

Title: The Niger, a lifeline: Economic and Ecological Outcomes of Effective Water Management in the Upper Niger River Basin

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Proposal Statement

Improving the efficiency of the existing infrastructure as well as economic activities in the Inner Niger Delta itself is a significantly more efficient way to increase economic growth, reduce poverty and protect the environment in the region than building a new hydropower plant in the Upper Niger.

Introduction

The Niger River is the lifeline for many people living in the semi-arid, western Sahel zone. The aim of this study is to develop a decision-support system for river management in the Upper Niger, in which ecological and socio-economical impacts and benefits of dams and irrigation systems can be analysed in relation to different water management scenarios. The study involves various components: hydrology, agriculture, livestock, fisheries, ecology, and socio-economics.

Hydrology

The annual rainfall in the catchment area of the Upper Niger varies considerably, but the variation in river discharge is still larger. The river flow is not only dependent on the rainfall in the preceding months, but also on groundwater aquifers. Because groundwater level is determined by rainfall during previous years, the river flow declines during a series of dry years. This is what occurred during the period of dry years known in western Africa as *La Grande Sécheresse* (the Great Drought), during which the flow of the Niger River declined to unprecedented low levels. Years with peak discharges below 4,000 m³/s occurred only twice between 1900 and 1980, but it has rarely been above this level in the last 20 years. The recent decrease in the flow of the Niger River cannot be attributed to reduced rainfall and groundwater aquifers only, since a dam and irrigation schemes have also been built in the area.

At present, there is only one hydropower reservoir in the Upper Niger -**Sélingué**- functioning since 1982. In years with high river discharge 10-20% of the peak flow of the Niger is withheld. However, in years with low discharge this fraction increases to as much as 20-30%. Without the releases from Sélingué, river discharge in the dry period declines significantly. Especially in years with a low flood, river flow in the period from March to May is largely dependent on the management of Lac Sélingué.

The **Fomi dam**, planned in a tributary of the Niger in Guinea, is still under consideration. Its reservoir is planned to be 2.9 times larger than Sélingué. If water management at the Fomi dam is similar to the management of the Sélingué reservoir, we expect that the impact on the flow during the wet and dry period will be similar to Sélingué, with its magnitude being around 2.9 times larger.

There is only one large water user in the Upper Niger. **Office du Niger** irrigates more than 700 km² in the "*Delta mort*". The amount of water used by Office du Niger is equivalent to only a small fraction in the flood period, but up to 50-60% in the dry period. The current irrigation in the dry season is thus largely reliant on the water released from the Sélingué reservoir.

Hydropower and irrigation deliver distinct benefits, but the downstream impact is obvious: river flow is reduced. One of the largest riverine floodplains in the world, the Inner Delta of the Niger River, is situated downstream of Sélingué and the irrigation of Office du Niger. The flooding of this area fully depends on the supply by the river because local rainfall is limited. To study the effect of the upstream, man-made infrastructures, the flooding of the Inner Delta was analysed and translated in effects for the local population.

Flooding

A water balance model and a statistical analysis revealed that the water level in the Inner Delta in August - October is 8 cm lower due to irrigation of Office du Niger and another 15 cm due to the management of the Sélingué reservoir. The Fomi dam will reduce the peak flood level with another 45 cm.

Satellite images clearly reveal the flooded areas of the Inner Delta. By comparing images from different dates with different flood levels, it is possible to describe the flooding as a function of flood level. The inundated area varies between 8,000 and 25,000 km². The Sélingué reservoir leads to a decline of the maximum inundated area with 300 km². Office du Niger and the Fomi dam cause an additional decline of 600 and 2000 km², respectively.

Fisheries

300,000 people in the Inner Delta depend on fisheries for their living. The annual fish production in the Inner Niger Delta, recorded since 1966, highly depends on the flood of the preceding year. The close relationship between annual fish trade in Mopti and flood level in the preceding year allows for the assessment of the average impact of Office du Niger and Sélingué on fish trade. Fish trade in the Inner Delta would have been 6% higher in absence of Office du Niger and an additional 13% higher without the Sélingué reservoir. The analysis predicts that fish trade will be reduced by another 37% in case of the construction of the Fomi Dam. These losses are partly compensated by fisheries in Lac Sélingué, where about 4000 ton fish is captured annually.

Cattle

During the Great Drought, many cows died and the herders lost more than half of their cattle. The collapse was due to reduced food resources as a consequence of the lack of rain and the reduction of the inundated area of the Inner Delta with two thirds. The situation further deteriorated due to overgrazing. Up to now the livestock has not yet arrived at the pre-Great Drought level. Our calculations reveal that the number of cattle, sheep and goat in the regions of Mopti and Tombouctou are expected to increase on average by roughly 4 to 5% per year, in the absence of Office du Niger irrigation and the Sélingué reservoir. The maximum amount of livestock is likely to be reduced by 10-15% due to the construction of the Fomi dam.

Rice

Rice production in the Inner Delta varies from year to year. This variation can be attributed to flood level and, to a lesser degree, to rainfall. In total, the average production amounts to 83,000 ton. At a low flood levels this drops to 10,000 tons; with high floods production can amount up to 120,000 ton. Based on the strong correlation between rice production and peak flood level, it has been estimated that as a result of Sélingué, farmers on average produce 4.9% less. Without the irrigation of Office du Niger, the rice production in the Inner Delta would have been 10.4% higher. The Fomi dam will have an even bigger impact: a decrease by 40%.

