LAKE CHAD BASIN COMMISSION

FEASIBILITY STUDY OF THE WATER TRANSFER PROJECT FROM THE UBANGI TO LAKE CHAD

SUMMARY DOCUMENT: MAIN RESULTS OF THE FEASIBILITY STUDY

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1. INTRODUCTION

This document is a summary of the main results of the feasibility study of the water transfer project from the Ubangi to Lake Chad. This project aims to fight against the drying up of Lake Chad, which is a strategic element for the entire region, namely for the more than 30 million people who depend on the natural resources of Lake Chad.

The updated objectives of the inter-basin water transfer from the Congo basin to Lake Chad are:

- Stop the drying up of Lake Chad through water release from the basin of the Congo River, while aiming for a gradual restoration to a normal environmentally-sound standard.
- Restore and Support socio-economic activities; irrigation, fishing, livestock farming, and ensuring the supply of drinking water to fight against poverty.
- Build a multi-functional dam in the region of Palambo which would help support minimum flow to regulate navigation on the Ubangi and production of hydro-electricity to satisfy energy requirements of the city of Bangui and surrounding areas of the two Congo, such as the cities of Zongo, Gemena, Libenge, and for the Interbasin transfer.
- Allow to link the LCBC Member Countries to both Congo by a navigable waterway with a improvement of navigation on the main Lake Chad Tributaries and on Lake Chad itself.
- Taking into account the first technical, economic and environmental estimate outlined in the Planning Report, showing that the transfer by gravity from the Palambo Dam, as originally planned, is not really realistic, an alternative solution, namely, an interbasin transfer by gravity via a Kotto River Diversion located at 18 km to the city of Bria, now part of the transfer options validated using a Multi-Criteria Approach.
- At the request of the CICOS (International Commission of Congo-Ubangi-Sangha), an environmental impact assessment of the water transfer project from the Ubangi to Lake Chad on a part of the Congo River basin, covering the territory of the Ubangi, the Sangha basin, the flooded forests located along the Ubangi-Congo confluence up to the Atlantic Ocean, completes the initial feasibility study.

The CIMA International's mandate is to analyze the feasibility of achieving the overall objectives of the project from a technical, financial, socioeconomic and environmental perspective.

This document contents 8 chapters: (1) Introduction; (2) Summary of Main Results of the Technical Feasibility; (3) Summary of Main Results of the Economic and Financial Feasibility; (4) Summary of Main Results of Environmental Feasibility; (5) Legal and Institutional Framework for the Implementation of the Inter-basin Project; (6) Role of the LCBC in the Management of the Inter-basin Water Transfer Project; (7) Communication Strategy; (8) Conclusion and Recommendation.

2. SUMMARY OF THE MAIN RESULTS OF TECHNICAL FEASIBILITY STUDY

2.1 Context

The main objective of the Technical Feasibility is to proceed to a technical evaluation of all transfer infrastructures, the determination of their implementation conditions and, the estimation of construction, maintenance and operational costs. All this should lead to the proposal of the project's General Development Plan, and a Table of Technical Costs. Throughout our work, five potential scenarios of transfer have been studied : (1)Gravity transfer via the Palambo from the Ubangi;(2) Transfer by pumping via the Palambo dam from the Ubangi; (3) Transfer by pumping via the Palambo dam, combined to a gravity transfer via the Bria/Kotto dam; (4) Palambo dam without water transfer and gravity transfer via the Bria/Kotto dam; (5) Gravity transfer via the Bria/Kotto dam.

On the basis of participatory multi-criteria analysis, a classification of these five scenarios was submitted to the LCBC to proceed to a final choice. Here we present the main components of the retained scenario that is a double transfer, namely, to transfer from the Palambo dam by pumping and the transfer from the Bria/Kotto dam, by gravity.

The proposed Development Plan is made-up of the following infrastructure: a multi-functional dam (water reservoir) at the Palambo site, a dam on the Kotto/Bria site, mainly destined for the inter-basin transfer from the Kotto, the water transfer infrastructure, engineering works and support infrastructure.

To each other infrastructure or group of infrastructure are attached the implementation costs.

2.2 Transfer Infrastructures

The LCBC Terms of Reference of the feasibility study recommended transferring by gravity from a dam (water reservoir) to be built at the Palambo site. Such a solution has been shown to be unrealistic involving tunnels and trenches up to 170 m deep, 600 km long and ranging in cost over 60 billion dollars. This option has been finally rejected on the basis of the multi-criteria approach for options selection.

2.2.1 Palambo Dam

The chosen dam is a multifunctional dam with three main objectives: support for minimum flow to regulate the navigation on the Ubangi, for the hydroelectric production and to serve as a starting point for inter-basin transfer to the Lake Chad. The chosen site for the development of the dam is the Palambo site, compared to other sites, including that of Longo, on the basis of a multi-criteria evaluation. It has been chosen mainly because it offers a relatively narrow valley, which greatly limits the size of the structure. This is the site that was originally investigated by the pre-feasibility study of SOGREAH (1990).

Figures 1 and 2 respectively show an aerial view of the site and the tree axes identified when the topographical survey was conducted, and the Palamo site, seen from the DR Congo, on the central axis.

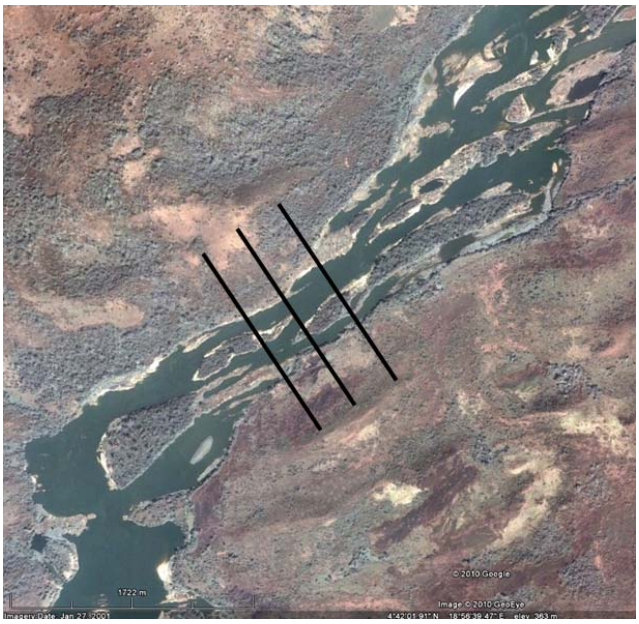

Figure 1 : Palambo site with the three investigated axes

Figure 2 : Palambo Site seen from DR Congo, on the central axis

With a rated flow of 1,650 m^3/s (6 units of 60 MW each), one can expect a production of up to 360 MW and as low as 160 MW for severe low flows.

