

# RESTORING THE RIVER NIGER

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## Abstract

The River Niger is the third longest river in Africa and this comes with high demands from raw water supply to agriculture and other livelihoods. This river located in West Africa passes through diverse climate regions on its way to the sea including areas prone to desertification; and although it is a transboundary river, much global interest is not placed on it; therefore much importance is not placed on preserving the nature and quality of the river. This paper incorporates information found on various databases in form of research conducted at strategic locations along the course of the river, from source to delta, and on its major tributaries. It uses this information as data to map man-made disturbances and its interaction with the environmental conditions along the course of the river. It outlines disturbances from the activities of the riparian community and the basin authority which contribute to contaminated tributaries from rural areas, wastewater disposal, heavy metal from catchment runoff, infrastructures and other restrictions on the river's flow path, and their interaction with the hydrology and climatic factors. It finally offers considerations for mitigating these disturbances, with reference to and lessons learnt from the actions and action plans from other river governing and monitoring bodies such as the Nile Basin Initiative.

*Keywords: River Niger, pollution, anthropogenic activities, major tributaries, River Basin Authorities.*

## 1. INTRODUCTION

The River Niger originates from the highlands of Guinea and flows into the North Atlantic Ocean, passing through Guinea, Mali, Niger, Benin (Northern border), and entering the ocean at the Niger Delta in Nigeria. River Niger (R. Niger) straddles through six countries but its river basin encloses nine countries including Algeria, Burkina Faso, Cote d'Ivoire and Cameroun, drained either by R. Niger itself or one of its major tributaries [1]. 50% of the R. Niger's drainage basin is subject to the harsh conditions of the Sahel Climate region, with effects such as drought and desertification. Being a source of livelihood to millions of people, anthropogenic activities on its course and on major tributaries choke the river and with over 70% of the rural population relying on natural resource based livelihoods; chronic and acute pollution changes the quality of the water which is also heavily relied on for drinking [2]. There has been significant change in the flow regime and rainfall pattern in the R. Niger Basin over the years [1]. Changes in the nature of a river though mostly from climatic factors are often traced back to anthropogenic activities. [3].

Most fascinations on R. Niger have been on its course, originating just a few miles from the Atlantic Ocean but flowing away towards the Sahara Desert and making a sharp turn to empty into the Atlantic Ocean at the gulf of guinea. Studies have produced a handful of theories over the years, which have evolved into our present knowledge of why the Niger acts the way it does [4]. This knowledge along with the drought of 1984 - within the basin - sparked interests in the flow regime of R. Niger. Matters of hydrology in the R. Niger have been covered extensively in [1, 5, 6, and 7]; these investigations also included the sole and collective hydrological effects of dams on the course of the R. Niger and its major tributaries. Majority of research on anthropogenic activities investigate the environmental conditions of the oil rich Niger Delta [e.g. 8], while others investigate infrastructures on the river [e.g. 3] and few on the effects of wastewater [e.g. 9]. The hydrological impacts are well known therefore this research aims to compile the knowledge of the activities around the R. Niger, in order to understand the sources of non-hydrological stresses on the river. It

focused on some of the impacts caused by the activities and living conditions of people in the riparian communities, with reference to more common environmental challenges.

