IMPACT OF CLIMATIC CHANGE ON RIVER NIGER HYDROLOGY

By
Ibraheem A. Olomoda
Water Resources Development Engineer
Niger Basin Authority
Niamey NIGER

1.0 INTRODUCTION

River Niger with total length of about 4,200 km, is the third longest river in Africa and its theoretical catchment area of about 2 million Km covering 10 Countries namely Algeria, Benin, Burkina Faso, Cameroon, Chad, Cote D'Ivoire, Guinea, Mali, Niger and Nigeria (see Fig.1), made it the 9th world's largest river basin.

The river is the source of water for over 100 million people and is also the major sources of hydropower to most of the Countries in its basin. It provides habitat for over 130 aquatic species, including fish varieties, hippopotami, crocodiles, sea-cows and birds. Its unique vegetal cover, lakes and reservoirs provides humid zones for these species.

Fig.1 Map of Niger Basin

1.1 The Low Flow Occurrence

Since the past 5 decades, the Niger basin has been affected by series of climatic changes causing extreme low flows along the river. For example in June 1985 the river Niger was completely dry in Niamey. This phenomenon was almost repeated in June 2002 when the flow recorded fell among the lowest in 50 years.

The Niger basin theoretical area of about 2 million sq km has also been reduced to an active catchment area of just about 1,500,000 sq km thereby excluding Algeria as shown in Fig.1.

Also Table 1 showed that the minimum (low) flows in the basin are found recently between 1973 and 1985 and the maximum (high) flows occurred in the past between 1925 and 1968. These are also clear indication of the impact of climatic change from the hydrological data collected from the Data Collection Platforms and Gauge Stations.

1.1 Data Collection Platforms and Gauge Stations Establishment

In 1964 when the 9 Countries covered by the river Niger active basin, formed the River Niger Commission that was changed in 1982 to Niger Basin Authority (NBA), with a view to fostering cooperation among member states in use, management and protection of the basin among others, one of the major problems identified facing the Niger basin was the lack of adequate hydrological data and climatic information.

Consequently in 1984, the UNDP, OPEC, EEC and the NBA member Countries establish 65 hydrological Data Collection Platforms (DCP) along the river Niger system under the framework of the Hydroniger project, with the WMO as the supervising agent. These DCP stations emit data through the Argos satellite which are received by Argos Satellite Direct Receiver installed at the NBA and National Hydrological Service (NHS) in some member Countries.

The NBA has also since the beginning of this millennium continued to establish several DCP Meteosat controlled stations to reinforce the hydrological data collection efforts in the basin under the framework of the Niger-HYCOS project.

Other major sources of hydrological data are through the NHS in the NBA member Countries that established staff gauges some of which are since early 1900 as shown in Table 1.

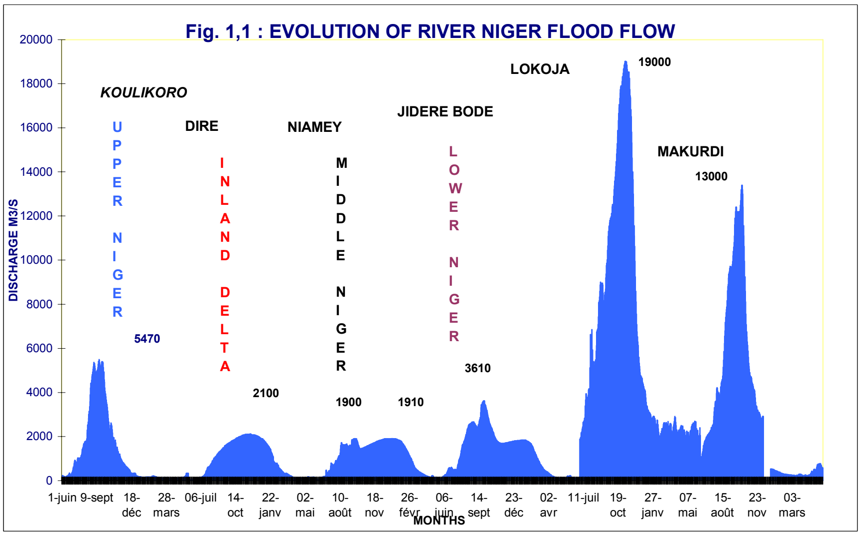
Table 1 : Discharge Characteristics of some Hydrological Gauge stations.