The support of navigation is possible throughout the year on the Ubangi downstream of Bangui, 8 years out of 10. The retention of flows at the navigability threshold involves a significant drawdown of the reservoir (10 to 15 m).

Reservoir, type of dam and hydraulic structures

The Palambo Reservoir extends over a distance of 200 km upstream, and at times of major flooding, could reach the foot of the Mobaye Dam.

As a civil engineering structure, the Palambo Dam will be made up of three sections: a rockfill dam, a hydroelectric generating station, and a spillway.

The proposed crest is 370 m, with the following operating levels:

- Minimum operating level: 350 m
- Maximum operating level: 365 m
- Maximum critical level: 368.5 m

Costs

Construction costs expected for the Palambo dam are about 2.7 billion dollars (1.2 trillion CFA francs). The dam allows the production of 2.5 x 10^6 MW-hr and the opening of navigation throughout the year, 8 years out of 10.

2.2.2 Bria Dam

The Bria Dam is located on the Kotto River. Its principal use is to raise the level of the Kotto River for an interbasin transfer toward Lake Chad.

The site selected for the dam is close to the village of Boungou, 18 km upstream from Bria. This site has been selected because it is located downstream from the confluence of the Boungou and Kotto rivers. This allows mobilization of larger quantities of water, and makes the Boungou available for the transfer. This is also the site where the valley is narrowest downstream from the confluence (Figures 3 and 4).

Kotto-Boungou Reservoir

The Bria Reservoir is set at a level of 580 m. It would extend for 55 km on the Boungou and for 70 km on the Kotto.

Retaining Structures

The proposed retaining structures are similar to those of the Palambo Dam. There would be a rockfill structure with a watertight core in bituminous concrete. The work would have a height of 45 m and a total length of 1,800 m. Part of this work will be made up of a power plant of 20 MW and a concrete spillway.

Figure 3 : Bria dam site

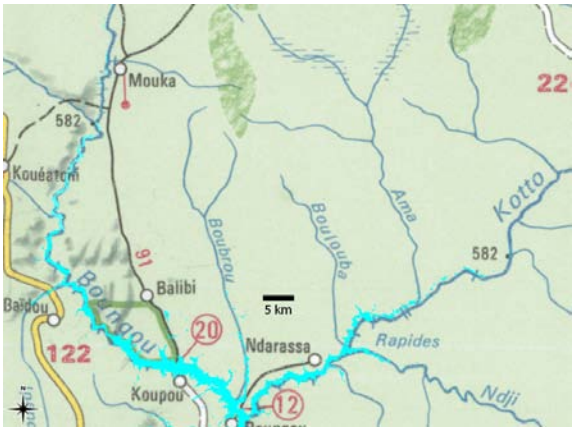

Figure 4 : Kotto reservoir (Level of 580 m)

Costs

Construction costs expected for the Bria dam are about $ 500 million (242 billion CFA francs). The dam allows the production of 147 x 10^3 MW-hr.

2.2.3 Transfer by pumping from the Palambo Dam

The first means of crossing the interbasin crest between the Ubangi sub-basin and the Lake Chad basin is to pump the water by means of a pipeline. Such a solution involves major infrastructures and the consumption of 73% of the energy produced at Palambo.

The pipeline route is presented in Figure 5. The layout follows the bed of the Tomi River up to the interbasin crest, where a trench will make it possible to reach the Lake Chad basin. Canals and works on the of Tomi, Fafa, Ouham and Chari river will convey the water to Lake Chad.

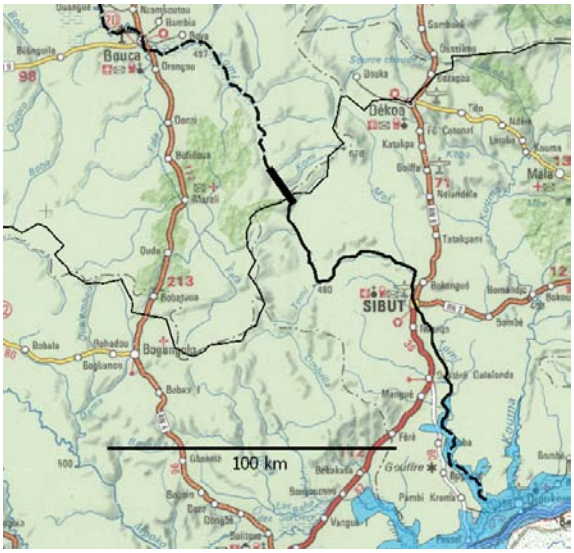

Figure 5 : Pipeline route

The electrical power available for an average year from the Palambo dam is presented in Table 1.

Table 1 : Potential of the Palambo site with regulation for an installed power of 360 MW

	P max (MW)	Remaining Power after pumping (MW)
J	360	92.2
F	364	69.2
M	353	45.5
A	322	92.3
M	271	62.3
J	208	89.9
J	216	91.0
A	222	97.2
S	227	28.4
O	246	47.2
N	295	74.6
D	388	116.5

Required Hydraulic Structures

The pipeline option requires major infrastructures, including a system of pipelines, pumping stations, a trench 7 km long, many developments of rivers and canals.

As an indication, the pipeline is 128 km long with a head difference of 180 m. The type of conduits considered is three conduits of 6 m of diameter. To transfer 100 m^3/s, this implies a power of 251 MW. Approximately 73% of the energy produced at Palambo would be used to power the pumps. A pipeline of this size will be extraordinary.

Water Quantity transferred and Impact on the Lake

We estimate the maximum transferable quantity to be 91 m^3/s (transfers of 100 m^3/s and 75 m^3/s during the months from May to August). This limit is determined by the quantity of energy available at Palambo.

Such a transfer would raise the level of Lake Chad by 40 cm in the South basin and by 50 cm in the North basin (increasing the lake area by about 3,000 km^2)

Support Infrastructures

2.2.3.3 Support Infrastructures

Support infrastructures are necessary for the construction and operation of the pipeline. They are:

- Power transmission lines and transformer stations, to provide power to the pumping stations;
- Roads along the pipelines;
- Development of streams / rivers crossed by the pipeline;
- Factory for the construction of pipeline components and so on.

2.2.3.4 Costs

Conduits and pumping works of this magnitude would be a world first. The expected cost is about 7.3 billion dollars (3,500 billion CFA francs). In addition to the additional annual costs up to $ 270 million USD (128 billion CFA francs) for the pumping energy must be taken into account.

