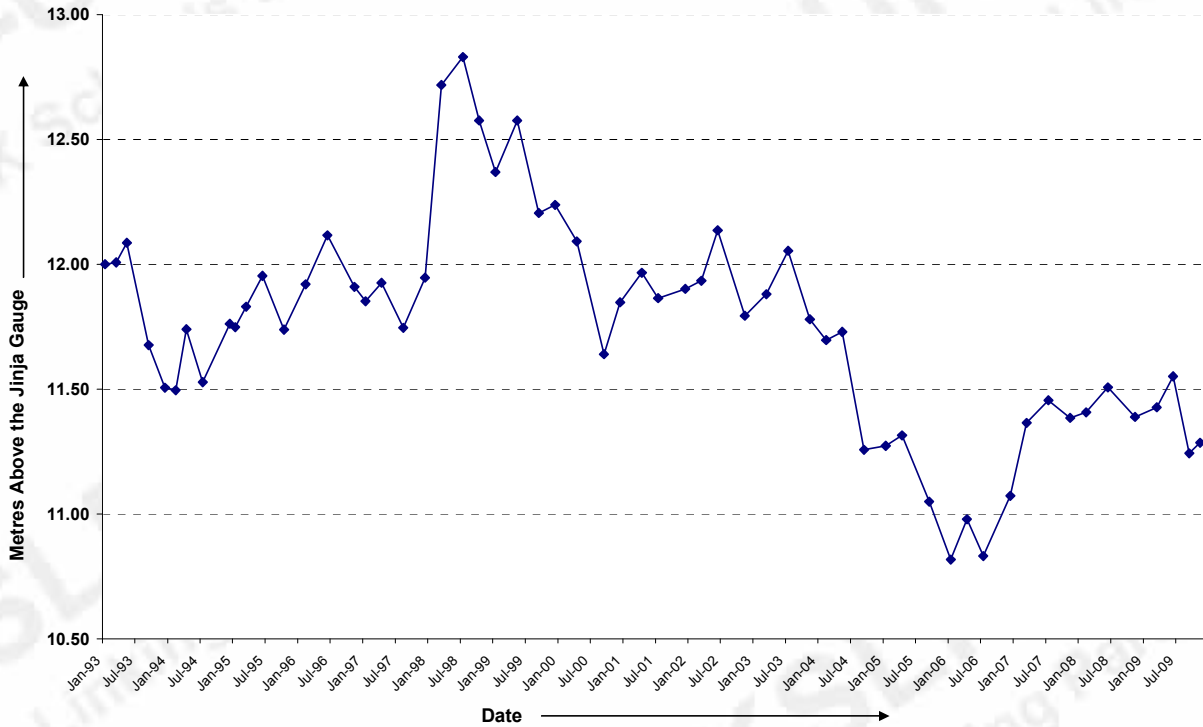
There has been a long standing agreement with Egypt that the release of water from Lake Victoria should correspond to the natural flow of the river before damming. This is referred to as the “Agreed Curve”. If the water level decreased it would be brought back to the “normal level” following the “Agreed Curve”. However since this agreement another pattern has been proposed called the “PPA (Power Planning Associates of Bujagali Project) Constant Release”, which would envision a slower rate of restoring the water level if it decreased.

The “Agreed Curve” is considered to be more akin to a natural lake filling up rather than the “PPA Constant Release” which more closely resembles that of a reservoir filling.

The Different Release Schemes for Managing the Water Levels in Lake Victoria



Water Levels in Lake Victoria 1993 to the Present



The graph above derives from elevation data from the Topex, Poseidon and Jason 1 satellites. There is an overpass every ten days and data is updated in real time.

References

USDA – Satellite Altimetry

http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/gr_regional_chart.cfm?regionid=eafrica®ion=&reservoir_name=Victoria

Lake Victoria Proposed Hydrological Curve Change

<http://www.internationalrivers.org/en/africa/bujagali-dam-uganda/lake-victoria-and-proposed-hydrological-curve-change>

Updated Report on the Water Release from Lake Victoria

<http://www.internationalrivers.org/en/africa/nile-basin/addendum-lake-victoria-report>

Renewable Energy Sources (Other than Hydropower)

By the African Wind Energy Association

a. Solar Energy

Uganda straddles the equator and has a very good average insolation of about 4 - 5 kWh/m²/day. Solar radiation has been used traditionally in the drying of crops and animal produce as well as other domestic purposes like drying of clothes.

Limited modern solar thermal applications are now available for crop drying, water heating and cooking. Solar photovoltaic (PV) applications have been increasing in Uganda since the late 1980s. These include electrification for rural households, health centres (especially vaccine refrigeration), community services (e.g. water pumping, schools, etc), and telecommunications.

There are currently several thousand solar home systems installed. However, large-scale adoption of PV electrification is hampered by the high cost of the systems.

Recognizing that PV technology is the available option for accessing electricity by the remote and dispersed populations in Uganda, Government has embarked on plans to remove market barriers, which include the high investment costs, lack of long-term finance to increase affordability, inadequate technical capabilities and low level of public awareness.

b. Geothermal Energy

Geothermal resources have been identified in the Rift Valley region in Western Uganda. Some preliminary studies have been carried out in which a resource of about 450 MW has been estimated.

There is however need to carry out detailed exploration to quantify the available resource capacity. Since the resource occurs in an agriculturally rich area, there is potential for using this resource for commercial food processing, using direct thermal energy and electric power.

c. Biomass

Uganda has immense forest and agricultural resources that can be converted into electricity. As an agricultural country, Uganda generates a lot of agricultural residues and forest products, especially those derived from coffee and rice husks; municipal and animal waste; saw dust, wood stumps and wood chipping. In fact, the major source of energy is biomass, which contributes over 90 % of total energy consumption and is largely used in traditional and non-commercial form. Every year, 20 million cubic meters of wood are consumed (destroyed) for cooking.

Therefore, biomass can provide substantial amounts of electricity, especially from co-generation by sugar industries, gasification from coffee processing industries and biogas from biodegradable wastes. Electricity so produced can be either connected to the grid or used to supply local demand in a mini-grid set-up.

d. Wind

Although the potential in this area has not yet been quantified, the Northeast region has fairly strong winds. Windmills have been installed in Karamoja for pumping water. This source of power can also be used for grain milling.

The average wind speed in Uganda is low - about 3.0 m/s. However, in more flat areas (e.g. Karamoja region of Northwestern Uganda), around the great lakes and hilltops in many parts of the country, the speeds may go as high as 6.0 m/s. This speed is adequate to run a wind turbine. The main application of wind energy so far has been mechanical water pumping, especially in Karamoja. There are several small wind turbines that have been installed in Uganda. However, most potential areas so far identified are far from demand centres and this has hampered commercial wind application. To harness the wind potential in Uganda therefore requires grid connection.

Reference

African Wind Energy Association

<http://www.afriwea.org/en/uganda.htm>