STATIONS	RIVER	PERIOD	Q. MEAN (m3/s)	Q. MAX (m3/s)	YEAR	Q. MINI (m3/s)	YEAR
Koulikoro	Niger	1907 -2000	1385	9670	1925	13	1973 et 1982
Niamey	Niger	1928 - 2000	870	2360	1968	(0)	1985
Lokoja	Niger	1915 - 2000	5 590	26 300	1956	599	1974

Source : Archives HYDRONIGER.

2.0 HYDROLOGICAL DATA ANALYSES

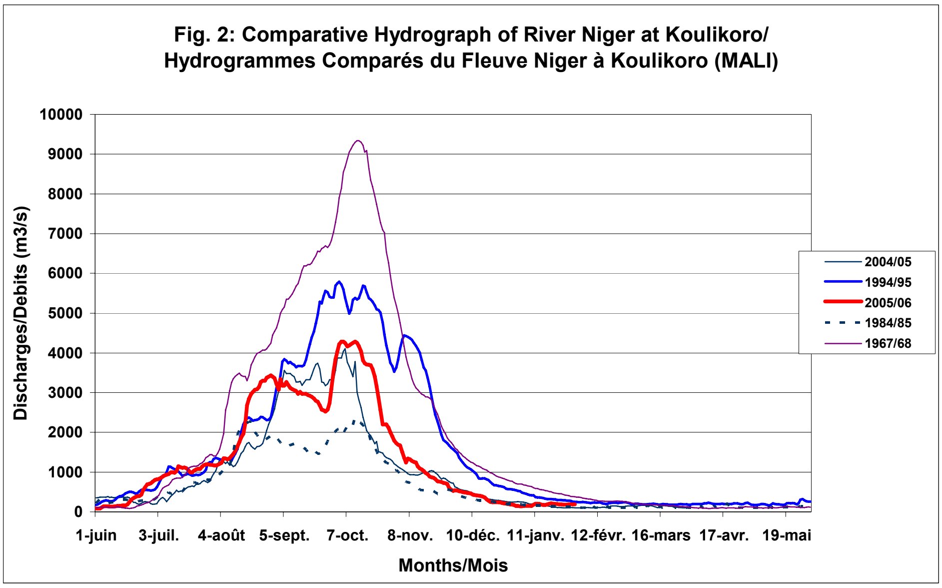
As a result of its peculiar physiographic and climatic characteristics the hydrological data analyses on the Niger Basin is carried out by sub-diving the basin into 3 sub-catchments using selected representative hydrological stations as follows; Koulikoro in the Upper Niger Basin in Mali; Niamey in the Middle Niger Basin in Niger Republic; and Lokoja in the Lower Niger Basin in Nigeria. Fig.1.1 shows the normal flow pattern of the river Niger at these selected stations including flow from the river Benue, its major tributary, at Makurdi in Nigeria and Dire in the Inland Delta of the basin.



2.1 The Upper Niger at Koulikoro

The Upper Niger Basin covers Guinea, Mali and Cote D'Ivoire with a total surface area of about 740,000 sq km. Rainfall ranges from 800mm in the hinterland to about 2000 mm in the coastal areas. Its main tributaries are rivers Tinkisso, Niandan, Milo, and Sankarani.

The hydrological gauge station at Koulikoro in Mali was established in 1907 and since then the maximum discharge ever recorded was 9670 m3/s, which was in 1925 and the minimum of 13 m3/s was recorded in 1973 and 1982 with the mean annual flow of 1350 m3/s as shown in Table 1. The flow pattern of river Niger at Koulikouro in 2005/06, 2004/05, 1994/95, 1984/85 and 1967/68 hydrological years is shown in Fig 2.



