An Analysis of "Bujagali II – Economic and Financial Evaluation Study – Final Reports" by Power Planning Associates

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The stated purpose of the study by Power Planning Associates, which was commissioned by the World Bank Group, is to evaluate the economic viability of the proposed Bujagali project in Uganda, while taking into account the economic, financial, social, and environmental aspects. International Rivers Network asked economist Pete Tsournos to analyze the report against a few key questions.

- **Does the report satisfactorily answer the question: "Can Bujagali operate economically during times of low water without more over-releases from Lake Victoria?**
- **What would be the economic implications of following the Agreed Curve (or is this information that not be extrapolated from the report)?**

The PPA report authors state that water already released for the existing Kiira and Nalubaale hydroelectric dams can be used to generate additional electricity downstream at Bujagali. In recent months, water was released above and beyond the "Agreed Curve" (a water-release agreement intended to ensure that the releases through the dams correspond to the natural flow of the river before damming) in order to mitigate a national shortage of electricity and high prices of energy. Coupled with an ongoing drought, the existing dams' water-release regime has led to dramatic reductions in the level of Lake Victoria. Since no additional water releases are necessary for the proposed downstream Bujagali site, more energy can be generated for any given water release. The authors state that Bujagali will generate 1.2 times the power already generated by the Nalubaale–Kiira complex, and that the generation of same total power would require a release of only 45% from the lake as compared to the present situation without Bujagali (p.47).

However, there are shortcomings to the analysis. First the analysis is based on a water release operation rule that does not follow the Agreed Curve. The existing dam operators' permits dictate allowable flows based on this agreement. PPA's recommended operation rule for Lake Victoria adopted for the analysis is instead a "constant release" scenario, which can be summarized as follows: Under the low hydrology scenario, the mean water release target is 687 m^3/s, while the high hydrology target is 1247 m^3/s, rather than the agreed curve of 400 m^3/s when lake levels are low (between 1133.5 and 1135 ft.) and 1850 m^3/s when lake levels high (exceeding 1136.2 ft) (p.51). The recommended operation rule is likely based on water release targets that optimize the operation of the electric turbines while also stabilizing (if not restoring) the water level of Lake Victoria. Appendix B.6.5 of the PPA report states that the recommended operation rule was derived so that the target energy will be supplied with a defined reliability of 95% of the time while the Minimum Operating level of the lake (taken as 1133.5) is only reached 5% of the time.

The entire economic analysis is based upon lake levels as have been observed in the last 100 years, rather than the lower levels that have been recently experienced. The report also assumes that climate change will not make an appreciable change in the Lake's levels for the project's economic lifetime. **These two assumptions, combined with the reliance on the less-dynamic hydrological model known as the "constant release" model as proposed in the PPA report, make it difficult to know whether the Lake will experience future declines due to the operation of the three dams.** The economic implications of following the Agreed Curve are difficult to extrapolate from the report. Generally speaking, if the operation rule of Lake Victoria was restricted to follow the Agreed Curve, then the estimated benefits of the Bujagali are likely overstated, and especially so if climate change has a greater impact on the Nile outflow than the report acknowledges.

The price/value of electricity is greatest when water and electricity are scarce. If the agreed flow 400 m^3/s, rather than the recommended 687 m^3/s, is followed during the low hydrology scenario, less electricity will be generated at a time when the price/value of electricity is relatively high. Under the low-hydrology scenario, the target energy level will not likely be met 95% of the time and the NPV and rate of return of the project under the low-hydrology scenario will be overstated and expected returns are less likely, with the Agreed Curve release of 400 m^3/s vs. the assumed release of 687 m^3/s. Furthermore, the least cost expansion plan may also be affected if less electricity can be produced from Bujagali, under the low-hydrology scenario when only 400 m^3/s of water is released. If target levels of energy cannot be met with Bujagali, other more costly sources may need to be considered, until the proposed the Karuma project can be commissioned, no earlier than 2012.

If 687 m^3/s, rather than 400 m^3/s, is released during the low-hydrology scenario, and the objective is to keep the level of the lake stable, less water must be released during the high-hydrology scenario. The proposed water releases of only 1133.2 m^3/s, rather than agreed releases of 1850 m^3/s, during the high-hydrology scenario, will likely have little impact on the estimated benefits of Bujagali. When water is relatively abundant, the price/value of electricity is lower and the capacity of Bujagali is reached at 1247 m^3/s. Any additional water released beyond 1247 m^3/s will only increase generation in Nalubaale–Kiira, not Bujagali.

