

Ecosystem Management for improved Human Well-Being in the Lake Faguibine System: conflict mitigation and adaptation to climate change

4. Project background and justification

4.1 Introduction

Situated some 80 km west of Tombouctou in northern Mali, the Lake Faguibine System (16°45' N, 4°W) is the northernmost depression that can be filled by the annual floods of the Niger River (Figure 1). The Lake Faguibine system consists of a complex of 5 interconnected low-lying fertile plains (or "lakes") of which the spearhead-shaped Lake Faguibine itself is by far the largest (maximum extent 590 km²). The system is connected to the main Niger River by two long (65 and 105 km) and tortuous channels that eventually join and carry the water over another 20 km to the first depression, Lake Télé. In favourable years the water can spill over into the main Lake Faguibine, some 60 km further north.

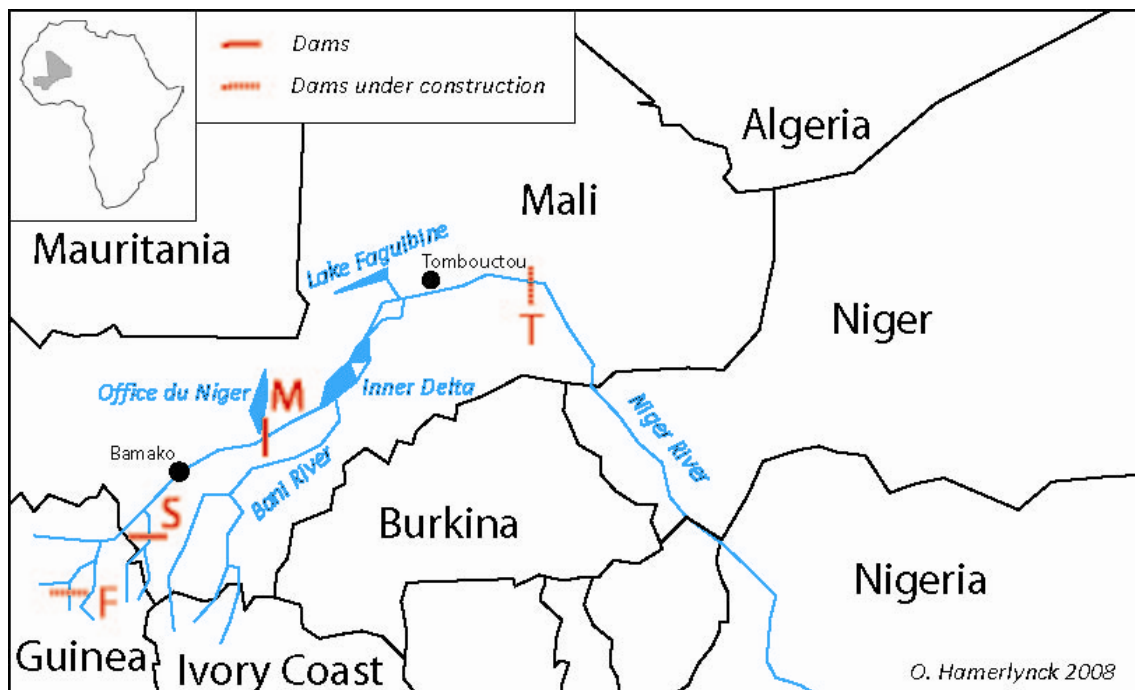


Fig. 1 Map of the Upper and Middle Niger River and the main current (S= Sélingué, M=Markala) and planned (F=Fomi, T=Taoussa) dams that (will) influence the Lake Faguibine system.

The low rainfall in the area (average 150 mm) strongly limits the economic options in the drylands surrounding the Lake Faguibine System (LFS), mainly to mobile livestock keeping in the short period just after the rains (July-September). However, when flooded, the system provides a range of additional livelihood opportunities in agriculture and fisheries and also provides dry-season grazing for livestock. In such

circumstances the system also accommodates hundreds of thousands of waterbirds, mainly overwintering migrants from Europe.

During the XXth century the LFS has been subject to several wet and dry phases but has been almost completely dry since the mid-1970s (Figure 2). At levels below 245 m IGN¹ only the southeastern corner of the lake is temporarily flooded while in optimal circumstances recession agriculture can be practiced on 180 to 350 km², an additional 70 to 100 km² of dry season pasture becomes available in the lowest lying parts and up to 5000 tons of fish can be harvested, traditionally by migrant fishers from the Inner Delta.

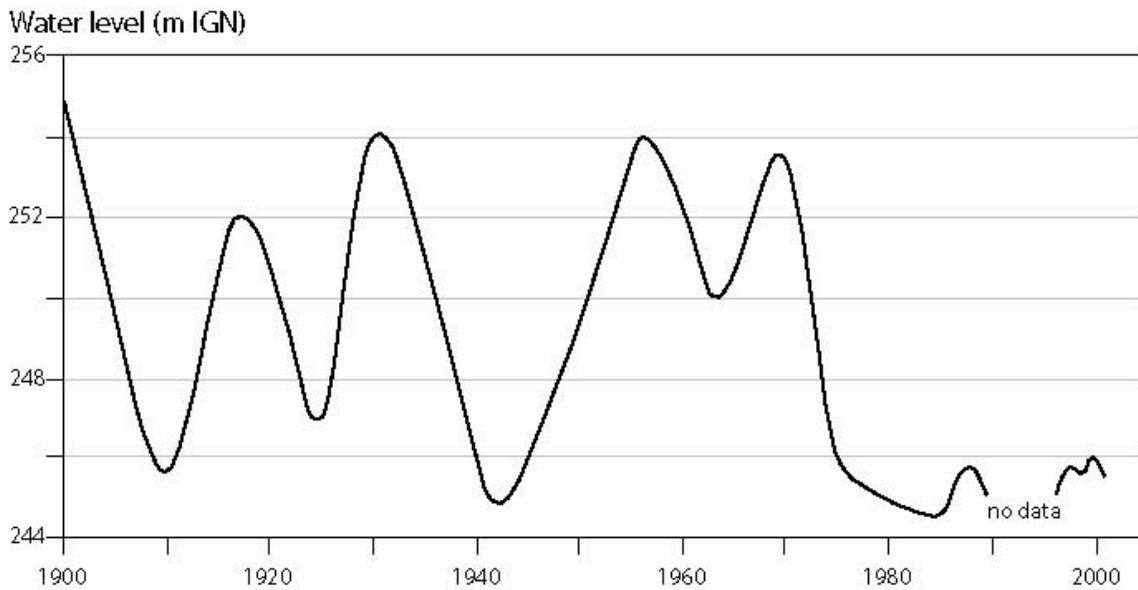


Fig. 2 Schematic representation of the water level in Lake Faguibine during its main wet and dry phases (source: Bouard & Tiers 2004, adapted from Haskoning 1987).