2.1.1 Flow Reduction Pattern at the Upper Niger

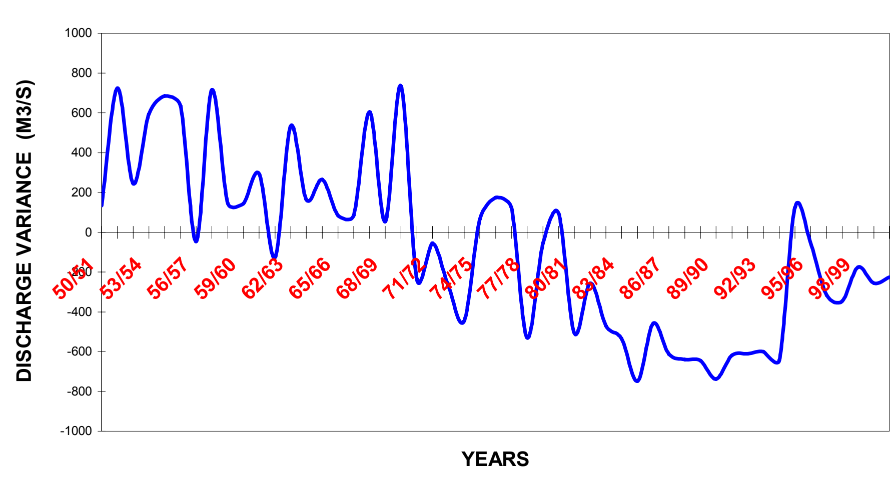
From the flow discharge records of 1950 to 2000 at Koulikoro, the average daily discharge (Qm) was 1376 m3/s. From 1950 to 1960 the discharge (Q) rose to 1764 m3/s showing a positive change tendency with a percentage flow difference of 28%. This situation continued from 1961 to 1970 with a positive flow difference of 216 m3/s and a percentage flow difference of 28% as shown in Table 2 and Fig. 3.

However from 1970 to 1980 the average flow Q declined and reduced to 1236 m3/s with a continued negative flow tendency and a percentage flow reduction of about 10% as shown in Table 2. This tendency continued from 1970 to 2000 as shown in Fig 3, also showing a clear indication of continued flow reduction at the Upper Niger basin.

Table 2: Comparison of Flow at Koulikoro

Periods	Q (m3/s)	Qm (m3/s)	Q-Qm	%change
1950 to 1960	1764	1376	388	28
1961 to 1970	1592	1376	216	16
1971 to 1980	1236	1376	-40	-10%
1981 to 1990	804	1376	-572	-42%
1991 to 2000	1065	1376	-311	-23%

Fig 3 : FLOW FLUCTION AT KOULIKORO 1950-2000

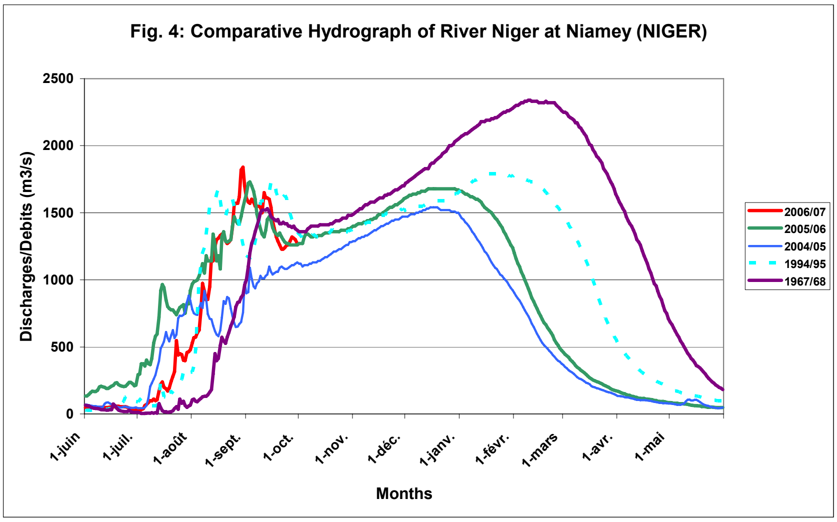


2.3 The Middle Niger in Niamey

The Middle Niger covers Mali, Burkina Faso, Niger, Benin and Nigeria with a surface area of about 530,000 sq km. The rainfall ranges from 200 mm in North to 700 mm in the South.

In Niamey in the Middle Niger in the Republic of Niger, the gauge station was established in 1928 with the maximum discharge of 2360 m3/s recorded in 1968 and a minimum of 0 in 1985 as shown in Table 1. The river Niger flow comparison in

Niamey during the 2005/06, 2004/05, 1994/95, 1984/85 and 1967/68 hydrological years are also shown in Fig 4.