2.2.4 Gravity Transfer via the Kotto / Bria

After diverse investigations, an interbasin transfer is also possible from the Kotto River, upstream of the city of Bria in the Central Africa Republic (CAR). This option is located at the end of the route of the Transaqua project. This option makes it possible to avoid depending on electromechanical equipments, but is limited in the quantity of water available. It also requires the construction of a dam at Bria.

2.2.5 General Description of the option

The proposed layout (route) would go through the Boungou River (reservoir of the dam), the Ipendo River, the Ouaka River, two trenches to cross the interbasin crests, and a canal along the Koukourou and Bamingui rivers before continuing to Lake Chad via the Chari River. The drawings and profile of the layout are presented in Figures 6 and 7.

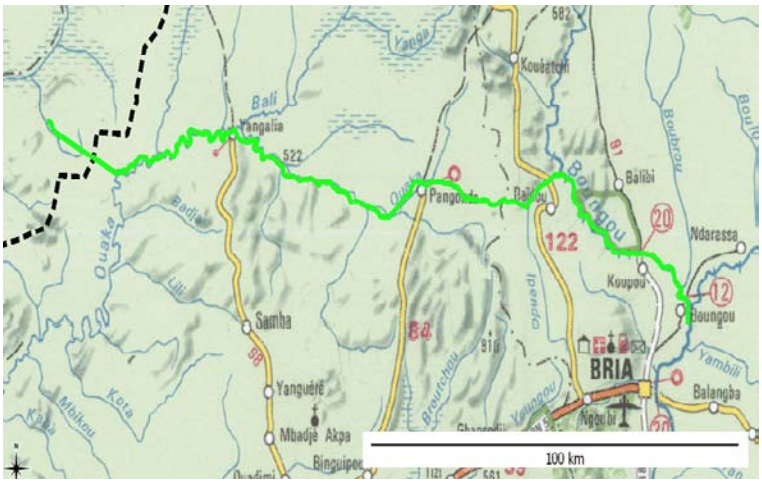

Figure 6 : Layout of the diversion of the Kotto (Ubangi Basin)

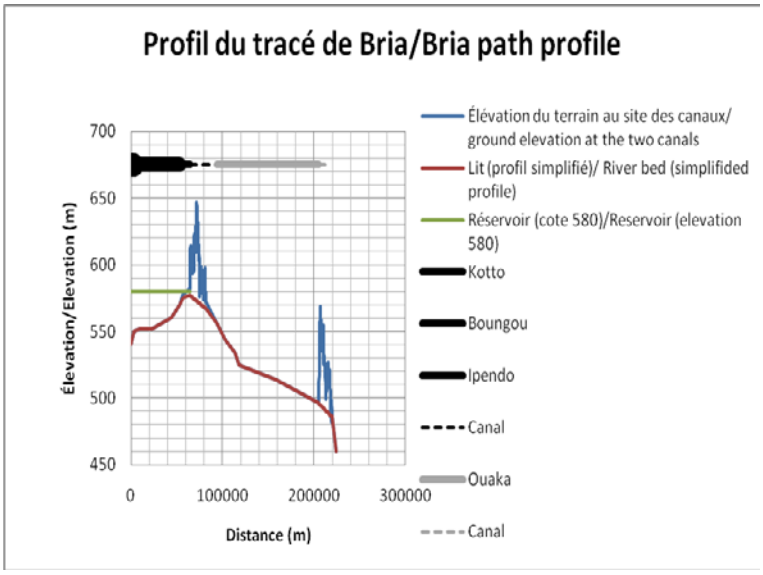

Figure 7 : Schematic Profile of the Diversion (Ubangi Basin) Necessary Hydraulic Infrastructures

Required Hydraulic Infrastructures

The option by gravity from the Kotto requires several infrastructures. The major components are the Bria dam/ Kotto, two trenches 17 and 14 km to cross the crests of Kotto-Ouaka and Ubangi-Chari, a canal along the Koukourou and Bamingui rivers, riverworks on the Boungou, Ipendo and Chari rivers and, road for maintenance of transfer the infrastructures.

Water Quantity transferred and Impact on the Lake

We estimate the average amount that is transferred at 108 m^3/s for an average year with a maximum of 300 m^3/s in flood and no transfer in the three months of low flow (February, March and April).

Such a transfer would raise the level of Lake Chad by 40 cm in the South basin and by 50 cm in the North basin (increasing the lake area by about 3,000 km^2)

Costs

The transfer option via the Kotto involves costs of about $ 4 billion (1,900 billion CFA francs)

2.2.6 Mixed (Combined) Transfer: Gravity via Kotto and Pumping via Ubangi

The mixed transfer is possible. This is the setting up of two transfer options simultaneously. Such a transfer would raise the level of Lake Chad by 1m in the South basin and by 1 m in the North basin (increasing the lake area by about 5,500 km^2)

Costs

Costs of this combined option are about 14 billion dollars (6.68 trillion CFA francs).

2.3 Waterways

The study of waterways in the two watersheds is an important component of the technical feasibility study, since one of the objectives of the feasibility study of the water transfer project from the Ubangi to Lake Chad is to improve the navigability of the Ubangi (via using of Palambo Dam) and to improve the navigability in the Lake Chad Basin (via additional water).

We first made a diagnosis on navigation in the main hydro-systems of the two basins involved: the Chari, Logone, Mayo-Kebbi, Lake Chad, Ubangi and the Congo River (from Bangui to Brazzaville).

In the Lake Chad Basin, the navigation of large vessels is currently not well developed, it is currently practiced as an adapted navigation focusing on the transport of agricultural products, fishing and commercial products.

The main obstacles to navigation in the Chari, Logone and Lake Chad have been identified, including lower water levels, siltation, invasive plants, the wild islands, meanders, narrowing, the rocky bays , bridges, etc. The solutions are riverworks on these rivers, the fight against siltation, dredging and marking.

In the Ubangi and Congo Rivers that already have a large commercial navigation; we also conducted a diagnosis on navigation, identifying the main obstacles. These are lower water levels, the difficult passes (Sandy and rock passes), including Boyele thresholds (Pk 362) and Zinga (PK 525-527.5) on the Ubangi, the thresholds sandy rock on the Congo River, including five barrels (560 km) between Gombe and Lukolela, the Pool of Bolobo (340-320 km) the Standy Beach (km 270 to 255) and Pool Malebo (km 40-5), the Congo River, the islands wildlife, invasive plants, stranded wrecks, etc.

We conducted preliminary work to analyze the improvement of the navigability of the hydro-systems, including survey sections (bathymetry) and hydraulic modeling. These would enable to assess development works of hydro-systems, cleaning of invasive plants, fight against siltation, dredging and signaling.