With the collapse of the lake and floodplain ecosystem productivity, the local communities, mainly arabo-berber livestock keepers (in the northern part of the LFS) and sonrai-speaking sedentary farmers (in the southern part of the LFS), have been forced to abandon their traditional livelihoods. Nomadic groups lost most of their livestock and became sedentary in order to benefit from emergency relief programmes. A substantial proportion of the able-bodied sedentary farmers migrated either to the parts of the LFS that were still flooding or to more southerly areas of Mali, especially to secondary towns and the capital, Bamako. During the Touareg rebellion (1990 to 1995) the area was almost entirely depopulated as most arabo-berber groups sought refuge in neighbouring countries while most sedentary farmers were moved to the Inner Delta. Since then repatriation and return migration have brought some 170,000 people back to the LFS. After initial resettlement, development projects have sought to diversify livelihoods, most prominently by the introduction of irrigated agriculture along the Niger River and its side branches (see www.mali-nord.de). Many inhabitants however consider their new livelihoods

¹ IGN = Institut Géographique National. The IGN level is a proxy for mean sea level.

(irrigation, market gardening, agro-pastoralism, trade and transport, urban migration) as a temporary solution, expecting the LFS to return to its "original" productive state.

With the decentralization process (initiated in 1999) the municipalities of the LFS lobbied strongly at the Regional Assembly of Tombouctou for a revival of the UNSO project (1986-1993) to reconnect the LFS to the Niger River in order to bring back the floods. Initial studies were funded in 2002, in April 2004 a regional forum discussed the development options and in January 2006 the "Office pour la Mise en Valeur du système Faguibine" (OMVF) was created. With government funding (some 2 M\$US per year), OMVF has initiated a vast programme of deepening of the connecting channels, the removal of man-made obstacles in the system, the stabilization of dunes and river banks, reforestation, etc. according to a project document developed by the Ministry of Agriculture (2005). This programme is already yielding some positive results with increasing flood extension and agricultural production, which has already led to a revival of local markets (OMVF 2008). The project document however is strongly oriented towards agricultural production while, for the harmonious development of all activities of the highly diverse local communities, a more comprehensive and integrated water resources management approach through participatory planning seems warranted.

In June 2008 the government of Mali called upon the UN system to support the rehabilitation of the LFS and a pre-identification mission was conducted by UNEP in August. One of the main conclusions of the mission was that the current state of knowledge about the LFS is inadequate to be able to describe in detail what can and should be done for its full rehabilitation. Also, the funding necessary for full rehabilitation (estimated to be of the order of 12 to 25 M\$US) is currently not available. It is therefore proposed to split the project into two phases of which the first short phase (2 years), will:

- collect the necessary information for the development of a project document that will encompass full rehabilitation
- strengthen the operational capacity of OMVF and its local partners so they can facilitate and accompany the local communities in a comprehensive participatory natural resource use management planning process
- mobilize support for the full implementation, including its funding
- support the initiation of a national dialogue on water and sustainable development in the light of climate change.

4.2 GEOGRAPHICAL AND CLIMATIC CONTEXT

With 1.24 million km² Mali is one of the largest countries in Africa. Like most of the landlocked countries in the Sahel² it is amongst the poorest nations on the planet

² The Sahel is the broad band of semi-arid lands (150 to 600 mm rainfall) just south of the Sahara, stretching from Mauritania and Senegal along the Atlantic Ocean to Eritrea on the Red Sea, characterized by a strongly seasonal and highly variable rainfall. It is one of the

with a GDP of about 13.47 billion \$US (2007) or about 1000 \$US per person per year. Main exports are cotton and gold. Mali has a largely rural population of about 12.3 million people. There is an important diaspora of about 1.2 million and it is estimated that the remittances of this group contributes over 3% to GDP. With an annual population growth rate of 2.7% and an average of 7.4 children/woman, Mali has a very dynamic demography. Adult literacy rate is still only 24%, which strongly contributes to Mali's low Human Development Index (HDI 0.38, ranked 173rd out of 177 countries). Women have even less access to education and the Gender Development Index (GDI) stands at 0.371 (ranked 132nd out of 156). Mali is strongly dependent on foreign aid which contributes nearly 40% of the annual government budget (700 million \$US/1.8 billion \$US).

Climate change has had extensive and profound impacts in West Africa, in particular in the Sahel. Following up on a comparatively wet phase in the 1950s and 1960s, resulting for example in an unprecedented increase in the number of livestock, the Sahel was struck by catastrophic droughts in the 1970s and 1980s. Though there has been a slight improvement since the 1990s the current rainfall levels are still below the XXth century average (Figure 3) and, in spite of some wet years (1994, 1999, 2003 and probably 2008), the current situation should still be considered as a drought. It is expected that, by the end of the XXIst century, the western Sahel would receive 10-20% less rainfall than in the 1980s-1990s (IPCC 2007).

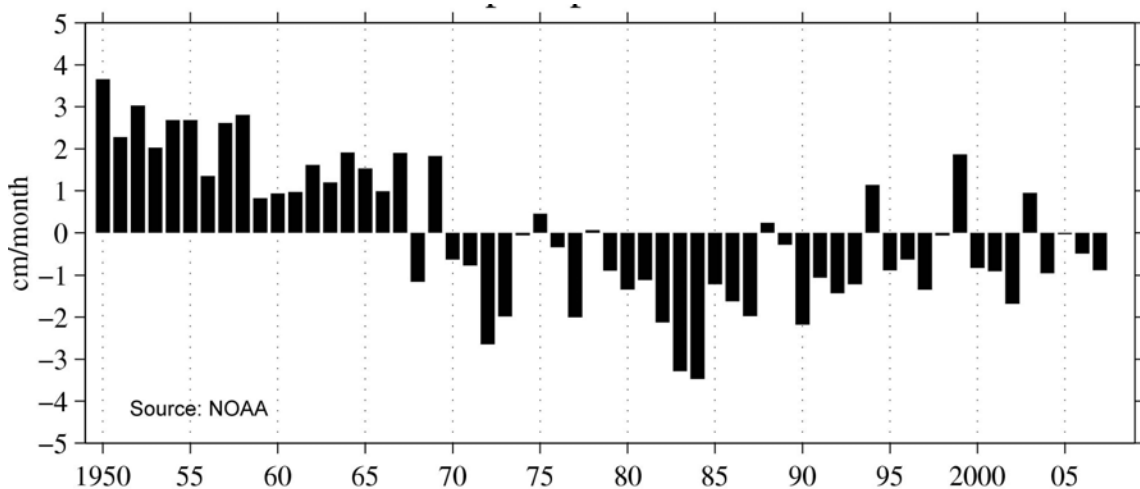


Fig. 3 Rainfall anomalies (deviation from the average since 1900) in the Sahel since 1950.

