Project “Development of Water Resources and Preservation of Ecosystems in the River Niger Basin

Environmental and Social Management Framework (E.S.M.F.), Framework of Population Resettlement Policy (F.P.R.P.), social and economic study and environmental Audit of Kainji and Jebba dams

REPORT ON THE SOCIAL AND ENVIRONMENTAL AUDIT OF KAINJI AND JEBBA DAMS

DRAFT REPORT

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTE DES ANNEXES</td>
<td>IV</td>
</tr>
<tr>
<td>LISTE DES TABLEAUX</td>
<td>IV</td>
</tr>
<tr>
<td>LISTE DES FIGURES</td>
<td>IV</td>
</tr>
<tr>
<td>LISTE DES PHOTOS</td>
<td>IV</td>
</tr>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>CONTEXT OF THE AUDIT</td>
<td>1</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>8</td>
</tr>
<tr>
<td>1.1 Audit context</td>
<td>8</td>
</tr>
<tr>
<td>1.2 Methodological approach</td>
<td>9</td>
</tr>
<tr>
<td>1.3 Nigeria Climatic Conditions</td>
<td>13</td>
</tr>
<tr>
<td>1.4 Regional Hydrology of Niger River</td>
<td>14</td>
</tr>
<tr>
<td>2. LEGISLATIVE AND REGULATORY FRAMEWORK</td>
<td>18</td>
</tr>
<tr>
<td>2.1 Nigeria regulation</td>
<td>18</td>
</tr>
<tr>
<td>2.1.1 Environmental impact studies</td>
<td>18</td>
</tr>
<tr>
<td>2.1.2 Wastes management</td>
<td>18</td>
</tr>
<tr>
<td>2.1.3 Waters</td>
<td>19</td>
</tr>
<tr>
<td>2.1.4 Protected zones</td>
<td>19</td>
</tr>
<tr>
<td>2.1.5 Other legislations</td>
<td>19</td>
</tr>
<tr>
<td>2.2 World Bank Regulation</td>
<td>20</td>
</tr>
<tr>
<td>2.2.1 Environment</td>
<td>20</td>
</tr>
<tr>
<td>2.2.2 Dams safety</td>
<td>20</td>
</tr>
<tr>
<td>3. KAINJI DAM</td>
<td>22</td>
</tr>
<tr>
<td>3.1 Institutional framework</td>
<td>22</td>
</tr>
<tr>
<td>3.2 Description of the installations</td>
<td>25</td>
</tr>
<tr>
<td>3.2.1 Location and description</td>
<td>25</td>
</tr>
<tr>
<td>3.2.2 Description of equipment and procedures</td>
<td>30</td>
</tr>
<tr>
<td>3.3 Description of the environment of installations</td>
<td>33</td>
</tr>
<tr>
<td>3.3.1 Biophysical environment</td>
<td>33</td>
</tr>
</tbody>
</table>
3.3.2 Socio-economic environment

3.4 Impacts on the biophysical field
- 3.4.1 The water resources
- 3.4.2 The soils
- 3.4.3 The fauna and flora

3.5 Impacts in the human field
- 3.5.1 Health and safety of people
- 3.5.2 Health and safety of workers
- 3.5.3 Socio-economic activities
- 3.5.4 Social organization

3.6 Environmental management framework
- 3.6.1 Environmental management plan
- 3.6.2 Management of waste
- 3.6.3 Fire Protection and health and safety at work
- 3.6.4 Maintenance and supervision of the dam
- 3.6.5 Safety of dams

3.7 Synthesis of audit result

3.8 Environmental management plan
- 3.8.1 Short term mitigation measures
- 3.8.2 Mid term mitigation measures
- 3.8.3 Short terms technical reinforcement measures
- 3.8.4 Mid term technical reinforcement measures
- 3.8.5 Short term institutional reinforcement measure
- 3.8.6 Emergency training
- 3.8.7 Implementation responsibilities
- 3.8.8 Estimation of the implementation costs
- 3.8.9 Overall cost of the Kainji dam mitigation measures

4. JEBBA DAM

4.1 Institutional framework

4.2 Description of the installations
- 4.2.1 Localization and description
- 4.2.2 Description of the equipments and procedures

4.3 Description of the installations environment
- 4.3.1 Biophysical Environment
- 4.3.2 Socio-economic environment

4.4 Impacts on the biophysical environment
- 4.4.1 Water resources
4.4.2. Soils ..............................................................................................................33
4.4.3. Fauna and flora .............................................................................................33

4.5. Impacts on the human environment .................................................................33
4.5.1. Population health and safety ........................................................................33
4.5.2. Workers’ health and safety ..........................................................................33
4.5.3. Socio-economic activities ............................................................................33

4.6. Environmental management framework ...........................................................33
4.6.1. Environmental management plan ..................................................................33
4.6.2. Management of waste ...................................................................................33
4.6.3. Fire protection, health and safety at the work site ........................................33

4.7. Synthesis of the audit results ...........................................................................33
4.8. Environmental management plan ........................................................................33
4.8.1. Mitigation measures .......................................................................................33
4.8.2. Measures for technical reinforcement ............................................................33
4.8.3. Short-term measures for institutional capacity building ..................................33
4.8.4. Short-term training .........................................................................................33
4.8.5. Responsibilities in the execution ....................................................................33
4.8.6. Estimates of the implementation costs ...........................................................33
4.3.2 Overall cost of the Kainji dam mitigation measures ........................................33

CONCLUSIONS ........................................................................................................33

ENVIRONMENTAL AUDIT IN NIGERIA – KAINJI & JEBBA DAMS .....................33
LIST OF ANNEX

ANNEX 1  Kainji ....................................................................................................................... 33
ANNEX 2  Jebba ...................................................................................................................... 33
ANNEX 3  World Bank Operating Policy OP 4.37 ................................................................. 33
ANNEX 4  World Bank Procedures WBP 4.3 ............................................................................ 33
ANNEX 5  Questionnaire for the technical audit of dams ..................................................... 33
ANNEX 6  Guide for interview in the localities of Kainji and Jebba dams ......................... 33

LIST OF TABLES

Table 3-1  Technical data for Kainji development ................................................................ 29
Table 3-2  Physico-chemical characteristics of Kainji dam waters (September 2006) ...... 33
Table 3-3  General data on the localities investigated ......................................................... 33
Table 4-1  Morphological characteristics of the Jebba reservoir ........................................ 33
Table 4-2  Main characteristics of the dams ...................................................................... 33
Table 4-3  Characteristics of the Jeba powerhouse ............................................................. 33
Tableau 4-4  Peak flow between 2001 and 2005 ................................................................. 33
Table 4-5  Physico-Chemical characteristics of Jebba Dam Water Resources (June 2006 – August 2006) .......................................................... 33

LIST OF MAPS

Map 1-1  Niger River Basin and its sections (Source: NBA – Niger Basin Observatory) ................... 16
Map 1-2  Niger River Basin and its portions (Source: NBA – Niger Basin Observatory) .............. 17
Map 3-1  Geographic situation of Kainji and Jebba powerhouses (source: NBA – Niger Basin Observatory) .......................................................... 27

LIST OF FIGURES

Figure 1-1  Steps of transition from NEPA to PHCN .......................................................... 13
Figure 3-1  Organigram of the high direction of the KHPBU ............................................... 22
Figure 3-2  General organization of departments ................................................................. 23
Figure 3-3  Organisation inside departments ...................................................................... 24
Figure 3-4  Kainji development plan .................................................................................. 28
Figure 3-5  Artistic section of the Kainji powerhouse .......................................................... 32
Figure 3-6  Previous figure (cont’d) ................................................................................... 33
Figure 3-7  Graph of emptying and filling in of Kainji reservoir .......................................... 33
Figure 4-1  Organizational chart of Jebba hydropower plant .............................................. 33

LIST OF PHOTOS

Photo 3-1  Floor of the alternator ; generator sets 9 to 12 ..................................................... 33
Photo 3-2  Storage of oil barrils of the floors of the alternators ........................................... 33
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstalation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Final Report

Photo 3-3 Storage of chemical products on the floor of the alternators .................................................. 33
Photo 3-4 Presence on the floor of alternators of some equipment for maintenance.......................... 33
Photo 3-5 Well of the turbines 1 to 3 ........................................................................................................... 33
Photo 3-6 Oil slick and pumping system in the well of turbine 4 ................................................................. 33
Photo 3-7 The way down to a well of turbines ............................................................................................ 33
Photo 3-8 Air – Oil system with its cooling system and its oil reservoir ...................................................... 33
Photo 3-9 Oil processing system in the event of the air-oil systems .......................................................... 33
Photo 3-10 Oil puddles on the floor ............................................................................................................ 33
Photo 3-12 Piling up of waste ....................................................................................................................... 33
Photo 3-13 Pumps ........................................................................................................................................ 33
Photo 3-14 Storage of gas under pressure ................................................................................................. 33
Photo 3-15 Compressed air reservoir ......................................................................................................... 33
Photo 3-16 Oil barrel ..................................................................................................................................... 33
Photo 3-17 Transformer T7-8 ..................................................................................................................... 33
Photo 3-18 Oil barrels in front of the T6 and mobil unit of filtration ............................................................ 33
Photo 3-19 Transformer T9-10 not repaired ................................................................................................. 33
Photo 3-20 Generator set and fuel tanks ..................................................................................................... 33
Photo 3-21 Auxiliary services transformer ................................................................................................. 33
Photo 3-22 General view of the batteries room ........................................................................................... 33
Photo 3-23 A low wall closes the entry of the battery room ........................................................................ 33
Photo 3-24 Series of cells in the corridor and behind the batteries for telecommunications with a low wall closing the access.................................................................................................................. 33
Photo 3-25 Equipment used for the manipulation electrolyte solutions .................................................. 33
Photo 3-26 Picture the mechanical workshop ............................................................................................ 33
Photo 3-27 Cleaning of the equipment ....................................................................................................... 33
Photo 3-28 Wastes in the workshop ........................................................................................................... 33
Photo 3-29 Floor drain in the workshop ..................................................................................................... 33
Photo 4-1 Overall view of the alternators floor ......................................................................................... 33
Photo 4-2 Alternators covers ...................................................................................................................... 33
Photo 4-3 Under the cover of the alternators .............................................................................................. 33
Photo 4-4 Oil reservoir of an oil air system ................................................................................................. 33
Photo 4-6 Floor for turbines ........................................................................................................................ 33
Photo 4-7 Air compressor ............................................................................................................................ 33
Photo 4-8 Water and oil filtration system ................................................................................................... 33
Photo 4-9 Circle of sluice gates in the turbines well ..................................................................................... 33
Photo 4-10 Passage around the turbines well and the driving rods ............................................................. 33
Photo 4-11 Vertical axis in the turbines well .............................................................................................. 33
Photo 4-12 Apron of the transformers ......................................................................................................... 33
Photo 4-13 Power transformer ................................................................................................................... 33
Photo 4-14 Auxiliary services transformer ................................................................................................. 33
Photo 4-15 Mobile Unit for processing transformers oil (in the adjacent concrete basin, there is the old oil processing system) ......................................................................................................... 33
Photo 4-16 Reservoirs for the storage of the oils undergoing processing .................................................. 33
Photo 4-17 Drain in the basin of oil reservoirs ............................................................................................ 33
Photo 4-18 Storage of oil barrels on the apron ............................................................................................ 33
Photo 4-19 Storage of oil barrels on the apron ............................................................................................ 33
Photo 4-20 Gutter of the apron which poors into the river ......................................................................... 33
Photo 4-21  Generator set with fuel reservoir
Photo 4-22  Basin of the fuel reservoir which is not closed
Photo 4-23  Front door of the batteries room (no low wall for confinement)
Photo 4-24  Inside the batteries room
Photo 4-25  Protection of batteries and maintenance equipment
Photo 4-26  View of the workshop
Photo 4-27  View of the workshop
Photo 4-28  Floor drain in the workshop
Photo 4-29  Recycling of various parts of equipment
Photo 4-30  Storage of waste and dangerous products in the workshop
Photo 4-31  Non identified products to be discharged in the drain
Photo 4-32  Example of waste management in the workshop
Photo 4-33  Fire control equipment in the workshop
Photo 4-34  Storage of alum (processing of drinking water)
Photo 4-35  Storage of spare parts
Photo 4-36  Inappropriate storage of oil
Photo 4-37  Articles stored any ld how
Photo 4-38  Various articles
Photo 4-39  Storage of additional parts and equipment outside
Photo 4-40  Storage of oil barrels
Photo 4-41  Contaminated area
Photo 4-42  Storage of used barrels of oil
Photo 4-43  Storage of carboys close to the main building (danger of explosion)
Photo 4-44  Ventilation of the container
Photo 4-45  Storage of an abandoned vehicle
Photo 4-46  Obvious contamination of the soil
Photo 4-47  Highly contaminated barrels and soil
Photo 4-48  Another surface area contaminated
Photo 4-49  Unused oil barrels
Photo 4-50  Effect of contaminated soil
# Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>Comité de suivi (Follow up commitee)</td>
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<tr>
<td>DE</td>
<td>Division Environnement (Environmental Division)</td>
</tr>
<tr>
<td>DH</td>
<td>Division Hydrologie (Hydrology Division)</td>
</tr>
<tr>
<td>DSS</td>
<td>Division Santé et Sécurité (Health and Safety Division)</td>
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<tr>
<td>ECN</td>
<td>Electricity Corporation of Nigeria</td>
</tr>
<tr>
<td>ESMAP</td>
<td>Energy Sector Management Assistance Program</td>
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<tr>
<td>ESMP</td>
<td>Environment and Social Management Plan</td>
</tr>
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<td>FEPA</td>
<td>Federal Environmental Protection Agency</td>
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<tr>
<td>JHPBU</td>
<td>Jebba Hydro Power Business Unit</td>
</tr>
<tr>
<td>KHPBU</td>
<td>Kainji Hydro Power Business Unit</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Area</td>
</tr>
<tr>
<td>NBA</td>
<td>Niger Basin Authority</td>
</tr>
<tr>
<td>NDA</td>
<td>Nigeria Dam Authority</td>
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<tr>
<td>NEPA</td>
<td>National Electric Power Authority</td>
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<tr>
<td>NESCO</td>
<td>Nigerian Electricity Supply Company</td>
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<tr>
<td>ONG</td>
<td>Organisme non-gouvernemental (Non Governmental Organism)</td>
</tr>
<tr>
<td>PDREPE/BN</td>
<td>Project « Development of Water Resources and Preservation of Ecosystems in the River Niger Basin</td>
</tr>
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<td>WB</td>
<td>World Bank</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