## **2. METHODOLOGY**

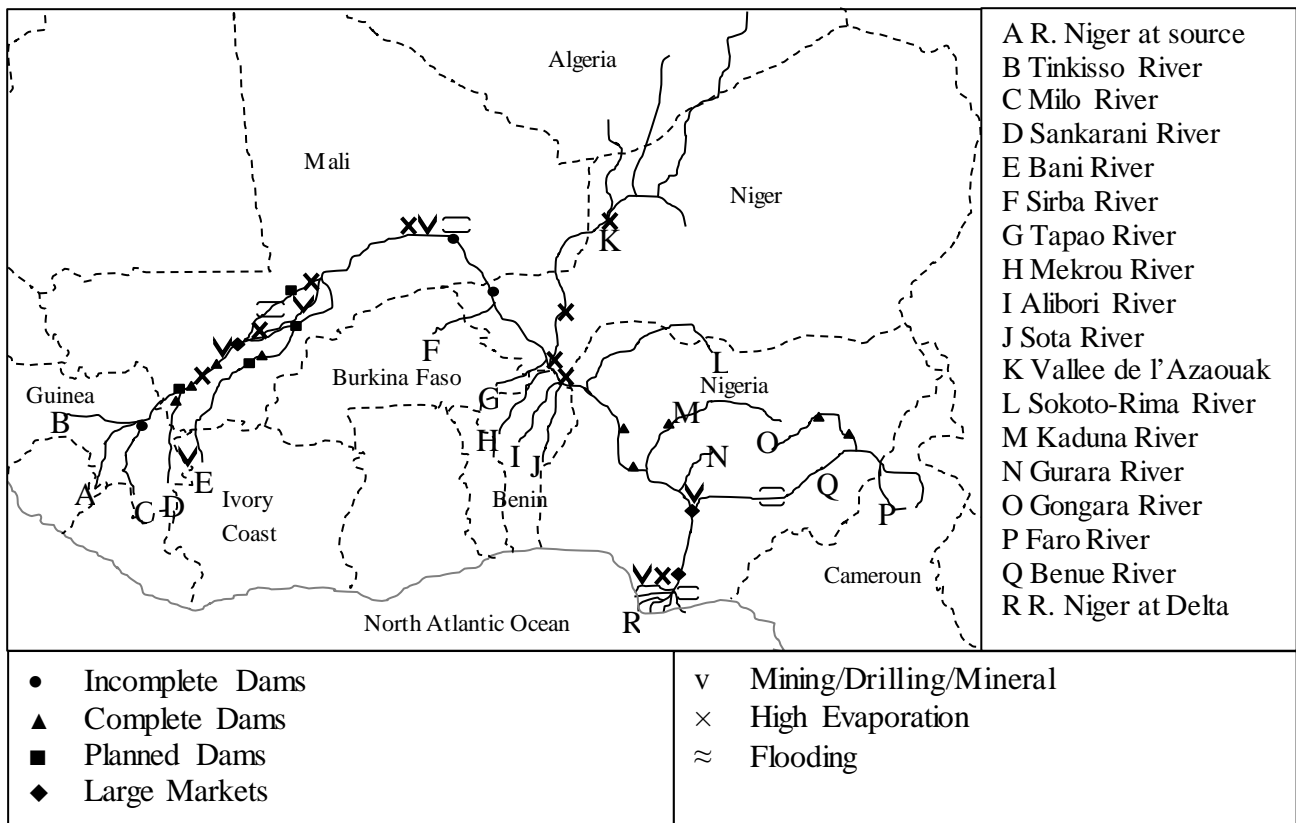
The anthropogenic activities along R. Niger including dams, mining and other human activities were mapped on its course. The location of tributaries helped to approximate the point at which an activity occurs. Following the presence of significant knowledge on hydrologic conditions, this paper assessed the effects of human activities and points to the natural occurrences which stimulate them when necessary. Research was done mostly using academic and non-academic sources. Academic sources however, did not cover in depth the situation at the upper reaches particularly Mali and Niger in which case non-academic sources were employed. Video documentaries on people, culture, livelihoods and devastations along the R. Niger proved particularly useful and provided a virtual tour along the river course from which anthropogenic activities and their effects were detected and recorded [10]. News outlets were additional non-academic literature sources for the upper reaches. Extra caution was taken when using this type of source, and activities reported were checked across other news outlets and the accuracy of the information was gauged through consistency across at least three independent outlets. Databases of organisations such as Worldbank, African Development Bank AFDB, and the Food and Agriculture Organisation of the United Nations FAO gave credible light on the hydrology of the Basin, location of infrastructure along the Basin, as well as projects and activities of the Niger Basin Authority NBA. Although these sources often correlated the information from the newspaper articles, further research presented them as in-exhaustive particularly for smaller infrastructure, low-impact projects or projects with medium-impact but long term execution.

### **2.1 Tributaries**

There are three major tributaries of the R. Niger in Guinea – Rivers Niandan, Tinkisso and Milo. In Mali, two main tributaries join the R. Niger – R. Sankarani rising from Guinea and R. Bani rising from Ivory Coast. In Niger Republic, the R. Niger is met by six major tributaries originating from Burkina Faso – Rivers Sirba, Gouroual, Dargol Gouroubi, Diamangou and Tapao. Further downstream R. Niger is joined by a seasonal transboundary river known as Vallee de l'Azaouak (also called Vallee de l'Azhar in southern Mali) which drains part of Southern Algeria, South-Eastern Mali and Northern Niger. At the Benin-Niger border, three rivers join the R. Niger – Rivers Mekrou, Alibori and Sota. Many small rivers join the R. Niger in Nigeria but its main sources of the water in this country are Rivers Sokoto-Rima, Kaduna and Benue, with R. Benue being the largest tributary of the R. Niger. R. Benue originates in the Faro highlands in Cameroun and is joined by the R. Faro before entering Nigeria. One of the main tributaries of the R. Benue is the R. Gongola, joining nearly midway of R. Benue's course. R. Benue joins the R. Niger at Lokoja on its way flowing southerly, R. Niger then disperses into several distributaries, forming the Niger Delta and entering the Ocean at the Niger Delta [5, 6, 11]. These are the main tributaries often referred to when addressing matters of the R. Niger.