On the Ubangi, the control of low flow using the Palambo reservoir would allow to maintain the minimum flow requirements for navigation 8 out of 10 years.

It is important to note that these estimates are made with optimal management of the reservoir by agreeing, during very dry years out of part of normal operation of the dam. In addition, such an operation involves a large drawdown (15 m) of the reservoir.

2.3.1 Link Chari-Logone-Mayo-Kebbi-Benue

Regarding the link Chari-Logone-Mayo-Kebbi-Benue, the main results of our studies show that it is not economically feasible to make this link navigable for boats other than canoes without a transfer of water from the Chari-Logone System. In fact the rivers are small and we note the presence of falls, sediment and invasive plants.

Make these waterways navigable without any additional water from the Chari-Logone system would require major developments of the Mayo Kebbi and Benue (Major infrastructures are also required to pass the Gauthiot falls). On the Benue, the navigation solutions pass through a dredging and maintenance of the river.

3. SUMMARY OF THE MAIN RESULTS OF THE ECONOMIC AND FINANCIAL FEASIBLITY STUDY

3.1 Context

As part of the feasibility study of the water transfer project from the Ubangi to Lake Chad, the economic and financial feasibility study aims mainly to identify: (1) the total cost of the project, including the cost associated to the implementation of the water infrastructures, the cost of building access roads, the environmental costs, the social costs and other temporary costs, (2) the operating and maintenance costs, administrative and management costs (3) the cost/benefit analysis to determine the expected benefits for member countries through the improvement of the living conditions of their populations, (4) the financial viability of the marketable entities, such as the sale of hydroelectricity produced by the hydroelectric plants of the Palambo and Bria dams.

3.2 Summary of the Overall Estimated Costs

The Overall Estimated Cost is presented by sub-project.

3.3 Table 2 : Summary of the Overall Estimated Costs

Sub-projects	Construction Cost ($ milliard)	Construction Cost ($ milliard FCFA)
Palambo dam	2.7	1,200
Bria Dam	0.5	242
Transfer by pumping via the Palambo Dam	7.3	3,500
Transfer by gravity via the Bria dam	4.0	1,900
Combined Construction Cost	**14.5**	**6,680**

3.4 Main Results of the Cost/Benefit Analysis

The goal here is to compare the overall quantifiable benefits to the overall costs associated with implementation, operation, maintenance and environmental costs, social costs and other costs. The capitalization rate used is of 15%, with an economic life for the project estimated between 25 to 40 years, depending on the components.

It is important to note that an in-depth economic analysis was conducted to quantify the major benefits associated with the socio-economic activities such as fishing, agriculture, breeding, water transport, local shops and other activities where water is used, that will benefit from the water surplus in the waters of the Lake Chad basin that will be involved in the interbasin transfer. In this analysis, we used several variables, indices and rates based on the country, such as the inflation rate, the deferral period, the repayment of debt, etc. The entire analysis process will be very well explained in the draft Final Report.

3.4.1 Summary of the Cost/Benefit Analysis

The Analysis is performed for three basic scenarios, calculating the Economic Rate of Return (ERR) and the Net Present Value (NPV).

The obtained Results are:

Table 3 : Summary of the Cost/Benefit Analysis

Inter-basin Transfer Scenarios	ERR	NPV
Transfer by pumping via the Palambo Dam + Gravity Transfer via the Bria Dam	14.53%	-337.9 milliards FCFA
Transfer by pumping via the Palambo Dam	17.4%	1,410.9 milliards FCFA
Gravity Transfer via the Bria Dam	24.83%	3,520.6 milliards FCFA

3.5 Analysis of the Financial Profitability

The goal here is to determine the financial profitability of the hydroelectricity produced at the Palambo and the Bria/La Kotto dams.

In order to simplify the process, we assume that all the electricity available to the project will be sold to ENERCA or SNEL, by developing a wholesale pricing strategy, depending on availability during the year, while taking into account other alternative uses such as pumping for the interbasin transfer. The calculations were performed for two possible prices for electricity. We also assume that there would be two options: with or without financial expenses.

3.5.1 Summary of the Financial Profitability Analysis

Case of hydroelectricity from the Palambo Dam

Table 4 : Summary of the Financial Profitability Analysis (Palambo Dam)

	Electricity Wholesale Price: 50 FCFA/KWh Discount Rate 15% Lifetime between 25 and 40 years	
	ERR	**NPV**
Without Financial Fees	22.91%	315.9 milliards FCFA
With Financial Fees	17.7%	93.15 milliards FCFA
	Electricity Wholesale Price for ENERCA : 80 FCFA/KWh Discount Rate 15% Lifetime between 25 and 40 years	
Without Financial Fees	37.63%	927.48 milliards FCFA
With Financial Fees	25.0%	704.48 milliards FCFA

Cas of Hydroelectricy from the Bria Dam /Kotto

Table 5 : Summary of the Financial Profitability Analysis (Bria Dam)

	Electricity Wholesale Price: 90 FCFA/KWh Discount Rate 15% Lifetime between 25 and 40 years	
	ERR	**NPV**
Without Financial Fees	24.7%	36.59 milliards FCFA
With Financial Fees	19.9%	15.69 milliards FCFA
	Electricity Wholesale Price: 110 FCFA/KWh Discount Rate 15% Lifetime between 25 and 40 years	
Without Financial Fees	30.65%	59.24 milliards FCFA
With Financial Fees	26.3%	35.73 milliards FCFA

3.6 Summary Analysis and Interpretation of the Results

The summary analysis of all the results obtained shows the following:

1) It is not economically profitable to transfer water using the two inter-basin transfer scenarios at the same time as the net present value of the combined scenario is negative.

2) The most economically advantageous transfer scenario is one where the one using transfer by gravity from the Bria/Kotto dam, with an economic rate of return of 24.83% and a Net Present Value of 3,520.6 billion CFA Francs.

3) The sale of hydroelectricity from both dams is a profitable endeavor from a financial standpoint, with an economic rate of return of up to 31%.

4) Other more detailed analyses will be presented in the draft Final Report.

4. SUMMARY OF THE MAIN RESULTS OF ENVIRONMENTAL FEASIBILITY

4.1 Context

Environmental impact study as a decision making tool allows the identification and assessment of consequences and repercussions that projects may engender on natural and human environments. In its implementation, it takes into account all the components of the biophysical and human environments likely to be affected by some features of the project. It thus helps in analyzing and interpreting the relationships and interactions between factors that influence ecosystems resources, people and communities. Potential sources of impacts include facilities provided at the pre-project, project and post-project operation and maintenance stages that could cause some changes in the environment.

