GLOWA Volta Policy Brief: March, 2008

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Impact of Climate Change on the Black Volta Basin and the Bui Dam

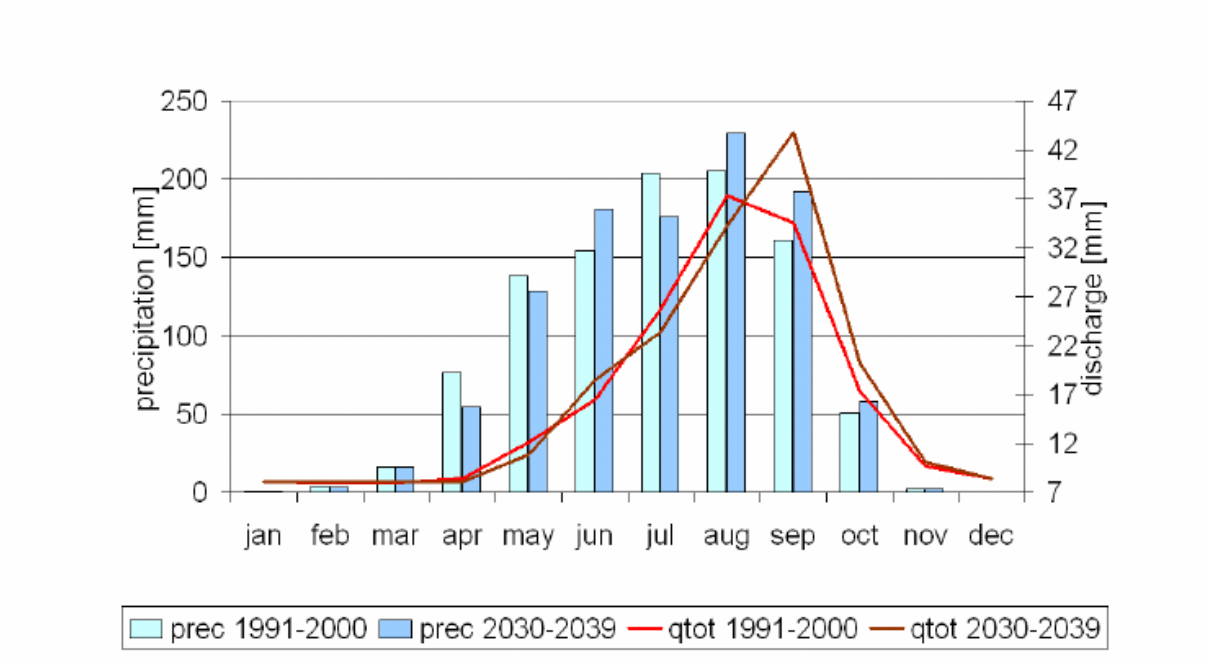
As contribution to the 'Second Ghana Dams Forum of the National Dialogue on Dams and Development' scientists of the GLOWA Volta Project (GVP) of the Center for Development Research (ZEF, University of Bonn) have undertaken a hydrological assessment of the likely impact of climate change on Black Volta River and the Bui Dam. Two different studies that investigate the impact of global climate change on the water availability in the Ghanaian part of the Volta River basin served as the scientific background for this analysis. Both studies are based on different global climate change scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) that reflect different predictions for world wide CO2 emissions.

Climate modeling does not lead to exact predictions of climatic events but allows projections into the future. By looking at different scenarios that take different assumptions into account and by comparing the modeling results for different scenarios, the reliability of climatic predictions can be enhanced. Future trends that can be observed under different scenarios are more likely to really occur than trends that can be only observed under individual scenarios. One prediction for the Volta basin on which various global climate change scenarios agree, is the overall increase of seasonal river flow variability due to a change of the rainfall pattern. In that prediction, less water will be available during the dry season, while river flows will increase in the rainy season.

GVP's regional climate predictions for the Volta Basin

A regional analysis on the impact of climate change on the Volta Basin was conducted by GVP researchers (Kunstmann and Jung, 2005; Jung, 2006). A coupled climate-hydrological model allowed simulating seasonal and spatial predictions for the Black Volta subcatchment, which is the main source of inflow for the Bui reservoir.