CONTEXT OF THE AUDIT

Under the framework of its Five-Year Action Plan (2003-2007), the NBA developed the project titled «Development of Water Resources and Preservation of Ecosystems in the River Niger Basin», which is in preparation so as to be financed by the World Bank. This project is composed of three (3) components including Component 2: Modernization, enhancement and planning of hydraulic infrastructure of national or regional scope. Part of this component directly relates to the Kainji and Jebba powerhouses in Nigeria and is more specifically defined as follows:

- Modernization and enhancement of the existing infrastructure:
  
  The actions to be conducted at the level of the existing infrastructure shall deal with the following aspects: (i) safety of the infrastructure; (ii) rehabilitation and update of the infrastructure; (iii) enhancement of management; (iv) modernization of the related equipment; and (v) development of multiple utilizations according to the appropriate scenarios. The infrastructure concerned by this sub-component include the Kainji, Jebba and Shiroro dams, as well as the small reservoirs in some targeted zones in Benin, Niger, Mali and Guinea.

In conformity with the directives of the World Bank, any project should be subject to an environmental assessment, whose objective is to identify and analyze the potential or real environmental and social impact of the project implementation. The environmental and social audit of the Kainji and Jebba dams in Nigeria falls therefore under the framework of the related environmental studies of Component of the Project «Development of Water Resources and Preservation of the Ecosystems of the River Niger Basin.

1.2 Methodological approach

The main objective of the environmental consists in making a summary of the environmental and social impacts of the two dams, the efficiency of the mitigation measures and the respect of the regulation in force. This main objective is composed of the following specific objectives:

1. To describe the current environmental and social situation.
2. To analyze the impacts of the two dams and activities associated with their rehabilitation.
3. To indicate the major risks to the environment in the short and medium term.
4. To develop a plan of mitigation and rehabilitation measures.
Description of the installations

The Kainji hydropower station is located in Nigeria, in Niger State, in the lower portion of the River Niger basin and at 102 km, North of the Jebba hydropower unit. The Kainji hydropower station became officially operational on 15th February 1969. The lake which developed from this dam covered a good portion of the Kainji Island except the extreme South. The Kainji island was 4.02 km large and was located between the River Niger at 9°40'N, and distant from 1030 km of the sea, it is 8.3 km long and 65.5 m high (Imevbore, 1975).

The power installed is presently 760 MW and the average annual production is about 2 000 GW*h. The powerhouse is equipped with 8 turbine-alternators groups including 4 type Kaplan types of 80 MW each, 2 turbines also Kaplan type of 100 MW each and 2 propeller turbines of 120 MW each. The raw fall ranges between 23.8 m and 41.2 m according to the water level in the reservoir.

The development perimeter is composed of the main dam, embanked dams located on both sides of the main dam and the saddle dam which closes secondary valley and two gates. The main dam is a concrete dam of 550 m long and a maximum height of 64 m. It is composed of the water intakes, the flood evacuator and the abutments. The powerhouse is located right downstream the dam at right angles with the water intakes.

The reservoir, which presently forms the Kainji lake, is 136 km long and has a capacity of 15 billion m³.

The Jebba powerhouse is approximately located between the coordinates of latitude 9° 31’ N and 9° 50’ N and between the coordinates of longitude 4° 30’ E and 5° 00’ E. It is also at 100 km downstream the Kainji powerhouse and at about 450 km North Lagos. See Map. To close the River Niger valley at the level of Jebba and form the reservoir, the main dam, an earth and rock-fill dam, is coupled with several auxiliary dams and infrastructure. The main dam is located in the south of the management and its imperviousness is secured by an upstream blanket. It is followed by the lock and the auxiliary dams 4, 3 and 2. Between these auxiliary concrete dam there is the spillway and the Powerhouse with its water inlet. Then we have the emergency reinforce spillway and the auxiliary dam 1 composed of a dike of the same type as the main dam principal. Finally, a saddle dam, of the same type as the main dam, closes a secondary valley. The normal operating level is 103.0 high.

The powerhouse is an imposing building of 206 m long and 36 m large. It is equipped with six water of 12.4 m high and 10 m large, and the same number of turbine-alternator groups. Each of the propeller turbines produces 96.4 MW for a high of net nominal fall and 102 MW for a net maximal fall. The total nominal power installed is 578 MW.
Hydropower production Principle

On its way through the hydraulic passages, the potential energy of the water accumulated in the height of the raw fall (difference between the upstream water level and the downstream water level) is transformed in electric power by the action of the turbine. The energy of the turbine is transmitted to the alternator through the shaft. It is the alternator with its rotor and stator which generates electricity. At the Jebba powerhouse, the electricity is generated at 16 kV, but to enable the transportation of this electricity over a long distance while minimizing losses, the tension must be brought to 330 kV by the power transformers of the powerhouse. At the exit of the transformers, the energy is channelled to the starting post located close to the powerhouse through aerial lines and supplies the main transmission lines.

Synthesis of the audit results

The main observations of the audit likely to generate environmental and social impacts and to affect their management are:

1. The prevalence of the cases of waterborne diseases associated with the presence of the reservoir and the consumption of non-processed water.
2. The failure of workers to respect safety measures in the workshops and units.
3. The reservoir management mode leads to periodical floods downstream with risks of material and human damages (7 times over the last 20 years).
4. The discharge of liquid waste directly in the river and the neighboring lands.
5. The destruction of the vegetation around the reservoir for domestic needs leading to a degeneration of forest from one year to the other.
6. The ignorance of the existence of the refuse in the waters and lands both from the qualitative and quantitative points of view.
7. The absence of a liquid and solid waste management plan.
8. The insufficiency of data enabling to quantify the liquid and solid refuse or even to conduct a mass assessment.
9. The utilised oil filtration practice is a recycling technique which reduce the volume of refuse of utilised oil.
10. The absence of a programme for collection and disposal of dangerous waste (acids, oil, etc.)
11. The non-secured storage of consumable products and materials in the warehouses and the real risk for the works’ safety, notably, in the event of accident or fire.
12. The under-rating of potentials for development of socio-economic activities around the reservoir (recessional cropping, fishing, animal rearing, etc.)
13. The occupation of lands located downstream the spillway for agricultural and habitation needs, despite the real risk in the event of flood and dam breaking.
14. The current method of the reservoir management is not optimal because it does not take into account the infrastructure located downstream, especially the Jebba dam.

15. The flood evacuation warning system not adapted to emergency of dam breaking situations.

16. The insufficiency of material and human resources at the health and safety department as well as a dysfunction which reduces its efficiency.

17. The insufficiency of the continuous monitoring of the environmental and social impacts associated with the exploitation of the installations.

18. The absence of a service or department exclusively in charge of the management of environmental and social impacts.

19. The absence of senior staff specialised in the management of environmental and social impact of this type of installation.

20. The management and the employees are not very sensitive to environmental and social issues.

21. The persons displaced during the construction still have bitterness vis-à-vis the project despite the number of years gone by.

22. The population is not at all involved in the management of environmental and social risks likely to result in floods and dam breaking.

23. The environmental and social management plan resulting from the 2002 audit was not implemented because of the lack of financial means and will of the management.

24. The auscultation and inspection of dikes and dams are not adequate.

25. The urgent activities relating to the maintenance and repair of dikes and dams are not conducted in due time, often because of the lack of human and material resources.

26. The lack of funds to conduct the repair or expansion activities such as the addition of the four groups missing at Kainji.

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Major environmental and social stakes

The environmental and social stakes of the project can be summarized as follows:

1. Modification of water resources
2. Degradation of surface water quality
3. Contamination of ground water
4. Sedimentation and erosion
5. Soil contamination
6. Degradation of forests and loss of habitats
7. Reduction of the biodiversity
And the major social stakes are listed here below:

1. Problems of populations’ health
2. Danger for populations’ safety
3. Increase of poverty
4. Economic potential poorly exploited.

- Environmental management plan
  - Short term mitigation measures
    - To provide drinking water to the populations
    - To sensitize the populations as regards waterborne diseases
    - Supply safety equipment and make its wearing compulsory
    - Safety perimeter downstream the infrastructure
    - Environmental tool kits with logbook
    - Warning mechanism for water evacuation
    - Practice of safer storage
    - Maintenance of dikes and dams
  - Mid term mitigation measures
    - Auscultation equipment for the dikes and dams
    - Dangerous waste collection and disposal program
    - Funding of income generating support actions
    - Reforestation sub-project
    - Evacuation of the safety perimeter and land exploitation plan
  - Short term technical reinforcing
    - Categorization of the and conducting a mass balance
    - Analysis of dams safety: Analysis of the structural sustainability, reservoir management plan, consequence of a dam breaking, emergency and contingency measures plan
    - Participatory management plan: floods and inundations
    - Waste management plan: solids, liquids, dangerous materials, spontaneous recycling
  - Mid term technical reinforcing
    - Optimization of reservoir management and hydropower production
    - Procedure for the request of works permit
    - Health and safety management framework at the work site
    - Environmental and social monitoring
    - Environmental audit every 5 years
- Analysis of needs in terms of fire protection equipment and availability of the basic equipment

- Measures for institutional capacity building
  - To create and make operation an Environment Division and development of an action plan
  - Health and safety workers Committee
  - Entreprise – community joint enterprise for impact management
  - To finance the ESMP

- Training
  - Training sessions on environmental management in a powerhouse
  - Training of two senior staff in environmental management and dam safety
  - Training of employees in health and safety
  - Sensitization campaign on health and safety using various means

- Implementation responsibility
  The Kainji Hydro Power Business Unit and the Jebba Hydro Power Business must integrate a division or a service in charge of the environmental aspect of the exploitation of the powerhouses.