The authors themselves state that the disadvantage of following the Agreed Curve is that variable water releases and thus variable energy output from all hydroelectric generators on the Victoria Nile does not allow for stable scheduling of generation to meet the total demand of the power system and to export energy to neighboring countries. Beyond this statement, the authors do not offer any formal analysis of the economic implications of following the Agreed Curve.

II. Impacts of Climate Change

The report states that climate change is not found to be significant enough in the medium term (to 2030), to influence hydrological scenarios for this dam. This assumption is driven by two factors: the literature on climate change cited, and the 10% social discount rate, utilized by the World Bank and the authors of the report.

The assessment of the impact of climate change on Lake Victoria water levels seems to be based on limited studies, particularly a single study by Tate, Sutcliffe, et al. Tate, Sutcliffe, et al, consider two 30-year baseline periods, 2021-2050 and 2070-2099. For the 2021-2050 period, the authors predict slightly smaller than historically observed outflows, while predicting slightly higher than present outflows for the 2070-2099 period. Thus, the authors believe it is acceptable to use historical evidence from 1900-2005 as a basis to predict and model future hydrological conditions (page 33 appendix). However, in summarizing the literature on the climate change in the Nile basin and predicted changes in Nile flow, Paris, Yamana, and Young state that nearly all studies predict temperatures will increase, but precipitation predictions are uncertain. Paris el al. further state that the literature review confirms that there is a great deal of uncertainty in predicting future Nile flows (including the White Nile), and thus it is important to consider different scenarios of climate change and water flows when assessing the performance of proposed dams on the Nile. **While the authors of the Bujagali assessment consider both high- and low-flow scenarios within the study, both scenarios are based on past historical evidence rather than the various predicted future scenarios of water flows altered by climate change.**

However, as long as the World Bank mandates the utilization of a 10% social discount rate, the intermediate and long-term effects of climate change will have only a moderate impact on the analysis. On page 35 of the appendix, the authors state: "In the process of present-worth calculation of all costs and benefits of various expansion strategies, based on a social discount rate of 10%, the present worth of elements of the calculation beyond 15 to 20 years after commissioning each new project is quite low. As a consequence, one should identify hydrological scenarios that form the most representative periods of 15 to 20 years from the known historical series of net inflows into the lake."

The World Bank utilizes a social discount rate of 10%. The discount chosen has a great impact when evaluating long-term issues such as the impacts of global warming. Suppose global warming leads to $100 million in climate related damages 50 years from now, a discount rate of 10% implies that we should only spend roughly $850,000 to avoid such damages. In other words, $100 million, 50 years from now, discounted by 10% is worth roughly $850,000 today. On the other hand, the NPV of $100 million, 50 years from now, is $8 million and $61 million when utilizing a social discount rate of 5% and 1%, respectively. **By utilizing a social discount rate of 10% the World Bank favors projects that produce short-term benefits and long-term costs.** Even a modest discount rate will favor small benefits conferred today over much larger benefits conferred in the distant future. Many economists have argued that when evaluating the intergenerational consequences of climate change, a high discount rate unfairly places a smaller weight or value on the well-being of future generations relative to the well-being of current generations. For example, the Stern Review on the Economics of Climate Change utilizes a discount rate of 0.1% when assessing the impacts of global warming. Even Nordhaus, who disagrees with the utilization of 0.1%, in his critique of the Stern Report, utilizes an initial social discount rate of 3% that slowly decreases to 1% over a 300-year period when evaluating the impacts of global warming. As long as the World Bank utilizes a social discount rate of 10%, it is unlikely that the various predicted future scenarios of water flows altered by climate change, 30 or more years down the road, will have much impact on the economic analysis of the Bujagali project.

III. Social and Environmental Cost

While the authors of the PPA study contend that the constant release scenario may stabilize lake levels and is beneficial in terms of energy generation and planning, there may be environmental impacts created when water releases no longer mimic “natural flows”. The more stable water flow can potentially lead to an increase in sedimentation, a change in water temperature, a change in vegetation and geomorphology that could affect fisheries and ecosystem functions. The constant water flow could also affect livelihoods, such as tourism and whitewater recreation opportunities, riverside farming, and the ability to produce electricity downstream. **The authors only highlight the benefits and not the costs associated with the change in water flows.** The authors do acknowledge the potential effects of changing water flows by stating that the exact criteria in shifting from low releases to high releases should depend on factors such as the minimum requirements on the lake level expressed by riparian stakeholders of the lake, requirements expressed by populations living near or downstream of Lake Victoria, power demand of the Uganda power system, power export opportunities and other means of power generation available. However, no attempt is made to estimate cumulative social and environmental costs of the proposed changes in water releases. Furthermore, when considering the incremental social cost and environmental costs of Bujagali, impacts are accounted for in a manner that is biased toward hydroelectric generation.