## **3. RESULTS**

Some of the impacting occurrences found along the river length happened at defined locations and were mapped out. A lot of them however, occurred very frequently along the river length and mapping them out proved to be of no practical relevance therefore, within this reason, they were assumed to occur along the entire length of the river. Figure 1, maps the location of some occurrences along the River Niger which influence its flow and quality, with respect to some tributaries. It can be seen that majority of the activities occur in the upper reaches in Mali, with some high impact activities in Nigeria and a few in Niger.



**Figure 1.** Anthropogenic and Natural Occurrences along River Niger and its major tributaries.

### 3.1 Dams

On R. Niandan is Fomi Dam, currently under construction, near the confluence of Rivers Niger-Niandan. On R. Sankarani is the Selingue Dam and on R. Bani are two dams: Djenne Dam and Talo Dam. On R. Niger in Mali there are two dams: Sotuba Dam downstream of Rivers Niger-Selingue confluence and Markala Barrage further downstream [12]. After the turn at the edge of the Sahara lies the site of the Taoussa Dam. Before the confluence of Rivers Niger – Sirba is the location of the Kandadji Dam project. R. Niger enters Nigeria at the intersection of Benin-Niger-Nigeria borders, and has two large dams and a major bridge on its path – the Kainji Dam, the Jebba Dam further downstream, and the Niger Bridge just before the Niger-Delta. The R. Sokoto Rima joins the R. Niger in Nigeria first and has two dams on its path: Gussau Dam on R. Sokoto and Goronyo Dam on R. Rima. R. Kaduna joins R. Niger after the Jebba Dam and holds the large Shiroro Dam. R. Benue is the largest tributary of the R. Niger. The R. Gongola has two dams on its course – Dadin Kowa Dam and Kiri Dam [5, 6, 11].

Some of these dams although beneficial to human population had the river system in mind by design for example Taoussa Dam which was also designed to improve the problem of desertification in the Saharan proximity of the R. Niger by increasing flooding into the Saharan Lake Fagueibine system [12]. However, excessive evaporation in the Taoussa Dam location means that this dam not only displaces its upstream population, but denies the downstream population of a lot of flood water for agriculture; it also denies the river of a lot of discharge force midway into its journey. This is a common problem associated with dams and reservoirs, particularly those located in the Sahel climate region. Dams designed to increase the water discharge during the dry season also deprive land of recovery period after the flood, which is especially detrimental to those susceptible to erosion along the river banks.

### 3.2 Mining and Drilling

The land in the Niger River basin is particularly potent with natural resources and these resources are being harnessed, including Uranium mining in the upper reaches of Vallee de l'Azaouak, Iron

Ore mining in Mali, Ivory Coast, and near the Niger – Benin border, Salt mining in Niger, Limestone in Mali, Coal mining at Lokoja, Lead mining in southern Nigeria, and Oil and Gas exploration in the Niger Delta region of Nigeria. Some of these mining sites are closed or have reduced activities; an example of this is coal mining in Lokoja, which had some sites closed due to an overwhelming oil exploration in Nigeria but small tributaries continuously bring water from the contaminated sites into the R. Niger. Although Vallee de l’Azaouak runs surface water mainly in the rainy season with a lot of sediments and high evaporation, a lot of its waters drain the Uranium mine site and go into the R. Niger as groundwater. After the dry season, the new rain brings heavy sediment load and “red floods” can be seen in some locations due to erosion of iron oxide rich soil. These mines are sources of pollutants which kill sensitive biota in the water [7, 13, 14].