- Overall cost of the Kainji dam mitigation measures
  - Emergency mitigation measures: US $ 435 000
  - Mid term mitigation measures: US $ 965 000
  - Short term technical capacity building: US $ 225 000
  - Mid term technical capacity building: US $ 325 000
  - Emergency institutional capacity building: US $ 110 000
  - Emergency training: US $ 75 000

  - Total short term: US $ 845 000
  - Total mid term: US $ 1 290 000

  - Grand total: US $ 2 135 000

- Overall cost of the Jebba dam mitigation measures
  - Emergency mitigation measures: US $ 305 000
  - Mid term mitigation measures: US $ 810 000
- Short term technical capacity building: US $ 225 000
- Mid term technical capacity building: US $ 285 000
- Emergency institutional capacity building: US $ 110 000
- Emergency training: US $ 75 000

- Total short term: US $ 715 000
- Total mid term: US $ 1 095 000

- Grand total: US $ 1 810 000
1. INTRODUCTION

1.1 Audit context

Since 1998, the Niger Basin Authority (NBA) is facing a new boom. It developed and implemented a three-year action plan (2000 – 2002) and, after an organisational and institutional audit, its Authorities took decisions and resolutions in order to define its mandate and make the Executive Secretariat operational. The 6th and 7th Summits of the NBA Heads of State and Government asked for a clear and shared vision of the NBA be developed with the support of development partners, with the World Bank as Team Leader. During a workshop which took place in Abidjan in 2002, the Shard Vision process led to a consensus on the following steps:

- Enhancement of information management, preparation of sectoral studies and strategic analyses;
- Reinforcement of exchanges, consultation and concertation;
- Capacity building and institutional development, and
- Reinforcement of the regional and international cooperation and donors’ coordination.

In order to ensure not only a strategic coherence of the actions already initiated and the shared vision process, but also to look for a synergy and complementarities among all the initiatives, the 21st Session of the NBA Council of Ministers held in December 2002 in Niamey has adopted a five-year action plan (2003-2007) whose general objective is to prepare the most appropriate conditions in terms of knowledge of the basin and its resources, the main uses of these resources, the methods and techniques adapted to the implementation of these resources etc… and to enable the NBA to firmly embark on the process of planification for a harmonious and sustainable development of the basin.

It is under this context that the project “Development of water resources and preservation of ecosystems of River Niger Basin” is under preparation so as to be financed by the World Bank. The objective of this project is to sustainably enhance the productivity of water resources so as to reinforce the economic development in Niger Basin countries where the project shall be implemented.

The project is made up of three components which were identified and redefined during the additional identification mission conducted from 7th to 21st October 2005. These three (3) components are defined as follows:

- **Component 1**: Modernisation of NBA, the national focal structures and capacity building for the actors;
- **Component 2**: Modernisation, enhancement and planning of the hydraulic infrastructure with national and regional impact;
- **Component 3**: Restoration and preservation the zones with high environmental degradation.
These three components are detailed in the aide-memoire of the project which can be consulted for further information on the components.

The component 2 is divided in two sub-components, which are (1) modernisation and enhancement of the existing infrastructure and (2) planning of new hydraulic infrastructure. The Kainji and Jebba dams are directly concerned by the first on these two sub-components.

- **Modernisation and enhancement of the existing infrastructure.**

  The existing frameworks are going to undertake some actions with particular aspects such: (i) framework security; (ii) restoration and increasing level of the framework; (iii) the improvement of the management; (iv) the modernisation of the associated equipments; (v) and the development of multiple use according to the appropriate scenarios. Kainji, Jebba and Shiroro and other small frameworks in identified areas of Benin, Niger, Mali and Guinea are interested by that sub-component.

According to the World Bank directives, any project must be subject of environmental evaluation whose objective is to identify and analyse the environmental and social impacts, potential or real in the project implementation. The environmental audit of Kainji and Jebba in Nigeria is in fact one of the associated environmental studies to the component 2 of the project of “water resources development and preservation of ecosystems in Niger Basin.

### 1.2 Methodological approach

The methodological process in realising the environmental and social audit of Kainji and Jebba dams contains the four following steps:

- Preparation to the audit;
- Installations audit or data collecting;
- Analysis of the audit results;
- Development of mitigation actions

The preparation to the audit started with the analysis of the legislative and regulatory framework for Nigeria and World Bank. Then a questionnaire has been prepared in order to direct the data collection. A particular accent was put on the environmental, health and safety stakes of the employees and the populations and also on the cartographic information about the operation sites, the history of activities and the organizational structure.

The audit as such was conducted led in the same way for both Kainji and Jebba dams. It was divided into two components: The component “dams sites”, and the component “neighbouring perimeter”. Concerning the components “dams sites”, we visited all the installations including the dams, the flood evacuators, the powerhouse and the connex buildings. The Principal Manager of each department was met and interviewed. They gave us the pertinent documentation available and explained to us the operation of their equipments, their working
methods, the products utilized, their daily activities and the different procedures in force in their departments.

In the case of neighbouring perimeters, we met the concerned populations upstream and downstream the dams in order to collect information about the impacts of the dams on their socio-economic activities, their health and safety. Those visits also enabled us to collect information on the biophysical environment of the neighbouring perimeter of the dams.

The objective of the social component of the audit of Kainji and Jebba dams is to characterize the socioeconomic environment of the dams perimeter, both upstream and downstream. The point is make a summary description of the human environment of each of the dams in order to make a reference situation so as to assess their real impacts on the riparian populations later on. The documents available on the socio-economic situation around Kainji and Jebba, especially the “Proceeding of the National Conference of two decades of research on Lake Kainji” were consulted and field investigations made it possible to validate the situation described in this documentation.

To achieve the objectives listed above, the methodology included five phases:

1. The exploitation of the existing documentation

2. The preparation of a guide for the collection of socio-economic and social information in some villages located in the dams perimeter.

   The guide which was utilized for the collection the information from the populations includes five headings. The headings make it possible to master the different social aspects associated with dams, taking in to account the references of the study ;

3. The selection of one village upstream and one village downstream each dam ;

   The selection of villages for the interview was reasoned. In fact, one village was selected upstream and one downstream each dam in order to conduct the validation of the information collected and to assess the possible differences in the living conditions of the populations as compared to the existence of dam.

   The selection of the villages took also into consideration the movement of populations during the construction of the dams. In other words, one of the villages selected as regards each dam has population displaced because of the construction of the dam and as for the other village, its population remained in the same place because the village is not located on the site of construction of the dam.

   As a conclusion, here is the presentation of villages
4. Phase of interview with the concerned population;
5. Phase of exploitation of the data collected.

The analysis of all data, collected during the visit of the places and available in the documentation enabled us to make a detailed and actual description of the dams and their biophysical and human environment. It was on the basis of this description that was conducted the analysis of the impacts of the dams and their activities. First, the impacts were identified, then we developed interactions, laying specific emphasis on the ecological and social development of the return to a more normal flow of River Niger. Later on, the sources of the impacts were analysed for each of the elements of the environment likely to be affected and a rate of importance (significant or not) was assigned to them.

The last step of the audit consisted in conducting a synthesis of the results of the analysis in order to come up with the main risks affecting the environment, in the short and mid term. This exercise leads to the development of an environment management plan, or a plan of mitigation and rehabilitation measures. This plan contains the environmental risks, by order of priority, the corrective and rehabilitation measures as well as an implementation program coupled with its responsibilities.

1.3. History of the hydropower installations

In Nigeria, the electricity production began in 1896 in Lagos with the arrival of foreigners who came to exploit the natural resources of Nigeria. The exploitation activities were spread out throughout the Nigerian territory and other powerhouses came into existence. They were then operated and maintained by the Public Works Department, (PWD). In 1929, the Nigerian Electricity Supply Company (NESCO) was created and began its activities with the construction of the Kura Falls powerhouse, next to JOS. Later on, the increasing needs for energy led to the creation of Electricity Corporation of Nigeria (ECN) in 1951, and the first electric line of 132 KV linking Ijora and Ibadan powerhouses was created in 1962. Right from 1951, the ECN asked for some studies to be conducted on the hydropower potential of the Niger River. It understood that it is an important and affordable source of energy that could satisfy the increasing demand of energy in Nigeria.
In the 50's, the Federal Government and the ECN asked for various studies on the hydrology and energetic potential of River Niger and the Benne and Kaduna Rivers. As a result of these studies, it was decided to join efforts of NEDECO and Balfour Beatty firms in order to produce a joint report on the power potential in the Jebba region. In December 1958, the consortium published "The Jebba feasibility Report" that recommended the development of an initial infrastructure, near Kurwasa followed by the development of the Shiroro and Jebba dams. According to the authors, this scenario would be more beneficial for Nigeria.

En 1959, the recommendations were accepted by the "National Economic Council of Ministers" and the studies still continue. In May 1961, the recommendations made by the experts related to the construction of the Kainji dam. This dam shall produce enough energy to satisfy the Nigerian request for many years, enhance navigation on the River Niger with a control of floods and increase the development of cultivable surface area downstream Jebba.

The experts report was accepted in 1962 with the creation the Niger Dam Authority (NDA) by a parliamentary Act. The Niger Dam Authority is responsible for the construction and the maintenance of dams and other infrastructures on River Niger, and elsewhere, generates hydropower energy, enhances navigation and promotes fishing and the development of agriculture through irrigation.

The construction of Kainji dams started in 1964 and ended in 1968 and entered into service in December 1968. The powerhouse has 12 turbine wells and an installed capacity of 960 MW, but in May 1968, 4 of the groups were set into service. Four Kaplan turbines of 80 MW each constitute groups 7, 8, 9, and 10 for an installed power of 320 MW. The official commissioning took place in February 1969 with the Major General Yakubu Gowon. The construction of the infrastructure required the resettlement of 44.000 people. Bussa city was displaced and has become New Bussa.

In 1976, two Kaplan tubines of 100 MW each were added to form groups 11 an 12, followed in 1978 by the addition of 2 propeller turbines in the wells of groups 5 and 6, bringing the installed capacity of the powerhouse to 760 MW. Since then, the wells of groups 1 to 4 are still waiting for their turbines.

However, the two units composing the Electricity Corporation of Nigeria (ECN) and the Dam Authority (NDA) were combined in 1972 to form the National Electric Power Authority (NEPA) whose mandate is to produce and provide energy to the whole nation in an efficient, structured and economical manner in order to support the industrial and technological development of the nation.

The Jebba powerhouse construction project was born in 1979. The powerhouse was completed in 1984 and set in service on April, 13 1985 with the objective to supply the needs of electric energy of Nigeria. Thus Nigeria will afford its increasing needs in energy in order to improve its exportations and its economy in general.
But in 2002, with a view to attracting private sector investment and supporting the development of energy sector, in order to ensure an effective and continuous service, the National Council on Privatisation (NCP) recommended the dismantling of NEPA concretized by the signing of the Electric Power Sector Reform Act on March 1, 2005. The transition from NEPA to PHCN is presented in figure 1-1.