The incremental environmental/social costs or damages from the Bujagali project are never monetized. By doing so, one is placing a zero dollar value to the environmental damages and social costs, by default. Only the mitigation program costs (actual expenditures) can be included as an environmental cost of the Bujagali project, which may or may not be enough to compensate for the environmental and social damage that will actually take place. On the other hand, the authors do monetize the environmental benefit of the avoided CO_2 from the Bujagali project. The report should include the monetized environmental costs of building a dam and altering water flows. The same rigorous, quantitative analysis techniques employed in the Stern Report can be applied to the Bujagali project, so that the full monetized social and environmental cost of the project can be determined. By only including the benefits and not the full social and environmental costs, the authors will underestimate the incremental impact of the Bujagali project.

- **Does the report clearly justify its assumptions that Bujagali will lower the cost of electricity in Uganda? What are the real-life implications of Bujagali on tariffs and affordability of electricity?**

The macroeconomic benefits of the Bujagali project are moderate at best and could not be determined in a rigorous or systematic manner, within the report. The macro-economic analysis considers two cases (1) the least-cost expansion plan with Bujagali and Karuma and (2) the least cost expansion plan without Bujagali and with Karuma commissioned as soon as possible, in 2012. The consultants have assumed the base demand forecast, base fuel and capital cost and the low-hydrology scenario when considering each of the two cases.

The main differences in the two cases are: thermal energy is displaced earlier, two investments take place instead of one, and tariffs will be lower, in the "with Bujagali" case relative to the "without Bujagali" case. The direct impact on households is expected to be small, since most households are not connected to grid, but for those who are connected, tariffs are expected to be 5% lower "with Bujagali" relative to the case "without Bujagali". Even if cost savings to producers are passed onto consumers, households can expect very little impact on the price of goods and services, since the price reduction in electricity to producers is small. Furthermore, the cost reduction in electricity production is unlikely to be great enough to be a factor in attracting new investment to Uganda, under either scenario.

The main advantage of the Bujagali project is that relatively costly thermal generated electricity is displaced. The Bujagali project has a higher NPV and likely a stronger macroeconomic effect, with the low hydrology scenario, relative to the high hydrology scenario. Under the high hydrology scenario, more electricity can be generated from the existing Nalubaale–Kiira operation, and thus displace more thermal generated electricity, relative to the low hydrology scenario. As the authors note, the energy capability of Bujagali is used up more quickly and displaces more thermal at an earlier date under the low hydrology scenario, relative to the high hydrology scenario. Under the high hydrology scenario, which is not considered, less thermal is displaced by Bujagali and at a later date, and, thus, will have a smaller impact on the cost of electricity production, tariffs and macro-economy. The work of the authors seems to indicate that under the high hydrology scenario, either Bujagali or Karuma could be avoided altogether. The benefits to the macro-economy will be dampened if only one investment takes place rather than two.

The macro-economic analysis is also based upon the low hydrology scenario mean water release target should of 687 m^3/s, rather than the Agreed Curve of 400 m^3/s. If target levels of energy cannot be met with Bujagali when the Agreed Curve is adhered to, other more costly sources of electricity must be considered, until the proposed Karuma project can be commissioned. Thus, the reduction in tariffs and macroeconomic impact will be smaller than the moderate impacts that have been estimated for the project.

IV. Conclusion

Had the authors based their analysis on the Agreed Curve, the expected benefits and value of the project would be lower than they are under the constant-release scenario as reported in the study. By operating Lake Victoria more like a reservoir, the expected benefits of Bujagali are likely greater than what could be expected under the more natural flows of the Agreed Curve. Despite basing the analysis on assumptions that will yield higher expected benefits, the effect of the proposed Bujagali project on the economy of Uganda is still moderate at best. Social and environmental impacts are poorly addressed throughout the analysis. When considering the incremental social costs of the project, the social benefits of hydroelectricity are included while the social costs are not systematically estimated and largely ignored, thus potentially creating a bias towards hydroelectricity in estimating the least-cost expansion plan. The report also fails to consider the economic, social and, environmental impact of the proposed changes to water releases, even though the report seems to acknowledge that various stakeholders will be impacted by changes to lake levels and downstream water flows. Finally, nearly all climate change studies predict changes in temperature and precipitation, in the Nile River Basin yet this extensive literature is ignored. Instead of addressing the potential effects of climate change, the entire analysis is based on historical data. It remains unclear whether the proposed constant water release plan will indeed restore and stabilize Lake Victoria water levels, under the various climate change scenarios