As part of the water transfer project from the Ubangi to Lake Chad, several issues and environmental impacts have been identified with linkages to the following main sub-projects:

- Palambo Dam on the Ubangui River
- Bria Dam on Kotto River
- Inter-basin water transfer from Ubangui to Lake Chad via the Palambo Dam
- Inter-basin water transfer from Kotto to Lake Chad via the Bria Dam

This summary presents an overview of key issues and the impacts that were identified during environmental analysis and are related the physical, biological and the human environment.

4.2 Summary of Environmental Issues

4.2.1 Physical environment issues

The expected main issues on the physical environment will affect the hydrological regime of the major rivers involved, such as Chari, Logone, Komadougou-Yobe, Ubangi, Kotto, Boungou, Ouaka, Tomi, etc.

In general, rivers affected by the project will have a significant change in their hydrological regime. Changes in the hydrological regime will have a long run impact on the downstream and upstream dams to be built. The positive effects of the changes in the hydrological regime due to the water transfer to the Lake Chad Basin must outweigh the negative effects in order for the project to be deemed feasible. Water quality has been identified as an important issue.

Stored water in the upstream of Palambo and Bria Dams will, in part, be transferred to the Lake Chad through the Chari River and some other rivers that are built to support a higher flow rate. Since water is used for consumption, irrigation, agriculture and for other activities such as fishing and farming, any significant disruption of its quality may have indirect effects on riparian populations of the Chari, Logone and Lake Chad. In addition, water quality could affect aquatic ecosystems of the Chari-Logone, the Komadougou-Yobe and Lake Chad, with subsequent affect on fish populations to the detriment of human population.

Creation of a water reservoir also has an impact on water quality. It creates stagnant water on its upstream. There is a risk of degradation of the aquatic environment due to the rise of some nutrients concentration such as, nitrogen and phosphorus. Eutrophication that results may affect the population of many aquatic and riparian species, and facilitate the

development of parasites and toxic algae, etc. The change in the water regime could also facilitate the proliferation of infectious agents responsible for infectious diseases (viruses, bacteria, parasites).

4.2.2 Biological environment issues

As for the biological environment, the main issues include changes in aquatic life and habitat due to significant changes in the flow of water and the barrier to migration, consequent on dams that will built on Bria and Palambo Rivers.

In addition, the water transfer of invasive species such as cattail (Typha australis) and water hyacinth (Eichhornia crassipes) pose a significant threat because the water transfered are from two different watersheds. Since Chromolaena odorata, Tithonia diversifolia and Mimosa pudica are the most invasive plants in agricultural areas; they rapidly colonize soil after the first planting and harvest.

It should be noted that in the Congo River Basin, there are also indications of the presence of the Nile Tilapia (Oreochromis niloticus), which could result in major changes at the local and regional fish populations.

4.2.3 Human environment issues

The main effect on the human environment concerns population settlements, agriculture and fishing. Indeed, at the periphery of the Lake Chad and the Palambo and Bria dams, the project will have major effects on the surrounding villages and especially settlements on the flood plains of the lake and the rivers affected by the water transfer. Thus, the relocation of several communities might occur.

However, the project will generate positive effects, notably on fisheries, agriculture, livestock and even river transport. In the case of the Lake Chad basin, these activities will reserve the drought conditions that some of the LCBC member countries are experiencing. Populations living near the Palambo and Bria dams will also benefit from these dams for fishing, gardening, and farming purposes.

With the control of water flow on the Palambo dam, river transportation will be improved on the Ubangi. It will engender positive effects at the local and regional economy; in CAR and in the surrounding towns and villages of both Congo, due to the river route from Bangui to Brazzaville. This could be the starting point for intermodal transportation initiatives linking the two Congo, CAR, Chad, Cameroon, Nigeria and Niger.

Another important aspect that should be noted is in creation of jobs during construction and operation of all water infrastructures that will be implemented as part of the inter-basin transfer.

4.3 Summary of project impacts

4.3.1 Impacts on the physical environment

The main impacts on the physical environment are change in the hydrology and water quality in time and space.

Hydrological regime

Water flows on the Ubangi and Kotto Rivers as well as all the rivers that will be used to transfer water from the Kotto and Ubangi to Lake Chad, will be modified by the construction of Palambo and Bria dams. It will also generate the creation of reservoirs on Ubangi and Kotto/ Boungou. The transfer of water from the Ubangi and Kotto will increase by an average of 0.9 m the level of Lake Chad.

Water will be stored in the reservoir on the Palambo dam upstream during the months of flood, while ensuring a significant portion (85%) of natural flow and it will be released gradually during the months of low water. This will not significantly alter the hydrological regime of the Ubangi and will help in 1) supporting the low water (maintaining a minimum flow) downstream of eight years out of ten, which will improve navigation on the River Ubangi, 2) transferring some of the water to Lake Chad and 3) producing hydroelectricity to power the city of Bangui and its surroundings communities. This low water retention will not cause any significant changes in the flow of the River Congo.

The main objective of the construction of Bria Dam on Kotto River is twofold; to transfer water stored in the reservoir created behind the dam to Lake Chad through the Chari River and generate hydroelectric power to surrounding towns, including the town of Bria. However, maintaining 30% of the flow in Kotto River or a minimum of 50 m^3/s at all times on the dam downstream is a considerable decrease in water level of the river. This diminution in water level could affect the habitats, the aquatic fauna, the fishing activities, the water supply for drinking purposes and the irrigation of agricultural land.

Some recipient rivers will see their flow to increase significantly, for example, Fafa River will be subjected to an increase in the raw average of up to 100%. While this increase will not be significant on Chari River, it can affect positively or negatively the habitats, aquatic life and fishing activities, depending on the amount of additional flow. It will favorably affect water supply consumption of the population and irrigation for agriculture. However the morphology of the watercourse will be altered.

The creation of reservoir on dams upstream will inundate 1,700 km^2 of land upstream of Ubangi River and 220 km^2 of land on the upstream of Boungou and Kotto Rivers at the dams' maximum critical elevation, as well as the mouths of rivers that feed Boungou and Kotto Rivers' reservoirs. This will flood the forests, farmlands, villages and alter the water quality.

Water Quality

The water quality is likely to be subjected to some changes because, the water stored at the upstream of Palambo and Bria Dams will in part be transferred to the Lake Chad via the Chari River. This will result in a mixture of water. In addition, sediments that develops may contribute to the silting of the receiving rivers and Lake Chad.

The creation of a water reservoir will impact on the water quality. It creates a stagnant water body on its upstream, and inundates the adjacent lands. There is a risk of degradation of the aquatic environment by eutrophication due to an increase in concentrations of nutrients, such as nitrogen and phosphorus. This eutrophication may impact many aquatic species, and may engender the proliferation of algae and bacteria, etc.