It is now generally accepted that rainfall in the Sahel is to a certain extent correlated with the Atlantic Multidecadal Oscillation index (AMO_i) and that we may currently be in a comparatively wet phase expected to continue over the next few decades

world's most underdeveloped and impoverished regions plagued by frequent armed conflicts and humanitarian crises with strong linkages to climate change (droughts).

(Figure 4).

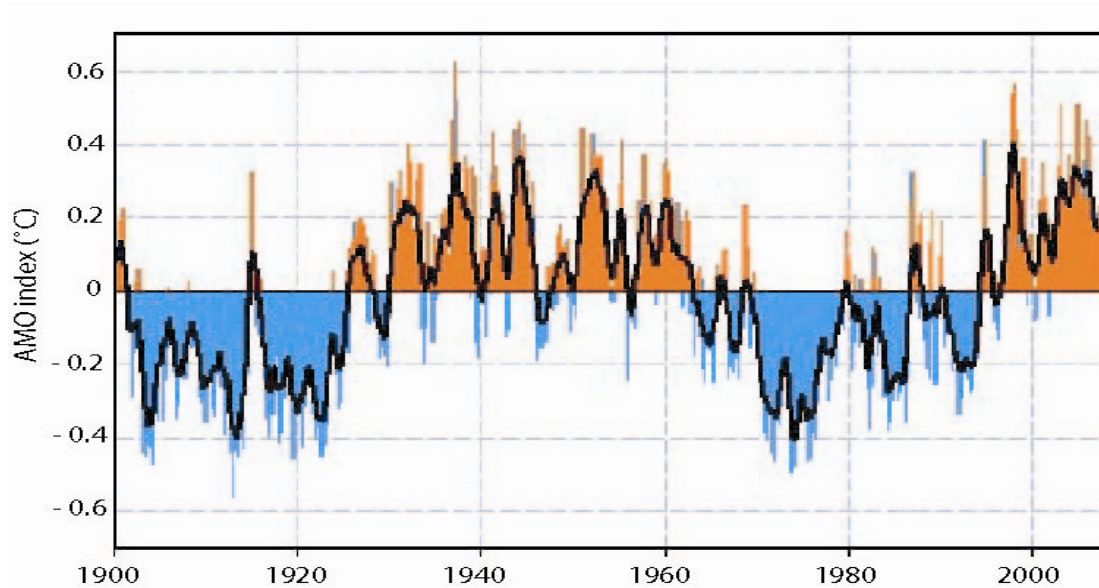


Fig. 4 The Atlantic Multidecadal Oscillation index (the relative mean surface temperature of the Atlantic north of the equator adjusted to exclude the long-term warming trend) between 1900 and 2007.

This would provide Sahelian countries with additional time to prepare for the main climate change impacts expected when the AMOi will move back into a negative phase. Still the correlation between the AMOi and rainfall in West Africa is not perfect and does not explain why rainfall remains lower than in the 1960s. Other factors, such as land use changes in the catchment areas may need to be taken into account. For the Lake Faguibine System the determining factor is the hydrograph of the Niger River, especially the height and the duration of the flood peak.

4.3 THE NIGER RIVER

With a length of 4200 km the Niger is the third longest river in Africa. The Niger River Basin covers some 2.11 million km² and is shared among 10 countries but in practice only about 1.1 million km² of the basin is productive and contributes to the flow. For the western part of the basin (Figure 5), relevant for the Lake Faguibine System most of the water (average discharge about 1300 cumecs³) is produced in the Fouta Djallon mountains and forested areas in Guinea for the Niger River proper (70%) and in northern Ivory Coast and southern Mali for its main tributary, the Bani River (30%).

³ Discharge is the volume of water transported by a river over a certain time period, often expressed in cumecs (cubic metres per second) or annually in cubic kilometers, e.g., 1300 cumecs is equivalent to 41 km³

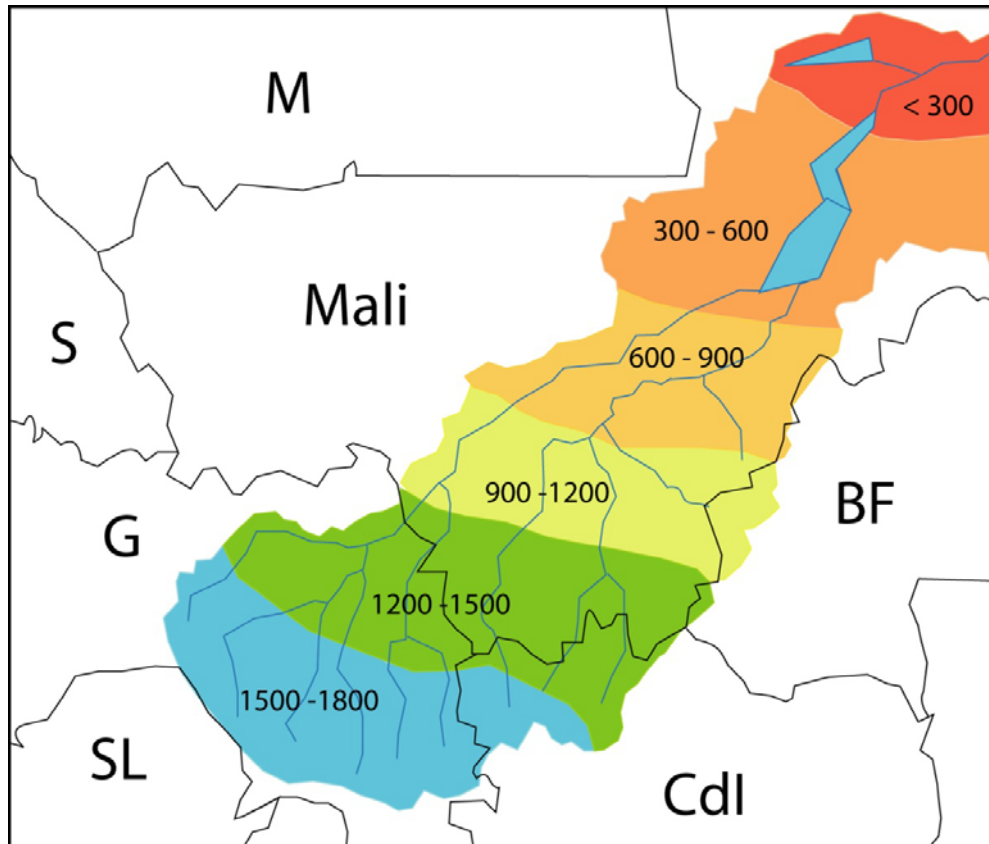


Fig. 5 Rainfall zones in the upper catchment of the Niger River. As the river flows north into the Sahel evaporation quickly exceeds rainfall.