Work Cited:

The Stern Review on the Economics of Climate Change

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Paris, Anthony, Teresa Yamana, and Susan Young, "Sustainability Considerations of Big Dams: Merowe, Nile Basin," Working paper

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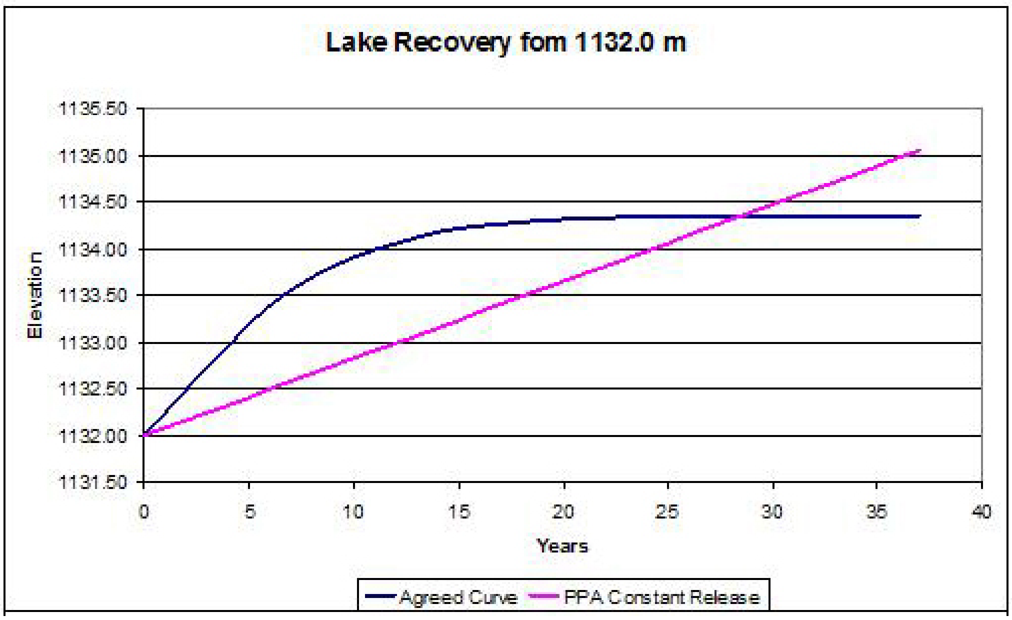
Annex A

Lake Victoria and The Proposed Hydrological Curve Change

New Release Regime for Bujagali Dam Would Slow Recovery of Lake

A new hydrological release plan (known as the "Constant Release" curve) has been proposed by Power Planning Associates for the Bujagali Dam project. This raises the question: "How will the new curve affect the recovery of Lake Victoria, which has already been badly harmed by excessive releases from two existing dams?" International Rivers Network asked hydrologist Daniel Kull to look at this question. Here is his reply.



The graph above shows that the Agreed Curve allows the lake level to recover more quickly than with the PPA proposed outflow regime. The graph looks at how Lake Victoria would recover from a baseline level of 1132.0 m (a low level that was experienced late last year) during 35 years of constant average inflow (average net basin supply "NBS" 1900-2005 computed in the PPA report). As the graph shows, the Agreed Curve releases would restore the lake to a relatively "normal" level within about six years, while the Constant Release flow will not reach that level for close to 18 years. The Agreed Curve response is more representative of a naturally functioning lake, as opposed to the PPA regime, which resembles the filling of a reservoir.

[1] *Daniel Kull is the author of* Connections Between Recent Water Level Drops in Lake Victoria, Dam Operations and Drought *(February 2006), which can be downloaded from http://tinyurl.com/2mpjzm*

[1] The lake's level as of January 2007 was reported to be 1,132.34 metres above sea level, according to the Tanzania *Daily News* (**http://www.dailynews-tsn.com/page.php?id=5214**). From the late 1800s to about 1960, lake levels averaged between 1133.86 and 1134.86.