On May 31, 2005, the Vice President Attiku Abubacar inaugurated the Administration Council of the Power Holding Company of Nigeria (PHCN). This new company shall head 18 new companies under the sectors of power production (GENCOS), power transmission (TRANSCOS) and power distribution (DISCOS). The generation sector (GENCOS) is composed of 6 new semi-independent companies including the Niger Hydro Power Business Unit (NHPBU) composed of the powerhouses of Kaindji (Kaindji Hydro Power Business Unit KHPBU) and Jebba (Jebba Hydro Power Business Unit JHPBU).

![Unbundling Stages](As contained in the EPSR Act 2005)

**Figure 1-1 Steps of transition from NEPA to PHCN**

### 1.3 Nigeria Climatic Conditions

The Federal Republic of Nigeria has the highest number of inhabitants out of the nine riparian countries with 140 millions inhabitants living on a territory of 923,768 km². It is located just under the equator between 40° and 140° of Latitude North and between 30° and 140° of longitude East.
and is limited by the Republic of Benin and the Republic of Niger in the West, by the Republic of Niger and the Republic of Chad in the North, by the Republic of Cameroon in the East, and by the Atlantic Ocean in the south.

After Mali, Nigeria is the second country in terms of surface in the Niger Basin. In fact, 30% of the basin is located in Mali while the Nigerian share is 28%. Niger is the 3rd country with 23.3% of the basin in its territory.

Nigerian topography is made of several eroded surfaces which form high plateaus whose elevation varies from 600 to 1200 m of altitude over the sea level. Between these plateaus there are low-lands which form basins of the most important rivers of the country.

The climatic conditions in Nigeria are mainly characterized by two seasons, the dry season and the rainy season result from the opposition of the two air masses in the region. The first is monsoon, an air mass that is very wet and comes from Atlantic between April and September. The second is a dry air mass which comes from the North-East, from the desert and the Sahara, and covers the country from October to March. During the year, the importance of one season compare to the other varies according to the latitude. The more one goes from the coast to the North, the more the effect of the mass of dry air overlaps on the mass of humid air, which reduces the rainfall.

In Niger State, annual rainfall ranges from 900 mm to 1.600 mm. But in Borgu Local Government Area, where the Kaindji dam is located, the annual rainfall ranges from 1.200 mm to 1.600 mm and the rainy season varies from 201 to 180 days approximately. Rains are more important in this region than in the whole Niger state because of orography.

1.4 Regional Hydrology of Niger River

After the Nile and the Congo, Niger River is the 3rd in Africa and the 9th in the world. It’s 4.184 km long and divided into three sections that are identified on figure 1.1 “River Niger Basin and its portions” (Source : NBA – Observatory of the River Niger Basin) : the Upper Niger, the Inner Delta, the Middle Niger and the Lower Niger. The surface of the basin is 1.500.000 km² scattered between nine countries. Five of them are crossed by the main stream of the river : Guinea, Mali, Niger, Benin, Nigeria and four countries are crossed by the feeders of the river : Côte d’Ivoire, Burkina Faso, Chad and Cameroon (Figure 1.3).

Niger river takes its source from Loma mounts at the border between Sierra Leon and Guinea, in the Fouta Djallon Region, water tower of west Africa. It goes in North east direction, crossing Guinea, teaches Mali in the south, continues so Bamako and follows its course in the same direction until the Inland delta. That delta spreads over a large plain of 40.000 km² where the content of the river is reduced to nearly 50% by evaporation and infiltration. After the delta it changes direction to south-east. It crosses Niger, Benin before reaching Nigeria. From there it changes again its direction near the south and gets Benue (Benoué) one of its main tributaries, reaches the sea delta and finally pours in the Atlantic Ocean, at Port Harcourt.
In its Nigerian portion, Niger River has too water floods. The first flood happens in November. It is less important in water volume. It comes from Guinea. That flood takes six months to cross Guinea and Nigeria. Water has abandoned its components suspended in the Inland Delta. We call it Black flood.

The second results from local rains and is characterized by the suspension of elements in the water, that gives it at a while colour. That's why we call it white flood. It occurs from April 15 to October 15 which is the rainy season in Nigeria.
Map 1-1  Niger River Basin and its sections (Source: NBA – Niger Basin Observatory)
NIKER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Final Report

Map 1-2 Niger River Basin and its portions (Source: NBA – Niger Basin Observatory)
2. LEGISLATIVE AND REGULATORY FRAMEWORK

2.1 Nigeria regulation

2.1.1 Environmental impact studies
The studies about the impact on the environment are compulsory for the factories in Nigeria after the enforcement of the laws that follow:


Two national organisms, FMEV and DPR (for oil industries only) are in charge of the review and the approval of the ESIS submitted in support of the enforcement of environmental licences.

2.1.2 Wastes management
The legislative framework for the management of wastes resulting from industrial activities in defined by the following laws:

- Decree N°42 November, 25 1988 about Harmful wastes (Special criminal provisions etc.).
- Regulations S.1.8, S.1.9, S.1.15, August 15 1991:
  - National environmental protection (pollution abatement in industries and facilities producing wastes) regulations.
  - National environmental protection (management of solid and hazardous wastes) regulations
- Notification of wastes
  - Industries are obliged to notify the FEPA about any harmful, toxique wastes or radioactivity that is warehousing on their place or that could be produced during their operations (regulations 1991, article 2). It is the same through the headlines of DPR that contains a technical fie for health and security given to the operators in order to provide any necessary information to the DPR for the identification of harmful materials. (DPR guidelines 1991, Part VIII, section 2.2.1.). The situation is different as regards the mode of identification of the wastes of FEPA, where the responsibility of identification of wastes falls on the producer of wastes.
- Wastes management
  - Concerning waste, there are legal grounds in Nigeria for the development and the implementation of a “step by step” retrieval system. More specifically, Solid and
Hazardous Waste Management Regulations 1991 of FEPA provided the development of a documentation system that covers the production, transport, transport and elimination of harmful wastes.

2.1.3 Waters

The legislation framework that relates to the protection of surface, ground and coastal waters comes from 30 years grants (inter alia) and the following laws, decrees, and regulations:

- Regulation of August 15 1991:
  - National environmental protection (effluent limitation) regulations;
  - National environmental protection (pollution abatement in industries and facilities producing wastes) regulations.

2.1.4 Protected zones

The legislative framework on the protected zones in the country comes from the 30 years grants and following laws and regulations:

- Ordinance of May 23rd 1937;
  - Forest ordinance – Northern region;
- Decree N°36 of August 26 1991
  - Federal National Parks Decree.

For instance Decree N°86/92 (Management Procedure on Environmental Impact Assessment) includes a number of provisions which relate to protected areas and require an environmental impact assessment when:

- Forest exploitation or forest conversion into another land use is planned in a catchment area used for hydropower production.

2.1.5 Other legislations

Here is a list in a chronological order, a list of other pertinent legislations for the analysis and the performance of PHCN from the environmental, health and security point of view.

- Law N°37 of August 16, 1958: Factory Act
- Law N°46 of June 30, 1979: Kaindji Lake, National Park Act
- Law N°87 of June 15, 1979: River Basins Development Authority Act
- Law N°35 of October 1st, 1986: River Basins Development Authority Act
- Decree N°50 of December 29, 1989: National Resources conservation Council Decree
So, the Kaindji dam exploitation is subject to many environmental regulations according to the directives of FEPA.

2.2 World Bank Regulation

2.2.1 Environment

The World Bank developed some operational directives and policies making possible the integration of environmental considerations in the development, planning and execution of projects. The operational directives and policies as regards environment, the most pertinent for the project are:

- OP 4.01 Environmental assessment
- OP 4.37 Dams safety

OP 4.01 policy shows the procedure and contents of the environmental analysis applicable to the projects financed by ADI. Any project is subject to a prior environmental review based on the type, location, degree of sensitivity, scope, nature and extent of its potential environmental incidences, which makes it possible to classify it in one of the three following categories:

- Category A: A project likely to have very negative, nevralgic various or unprecedented incidences on environment. This project must be subject to a detailed environmental impact study that consists in examining the negative and positive environmental incidences comparing them with the effects of other options including the “no project” option and recommending an environment action plan.

- Category B: project whose negative effects it is likely to have on population or important zones from the environmental point of view (wet lands, forests, grasslands and other natural habitats, etc.) are less dangerous than those of project from category A. The effects are of a very local nature and very few of them are irreversible and easier to mitigate. This project is subject to an environmental assessment more limited than the one of category A projects.

- Category C: A project whose probability of negative impacts on the environment is deemed minimal or void. This project is not subject to any environmental evaluation after the prior review.

2.2.2 Dams safety

As regards dams safety, the World Bank has operational policies (OP 4.37) and procedures (OP 4.37). Those documents are presented in the annex to this report.

The OP 4.37 mainly relates to concerns of dams stability dams when the World Bank finances projects which depend directly on the existence of a dam and the safety it represents. The procedures determine a project implementation from the point of view of dams safety. This framework is defined for each of the steps of the project, i.e. the operational cycle, the
preparation, the assessment and the supervision. An annex to this document also defines the framework for the reports on the dams safety in four points:

1. Plan for the supervision of the construction and insurance-quality;
2. Plan for the provision of auscultation equipment;
3. Plan for exploitation and maintenance;
4. Plan for intervention in the event of emergency.
3. KAINJI DAM

3.1 Institutional framework

Since the electric energy sector reform in March 2005, the Power Holding Company of Niger has been heading 18 companies (6 Gencos, 1 Transco and 11 Discos). The NHPBU (Niger Hydro Power Business Unit) is among the 6 Gencos and it includes the Kaindji Hydro Power Business Unit (KHPBU) and Jebba Hydro Power Business Unit (JHPBU). The organizational structure of these new companies was not given to us, but from the information we got from the internet site of the PHCN, we could reconstitute the organizational of the management of the KHPBU.

![Organigram of the high direction of the KHPBU]

Concerning the organizational chart of the Kainji powerhouse, one must refer to the following organizational charts taken from 2002 Audit. We were told that these organizational charts were still in use. The following departments are under the authority of the assistant manager (Generation):

- Electrical Maintenance Section (EMS)
- Mechanical Maintenance Section (MMS)
- Protection, Control and Metering (PC&M)
- Generation or Operation section (Generation)
- Hydrology Section (Hydro)
- Technical Services Section (T/S)
- Medical Services Section (Hospital & Clinics)
- Education Services Section (Schools)
- Administrative Section (Admin)
- Accounts Section (Accounts)
- Planning and Material Control (Stores)

**Figure 3-2 General organization of departments**
Figure 3-3    Organisation inside departments

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Environmental Audit
of Kainji and Jebba Dams
FINAL REPORT
3.2 Description of the installations

3.2.1 Location and description

The Kainji powerhouse is located in Nigeria, in the Niger Province, into the lower part of Niger basin and at 102 km in the north of the Jebba powerhouse (Map 3.1 Geographical situation of the Kainji and Jebba powerhouses (Source NBA – Observatory of the River Niger Basin).

The Kainji hydropower dam became officially operational on February 15, 1969. The lake that was formed from that dam covered the most important part of Kaindji Island the south side. Kaindji island was 4.02 km large and located between Niger River at 9°40’N, and was 1030 km from the sea, it was 8.3 km long and 65.5 m high (Imevbore, 1975).

The water catchment in Kaindji reservoir exactly started on August 2nd, 1968. The water levels are regularly increasing and can reach 140,2 m (from October 19,1969 within a period of 78 days). The lake thus formed covers a surface of 1250 km², and has a maximum depth of 54,9 m and is spread from Kaindji to upper Yelwa on 136,8 km. It is 24,1 km on the largest part (Niger Dam Authority).