The rainfall in the upper basin is highly seasonal (March to October, peaking in August), which causes a unimodal flood peak that propagates through the system and is attenuated in the floodplains of the Inner Delta, modifying the hydrograph from a sharp peak to a much gentler curve (Figure 6). The Inner Delta is a vast

Flow (cumecs)

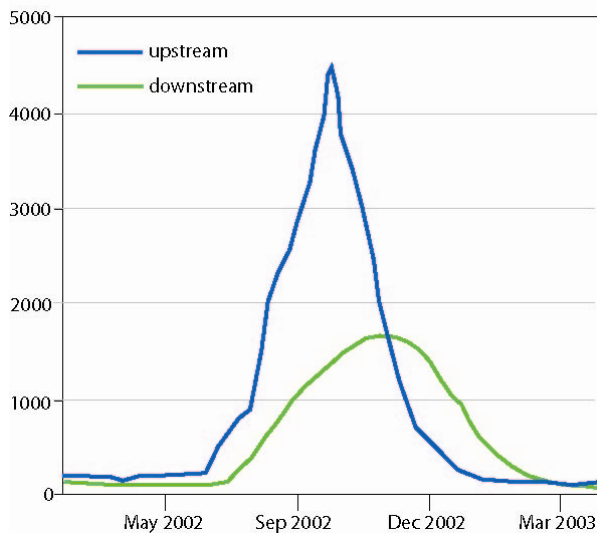


Fig. 6 Flood peak attenuation by the Inner Delta in 2002

The flooding of the Lake Faguibine System (LFS) is determined by events occurring in two distinct parts of the Niger River:

- the Niger River proper upstream of Diré (Figure 7)
- the connecting channels between the Niger River and the various lakes of the LFS downstream of Diré (Figure 9).

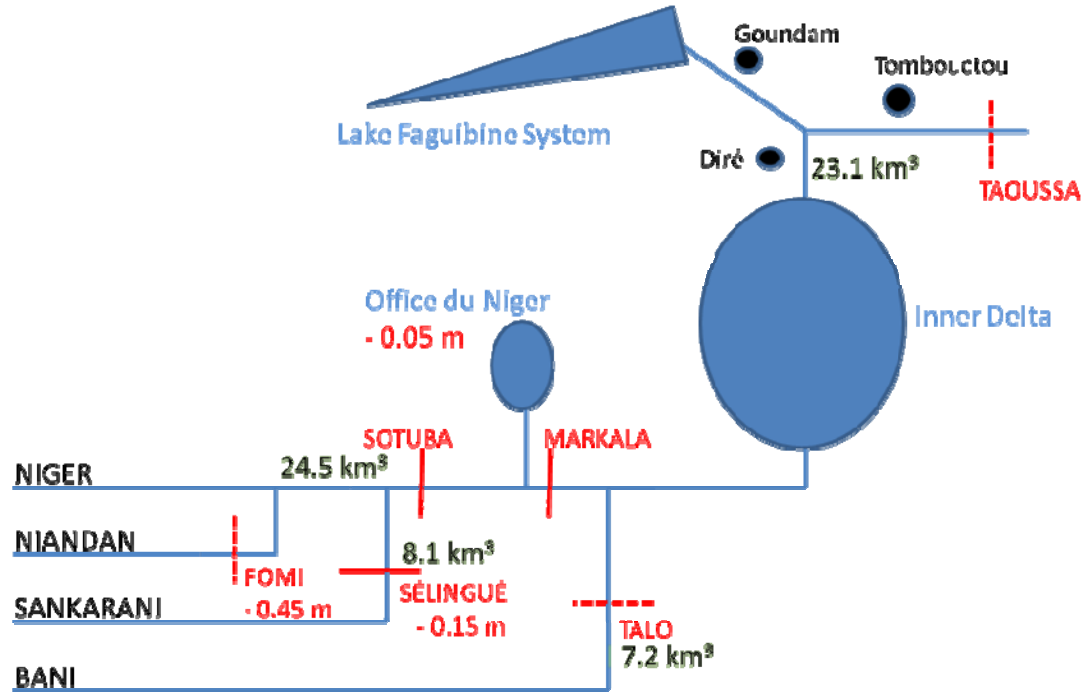


Fig. 7 Schematic representation of the Niger River upstream of the Lake Faguibine system with existing (red lines) and planned (dotted red lines) dams. The impact of those dams and of the Office du Niger (abstraction for irrigation) on the height of the flood peak is mentioned in red. Annual discharge of the main contributing rivers is presented in the green boxes. The river “loses” about 40% of its discharge through evaporation in the 10,000 to 20,000 km² of floodplains of the Inner Delta (adapted from Zwarts et al. 2005).

Upstream of Diré

Most of the discharge in the Upper Niger River comes from the high rainfall areas in Guinea, Ivory Coast and southern Mali. As has been the case for the Sahel (Figure 3) the tendency in these areas has been a decline in rainfall that has been reflected by a decline in average discharge of the Niger River. In addition to climate change the other factors that determine the flow in the Niger River are human interventions such as land use change (mainly deforestation for conversion to agriculture), increased abstraction for irrigation (in particular by the vast Office du Niger) and the use of dams for hydropower production. All these factors are affecting the hydrograph⁴ of the river with the tendency for the reduction of the height of the flood peak causing the most concern, especially the one caused by the important storage capacity of the planned Fomi dam in Guinea. Effectively, for the LFS the most relevant variables

⁴ Hydrograph : the temporal variation in the flows of a section of the river

are the height and duration of the flood peak at Diré just upstream of the system (Figure 8). These will essentially determine the potential inflow into the system.