4.3.2 Impacts on the biological environment

The main impacts on the biological environment related to the aquatic wildlife and its habitats; due to significant changes in water flow and the obstacle to migration posed by a dam (if a lock is built). As for the terrestrial wildlife, the planned developments may constitute physical barriers that will prevent the movement of wildlife to the rivers. In addition, invasive aquatic species such as cattail (Typha australis) and water hyacinth (Eichhornia crassipes) are likely to cause significant impacts on aquatic ecosystems as mixed water are sourced from two different watersheds. Other invasive plants like Chromolaena odorata, Tithonia diversifolia and Mimosa pudica are able of colonizing the agricultural communities and cause damage in planting and harvesting.

There are also indications of the presence of the Nile Tilapia (Oreochromis niloticus) in the Congo river Basin; its presence could have negative impacts on local fish populations and on aquatic invertebrates. Inevitably, this impact could negatively impact economic and social development.

4.3.3 Impacts on the human environment

Overall, several elements of the human environment are likely to be negatively impacted by major construction works and operation. The main impacts will be on human population living in flooded areas. However, local and regional such as in landscape aesthetics, river and trade transportation, agriculture and overall quality of life will experience a beneficial impact.

In general, the project will result in more positive impacts than negative ones on the human environment; considering the fact that, the transfer of water is to provide the Lake Chad and population with a water level that will promote commercial fishing and subsistence, as well as the irrigation of the fertile lands bordering the shores of the Lake Chad.

4.4 Environmental and Social Management Plan

Environmental and social impacts risks identified in this study must be addressed mainly in the context of Environmental and Social Management Plans (ESMP). ESMP identifies measures to prevent, minimize, mitigate, or compensate for the adverse impacts, and to improve the environmental performance of the project while ensuring compliance with environmental standards during the phase of planning, design, and construction, as well as the operation components of the project.

On the basis of ESMP, countries affected by the water transfer project from the Ubangi to Lake Chad will ensure the integration of mitigation measures, compensation measures and some environmental monitoring activities specified in the impact study.

In this regard, the following measures and actions are needed as part of the planning and the implementation regime of the project:

1. Environmental specifications must be integrated into the plans and specifications for the construction of various project components (e.g. Palambo Dam, Bria Dam, canals for water transfer, riverworks on river banks, etc.).

2) Compensation plans for loss of natural areas in national parks and reserves and in sensitive environments should be prepared in accordance with relevant regulations in each country;

3) Compensation plans for property loss in flood zones, in transfer, or water intake should be prepared. These compensation plans should include:

- public consultations in the affected areas;
- the inventory of properties and property to be expropriated / offset;
- legal survey of the flood areas;
- cost calculation of properties and property expropriation / compensation;
- the negotiation with landowners and the communities affected;
- the development of a displacement plan for the populations;

4. An environmental monitoring plan should be developed, by which we ensure:

- the effectiveness of mitigation measures;
- the performance of the compensation plans;
- the integration of the displaced populations;
- the social and environmental impacts that were not anticipated and may deserve the application of additional measures.

Note that, in order to develop the institutional capacity to implement ESMP; training should be budgeted for in order to ensure the satisfactory completion of environmental and socio-economic performance of the project. The training should include the reinforcement of capacity building, environmental assessment, environmental mitigation plans, monitoring and environmental follow-up.

5. LEGAL AND INSTITUTIONNEL FRAMEWORK FOR IMPLEMENTATION OF THE INTERBASIN TRANSFER PROJECT

In the framework of the feasibility study of the water transfer project from the Ubangi to Lake Chad, we are proposing to initiate a negotiation process between the instances of the LCBC and CICOS enabling to set up a legal and institutional implementation mechanism in regard of the inter-basin transfer project between the Congo River basin and the Lake Chad Basin.

This procedure should be implemented in the framework of a negotiation of a multilateral agreement.

It is through negotiation and cooperation that the countries included in the two watershed will succeed in establishing a regional law to govern the implementation of the interbasin water transfer project and the management of the related infrastructures.

This sub-section will cover, for illustration purposes, the main measures that must be included in a multilateral agreement of this type.

General Considerations

This section will include definitions of key terms used in the Agreement, the Objective of the Agreement, the Project Objective, the basic principles that the Agreement will implement. For the latter, one could insist on the duty of cooperation, information sharing, the obligation not to cause significant harm, solidarity, sustainability, accountability, sharing of costs and benefits, participation, equity, good environmental governance.

Project Implementation

This section will describe clearly, with an appendix, all phases of the implementation of the project in all its components: water transfer, construction of the hydro-electric plant, development of waterways, construction of access roads, canals, trenches, etc.

General Obligations of the Contracting States

These are the general obligations that fall upon the contracting states at all the stages of the project: planning, development, implementation, operation and management, maintenance. The contracting states will take the necessary measures including safety, so that the project can be implemented without obstructions.

The contracting states will determine with precision their rights and obligations - namely the financial arrangements, the eventual royalties to be paid - with regards to the water transfer, the construction of the hydro-electric plant, the development of the navigable waterways and other infrastructures related to the project.

Each contracting state, with regards to its territory, will ensure that the basin organizations and other inter-state entities that can be set up as part of the project implementation, have all the required rights, authorizations, exonerations to see to the implementation, operation and maintenance of the project.

Each contracting state must adopt an appropriate legislation enabling it to put into effect the provisions of the agreement and to ensure that all the laws are adopted in time to enable the implementation, operation and maintenance of the project.

It is understood that the implementation of these procedures, the operation and monitoring of the works related to the project must be done in compliance with recognized international standards.

Financing Agreements

The contracting parties have the general obligation to ensure that the project has an adequate funding mechanism. To this end, it must be ensured that donor interventions are made under easy loan conditions (concessional interest rates, fairly long period coupled with significantly deferred period) and grants adapted to the financing of infrastructure projects based in developing countries.

The contracting states must provide the basin organizations with the support required for the mobilization of these resources. The basin organizations would have the obligation to mobilize funds through loans, lines of credit or other types of loans, required for the implementation, operation and maintenance of the project or that may be required to meet the requirements of the lenders or to perform their duties. All financing agreements must be submitted for prior approval to the contracting states, working through the cabinet in each watershed, with the possibility for both cabinets to hold joint sessions.

As the infrastructures linked to the project are common infrastructures (dam, canal, trench, access road, etc.) it is recommended that the capital cost and operation costs be shared between the co-owner states based on the profits that each co-owner state will gain through the operation of the common infrastructures based on the various sectors: irrigated agriculture, hydroelectricity, navigation, fishing.