These losses are compensated by irrigation at Sélingué (yielding 6,000-7,500 ton rice) and in the area of Office de Niger (320,000 tons). At present the irrigation zone of Office du Niger has grown into the granary of Mali. Nowadays the Malian rice production covers 90% of national demand, of which Office du Niger accounts for 40%. The recent expansion and enormous leap in production was realised independent of rainfall and without using additional water. In fact, the use of water has become much more efficient over time: until halfway the 1980s, about 30,000 litres of water were needed to produce one kilogram rice. Nowadays this has been reduced to 7,500 l/kg with further reductions being feasible. Throughout the years, the irrigation zone of Office du Niger provided a secure food resource, independent of rainfall and flood performance. Even during the drought periods of the early 1970s and the mid 1980s there was no significant decreases.

Biodiversity

The Inner Niger Delta, which is one of the largest Ramsar sites in the world, can be considered as a hotspot of biodiversity. It accommodates two of the largest known breeding colonies of large wading birds in Africa and in addition supports up to 3 to 4 million staging waterbirds, residents and migrants from all over Europe and Asia. The hydrological and related ecological conditions in the Inner Delta largely determine the population size of these waterbird species. Migratory water birds reveal the interrelations between different

wetland ecosystems, thousands of miles apart. An example is the direct relationship between breeding population size of Purple Herons in Europe and water levels in the Inner Niger Delta where they reside outside their breeding season.

Analysis of vegetation maps derived from satellite images reveal that the Sélingué reservoir and water intake for irrigation have a significant impact on the area of valuable floodplain habitat, in the form of shallow *bourgou* fields and related vegetations, in the Inner Niger Delta. The Fomi dam will reduce the floating *bourgou* fields – a key habitat - with 62% relative to the present situation. Newly created wetland habitats as irrigated rice paddies, lakes and stagnant swamps at Sélingué and in the irrigation zone of Office du Niger, do not compensate for the loss of valuable habitat in the Inner Delta. Calculations show that the ecological quality of irrigated rice fields, in terms of species diversity and abundance, is only 6% of a comparable surface area of *bourgou* fields and related habitats. The Fomi dam will result in a loss of ecological values in the Inner Delta of at least 36%, but due to cascading effects the impact is probably much larger at low floods. This implies that in such a situation the last large breeding colonies of cormorants, ibises, herons and egrets in West Africa could be pushed to the edge of existence. The Fomi dam also leads to significantly lower population levels of several waterbird species including resident birds as well as a wide range of migratory species of European conservational concern.

Analyses to support decision making

Nearly one million people try to make their living in the Inner Delta as fishermen, cattle breeders or farmers. The annual production of fish, cattle and rice is determined by the river discharge and is insufficient to feed the local people in the drier years. That is why many people have departed from the drier parts of the Inner Delta during the past 40 years.

An economic analysis has been conducted to determine the role of dams in the economy of the Inner Niger Delta and the Upper Niger region. By combining the above information on hydrology, ecology, fisheries, and agriculture, several conclusions have been drawn:

1. The economic value of dams in the Niger River depends predominantly on the amount of water diverted from the river. The Sélingué and the Markala dam appear to be economically feasible. They jointly generate €26.4 million of benefits per year to the society at large. The addition of the Fomi dam to the two existing dams reduces economic prosperity by €5 million per year.
2. The benefits are comprised of various sectors and vary widely depending on the level of water diversion from the Niger River. The additional financial costs of the Fomi dam are only partly compensated by additional electricity and agricultural benefits. Moreover, the indirect loss in fisheries, livestock and biodiversity downstream dominate these direct revenues. These negative downstream effects are less pronounced in case of the Office du Niger and Sélingué.
3. Besides changes in the absolute level of welfare, dams are likely to cause transfers of benefits from one region to the other. The results clearly show that with each additional dam, benefits are transferred from the Inner Niger Delta to the Upper Niger region. This transfer is especially large in case of the addition of the Fomi dam, which substantially benefits Guinea at the expense of the economy in Mali.
4. Dams in the Niger have mixed effects on poverty. The population of the Inner Delta experience a significant decline in per capita income with an increase of the number of dams. The per capita economic benefits of the Upper Niger population show an opposite relationship with the number of dams. The average river-related benefit per person increases with each additional dam from €44 (no dams), to €48 (Sélingué) and €68 (Sélingué and Markala). The Fomi dam is expected to reduce the river associated welfare of the involved Malinese population from €68 to €52 per capita.
5. Finally, the sensitivity analysis of climatic conditions reveals that especially the Inner Delta and, to a lesser degree, the Upper Niger regions suffer from increased drought. The vulnerability of the Inner Niger Delta is substantially enhanced by the construction of the Fomi Dam.

Main conclusion

One million people in the Inner Niger Delta make a living from agriculture, fisheries and cattle farming. Water is the lifeblood of this system. Upstream dams (one built for electricity generation and another for irrigation) affect this downstream multifunctional use of water. The study shows that building new dams is not an efficient way to increase economic growth and reduce poverty in the region. In fact, such efforts are counter-effective. Instead development efforts should improve the efficiency of the existing infrastructure as well as economic activities in the Inner Niger Delta itself.