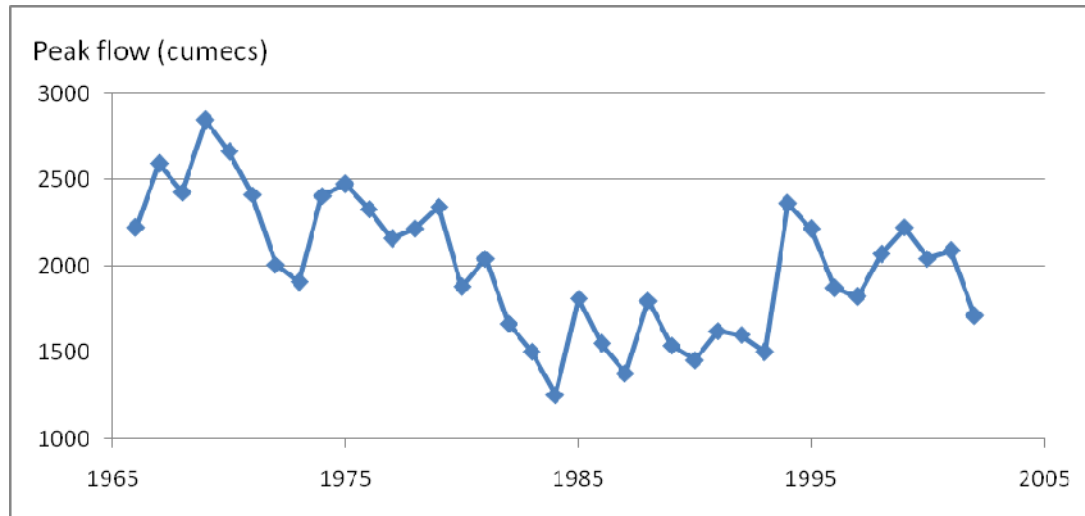


Fig. 8 Variation in the peak flow at Diré since 1966. The decline in peak flow to levels below 2000 cumecs in the early and then again in the late 1970s and all through the 1980s and early 1990s is thought to be one of the main factors that have led to the drying of the LFS.

Effectively, because of the long distances the water has to travel to reach Lake Faguibine the force with which it enters the system is a major determinant. That force is mainly determined by the height of the water at the entry points to the LFS. In fact in the 1950s

Downstream of Diré

The Lake Faguibine System connects to the western Farabango branch of the main Niger River just downstream from Diré (Figure 9). The two channels, the southernmost Kondi (64 km in length) and the more northerly and larger Tassakane (104 km in length) meander through comparatively flat areas (the Killi and Kessou floodplains) that are increasingly invaded by small dune fields that slow down or obstruct the flow. There is a rocky threshold on the Tassakane at Zinzin (or Djindjin in some publications). The two channels unite at Kaney to the east of Goundam with the flow from the Kondi normally arriving first, and at least a month after the water has started entering the channels.

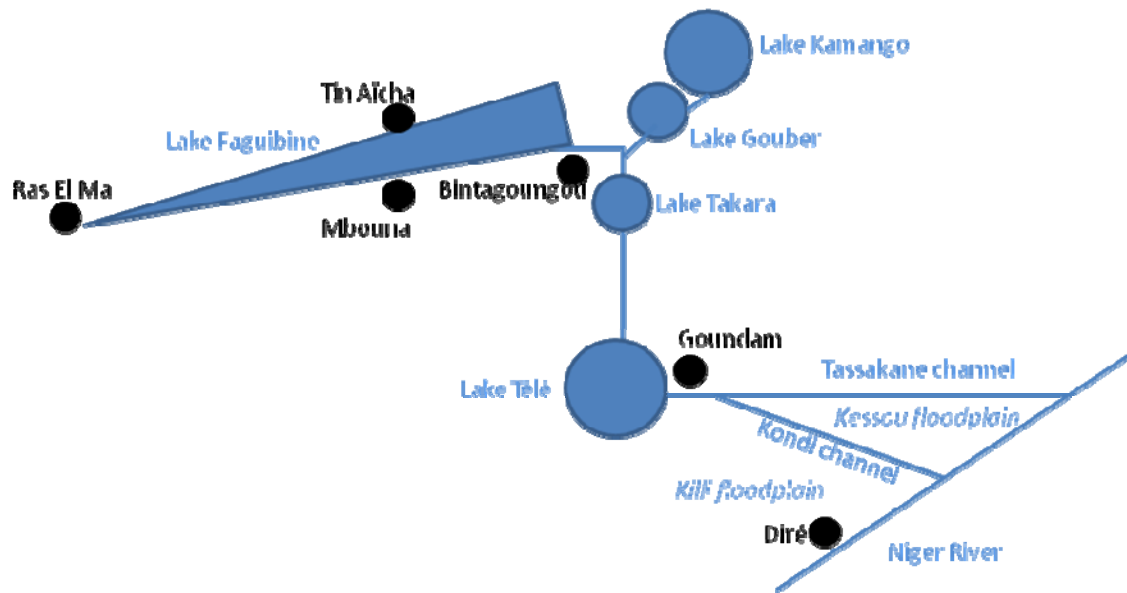


Fig. 9 Connecting channels and main depressions (that become “lakes” when filled) in the Lake Faguibine System downstream from Diré.

The channel around Goundam is threatened by large dune fields that can slow down or obstruct the flow. After Goundam the water fills a first major depression (Lake Télé) and starts to move north towards Lake Takara. Just north of Takara the water reaches the rocky threshold of Kamaina (situated at 251 m IGN). When the flood peak in the Niger River is sufficiently high and long (it takes over a month to fill Lake Télé) succeeds in pushing the water over this threshold it first flows along a very high dune field on its eastern bank. Then, after passing the connecting channels to Lakes Gouber and Kamango, the water turns west past Bintaougou to reach Lake Faguibine. The thresholds to Gouber and Kamango are so high that the water needs to fill Lake Faguibine first before it flows back up into the more easterly lakes.

Because of the length (over 170 km) and complexity of the connections between Lake Faguibine and the Niger River it takes a series of high flood years to completely fill Lake Faguibine and similarly, once full, it takes several years for it to dry out. This explains the various filling and drying phases of the main lake with the annual fluctuation of the water level largely determining the productivity and the activities that can be conducted. In fact at the very high water levels in the 1950s and 1960s the local communities were looking for solutions that could reduce the inflow into the LFS.

Indeed, both at very high and very low levels of Lake Faguibine recession agriculture is impossible (Figure 10), leading to a loss of livelihood opportunities for the communities inhabiting the lake’s edge, most notably for the sedentary farmers. Optimal conditions for recession agriculture require intermediate filling levels of the lake, allowing cultivation on 180 to 350 km². The bottom of the lake is constituted by fine and fertile diatomite clays with high water retention potential. Lateral water transport through capillarity allows cultivation at up to 300 meters from the water’s

edge, up to one meter above the highest flood level (Bouard & Tiers 2004). The fertility and water retention capacity of the soils allows production in a sophisticated traditional intercropping system with the possibility of sequential harvesting of two cereal crops (maize in June and sorghum in October) and a number of other crops (ladies' fingers, cotton, beans, etc.) from the same field in a single season without any inputs such as fertilizer.