It would also be expected, in the financing arrangements, that co-owner states guarantee the repayment of the principal, the payment of the interest and other charges on loans contracted by the basin organizations for the construction of infrastructure related to the project.

Royalties

The contracting states must decide if, in addition to the benefits of the project in the donor basin, the implementation of an infrastructures programme including the development of the navigable waterways, the construction of a hydroelectric plant, the construction of roads and ports, royalties must be paid for the amount of water transferred to Lake Chad. If such an agreement could be reached, it will be reinforced by the mutual benefits and interests known to the contracting parties.

Social and Environmental Concerns

The agreement will include provisions on environmental protection, protection the properties of the people and communities directly affected by the project, compensation for the negative impacts of the project, in particular on the displaced or otherwise disadvantaged communities, as a result of the project; the following will be taken into account: loss of tangible assets, loss of agricultural goods, loss of community resources, etc.

Implementation Institutions

For each watershed, the implementation of the project would occur under the guidance of each basin organization (LCBC or CICOS), acting on behalf of the contracting states that operate through the main common entities, namely the Sommet des Chefs d'États et de Gouvernment and the cabinet. These institutions could, if need be, hold joint sessions including the member states of both watersheds.

From the government, each contracting state would designate a government department (ministry) in charge of the implementation of the provisions of the Agreement.

On the advice of basin organizations, the contracting states may also decide to set up inter-state government agencies responsible for the management and maintenance of infrastructures linked to the project. All these organizations would be invested by the contracting states, with all the powers necessary to carry out their responsibilities. However, these agencies would perform their duties in accordance with internationally recognized standards of technical and managerial skills, expertise and good practice and to this end, they can, if necessary, require the contribution of the experts that specialize in one or the other area of their jurisdiction.

It is also recommended that a joint commission (LCBC/CICOS) be created, which would preside, on a rotating basis and for a period to be agreed upon (one or two years for example), by an Executive Secretary (General) of the two basin organizations. In addition to playing a general role of advisor on how to maximize the expected objectives of the project, the joint commission would have expertise in dispute resolution.

Moreover, given the nature of the project, it is recommended to set up an international advisory board including development partners (contracting states, funding institutions, donors, intergovernmental organizations, including the two basin organizations, representatives of civil society, etc.).

Conflict Prevention and Resolution

The agreement must include the provisions of the obligation for a peaceful inter-state conflict resolution, the use of the joint LCBC/CICOS commission, the use of the proper regional and sub-regional authorities and organizations, the use of arbitration or the International Court of Justice for conflicts that cannot be resolved using the methods listed here.

Implementation of the Agreement

The agreement must include provisions for its implementation both from a national and international standpoint.

With regard to the implementation at the national level, it will requested from the contracting states that they take the necessary internal measures, including legal, institutional, operational and financial for an effective implementation of the agreement. In addition, it will be asked of each contracting state to develop and submit to a joint LCBC/CICOS commission a national report on the implementation of the agreement.

It is recommended that the periodic assessment of the implementation of the agreement, at the international level, be entrusted to the joint LCBC/CICOS commission which will produce an assessment report every 2 years. The joint commission could, if need be and depending on the agreed upon terms, conduct an inspection in the contracting states in order to gather information on the implementation of the agreement.

Final Provisions

In addition to the usual provisions, namely on the entry into force of the agreement, the agreement must specify under what conditions it may be amended at the request of a contracting state and the possibility for the contracting state to terminate the agreement.

6. ROLE OF THE LCBC IN THE MANAGEMENT OF THE INTERBASIN WATER TRANSFER PROJECT

Based on the idea that the LCBC will play an important role in the implementation of the water transfer project from the Ubangi to Lake Chad, acting on behalf of the member states, by operating through the usual main organizations, namely the Heads of States Summit and the governments and the Ministry, we recommend that it put in place an organizational structure that will be exclusively in charge of implementing the project.

The organizational structure would be the type that is under the tutelage of the LCBC, with a legal status to be defined based on the statutes of the LCBC and the decisions set forth in the legal and institutional framework. It could be called the **Infrastructure Managing Company for the Water Transfer Project from the Ubangi to Lake Chad (SOGITEAU)**. It would be in charge of implementing the project and later, of the water transfer infrastructures, as there are still numerous steps to accomplish before getting to the execution of the project. This organizational structure must be created in a timely manner based on a calendar established by the LCBC.

In its operation, the LCBC will preside over the Board of Directors of the organization. The administrators, the managers and the technical experts will come from the ministries and other organizations from the LCBC member states, the private sector and if applicable the CICOS.

A preliminary draft of the organizational structure and its mode of operation are presented for illustration purposes. A more in-depth study is required given the complexity of the operations of the structure, from a human resources, material and financial management standpoint.

A strategic communication and collaboration center is planned in the organizational structure. The implementation of the center also requires more work.