Figure 1: Monthly amounts of rainfall (precipitation) and river flow (discharge) 1991-2000 and 2030-2039).



Comparing the simulated rainfall and streamflow for a historical time series (1991-2000) and a global climate change scenario (2030-2039) the following changes are predicted:

- Decreasing rainfall in the month of April
- Increasing duration of the dry season
- Increasing unpredictability of the onset of the rainy season
- Increase and intensification of rainfall at the end of the rainy season
- Slight decrease of river flow
- Increase in flood-events

Potential consequences of GVP regional climate predictions:

The decreasing rainfall in April and an increased duration of the dry season render rain-fed agriculture less reliable. It becomes difficult for farmers to predict the onset of the rainy season and therefore the right time to plant crops. Greater variability and a general shortening of the rainy season may cause the loss or even failure of crops. With regard to the Bui dam, the decrease of stream flow and the increase of flood events have negative impacts. Less water becomes available, while floods increase erosion and speed up the siltation of the dam.

Regional Climate Predictions of the Water Research Institute

The second study discussed at the Forum was conducted by the Water Research Institute (WRI, 2000) as part of Netherlands Climate Assistance Programme (NCAP). While eight independent sectoral climate change studies were undertaken, the WRI study had a special focus on the impact of global climate change on the water resources. The predictions of this study with regard to surface water availability and river flows were discussed at the Second Dam Forum.

Based on different GCM-based global climate change scenarios, the change in river flow in the Volta Basin was simulated for years 2020 and 2050.

Table 1: Percentage change in streamflow in the Volta Basin from GCM-based climate change scenarios for year 2020 and 2050.

YEAR	Low Sensitivity	Medium Sensitivity	High Sensitivity
2020	-8.8	-15.8	-22.9
2050	-24.0	-37.1	-50.9

Potential consequences of WRI's regional climate predictions:

The WRI study predicts a considerably stronger reduction in river flow than the GVP study. The decrease of the annual mean of river flow and the predicted increase of temperatures and evapo-transpiration would seriously impact the Black Volta basin and the Bui dam. Under these scenarios the inflows into the reservoir will be seriously reduced and may render the dam operations under the current design difficult.

Conclusions

Both studies discussed at the Second Ghana Dams Forum predict a significant negative impact of global climate change on the water resources of the Volta River basin. While the GVP study predicts relatively small changes in overall water availability, it points to serious changes in seasonal rainfall and river flows that may cause droughts and flood events. The WRI study predicts a much higher decrease in river flows. Both studies agree that water availability will be further reduced by higher temperatures and increased evapo-transpiration. While these factors alone have the potential to negatively affect water availability in the Black Volta basin and the operation of the Bui hydropower project, additional factors have to be taken into consideration also. The increase in flood events predicted by the GVP study will increase erosion and speed up the siltation of the Bui dam. This has the potential to seriously affect the lifespan of the dam. Increased erosion, also through an increasing deforestation of the Black Volta basin, needs to be taken account of when the economic viability of the Bui project is evaluated.

It is a serious oversight that the impact of global climate change was not taken into account when the plans for the construction of the Bui dam were evaluated and finalised. This is even more so, as climate change will not only affect rainfall, evapo-transpiration and river flows directly, but will also lead to an increase of water demand for irrigation. The overwhelming majority of the population of the Black Volta basin depends on rain-fed farming for their livelihoods. However, climate change makes rain-fed agriculture increasingly unreliable. Throughout the Volta Basin this will lead to an expansion of irrigated agriculture. How competing water needs for hydropower generation and agriculture will affect each other is very important and should have been taken into consideration when the Bui dam was planned. The failure to account for the dynamics of climate change is a major shortcoming of the planning and evaluation process of the Bui dam and should not be repeated when other major hydraulic infrastructure projects are planned and commissioned.

Literature:

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Links:

www.zef.de www.glowa-volta.de

The GLOWA Volta Project has been generously funded by the Federal German Ministry for Education and Research, BMBF.