When the Faguibine system is flooded it provides an important fishery, estimated at about 5000 tons annually. Other important functions are the provision of drinking water for humans and livestock, groundwater recharge through infiltration in the sandy soils and dry season pasture ("bourgou", *Echinochloa stagnina*) in the lowest lying parts of Lake Faguibine (70-100 km²) and the western part of Lake Télé. Lakes Gouber and Kamango to the east of the main lake only fill at high water levels (over 250m IGN) and were mostly known for rice cultivation.

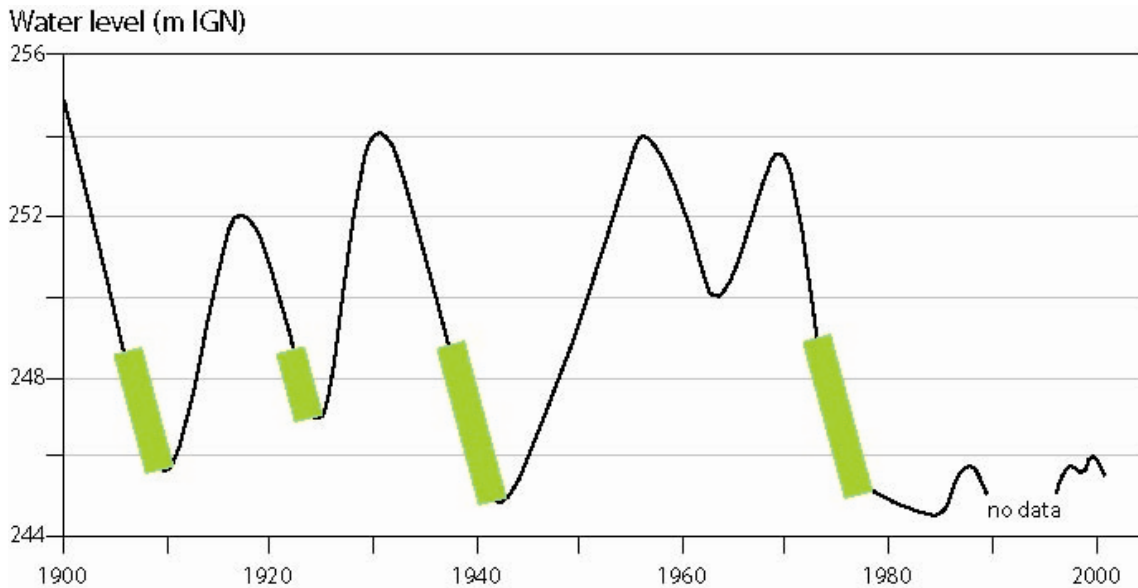


Fig. 10 The optimal water levels for recession agriculture occur during drying out phases of the lake that are sufficiently low to free up the diatomite clays (green rectangles).

The flood peak at Diré usually occurs between early November and late December, but the water level peaks at Goundam about a month later and at Bintagoungou at the entry of the main lake in February.

Complete filling of the 590 km² Lake Faguibine takes some 4 km³ of water, a substantial proportion (some 17%) of the average discharge (1970-1998) of the Niger River at Diré estimated at 23.1 km³ by Hassane *et al.* (2000). Such complete filling usually takes a series of years with high hydraulicity (at least 130% of the 1907 to 1957 average as measured at Koulikoro, just downstream of Bamako). Once full, the Lake Faguibine-Lake Télé system would need some 1.5 km³ of water (1500 million m³) annually to compensate for the 1.5 m of water level loss through evaporation (infiltration is thought to be negligible on the diatomite clays of the lake bottom).

However, “optimal” filling levels, using the criterion of maximum surface area covered and uncovered arable land, are much lower with the lake containing just under 0.5 km³ of water (498 million m³). Under these conditions the lake would require “only” an annual supply of 0.653 km³ of water (653 million m³), i.e. only 3% of the average annual flow at Diré. Still, other stakeholders (fishers, livestock keepers, biodiversity, etc.) may prefer/require large amplitudes and interannual variability of the flood levels is probably a prerequisite to simulate the natural system and prevent dominance of certain vegetation types.

The southern edge of the Sahara around Tombouctou has, even in historical times, known more humid periods. At the end of the XVth century Sonni Ali Ber planned the extension of a channel westward from Lake Faguibine to use canoes for his attack on Oualata in Southeastern Mauritania (see Quensière 1994). Subsequently, interspersed with drier periods, large floods occurred during the XVIth to the early XVIIIth century corresponding with the “little ice age” in Europe and occasionally flooding Tombouctou itself. Between 1875 and 1895 exceptional floods again filled Lake Faguibine and even spilled over into the Daouna lakes (filled between 1893 and 1895), resulting in bumper harvests. The Daounas are situated in the western extension of the depression (the “tayeurt”) of which Lake Téli is currently the only regularly flooded part. Such flood levels have not been experienced in the XXth century and efforts to restore the connection between Lake Faguibine and the Daouna depressions during the high floods of 1929-1930 and in 1955-1956 have failed (Brunet-Moret et al. 1986).

Lake Faguibine dried out completely in 1914 and 1924, again in 1944 and has been at very low levels since the mid 1970s. The series of good floods from 1924 to 1930 (hydraulicity 135% as compared to the 1907-1957 average as measured at Koulikoro, just downstream from Bamako) and from 1951 to 1955 (average hydraulicity 128%) completely filled the lake. This indicates that, for complete filling, the water balance of the Lake (inflow from the river plus local rainfall and runoff minus evaporation) needs to be positive for a series of consecutive years. Such series of high flood years have not occurred since the 1970s. However, from a human livelihood perspective, complete filling of the Lake (590 km²) is not its most desirable state as the best recession agriculture soils (180 to 350 km²) and high quality flood-dependent pasture (70-100 km²) are situated in the lowest parts of the Lake. The annual flooding and drying of these areas is perceived locally as the ideal state. This requires the inflow from the river to be at least equivalent to evaporation estimated at 1.5 to 2.5 m per year.

Local rainfall makes only a marginal contribution to the filling of the LFS but is of obvious importance for the productivity of the surrounding drylands, especially for the livestock that moves into the sandy dune areas after the wet season. Annual rainfall in Goundam averaged 150 mm between 1965 and 2005, a decline of 30 % in comparison to the preceding 4 decades.