### **3.3 Markets, festivals and traditional activities**

Confluences often form good locations for markets because of their easy access to affordable transportation in different directions, particularly for live goods – a good example is Rivers Niger-Bani confluence at Mopti. River side markets put stress on the river; they often house craftsmen, such as Boat carvers and the waste products from these crafts such as wood chipping and broken equipment wash into R. Niger, piling up at the banks and eventually getting buried under settling sediments and raising the river banks. The R. Niger bank houses the largest market in Africa – the Onitsha market – at Onitsha, before the Niger Delta. Trips to markets could last from hours to days, the boats used are usually old and leak fuel into the water, and are washed at the market banks. Long haul trips have people living on the boats for days and disposing solid, animal and human waste into the water. Festivals, marriages and boat launching in Western Africa commonly involves the use of water, particularly where there is a flowing source nearby. Festivals, such as the fishing festival, harvest festivals and other sporting festivals bring numerous people into the water at the same time instantaneously decreasing the number of fishes in the water, disturbing fish spawning grounds, and often killing juvenile fishes in the water. Boat launching occasionally involves the sacrifice of animals in the river, believed to make the river accept the boat and keep it safe. Other common instream uses of the river continually stir up the water causing extended periods of high amounts of suspended sediments [15, 16, 17, 18, 19].

### **3.4 Farming, fishery and deforestation**

The main occupations of people by the river side are farming and fishing. Fishing occurs along the length of the river length at depths over 0.5m. Dams such as Selingue, Talo and Kiri were created for the primary function of irrigation, and all Dams on the R. Niger were purposed to promote fishery along with their primary functions. The two deltas support rice and other crops which thrive in floods and their shallow waters also help to promote net fishing. Herdsmen also bring their livestock to the riverside to drink water as well as feed on riparian vegetation. These herdsmen often lead their cattle along the banks of the river for months, threading miles of the river banks, destroying vegetation and also leaving waste to be washed into the river. Practices associated with farming such as application of fertilisers and pesticides often increase the amount of certain chemicals in the water, including heavy metals such as Lead and chromium. The Inner Delta has been found to have increased levels of Lead and other heavy metals, some of which are toxic to humans and aquatic life, and come from the use of fertilizers. Also use of pesticides in cotton production has been seen to have an effect on reproduction in fish ecology. Forests are associated with acidic waters and the natural forest vegetation in the Niger Delta in Nigeria stimulates deforestation which causes severe land erosion [20, 21].

### **3.5 Flooding and Evaporation**

In the Sahel Reaches of the R. Niger, the rainy season is much anticipated for the flood it brings which promotes agriculture and other pastoral livelihoods. The reach of the flood each year, serves as evidence of drought and desert encroachment but the further the reach, the more open animal and human waste it washes into the water. Although in some reaches such as the Niger Delta, year-

round flooding has caused severe shortage of housing, causing entire villages to live in elevated houses on the water. Intense flooding is undesirable at inhabited areas along the river basin; it causes loss of house and property and storms and sewage drains overflow onto streets and run into the river body along with other small materials. This kind of flooding has been seen to occur along the Benue. Flooding also occurs when large amounts of rain falls over extended periods causing Dams and Weirs to give way. Evaporation is a major problem to the R. Niger because of its climate region. It is particularly a problem at places with shallow waters; evaporation is estimated to take about half of the water entering the Inner Delta, with some lose to seepage [5, 6, 11].

### **3.6 Settlement – domestic and industrial waste**

River confluences also host large settlements; initially, it was predominantly for transportation and accessibility, but gradually its uses extended to provision of water upstream and disposal of wastewater downstream. In more rural areas, these settlements have compost sites which runoff into the water. Sites along the R. Gongola, R. Kaduna, and along the R. Niger in Mali have industries such as the Textile and Tannery industries, with runoffs containing high amounts of heavy metals. Pottery industries which is common among the women of Mali and Niger, often brings ash from the clay firing process. Wastewater disposal into R. Niger has been recorded at parts of Niger and Nigeria, and runoff from composting pits is the most common source of wastewater into the river at Mali [9, 15, 18, 19].

## **4. DISCUSSION**

The Niger Basin Authority NBA is made up of 11 member states affected directly or indirectly by R. Niger; they deliberate on and oversee the affairs of the R. Niger and the activities on its major tributaries. In carrying out its functions, the NBA has made progress towards optimal use of the R. Niger, although natural occurrences such as great falls in the hydrological regime, uneven surface water resource distribution, including inactive regions, still lead to unequal development and cause challenges in management of the river basin [23]. Projects such as the Kandadji Dam – known as Kandadji regeneration of ecosystem and development of the Niger Programme – have given priority to the environment and state of the R. Niger [24]. Dams like Fomi which have been designed to include capacity for water discharge regulation – less water during the rainy season and more water in the dry season – will cause a decrease in the level of water in the inland delta, but will also reduce the duration of exposure of some lands to drought [25]. Even though new dams show increased investment in agriculture and energy, studies on the NBA proposed dams have been seen to have major impacts particularly hydrological [26], but the transboundary benefits of these dams mean that undesirable impacts have to be managed across affected countries and overseen by the NBA. Predictions note areas with shallow waters exposed to desertification and parts of the inland delta drying up completely [11]. Dams and reservoirs displace people from their homes and as much as people need a river for sustenance, a river also needs its people because people introduce waste into the water which provides for the lower food chain and in turn supports the river's ecosystem.