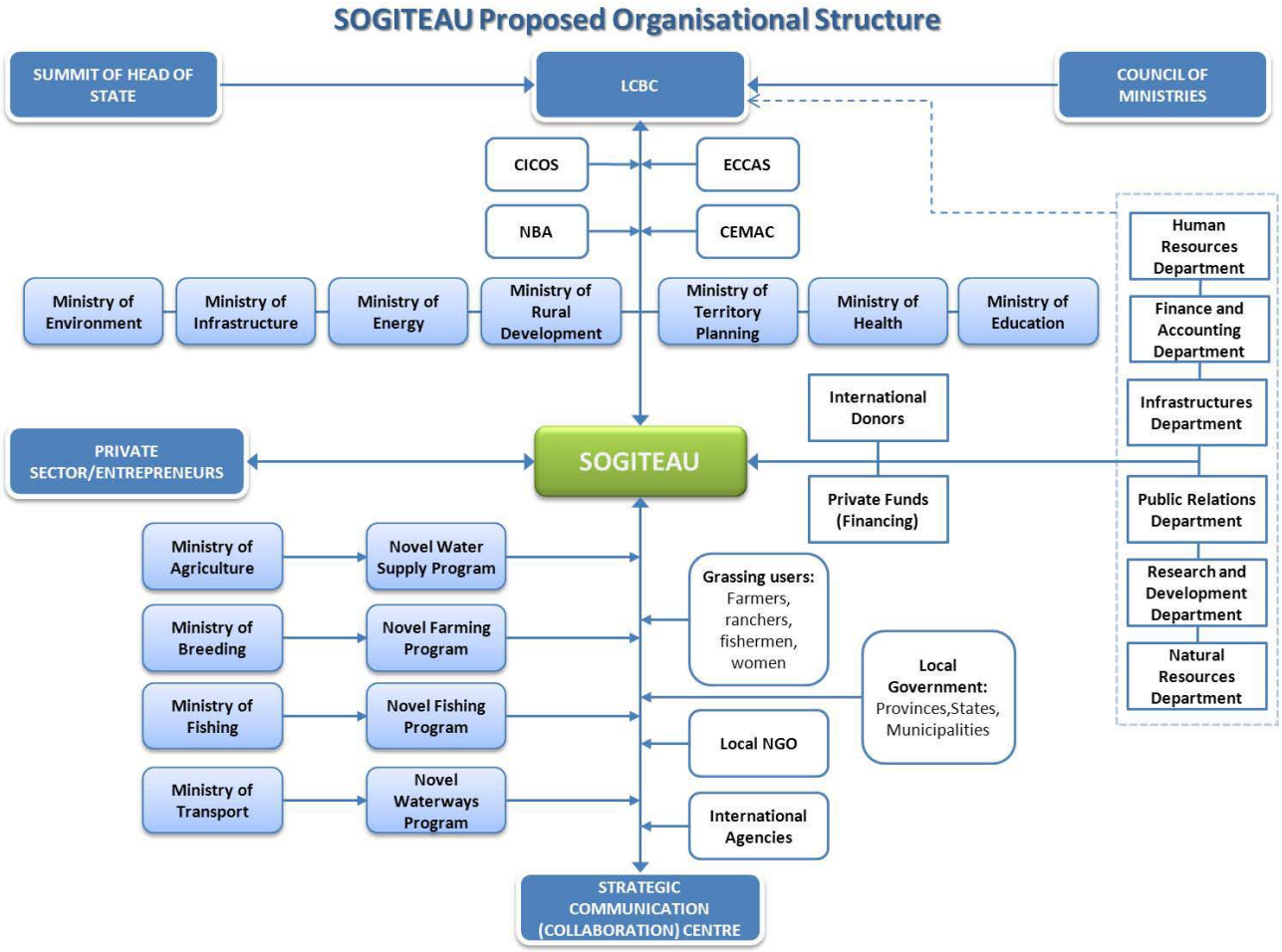

Figure 8 : Structure organisationnelle de SOGITEAU propose

7. COMMUNICATION STRATEGY

7.1 Context

The Water Transfer Project from the Ubangi to Lake Chad represents enormous challenges between countries that are part of the donor basin, namely the Congo River basin on the one hand, and countries that are part of the Lake Chad basin, with apprehensions and sometimes diverging interests.

To achieve this project, it is critical to take all the necessary precautions and to properly involve all stakeholders. Hence the merits of implementing a communication strategy and to circumscribe the necessity whether or not to hold the public hearings.

The overall objective of this strategy is to develop and implement a participatory communication approach that involves all stakeholders in order to achieve the aforementioned feasibility study.

Specific objectives are:

- Involve local riparian populations in the water transfer process to obtain their support and commitment in carrying out the feasibility study and for the possible implementation of the project.
- Inform and educate other stakeholders on opportunities and constraints of the water transfer project from the Ubangi to Lake Chad.
- Discuss opportunities and environmental, socio-economic and anthropological constraints linked to the water transfer project and their effects on populations.
- Initiate any communication prospect can facilitate the acceptability of the project by all stakeholders

Simply put, a timetable will be created for the activities linked to the awareness campaign geared towards the focusing on the general aspects of the project, but also touching on issues such as interest and above all the strategic challenges posed by the DR Congo, the Republic of Congo and the Central African Republic and LCBC member states in the completion of the water transfer project, land use around Lake Chad, the Palambo and Bria dams, location of villages, the fight against poverty, the development benefit of socio-economic activities along the watercourse in the contest of fight against the poverty, the prevalence of water-borne diseases around the dams, etc.

7.2 Steps of Communication Strategy

The communication strategy proposed is based on a participatory communication approach, involving all stakeholders.

The Steps of process are:

- Identifying all stakeholders.
- Defining communication objectives.
- Identifying communication activities and main communication tools.
- Implementing the communications strategy.

8. CONCLUSION AND RECOMMENDATIONS

At the end of the feasibility study, which will have lasted two years, CIMA International has concluded that the water transfer project from the Ubangi to Lake Chad is feasible from a technical, economic and environmental standpoint and that the socio-economic activities, around both dams, along the transfer route and around Lake Chad will improve the living conditions of the affected populations.

However, given that the transfer scenario to be recommended to the LCBC must be feasible from a technical, economic/financial and environmental standpoint, before giving our final recommendation, we also considered other improvements that are likely to help bring Lake Chad back to a normal level to meet the socio-economic needs of the populations and maintain its ecological equilibrium.

Among the improvements associated with the final option that will be recommended are:

(1) Improve water availability of the Chari: limit the losses in the flood plains, this could be grafted onto the selected option. A preliminary analysis of flows downstream from Sarh, for example, makes it possible to estimate the amount of water that can be mobilized to 100-150 m^3/s.

(2) Remove sand from Lake Chad and the watercourses that bring water to the lake, in order to limit losses and to have a better distribution of water resources between the two basins (North and South) of the lake.

This way, based on the overall analysis which takes into account the technical, economic, financial and socio-economic aspects, which are well explained in the draft final report, we recommend the following to the LCBC:

i) Build the Palambo dam to regulate the flow, to support navigation and the production of hydroelectricity;

ii) Build an interbasin transfer infrastructure using gravity from the Kotto river using the Bria dam;

iii) Improve the hydraulicity of the Chari in order to limit the losses in the flood plains;

iv) Develop Lake Chad and its main tributaries, namely by fighting against sanding-up, in order to obtain a better distribution of the water in the various basins of the lake.

Indeed, the solution which suggests a transfer from the Kotto, despite it being relatively costly, remains the most economical at $4 billion dollars to which must be added the cost for the Palambo dam at $2.7 billion, which is included in our final proposal. The Bria dam is able to generate up to 20 MW, with a good financial profitability for the overall electricity that it will produce.

It is important to note that the operation of a system using gravity is more manageable than a system using pumping with pipelines of a large diameter, in addition to the management and maintenance of the electromechanical equipment which also poses some difficulties.

Overall, this recommendation would make it possible to improve Lake Chad by 0.5 m to 1 m, by combining this option with the improvement to the hydraulicity of the Chari.

Moreover, the construction and operation of the Palambo dam, without being directly involved in the interbasin transfer process, would be used in the low flow control to regulate navigation on the Ubangi and provide electricity to the city of Bangui and its surrounding areas. The sale of electricity at the ONEA, a profitable operation, would contribute to reduce the operating costs of the overall infrastructures of the inter-basin transfer.