2.3.1 Flow Reduction Pattern in the Middle Niger

In Niamey within the Middle Niger basin the average flow discharge (Qm) from 1950 to 2000 was 71 m3/s. From 1950 to 1960 it rose to 174 m3/s thereby showing positive flow tendencies with a percentage flow difference of 145%. This tendency continued from 1961 to 1970 as shown in Table 2.

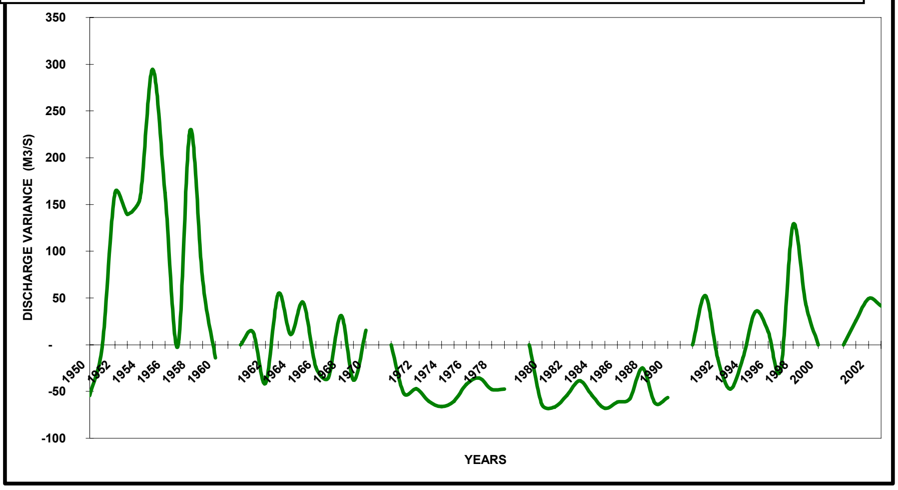
However, from 1970 to 1980 this flow pattern changed and the average flow was reduced to 20 m3/s as shown in Table 3. This reduction continued from 1981 to 1990 with Q reduced to between 0 to 15 m3/s (0 in 1985) and corresponding percentage flow reduction of about 70% to 100% which is also a clear case of flow reduction as a result of climatic change during the periods.

This tendency only started to changed from 1990 to 2000 with a rise of 24% as shown in Fig 5.

Table 3: Comparison of Flow at Niamey

Periods	Q (m3/s)	Qm (m3/s)	Q-Qm	%change
1950 to 1960	174	71	108	145%
1961 to 1970	74	71	3	4%
1971 to 1980	20	71	-51	-72%
1981 to 1990	15	71	-56	-72%
1991 to 2000	88	71	17	24%

Fig 5 : FLOW FLUCTION AT NIAMEY 1950-2000

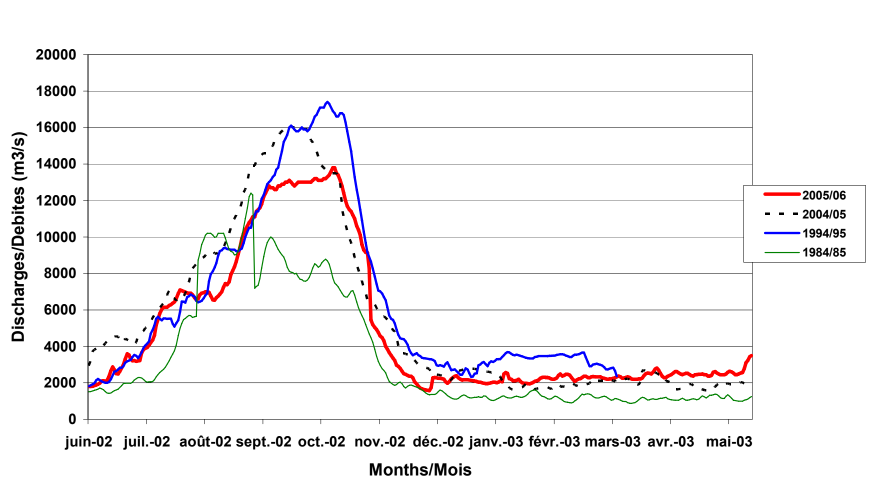


2.4 The Lower Niger at Lokoja

The Lower Niger covers Nigeria, Chad and Cameroun with a total surface area of about 650,000 sq km and rainfall ranging between 700 mm in the North to 3000 mm in the South.