Between 1910 and 1915 an attempt was made to connect Lake Fati to Lake T    by digging a major canal to improve the water supply to Lake Faguibine (which was drying out at the time). The attempt failed but the structures are still visible (Brunet-Moret et al. 1986). There have been more recent attempts to deepen the connecting channels between the Niger River and both Lake Horo and Lake Faguibine. The costs have been high compared to the disappointing results (ABN-NBA 2006).

4.4 PEOPLE AND LIVELIHOODS

Most of the Lake Faguibine System, covering some 3360 km², is located in the administrative “cercle⁵” of Goundam which, in 1998, had a population of 131,406 inhabitants and currently some 170,000. Fifteen municipalities are in the Goundam “cercle”, 3 in neighbouring Diré and 1 village in Tombouctou.

Within Mali the Tombouctou Region is amongst the poorest with very low human well-being indicators in comparison to the rest of Mali (Table 1).

	Tombouctou	Mali
Rural population	74%	70%
Average number of children/woman	7.9	6.7
Infant mortality (per thousand births)	198.3	122.5
Child mortality	314.3	237.5
Vaccination coverage below 2 years	27%	30%
Stunted growth below 3 years	41%	30%
Access to safe drinking water	27%	48%
School attendance in 6 to 15 year olds	21%	26%
Adult Illiteracy rate men	98.5	69.3
Adult Illiteracy rate women	88.4	81.1
Mean annual expenditure per capita (\$US)	52	183

Table 1. Some characteristics of the population of the Tombouctou Region in comparison to the rest of Mali

Lake Faguibine is situated at a critical contact point between the northern arabo-berber nomadic pastoralists and the southern sedentary farmer communities (Figure 11) but in fact a complex mix of tribes, fractions and socio-professional castes of various origin. Schematically one could say that:

- the western and northern edges are dominated by berber Touareg and Moorish tribes mixed in with arabs, mainly mobile livestock keepers and traders (feudal tradition with landless bella)
- the southern part of Lake Faguibine is dominated by Sonraï speaking sedentary farmers again of various origin but also organized as a feudal system with landless castes
- around the connecting branches to the Niger river Sonraï and Pulaar speaking people both sedentary and mobile do both farming and livestock keeping

⁵ The “cercle” is the administrative unit between the “commune” (municipality) and the region. There are 8 administrative regions in Mali of which Tombouctou is by far the largest but has the lowest population density (less than 2 inhabitants/km²)

- during flooding mobile fisherfolk (Bozo, Somono, etc.) migrate from the Inner Delta

As elsewhere in the Sahel, the formerly quite strict specializations of each community and caste have been weakened and most inhabitants have become farmer-livestock keepers, fisher-farmers, etc. This also means a lot of the social and economic exchanges e.g., trading livestock for grain, pasture for nomadic herds on the stubble fields, etc. have faded. Both the mobile and sedentary communities are strongly hierarchically structured and, though these distinctions have also declined, partially by the common experience of depending on food aid in refugee camps. Still, the (formerly) subservient castes are often still quite vulnerable (see Macko 2007 for an interesting analysis of the Gourma Rharous region on the south bank of the river).

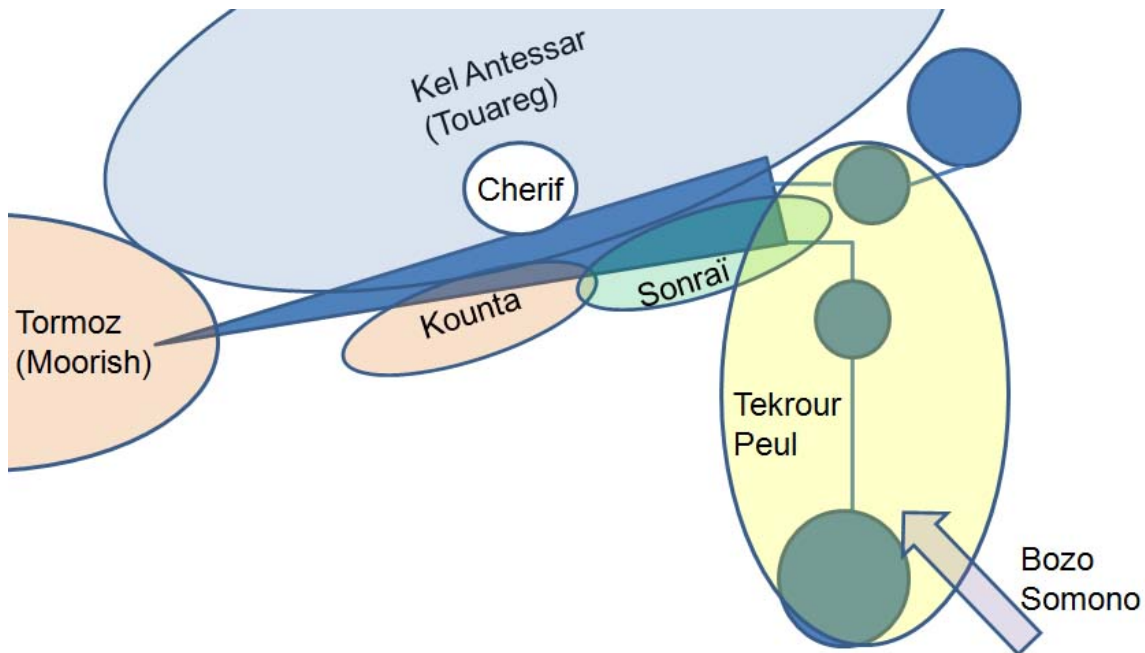


Fig. 11 Schematic representation of the dominant ethno-tribal groups of the LFS

4.5 Biodiversity

There are no comprehensive surveys of the biodiversity values in the Lake Faguibine system before its drying out. Even at low flooding levels e.g., 1983 it held over 400,000 waterbirds, mainly migrating palearctic ducks and waders (Robertson 2001). The area regularly held over 20,000 waterbirds and therefore qualifies as a Ramsar site. Its northern position at the edge of the Sahara desert makes it an important staging post for migrating birds providing a resting and feeding station. Both survival rate and reproductive success of migrating birds can be expected to be positively influenced when favourable habitats are available in the Faguibine system. According to local

sources the system would harbor Black Crowned Cranes (*Balearica pavonina*) and there have been recent observations of vultures (Ascofaré pers.comm.). During the field visit several hundred grasshopper buzzards (*Butastur rufipennis*) were present.