The level of lake water varies annually from 10 to 11 m with a surface temperature from 23 to 31°C and some water catchment surfaces around 16 x 10⁶ km² (Welcome, 1972).

Before this water catchment, Foge Island was at the mid-way of the lake. The Island was rid of its vegetation in order to favour fishing on the lake. A part of the vegetation was left as a protection.

The power put in is actually of 760 MW and the annual production is around 2000 GW*2. The central is equipped with 8 alternators turbine groups among which 4 kaplan turbines of 80 MM each, 2 other Kaplan turbines of 100 MW each and 2 screw turbines of 120 MW each.

The harnessing is made of the main dam, of built on the two opposite sides of the main dam and of another col dam which closes a secondary valley.

The main dam is surrounded by 550 m long and 64 m high concrete. It is made of hydrants, flood draining and some abetments. The central is just below the dam right to the hydrants.

At the west of the main dam, it means on the right side, the embankment dams spreads on 2.4 km. The first section of the Dam is made of stone bed whereas the second is made of land.

On the main dam side, it means on the left side, the dam is of stone bed until its conjunction with the flood gate over the flood gate, the dam is land with a section recovered by a concrete shell which serves as emergency outfall. This dam ends with a dam of col which closes the secondary valley. Today The whole dams spread out along 7,8 km. The reservoir that makes Kaindji lake is 136 km long and has a capacity of water. Carrying of 15 billions m³/s.

Flood drainer is made of four radial square gates of 15,3 m and has a maximum draining capacity of 7.900 m³/s.
Two flood gates are built with the dam to facilitate the sailing on Niger River.

Unfortunately, they haven’t been maintained, and used for a long time and are completely out of date. Probably because they didn’t satisfy the needs of the population. Figure 3-4 represents all the associated dams to the Kainji powerhouse.
NIger Basin Authority (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Final Report

Map 3-1 Geographic situation of Kainji and Jebba powerhouses (source: NBA – Niger Basin Observatory)
Figure 3-4 Kainji development plan
The table below is a summary of some technical data on the development perimeter

### Table 3-1 Technical data for Kainji development

<table>
<thead>
<tr>
<th>Water Levels</th>
<th>Niveau maximal d’exploitation</th>
<th>141.73 m</th>
<th>465.0 pi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Niveau minimal d’exploitation</td>
<td>129.0 m</td>
<td>423.0 pi</td>
</tr>
<tr>
<td></td>
<td>Niveau maximal normal dans le bief aval</td>
<td>106.7 m</td>
<td>350.0 pi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excavations</th>
<th>Quantité de mort terrain</th>
<th>4 200 000 m³</th>
<th>5 500 000 vg³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantité de roc</td>
<td>3 400 000 m³</td>
<td>4 500 000 vg³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water intakes, dam and flood evacuator</th>
<th>Elévation du dam en crête</th>
<th>145.0 m</th>
<th>475.0 pi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hauteur maximale (de la crête aux fondations)</td>
<td>65.5 m</td>
<td>215 pi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Longueur</th>
<th>550 m</th>
<th>1 800 pi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vannes</td>
<td>4 vannes radiales</td>
<td>15,3 m x 15,3 m</td>
<td>4 vannes radiales</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evacuation capacity</th>
<th>Capacité d’évacuation</th>
<th>7 900 m³/s</th>
<th>280 000 pi³/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vannes de prise d’eau : Vannes wagon à 24 roues fixes</td>
<td>4,88 m x 10,8 m</td>
<td>16 pi x 35 pi</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conduit blindé</th>
<th>2,6 m Ø</th>
<th>8,55 pi Ø</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Volume of concrete</th>
<th>611 644 m³</th>
<th>800 000 vg³</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dikes</th>
<th>Longueur totale</th>
<th>7,6 km</th>
<th>4 ¾ mi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume total</td>
<td>6 900 000 m³</td>
<td>9 000 000 vg³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Production</th>
<th>Longueur totale de la centrale</th>
<th>346 m</th>
<th>1 135 pi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume de béton de la centrale</td>
<td>134 180 m³</td>
<td>175 500 vg³</td>
</tr>
<tr>
<td></td>
<td>Capacité installée totale</td>
<td>760 MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Installation initiale</td>
<td>4 turbines Kaplan de 80 MW chacune</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Première installation additionnelle</td>
<td>2 turbines Kaplan de 100 MW chacune</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deuxième installation additionnelle</td>
<td>2 turbines hélices (à pales fixes), 120 MW chacune</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chute brute</td>
<td>23,8 à 41,2 m</td>
<td>78 à 135 pi</td>
</tr>
<tr>
<td></td>
<td>Capacité du pont roulant</td>
<td>200 t</td>
<td></td>
</tr>
</tbody>
</table>
3.2.2 Description of equipment and procedures

The figures on the following pages (Figure 3-5 and Figure 3-6) show a section of the Kainji powerhouse. The water of the reservoir is captured by a water intake, then it rushes into the gully up to the feed tank where it makes the turbine turn. It is then rejected in the downstream portion through the aspirator.

Contrarily to water in the reservoir, once produced, the electric power cannot be stored and must be consumed. One therefore needs to have good control of the waters so as to produce just the electricity needed. That is why each hydraulic passage has a water intake gate and an aspirator gate which enables the isolation of this passage. Furthermore, the turbine is equipped with driving rods mounted a circle of sluice gates so as to control the rotation speed of the turbine. When the aperture of the driving rods is maximal, the production of energy by the turbine is maximal while when the complete aperture of the circle of sluice gates isolates the turbine so as to avoid racing for example. The control of the driving rods make it possible to adjust the quantity of water passing through the turbine and thus to meet exactly the electricity demand.

On its way through the hydraulic passages, the potential energy of the water accumulated in the high of the raw fall (difference between the upstream water level and the downstream water level) is transformed in electric power by the action of the turbine. The energy of the turbine is transmitted to the alternator through the shaft. It is the alternator with its rotor and stator which generates electricity. At the Kainji powerhouse, the electricity is generated at 16 kV, but to enable the transportation of this electricity over a long distance while minimizing losses, the tension must be brought to 330 kV by the power transformers of the powerhouse. These 170 MVA transformers are located on the upstream apron of the powerhouse, between the powerhouse and the dam. At the exit of the transformers, the energy is channelled to the starting...
post located on the Kainji island downstream the powerhouse through aerial lines and supplies two main transmission lines: the line towards Jebba, the line towards Sokoto in Nigeria and Niamey in Niger.
Figure 3-5 Artistic section of the Kainji powerhouse
Figure 3-6  Previous figure (cont’d)
3.2.2.1 Management of the reservoir

The Kainji Lake was formed by the construction of the dam on the Kainji island. It is located between 9° 50’ and 10° 50’ of latitude North and between 4° 23’ and 4° 45’ of longitude East. At its maximal level, the lake covers a surface area of 1 250 km². Its maximal depth is 54.9 m and it covers a distance of 136.8 km upstream Kainji. Its maximal width is 24.1 km.

During a year, the level of water in the reservoir ranges between 10 and 11 m. Generally, the emptying starts at least in February, towards the end of the dry season, and continues up to July and August. The reservoir then reaches its minimal level of exploitation. The white flood then makes it possible to commence the filling. When the rainy season is over, around mid-October, it is the arrival of the Malian flood (Black Flood) which makes it possible to complete the filling which ends in January. During some years, when the Malian flood is in deficit, the filling is incomplete. But during some years too, it is necessary to discharge through the spillway, because les floods are more important. In 2005, the management of the reservoir was optimal because no discharge through the spillway was done.

3.2.2.2 Observations and monitoring

The hydrometric data collected are analyzed and interpreted and they make it possible to obtain a detailed description of the dam operation.

The observations relate to the rainfalls, the temperatures, the dominating winds, the water inputs discharges of the River Niger and the other tributaries of the Kainji lake, the turbinated flows and the discharged flows. All these data are analyzed and recorded in an annual report.

The hydrology department has and operates a meteorological station located at the Kainji dam. This station continuously measures the temperature, the rainfalls, the evaporation, the relative humidity, the wind speed and direction, etc. Furthermore, this department also has a network of hydrometric station which it operates and maintains. These stations are along the River Niger and the various tributaries of the Kainji Lake. The data on water levels and flows are recorded there three times a day.

3.2.2.3 Spillways

In addition to the spillway, Kainji has a wasteway which is a kind of over-full. Its top level slightly higher than the maximal level of exploitation and in the event of flood, the Authorities have a reaction time thanks to this wasteway. The vegetation in place downstream this wasteway shows that it is no longer used.
3.2.2.4 Alternators floor

The alternators floor is the location through which one has access to the powerhouse and the apron of the transformers. During the visit the generators 5 and 6 were in operation. The location is clean, with the exception of the waste, but oil barrels were stored all over the place on the floor. There is no temporary basin for oil recuperation and no environmental emergency kit enabling to recuperate and collect a possible oil damage.

Furthermore, some crates of sulphur hexafluoride, an electronegative gas utilized in the circuit-breakers and transformers, is stored near the generator 6.

At the extreme left of the powerhouse, one can go outside to observe the wells of the turbines 1 to 4. These open-cast wells are full with the river waters coming from various sources:

- Infiltration through water intake.
- Water coming from the emptying of the hydraulic passage of a turbine under going repair.
- System of drainage of the powerhouse.

Some pumps were installed so as to empty these wells in the downstream portion of the river. The water, in the well of turbine 4, is covered with oil slick. According to the responsible staff, this oil is occasionally collected and is not pumped in the downstream portion. The turbine well would therefore operate as a water-oil separator; the water is pumped by the bottom of the well and the oil remains on the surface.

The alternators are cooled with air.

On this floor, there are drains which are channelled towards the drainage wells of the powerhouse.
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Final Report

Photo 3-1 Floor of the alternator ; generator sets 9 to 12.

Photo 3-2 Storage of oil barrels of the floors of the alternators.
Photo 3-3  Storage of chemical products on the floor of the alternators

Photo 3-4  Presence on the floor of alternators of some equipment for maintenance
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Final Report

Photo 3-5  Well of the turbines 1 to 3

Photo 3-6  Oil slick and pumping system in the well of turbine 4.
3.2.2.5 Turbines floor

At that level, there are the access to the turbines well as well as all the system for the cooling and lubrication of the turbines and the turbines floor. There are also various air compressors. Some space is utilized for the stage of useless or broken parts and other industrial waste.

The oil-air systems utilize oil under pressure to lubricate the turbines floor and operate the circle of sluice gates for the opening and closing of the driving rods. The oil is contained in reservoirs and circulates in a system of pipes and fittings. This oil is cooled with water. In such a procedure, where water is permanently side by side with oil, the rejection of oil in water is unavoidable. In fact, the turbines consumes oil either through the loss of oil in the water, or through heat as in the case with a motor. We could not obtain precise information neither on the exact quantity of oil consumption by the turbine-alternator groups, nor on the proportion lost through leakage into water or through heat. These data are not available on the data sheets of the manufacturers.

The losses of oil into water are more important when starting from cold. This situation occurs rarely because the powerhouse has a generator set for the starts.

Two reservoirs of oil are installed in a concrete basin. They contain the used oil and the proper oil during the filtration of the oils of the air-oil systems. They can seen in photo 3-9 and photo 3-.

On the floor, there are empty or full barrels of oil. At some places, there are oil slicks but there is no equipment enabling to soke this oil from the floor.
The way down to a well of turbines

Air – Oil system with its cooling system and its oil reservoir.
Photo 3-9  Oil processing system in the event of the air-oil systems

Photo 3-10  Oil puddles on the floor
Photo 3-12 Oil processing system

Photo 3-11 Piling up of waste
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Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

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Photo 3-12  Pumps

Photo 3-13  Storage of gas under pressure
Photo 3-14  Compressed air reservoir

Photo 3-15  Oil barrel
3.2.2.6 Transformers Apron

The transformers apron is located between the dam and the powerhouse, in the middle of the river and on this apron, there are 6 powerful transformers (T5, T6, T7-8, T9-10, T11 et T12), 2 auxiliary services transformers, a gas il generator set with fuel reservoirs, one filtration unit which is out of use. All the powerful transformers were changed during the period of repair, except the T9-10, which is genuine.