The river Niger flows into the lower Niger in Nigeria through Jidere Bode into the Kainji dam and then into Jebba Dam. The other important dams in the area are the Shiroro dam along the river Kaduna in Nigeria and Lagdo along the river Benue in Cameroun. The river Benue is largest tributary of river Niger and joined it at Lokoja in Nigeria.

Fig. 6 Comparative Hydrographs of River Niger at Lokoja (NIGERIA)



At Lokoja the hydrological gauge station was established in 1915 and the maximum flows ever recorded was 26,000 m3/s and was in 1956. The minimum flow was 599 m3/s recorded in 1981 as shown in Table 1. The river Niger flow comparison at

Lokoja during the 2005/06, 2004/05, 1994/95, 1984/85 and 1967/68 hydrological years are also shown in Fig 6.

2.4.1 Flow Reduction Pattern in the Lower Niger

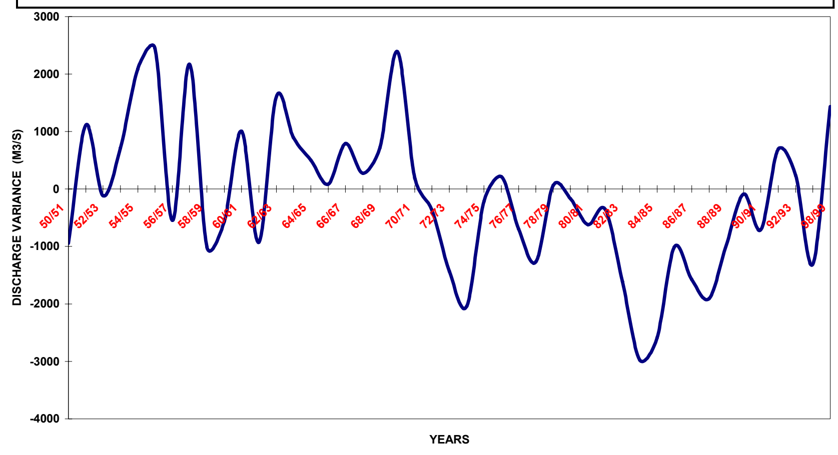
Based on the flow discharge records from 1950 to 2000 at Lokoja in the Lower Niger, the average daily discharge (Qm) was 5707 m3/s. From 1950 to 1960 it rose to 6285 m3/s showing a positive change tendency with a percentage flow difference of 10%. This situation continued from 1961 to 1970 with a positive flow difference of 653 m3/s and a percentage flow difference of 11% as shown in Table 5 and Fig. 7.

However from 1971 to 1980 the average flow Q reduced to 5055 m3/s with a continuous negative flow tendency and a percentage flow reduction of about 11% as shown in Table 5. The negative flow tendency continued from 1981 to 1990 as shown in Fig 7 before changing with a rise of just 5% from between 1991 to 2000. This is also a clear case of continued flow reduction at the Lower Niger basin.

Table 4: Comparison of Flow at Lokoja

Periods	Q (m3/s)	Qm (m3/s)	Q-Qm	%change
1950 to 1960	6285	5707	578	10%
1961 to 1970	6360	5707	653	11%
1971 to 1980	5055	5707	-652	-11%
1981 to 1990	4328	5707	-1379	-24%
1991 to 2000	5970	5707	263	5%