The Lake Faguibine system is situated in the historical area of occurrence of the Scimitar-horned Oryx (*Oryx dammah*). The neighbouring Tilemsi area on the border with Mauritania probably held one of the last population remnants up to the 1960s (Beudels et al. 2005). The Dama gazelle (*Gazella dama*) also occurred in the area and marginal populations of Dorcas gazelle (*Gazella dorcas*) presumably still exist. The potential for reintroduction of Scimitar-horned Oryx and Dama gazelle should be evaluated. Critical factors will include local community support for a strict hunting ban and measures to reserve certain pasture areas from disturbance by livestock, e.g., in the Daounas area.

4.6 RISKS FOR THE PROJECT

The underlying hypothesis conditioning the restoration project of the LFS is that by removing the “dunes” that are blocking the connecting channels between the Niger River and the Lakes Télé and Faguibine all the ecosystem functions of the lake will be restored to a level that satisfies “all stakeholders”.

This hypothesis needs to be detailed from a socio-economic point of view. Who were the original stakeholder groups and how did each of them benefit from which ecosystem services provided by the flooded lake? How was access to those resources regulated? Were there mechanisms in place that ensured access to vulnerable groups (e.g., bella, women)? How has this configuration changed and where have conflicts arisen, to what extent and over which resources?

Alternative hypotheses should also be considered and falsified or analysed in sufficient detail to be refuted as being substantial risks of project failure:

- Though certain ecosystem services have been lost (fisheries) or considerably reduced (recession agriculture) there is a new set of ecosystem services available that provides benefits to certain stakeholders e.g. the *Acacia radiana* forests that have colonized the lake bottom provide favourable conditions for camels and goats, produce firewood and provide a haven for biodiversity such as gazelle. The southward migration of fishers and farmers has reduced pressure on the ecosystem which is beneficial to mobile livestock keepers, the most vulnerable group with the fewest livelihood alternatives. Reflooding the lake will destroy the new set of ecosystem services and enhance conflict, especially if traditional regulatory mechanisms cannot be restored (e.g. influx of venture capitalists, etc.). As mentioned by Mohamed (2008) reflooding of the lake is already perceived by at least part of the local community as an intervention that will mainly benefit farmers and will further marginalize livestock keepers.

- There is an active tectonic process ongoing that is uplifting west bank of the river. Interventions targeting the connections are bound to fail in the medium and long term. Lake Faguibine overlies an important fault line in the West African craton extending eastward from the Nara trough and which, according to El Abbas et al. (1993) would have been tectonically active during the Quaternary. This is attested by the presence of a raised beach at 15 m on Taguilem island in the northeastern part of the lake and by the presence of lavas overlying the diatomites in the dried out Daouna lakes. The presence of lava is however contested by Svensen et al. (1983) who contend that there is no active volcanism and that the surface temperature anomalies are related to subsurface combustion of organically rich materials.
- Changes in rainfall pattern in the upper catchment, increased storage behind dams, increased abstraction for irrigated agriculture, deepening of the river bed in the inner delta and downstream (threshold of Taoussa) have (or will in the near future) modify the hydrograph (flood peak height and peak duration) of the Niger River at the entry point of the channels connecting to Lake Faguibine to such an extent that removing any obstacles on its path will not achieve sufficient flooding of the lake to restore ecosystem services.
- Refilling Lake Faguibine will negatively affect downstream ecosystems and livelihoods (during the great drought the river stopped flowing at Niamey). A detailed impact assessment is necessary to assess impacts all the way down to the Niger River Delta in Nigeria.
- Important gains in ecosystem service delivery may be achieved at lesser cost (both in terms of water quantity and infrastructure investment) and with greater sustainability through the rehabilitation of parts of the Inner delta or other, more upstream, lakes on the West (Tanda, Kabara, Tagadji, Horo, Fati) and East banks (Korarou, Aougoundou, Niangaye - Dô – Garou- Haribongo). The next two hypotheses are linked to this one:
 - Filling of Lake Faguibine can only be sustainably achieved by closing off connections to more upstream lakes on the West and East banks. A detailed cost benefit analysis of those interventions would be necessary, e.g., the East bank lakes are essential for the survival of the small population of Gourma elephants.
 - Filling of Lake Faguibine can only be achieved through the construction of the Tossaye dam. A complete and thorough assessment of the impacts both upstream and downstream of this dam needs to be made.

Information needs

Hydrological data: complete time series (daily water levels) of all the relevant stageboards (Koulikoro, Douna, Youvarou, etc.) but in particular Diré and Tossaye and all stageboards associated with the 4 lake complex e.g., Goundam, Ras El Ma, Alfao, etc.

This should be available from the GIREN programme at the IRD office in Bamako luc.ferry@ird.fr. Other important people to contact in IRD Bamako are: Alain Dezetter alain.dezetter@ird.fr (UMR Hydro-sciences), Marc Berthelot marc.berthelot@ird.fr a technician with enormous experience of the Inner Delta and Lakes (see attached).

Measurements at Goundam would be especially relevant to see if the correlations (height, timing, if possible flows) between peak flood levels at Diré and Goundam have remained the same. Indeed, the underlying cause of reduced filling of Lake Faguibine may not be situated north of Goundam but by a reduced hydraulicity of the channel connecting Goundam to the main Niger River.

CGIAR Challenge programme Water and Food: the Niger River is a Basin Focal Project in this programme. We need to contact these people.
www.waterandfood.org. **Contact Francis Gichuki?**

For hydraulic outlay and development potential we could contact François Gadelle, 60 Bd Montparnasse, 75015 Paris, +33 1 42 22 99 25

There is an issue with the altitudes in the area, sometimes expressed in m IGN and sometimes in m DNCT. There are also some differences in the levels mentioned between older and newer documents.

Intervention information: according to Zwarts et al. (2005) dams were built in several lakes in the 1980s and 1990s, probably to try to increase maximum water level for a given (comparatively low) amount of water flowing in from the Niger River. Lake Tanda (1987), Lake Kabara (1987), Lake Faguibine (1989), Lake Fati (1991), Lake Takadji (1991) and Lake Horo (1994). We would need detailed information on the feasibility studies of these interventions and on their impacts on water levels, ecosystems and livelihood activities.

Satellite imagery: Landsat images of late 2007/early 2008 to see how far the flood peak reached in the channel connecting Lake Télé to Lake Faguibine. Higher resolution images would obviously be even better (possibility to localize critical narrow passages on the connecting channels).

Digital Elevation Model: A detailed analysis by differential GPS of the connecting channel, to localize any thresholds, would also be a prerequisite. **This may need to be updated from Haskoning 1987**

Biodiversity values: waterbird counts from Lake Faguibine, Lake Télé and other areas, perhaps from Wetlands International, Leo Zwarts l.zwarts@riza.rws.minvenw.nl and/or Olivier Girard o.girard@oncfs.gouv.fr

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