The transformers contain about 58,000 litres oil, which should be periodically filtered and occasionally changed when the oil is too dirty. The transformers oil filtration system is inside a mobile oil filtration unit which is installed on the transformers apron because the original system of the powerhouse is no longer operational. Thus mobile unit is moved from one transformer to the other as needed. The filters utilized in the process must be cleaned when needed in a boiler containing a grease remover of the « Electra Clean » type. When the filter is clogged up, it is put aside and replaced by a new one.

Each rehabilitated transformer is installed in a basin and is isolated between two reinforce concrete walls of about 200 mm thickness which act as fire-break, even though the walls are not sufficiently high to prevent the propagation of flames from the up side. The transformers basins are not equipped with break-flame gravel but can prevent the propagation of flames over the apron of a possible oil leakage. However, the basins have at least one drain to discharge the run-off waters and this drain pour into the downstream portion. An oil leakage shall therefore be directly discharged in the downstream portion. The T9-10 power transformer as the auxiliary services transformers do not have retention basin.

As is the case else where in the powerhouse, several oil barrels are stored on the apron, with no temporary basin for oil recuperation.
NIger Basin Authority (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstalation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

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Photo 3-16 Transformer T7-8

Photo 3-17 Oil barrels in front of the T6 and mobil unit of filtration.
CIMA INTERNATIONAL
LI0062A
Environmental Audit
of Kainji and Jebba Dams
FINAL REPORT

Photo 3-18  Transformer T9-10 not repaired

Photo 3-19  Generator set and fuel tanks
3.2.2.7 Batteries room

The batteries room is located at the basement flat of the administrative building. All the batteries are located in a completely closed room. Access to the room is also closed by a low all to step over so as to access the room. The room is not drained.

The telecommunication batteries located in another room whose access is also closed by a low wall.

In the corridor, there are a series of additional cells which do not need basin so as to collect a possible discharge.

Everyday, the level of electrolyte in the batteries is controlled and if necessary solution is added to maintain the level in the cells. The mixture of products o as to obtain electrolyte solution is generally done in the corridor with rudimentary equipment. There is no set up procedure for the manipulation of these products, but still no accident is so far reported. There is no emergency equipment associated with the manipulation of this type of products, including ocular douche. Only one extinguisher is in the corridor, but not in the main room of the batteries.

There is no procedure for the management of the waste associated with the maintenance of the batteries. On the spot, there are several waste and the surplus of solution are probably discharged in the drains while the obsolete cells are recuperated by some private individual for sale in the market.
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Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstalation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

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Photo 3-21 General view of the batteries room

Photo 3-22 A low wall closes the entry of the battery room
Photo 3-23  Series of cells in the corridor and behind the batteries for telecommunications with a low wall closing the access

Photo 3-24  Equipment used for the manipulation electrolyte solutions.
3.2.2.8 Mechanical workshop

The mechanical workshop is well maintained in general but an in-depth review makes it possible to note that waste management does not exist and that the utilization of toxic products is not subject to a defined procedure.

On the photos, it can be noted that the waste is placed in a haphazard manner with spare parts under the workbench. The cleansing products are poured in the buckets together with the contaminated pieces of equipment. Once the piece of equipment is well cleaned, the product shall be discharged in the drain of the floor which directly pours into the river.
Cleaning of the equipment

Wastes in the workshop
3.2.2.9 Works and over-all maintenance

The working areas are well identified and marked out. The withdrawal process is well set up with the padlocking system and the working license at the commanding room. However, the emergency equipments and environmental kits for accidental discharge do not exist.

3.2.2.10 Main impact sources

The exploitation of Kainji dam installations comprises activities which are liable to generate significant impacts on the environment. The main impact sources activities are:

- the management of the reservoir;
- the cooling of turbines;
- the operation of groups;
- the maintenance of transformers;
- the maintenance of batteries;
- the operation of mechanical workshop;
- the stocking of various products;
- etc.
3.3 Description of the environment of installations

3.3.1 Biophysical environment

3.3.1.1 Water resources

Kainji Lake is fed by two main sources, either the River Niger and the local rivers which directly drain into Kainji Lake, or into the upstream of River Niger. Kainji Lake receives two floods a year, which govern the management of the reservoir. The first flood is the Malian flood, also called « Black Flood » and it takes place from November - March. It comes from Fouta Djallon region in Guinea and follows the course of River Niger during six months before reaching Kainji Lake. During its course, the waters cross the internal delta of the River in Mali, in Timbuktu region and the losses due to evaporation and infiltration are estimated at 65 %. It is also the place where materials in suspension settle down and water becomes more and more translucent with a black look, hence the name Black Flood.

The second flood, is the local flood also called « White Flood » and takes place between mid-April and mid-October and is generally more important than the Malian flood, in terms of water volume. It is generated by the local rainy season and its waters are charged with limons, bringing out its opaque and white look.

Kainji Lake occupies an area of 1,280 sq.km, with a length of 139 km and a width of 24 km at its largest portion. In a year, its entire water volume is about four times replaced. The lake is subdivided into three basins. The upstream basin which receives the waters of the River Niger, the median basin which is larger and less profound and the downstream basin, just at the upstream of the dam, narrowed and more profound.

The losses of water in Kainji Lake, are caused by slogging and pouring out during the flood drainage when necessary. But it must also been taken into account the losses through evaporation, which are estimated at 1,500 – 2,000 mm/annum (Srinne, 1989), the infiltration, water supply for local communities and irrigation.

For hydropower production purpose, the reservoir is emptied and filled in by the floods (11). The emptying commences from the month of March and the reservoir gets down to its lowest level during the month of August. The local flood enables to re-start raising the level of reservoir, which will be completed with the arrival of the Malian flood, getting to the end of December. The variation amplitude of the level of water of the reservoir is above 12.7 m, between levels 141.73 m et 129.0 m.
Figure 3-7  

Graph of emptying and filling in of Kainji reservoir

The waters of Kainji Lake have a high turbidity due to the presence of clay and silt particles in water suspension. This turbidity is less important during the Malian flood and considerably increases during the local flood. The local rainfall results in streaming of a lot of fine particles which remain in water suspension. The table 3-2 gives a characterization of upstream and
downstream waters of the dam in September 2006. Globally, water remains in good quality notably for the agricultural activities. But, it must be noted a certain level of pollution between the upstream and downstream in terms of oil and fat, TSS and hardness. On the other hand, the concentrations are below the reject norms of rivers.

### Table 3-2  Physico-chemical characteristics of Kainji dam waters (September 2006)

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SAMPLE UPSTREAM (LAKE)</th>
<th>SAMPLE DOWNSTREAM</th>
<th>LIMIT FME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>28.1</td>
<td>28.7</td>
<td>40</td>
</tr>
<tr>
<td>Conductivity ($\mu$Scm$^{-1}$)</td>
<td>56</td>
<td>51</td>
<td>NS</td>
</tr>
<tr>
<td>pH</td>
<td>7.51</td>
<td>7.21</td>
<td>6-9</td>
</tr>
<tr>
<td>TDS</td>
<td>28</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Turbidity</td>
<td>15.58</td>
<td>21.17</td>
<td>NS</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>16.23</td>
<td>17.78</td>
<td>NS</td>
</tr>
<tr>
<td>TSS (mg/l)</td>
<td>12.00</td>
<td>15.28</td>
<td>30</td>
</tr>
<tr>
<td>TS (mg/l)</td>
<td>47</td>
<td>53</td>
<td>NS</td>
</tr>
<tr>
<td>Dureté (mg/l)</td>
<td>22.0</td>
<td>25.01</td>
<td>NS</td>
</tr>
<tr>
<td>THC (mg/l)</td>
<td>0.1500</td>
<td>0.1299</td>
<td>NS</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>19.93</td>
<td>19.58</td>
<td>30-50</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>18.64</td>
<td>19.37</td>
<td>100</td>
</tr>
<tr>
<td>Oil/Grease (mg/l)</td>
<td>0.14</td>
<td>0.29</td>
<td>10</td>
</tr>
<tr>
<td>$PO_4^{2-}$ (mg/l)</td>
<td>0.30</td>
<td>0.37</td>
<td>5</td>
</tr>
<tr>
<td>$NO_3^{2-}$ (mg/l)</td>
<td>0.09</td>
<td>0.14</td>
<td>20</td>
</tr>
<tr>
<td>$SO_4^{2-}$ (mg/l)</td>
<td>1.82</td>
<td>2.50</td>
<td>600</td>
</tr>
<tr>
<td>Cl$^-$ (mg/l)</td>
<td>1.36</td>
<td>1.57</td>
<td>200-600</td>
</tr>
<tr>
<td>$HCO_3^-$ (mg/l)</td>
<td>14.84</td>
<td>15.03</td>
<td>NS</td>
</tr>
<tr>
<td>Ca$^{2+}$ (mg/l)</td>
<td>19.72</td>
<td>14.32</td>
<td>NS</td>
</tr>
<tr>
<td>Mg$^{2+}$ (mg/l)</td>
<td>12.562</td>
<td>8.97</td>
<td>200</td>
</tr>
<tr>
<td>K$^+$</td>
<td>4.18</td>
<td>2.23</td>
<td>NS</td>
</tr>
<tr>
<td>Na$^+$</td>
<td>11.61</td>
<td>10.46</td>
<td>NS</td>
</tr>
</tbody>
</table>

#### 3.3.1.2  Soil and topography

Considerable works have been conducted on the soils in Kainji Lake area. Some of these works are those of Pullan and Lecum (1964), Klinkerberg (1965), Howell (1968) and valette (1973). Brief reports presented in Child (1974) and Minco (1977), Nedeco and Balfour Beatty (1961) provided the first geological cards which served as base for conduct of these studies. Child
(1974) observes that the profoundness of the soils increases with the slope and brings back a slightly undulated (pleated) topography of the area with red to brown soils, well drained and different textures varying from limon-sand to limon-clay.

Klinkerberg (1965) in a detailed report noted that the types of soils of the area vary according to the types of related bases. The geology of the area is characterized by the presence of meta-sediments, gneiss, granites and sandstone « nupe ». He gave the details of the types of soil above these types of rocks. The lake basin and its surroundings are characterized by an undulated topography with the « eastern » talus which is flatter than the « western » talus.

The soils on the Gneiss are found in the southern Shagun. They go through River Menaï and are spread up beyond River Doro. They also appear on the talus at North-east of the lake above River Melando et beyond Yelwa. Such soils are grey brown or yellow brown silt sands above the clay silts toward frequent outcrops (Klinkerberg, 1965).

The soils above the meta-sediments (areas of sandstone nupes) start from the river. The areas designated as property of the lake basin are those which are contiguous to the lake, starting from the places where the streams and rivers flow into the lake. This area takes into account the water reserves like Yelwa, Melanville, Melando and Kourouwassa-Yelwa (NEDECO and Balfour Beatty, 1961). From these 3 dams, the sediments and limons are heavily set up.

As observed by Klinkerberg (1965), the related geology (Rock) determines the soils, their different characteristics and their properties.

The whole western talus is entirely covered by the variable passing nupe (sandstone nupe). Below them are found the primary rocks, formed by schists, gneiss, which are brought by the Precambrian age complex. The sandstone nupe spreading from western Shagun to the natural reserves of Borgu, has an profound, red, silt-sand and silt clay soil (Vine, 1948). Klinkerberg (1965) a reported the same, that the escarpments with a 36 m height are spread on a 9 km width in norther Shagun and are mostly notched with small ravines.