Restoring the River Niger is not only a task that should be undertaken by the Niger Basin Authority NBA, but also by the people on the river bank and the local authorities. Often these people have general rules set by their unit heads as guidelines concerning location of compost pits, disposal of solid waste and parts of the river for domestic activities in order to maintain a good quality of water for drinking and fishing but the nomadic nature of some of the people, particularly in the Sahel and Fulani reaches, does not promote the continuity of a particular quality of water at a site. Less rain and decreased flooding during the rainy season is causing increased migration towards to the river bank during the dry season because water from the rainfall was not enough to last the dry season. Regulation of markets along R. Niger has become a necessity for the overall wellbeing of the river and not just the problem of market users since solid waste washes unfiltered into the river. Large

markets such as Onitsha market, albeit more developed than those in Mali, do not have drainage systems adapted to the condition created by overcrowding as well as heavy rainfall; and like most markets, they have piles of solid waste around or blocking their drains, leaving poor quality surface water to flow into the river [22]. The NBA is not usually responsible for the standards at these markets; such responsibilities lay with the local authorities and often traders' unions. It is often the case that traders with similar products for sale form clusters to help the customers know where to go for particular items, but due to the fact that various products produce different kinds of waste, this approach keeps some parts of the market cleaner than the others.

## 5. CONCLUSION

The Upper Trenches of the Niger could benefit from more research to inform better decisions by the Niger Basin Authority. Most projects in this region receive funding from Worldbank, African Development Bank AFDB, humanitarian organisations and NGOs. Efforts to restore the R. Niger should come at the pipeline stage of projects. The organisations commonly involved have benchmarks to ensure minimal environmental and human impact in their projects but do not put into consideration the domino effect caused by each criterion on the other. Bearing this mind would help restore ecological connection between people and the water, and will serve as a good step towards regenerative sustainability as opposed to the current approach of using dams. Adaptation to processes of regenerative sustainability will integrate human fulfilment with environmental interests and promote socio-environmental resilience, particularly with impacts from settlements and industrial activities

Tradition rites, festivals and market activities are part of the African culture and persuading people to avoid generational activities will be futile; but taking advantage of people's consciousness of the "ways" of the river and their first-hand experience in observing the behaviour of the river in recent decades will go much further in stirring up response to environmental concerns. Though the responsibility of execution of maintenance for R. Niger will depend on cooperation from local authorities, Initiative and Funding must come from National river basin authorities, Ministries for water and agriculture, Niger Basin Authority, Non-government organisations and charities because research must be conducted into the decadal effects of year-round practices of residents in river bank communities in order to determine the best practices that ought to be adapted to each community to relieve the river. Implementation of these practices will require capital in order to less the burden on the residents and gain more cooperation. The foreseeable challenge with this approach is the same with most associated with adapting new practices to the culture and belief of local communities specifically those including built facilities; often, this type of environmental and humanitarian project will uncover issues like a) infrastructure built to steer clear of the river runoff is too far for residents as a result they continue using the river, b) men and women do not share common facilities and disputes also hinder neighbours from sharing hence they continue using the river; and certainly, c) the responsibility of maintenance. Factors like these continue to create challenges for organisations striving to maintain the R. Niger and demands more dynamic solutions.

The Niger Basin Authority NBA stands to learn lessons from other international river basin authorities. A close example would be the R. Nile basin authority known as the Nile Basin Initiative NBI. The NBI share difficulties similar to the NBA such as unequal water resource distribution, high evaporation, pollution from tourism activities in the upper course, a very large dam in the lower course and extensive farming and fishing. Research on basin management has however progressed more in the R. Nile basin than the R. Niger basin. This is because the R. Nile has an older and more established basin authority and it runs through more countries with established education systems. Nile river basin has benefited from several research on the interaction between human activities and the environment, including the roles of the river basin management authorities as seen in [27, 28, 29, 30]. The Niger could learn from the Nile basin by transforming the traditional

and cultural uses of the river into modern management tools [27, 30], and watching closely the delivery of the action plans and initiatives from the Subsidiary Action Program (SAP) and Shared Visions Program (SVP) of the NBI.

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