Fig 7 : FLOW FLUCTION AT LOKOJA 1950-2000



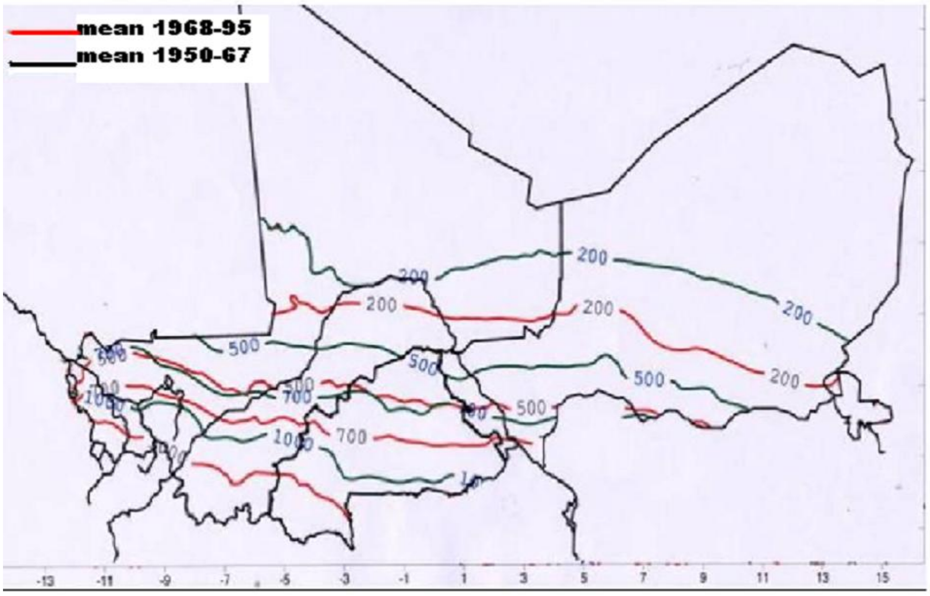
3.0 OTHER CLIMATIC CHANGE INFORMATION

3.1 Decrease in Rainfall Southwards

There is a distinct shift of rainfall from the North to the South. For example from Fig 8 showing the Isohyetal map, the line of 200 mm in 1950-1967 is shown to have shifted southward at a distance of about 100 km range between 1968-1995 .

The same shift applies to lines 500, 700 and 1000 as shown in Fig.8 that also clearly indicated movement of desertification southwards.

Fig.8: ISOHETAL MAP OF RAINFAL DECREASE SOUTHWARDS



3.2 Increase in Evapotranspiration Rate

The Evapotranspiration rate in the Niger basin is now as high as at between 1800 mm and 2200 mm/year and temperature of about 50°C in the north.

3.3 Reduction in Catchments Area of the River Niger

The continued high temperature and evapotranspiration rate and low rainfall caused by climate change are turning perennial rivers into seasonal and the drying up of the seasonal rivers with consequences on the reduction of the basin area from 2 million sq Km to just about 1.5 million sq km with Algeria now excluded from the active catchment's area of the river Niger basin.

3.4 Excessive River Siltation

Strong wind occurrence caused by the climatic change coupled with poor agricultural practices resulted into soil erosion thereby causing excessive siltation of river bed and increasing river meandering and flooding.

3.5 Ground water Depletion

The low flow also affects the groundwater and its recharge which is the consequences of climatic change in the river Niger Basin.

3.6 Water Conflicts

Movement from people from low to high water zone areas is common phenomenon most especially among the nomads which often create conflicts between them and farmers.

3.7 Socio-economy

Socio economic development is grossly affected as a result of displacement of people from one place to the other due to inadequate water and problems of increasing aquatic weed causing reduction fisheries production etc.

4.0 CONCLUSION

The river Niger which is the source of water to over 100 million people and habitat for over 130 aquatic species is evidently facing the impact of climatic change that has continued to threaten the ecosystems and reduced the size of basin.

The climatic change is also the cause of the persistent drought that is causing the Sahara desert movement southward towards the Atlantic Ocean with consequences on erosion and river siltation that is causing flooding with its attendant loss of lives and properties; continued reduction in reservoir storage capacities leading to acute water shortage and increasing water demand; pollution, weed encroachment and increasing water borne diseases, exacerbating the mortality rate, famine, urban migration and poverty.

However, in line with the millennium objectives, the NBA in conjunction with its member Countries and assistance from its developing Partners is developing a **Shared Vision** common to all Countries and shared by all the stakeholders to be implemented through an action program for the sustainable development and protection of the river Niger Basin.

The Shared Vision is also aimed at enhancing the development of a long term legal and institutional framework favourable to cooperative dialogue and consultation that will pave way to the development of water resources in the Niger basin in a sustainable and equitable manner.

It is hoped that the International Communities and Donor Partners will continue to support the NBA in its implementation of the shared vision that will provide an efficient management and optimum utilization of the water resources of basin and foster cooperation and joint actions among the member Countries thereby pave way to poverty alleviation and foster regional economic cooperation and integration.