During the rainy season, the lake is heavily charged with sediments and limons from three dams (fadams). Vegetables are dominant during the dry season especially due to the irrigation systems, using less-expensive equipments.

3.3.1.3 Vegetation and flora

Kainji hydropower house is located at the belt of Nigeria in the Guinea savanna zone. The Guinea savanna zone is the largest vegetation in central Nigeria and almost covers the half of the country. It covers Ondo, Edo, Anambra States and finally the south, goes through Oyo State and over Zaira in Kaduna State. It is a belt comprising a mixture of trees and high grasses in the south, with lower grasses and less trees in the north like the site Kainji hydropower house. Its results from local climatic conditions, with low rainfall and long dry periods associated with the devastation caused by man during the process of bringing the lands to cultivation.
The Guinea savannas with their typical trees of low-height and their high grasses are the most luxuriant ones of the savanna vegetation belts in Nigeria.


The species like : *Khaya senegalensis*, *Daniellia oliveri*, *Afzelia Africana*, *Vitellaria pardoaxa*, *Pterocarpus erinaceus*, *Prosopis Africana*, *Ceiba pentandra* (Harris, 1930 & Johannes, 1970 in Proceeding of the National Conference on Two Decades of research on Lac Kainji, 1989) are locally used in manufacturing of boats and canoes.

Travelling throughout the Kainji hydropower house, one realizes that :

- At upstream, the vegetal species previously identified have almost disappeared on a portion of about 6 km of the dam leaving only some witness relics trees. This is explained by the fact that the perimeters between the station and the town of New Bussa have been shifted and forbidden for human habitation due to eventual drop in level of the River Niger. However, during the favourable periods, farming activities do prosper : cultivation of sorghum, maize, tuber (cassava, taro) and various vegetables (groundnuts beans, etc.).
- At downstream, between the station and NASARAWA village, the crops found are identical to those found at upstream, but the density is more important. The agriculture being the main activity of the resident people.

3.3.1.4 Fauna resources

The fauna resources of Kainji basin are generally represented by : Kolaix kob, Papio anubis, Sycerus cafer, Hypotragus equinus, Akelaphus bicephalus, Kobus kob Kobus defassa, Redunca redunca, Cephalephus rufatus, Cephalephus ourebia, ourebia ourebi, Panthera leo, Panthera pardus, Hippotragus equinus, Hippopotamus amphibius, Phococoerus sp, Erythrocebus patas, Crocildius niloticus. However, it would be as well to penetrate en depth the forest galleries before seeing the said species.

The most common reptiles are : Python sebae, Bitis gabonica, Anteris coraechys Akelaphus buselaphus, Naja aja aja, Veranuiloticus, etc. They live together within the immediate surroundings of the dam basin.

As for the birds fauna, the common birds are : Cumcum vocifea, Burerous abyssinicus, Psiohesus pentrosus, .Segartarious sapeitruis, Ardea melanocephala, Mulvus migrants, etc.
Finally the most fished fishes are: Gymnarchus niloticus, Clupisidius niloticus, Heterobranchus bidorsalis, Clarias lazeria, Clarias anguilaria, Lates niloticus, Alestes baremose, Alestes macrolopidotus, Hydrocynus brevis, Hydrocynus forshkali, Citharinus citharus, Citharinus distichodoideas, Distichodus brevipinnis, Distichodus engycephalus, Distichodus rostratus, Labeo combie, Labeo pseudocoubie, Labeo senegalensis, Auchenoglanis biscutatus, Auchenoglanis occidentalis, Tilapia galilleae, Synodontis spp, etc.

It is good to note that the potential of these species has highly decreased due to the climatic conditions and the drop in the charges of their habitat.

3.3.1.5 Air in the surroundings of Kainji hydropower complex

At upstream, as well as at downstream of Kainji hydropower complex, the air remains less polluted due to the vegetation area surrounding the complex.

3.3.2 Socio-economic environment

The documentation consulted indicates a very high level of poverty among the displaced populations as well as the neighbouring ones who did not experience resettlement. Poverty in Nigeria is very spread, deeply rooted and severe (NBA Assessment of the Opportunities and Constraints to the Development of the Nigeria’s portion of the River Niger Basin) and it was also what we noted during our trips in the regions of Kainji and Jebba and during our discussions with the persons met. In addition, the studies of the Conference indicate that the populations resettlement did not make it possible for these populations to enhance their living conditions. The populations live on an economy which depends on the primary sector, i.e. animal rearing, fishing and agriculture and conduct small trade especially in centers such as Kainji and Jebba.

In the displaced zone, several villages have a difficult access because of the poor conditions of the roads, some of the villages are accessible only during the dry season while other cannot be reached even by road.

Very few villages have access to drinking water and the populations generally prefer drinking the water from the lakes and streams because of its taste.

Centers like New Bussa and Jebba have an electrical network and recently the Nigerian Government developed a rural electricity supply program which enabled the electrification of some localities in the regions of Kainji and Jebba, but this electrification remains marginal if it is consider that more than 130 villages were displaced in the Kainji region.

Socio-economic investigations in form of discussion group (focus group) have been conducted in the villages of the immediate perimeter of the dam, which are directly affected by its operation. The discussions with the people were done in their local languages (hausa or lopi) in form of an semi-formal interview. The relational contact was easy, even cordial. In fact, the people easily gathered themselves on arrival of the consultant and expressed interest in the discussions.
The data collected in the human and social field on the audit of the dams are summed up in the table below. The town of New Bussa has been tripled so far as the population is concerned while the population of the village of Nassarawa has been multiplied by more than five.

<table>
<thead>
<tr>
<th>Dams</th>
<th>Villages/localities</th>
<th>Situation compared to the dam</th>
<th>Distance compared to the dam</th>
<th>Population (Inhabitants)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Before dam</td>
<td>Present</td>
</tr>
<tr>
<td>Kainji (1969)</td>
<td>New Bussa</td>
<td>Upstream</td>
<td>6 km</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td>Nassarawa</td>
<td>Downstream</td>
<td>2 km</td>
<td>1000</td>
</tr>
<tr>
<td>Jebba (1984)</td>
<td>Mazhi</td>
<td>Downstream</td>
<td>8 km</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Patizhiko</td>
<td>Upstream</td>
<td>2.5 km</td>
<td>500</td>
</tr>
</tbody>
</table>

3.3.2.1 Health of the people

In the locality, there are State health centers to impart primary care to the people. The consultations are free of cost but a contribution is demanded from the people for the medicines. The estate of the workers of Kainji station at New Bussa possesses a health center for them. Access to this center is naturally forbidden to the public.

People do consider that the primary treatment should be free of cost, at least, this was the promise given to them during the negotiations regarding their shifting and re-installation at the end of years 69.

People denounce the non-treatment of the water from the dam before its supply for consumption, which may cause diseases of hydrous origin. In the absence of official statistical figures, we are not in a position to quash or confirm this information. But the information has been supported with insistence by the committee of the people shifted to New Bussa whose king is the president.

The situation is more deplorable in other riparian localities of the dam. For instance, in the village of Nassarawa, at distance less than five km from the station, there is no water supply system. The people drink water from the river without prior treatment, which is potentially dangerous for health. Waterborne diseases are present and cases are mentioned in the annual report on the Kainji Health Center. Despite all these fears potential associated with the non-availability of water, no epidemic of waterborne was reported.
3.3.2.2 **Health and security of workers**

- **Security equipment**

  The security equipment, either boots, track suit, helmet and spectacles, is supplied free of cost to the workers of the power house. Despite the sensitization and information campaigns made at the working sites, very less workers wear clothes in a suitable manner. Most of the workers wear civil clothes and sandals without helmet in the workshops and operation rooms.

- **Emergency equipment and fire protection**

  Emergency equipment, of eye-shower type, does not exist and would be essential for the places where dangerous products are handled, such as the batteries room and the mechanical workshop. There are however several fire distinguishers, but according to the information received they are not regularly checked and there is no guarantee upon their functioning in case of emergency. In its annual report of 2005, a question of willingness on putting into order the fire protection equipment was raised. A lot of job is to be done in this field.

  Furthermore, there are at the power house some fireproof cabinets containing only hose pipes for watering but no tools (hatchet or spanner). In addition, these cabinets are mobile. It would be preferable to fix the cabinets close to taps so that the pipes be at the right place in case of emergency. The annual report brings out the disuse of the fireproof network (water) and points out that major work must be undertaken.

- **Working area and withdrawal procedure**

  About the withdrawal of equipment during the works and delimitation of working areas, it seems that the procedure set up is efficient for officially the administration does not report grave accidents which occurred during the major works. At any time that the works require withdrawal of an equipment, one must approach the commanding room and the same must be indicated in the related register. It is the chief of the power house or the staff in charge of the commanding room who may proceed to the withdrawal and re-start. According to our observations the working areas are correctly identified and marked out. We have not received the written procedure.

- **Training and sensitization**

  In addition to the documentation and manuals relating to health and security of the workers, the headoffice proceeds to systematic training of the new staff and offers continuous training to the staff and their families. During the year 2005, three training activities took place. The headoffice undertakes also sensitization campaigns like the week of health and safety pasting posters. It seems that efforts and incentives would be necessary to increase the efficiency of these campaigns and trainings.
Infirmary and health care

The PHCN possesses a health center at New Bussa, at exclusive disposal of staff of the station and their families. A dispensary affiliated to this hospital is operated at the working site of the station of less important or urgent treatment in case of an accident. A physician should be assigned for the dispensary, but the lack of staff at the health center is problematic and this is shown through the retrenching of a physician or a qualified medical staff from the dispensary.

At the power house, no aid kit is available at the station. Those which have already been installed were promptly stolen.

3.3.2.3 Socio-economic activities

The Kainji dam locality is mainly an agricultural vocation-area. Food crops farming is the main activity of the people followed by fishing and small trade.

People generally cultivate cereals (sorghum, millet, maize, rice), tuber and roots (sweet potato, cassava), vegetables (groundnuts). Some cash crops are also cultivated like cotton and fruits. The surplus of the food crops is subject to small food crops trade in the local markets by women.

The yield is quite weak due to the traditional way of farming: archaic working tools, agriculture on bush burning, traditional production practices: non water management, non utilization of organic and chemical manure, non utilization of selected seeds etc…).

The land is a restrictive factor in the area. Large areas of land are available and can be farmed upon a simple request addressed to the land traditional hierarchy (traditional chiefs). Fishing is traditionally done on the banks of the river on amateur grounds (autochthons) and by some rare professional fishermen (from Sokoto, Ghana, Niger). The Government tried to promote the development of commercial fishing through various economic incentives but it should be noted that the expected results were not achieved. The number of commercial fishermen increased in the early 70s but quickly stagged because of over exploitation, inadequate equipment and lack of know-how (Proceedings of the National Conference of Two Decades on Lake Kainji, 1989)

The fishing products are freshly sold by women or after smoke curing.

The stock farming is done in area: cattle, sheep, goats and poultry. There are important natural pastry lands and water points cattle farming.

The socio-economic activities remain around the Kainji reservoir.

3.3.2.4 Social organisation

Like the entire country, the area is composed of several ethnical groups: boo or boko, bariba, yoruba, peulh and in certain case hasus.
Men undertake farming and fishing activities while women deal with small food crops and fish trade despite the efforts of the Authorities to financially assist the commercial fishing in the region, this activity failed.

The farmers are autochthons. The peulhs are stock farmers, notably cattle farmers. The professional fishermen are generally people immigrating from somewhere else either on season basis or permanently.

In the socio professional organization, it is registered in the area the setting up of professional organizations of fishermen, farmers. These are organizations of services (Agri Bank for instance for small credits to the members).

3.4 Impacts on the biophysical field

3.4.1 The water resources

3.4.1.1 Hydrological system

Of course, the construction of Kainji dam had a major impact on the hydrological system of River Niger. These transformations are now integrated by the environment and it is the mode of management of the reservoir with its impacts on the water resource.

The positive impact of the mode of management of the reservoir on the water resource is doubled. Apart from producing a lamination which reduces the amplitude of the floods and their negative effect, it creates an easily accessible water reserve.

On the other hand, the mode of management of the reservoir also has some negative impacts on the water resource. The amplitude of variation of the water level is well pronounced. Moreover, the availability of water at the downstream of the station is tributary to the operations of the power house. For instance, if the pouring out and slogging are reduced in order to favour the filling of the reservoir, there can be a significant reduction in the debit of the millcourse of the downstream. On the other hand, the arrival of an important flood can require opening the flood spillway gate, which may considerably increase the debit of the millcourse of the downstream and provoke inundations. Even if an inundation is never desired, it must be recalled that inundations are of less importance compared to what they might be without the presence of a dam.

3.4.1.2 Sedimentation and erosion

The main reservoirs formed by the dams promote sedimentation, which can becomes a problem for fishing and the operations of the powerhouses. On that issue, one can consult the diagnosis conducted on sedimentation in the Kainji and Jebba dam reservoirs. According to this study, it seems that sediments are not contaminated and that they have limited impacts on fishing activities. On the opposite side, it constitutes a problem for powerhouses exploitation.
Furthermore, the fact of retaining sediments in the reservoirs rather than allowing them to go freely can have impact on the sediment regime downstream, up to the confluent with the Benue River and in the maritime Delta. There is data or information enabling to assess the positive or negative extent of this impact. However, one can think that, though real, this impact is limited, because the local flood waters (White Flood) have the same appearance both upstream and downstream dams. They therefore loose only a small part of their concentration in sediments.

The evacuations through spillway, because they represent substantial quantity of water with an important energy to dissipate, can also have an impact on banks erosion and sedimentation. This erosion is however very localized and not frequent because the spillway is rarely used. The enhancement of the reservoir management shall make it possible to reduce this impact through the release of small quantities of water over a longer period.

3.4.1.3 Quality of surface waters

The oleo-pneumatic systems, the cooling of the bearings of the turbines, the activities for filtration of oil for transformers and general mechanic workshop have oil reject which is directly found in the downstream waters of the dam. Important quantities of oil are collected in the shafts of the turbines where they are pumped toward the downstream even if a part is collected in form of scum. It does not exist a system for collection and efficient separation of oil. On the other hand, it does not exist data on the reject volume nor the consumption volume of the different components.

Monitoring of water quality is done each month on the basis of instantaneous samples which does also not enable to measure the real impact on the concentration of oil and fat in the downstream waters of the river. There is of course a dilution effect, but there can be, at reject time, high concentrations which could exceed the reject norms.

The maintenance of batteries, requiring periodical addition of acid electrolyte, also forms a source of reject in the waters of the river. The mixture of the acids is done on the spot. Any accidental pouring out will be directly found in the river and will affect the quality of the resource. The data available does not allow to quantify nor even assess the acid rejects of the installations.

3.4.1.4 Ground Waters

The presence of the dam reservoir has immediate consequence which is raising the level of ground waters in the region. The ground waters are therefore more vulnerable for contamination. The practices consisting in stocking empty containers and liquid rejects (waste oil) form a source of potential contamination of underground waters which can deteriorate their
quality. No data is available on monitoring the ground waters and this does not enable to appreciate and quantity the extent of a plan like the impact.

3.4.2 The soils
Agricultural activities based on rainy farming are intensified within the immediate surroundings of the upstream and downstream of the dam. The population in the area highly grew, reflecting the high demand in lands. These lands are relatively divided up and are subject to heavy pressures causing with the time their gradual deterioration. It is also notably noticed at downstream the question of erosion of the banks associated with the management of the dam waters.

In the warehouses for stocking, the exhausted products are directly stocked on the surrounding soils with any risk of contamination.

3.4.3 The fauna and flora
The requests for new lands by the people in the area led to an important deforestation around the reservoir. The vegetation which was formerly under the forest gallery is now transformed into a savanna planted with trees. But the phenomenon is relatively limited in keeping with the enormous forest potentialities in the region.

With the destruction of its habitat, the fauna fell back to the areas which are more favourable and is no more very present in the immediate surroundings of the dams.

The halieutic fauna was also reduced at downstream but its development in the reservoir compensates this reduction. On the other hand, the filling in of the reservoir through deposit of sediments reduces the development of the halieutic potential of the latter.

The proliferation of aquatic vegetation (water hyacinth, water lettuce, etc.) in the reservoir is quite restricted and this is beneficial for the halieutic fauna and functioning of the installations.

3.5 Impacts in the human field

3.5.1 Health and safety of people
The people living in the surroundings like those of New Bussa and Nassarawa consume the waters of the river without treatment. The stagnation of the waters in the reservoir during some months favour the development of vectors of water related diseases. The consumption of such a water causes some risks to the health of the people. The latter report that the proliferation of water related diseases is one of the main health problems being faced in the region. But they do not have monitoring data enabling them to support such a hypothesis.

The evacuation of floods is an activity which concerns the health and security of the people. In fact, the discharge of important volume of water can cause material damages, but also human one through drowning, if the people are not quite warned. In fact, the fishermen come upto some meters from the flood spillway gate and the farming activities are done on the perimeter.
located immediately at the downstream of the development. At present the people are warned through written correspondence and an alarm before the evacuation of the people. But in case of emergency such a procedure cannot be respected. It is obvious that in case of breach the situation can be critical with considerable damages.

3.5.2 Health and safety of workers

Working and circulation in the different workshops are sources of accidents which can have corporal consequences. So far as the staff do not respect the instructions on wearing safety equipment. The practices on management of oil found on the ground forms another source of important accidents. The statistical figures on the accidents are not available and this does not allow to measure the extent of this impact. But this impact is major for it threatens the health of the workers.

In the warehouses for stocking the products are higgledy-piggledy laid products comprising dangerous products with any associated risks, among other things the case of fire. The health of the workers is threatened by being exposed to dangerous products, more particularly in case of fire.

3.5.3 Socio-economic activities

Important areas of lands are sacrificed at the downstream for flood evacuation requirements. Of course even if some unconditional persons continue cultivating a part of these lands, they are liable to be subject to a risk of inundation and as such loss of their crops at any time. The flood evacuation during the farming period is also source of conflict with the farmers in case of loss which can result in proceedings like the Jebba case during the inundations in 2001.

The presence of the reservoir favoured the development of stock farming and fishing but these economic activities remain restricted compared to the existing potentialities.

3.5.4 Social organization

The major positive impact on the plan is the development of the town of New Busa which has been raised to 100 000 inhabitants and over who mainly rely upon the economic activities linked with operation of Kainji dam. In fact, this town was formed by the people shifted from the dam who, among other things, kept their entire traditional social organization. On the other hand, still these people do not have access to reliable basic services notably quality potable water. Despite all these past years, the persons shifted continue claiming infrastructures and lands for farming.
3.6 Environmental management framework

3.6.1 Environmental management plan

Kainji hydropower did not possess a plan on management of environmental and social impacts PGIES. In fact the environmental issue is relatively new due to the fact that the dam has not been subject to a detailed environmental assessment at the time of conducting the technical studies. The environmental management is, mainly, summed up on the management of health and security of the workers of the power house. The environmental management is therefore weakened in the various departments since there is no service nor office which is entirely in charge of this head. These are the following departments (the organization charts are presented in article 3.1 Figure 3.1, Figure 3.2 et Figure 3.3) which are responsible for the management of the environment:

- Production and Operation
- Hydrology
- Medical services
- Fire protection

The environmental management is mainly based on the health and safety at work, as well as on the floods and inundations management. In 2002, an environmental and social audit on the installations was conducted including elaboration of a plan for environmental management. But this plan has not been implemented due to lack of funds and willingness from the top management. There was neither monitoring of the environmental and social impacts. There was a monthly monitoring of the quality of waters, which was entrusted to a private body since 2002 following the environmental audit. It was planned to set up an environmental and social field for all, every three years, but it would be difficult to achieve the objectives expected if there is no data.

3.6.2 Management of waste

At the power house, as well as at some other places in the community, there is no waste management plan. As such, it is impossible to draw the results or assess the quantities of waste generated. No collection was conducted for the garbage, no collection of recycling material, nor management of dangerous waste. On the other hand, the scarcity of resources results in spontaneous recycling which is mostly beneficial, but which can sometimes be dangerous and have negative impacts on the environment. This is, for instance, the case of batteries which, when they could no more serve the power house are disposed and then collected by individual persons and are probably sold in the market, where they find a second life. During this process, the electrolyte solution which is a dangerous material, may perhaps been thrown anywhere and could contaminate the environment. Without forbidden this practice, it would be good to determine the manner how the waste would be disposed off at the station taking into account the
spontaneous recycling. On the same grounds, the exhausted oil is partly recycled through its spreading on the gulf field of the staff of the company. This is another example of spontaneous recycling, which is very bad for the environment, for this oil does contaminate the soil and the ground waters.

The empty containers notably the dangerous products are stocked throughout years at the warehouses waiting for being collected and being disposed by the parent company. They therefore form a source of contamination of the environment, notably the soils and water resources.

3.6.3 Fire Protection and health and safety at work

- Company Culture
  The PHCN is anxious about the importance of health and security of workers and possesses a service dealing with this important issue.

- Over-all framework
  The administration shows a great willingness to improve the performance in terms of fire protection and security at work. A lot of efforts are being done to improve the equipments and the setting up of a training, courses and workshops programme for the staff and their families, with a view to improving the security of workers at the power house. It goes the same for fire protection. The annual report enables each year to issue a report on the activities and equipments.

  The fire protection management framework which can be found through the documents consulted and the information obtained is managed by the health and security department led by two staff and focal points in each department.

  The health and security department is responsible for the security of individual persons, goods and installations comprising the following:

  5.  The keeping of Work Code and Safety Regulations
  6.  The activities relating to fire protection.
  7.  The supply and maintenance of fire fighting equipment and security equipment.
  8.  The investigations on the accidents, their analysis and keeping of related statistical data.
  9.  The training on security under the framework of daily work.
 10. The training, workshops and sensitization campaigns.
 11. The implementation of safety management Policy.
 12. The strengthening of use of personal protection equipments and maintaining good practices for over-all maintenance.
 13. The keeping of a register on activities, incidents et accidents.
14. The elaboration of a Report on activities of the department, on monthly, quarterly and annually basis.

The management of health and safety of workers faces a lack of human resources and organizing within the company for a better efficiency. The department is considered by the workers as defender of the interests of the top management. There is also a lack of equipments for fire fighting at the units and drinking fountains.

- The framework of maintenance or refection works

The management of works requiring the withdrawal or switching-off the equipment is subject to a very strict procedure. One must obtain a working license issued by the staff in charge of the commanding room. This license is entered in a working license requests register kept in the commanding room. The holder of a license becomes responsible for planning of works and the works can not be considered terminated before the license is returned to the commanding room.

This procedure is rigorously monitored and it is quite probable that it was due to this reason that no major accident has been reported to the power house since it became operational.

3.6.4 Maintenance and supervision of the dam

The supervision and maintenance of the development is assured by a team checking all the measuring instruments of the different dams. The information obtained pointed out that the verification is done on monthly basis.

The procedure for supervision and maintenance of the dam and dykes is partially described in the annual report of the powerhouse. Actually, the description of inspections conducted in the year is found there as well as any question raised.

The following table sums up the instrumentation presented in the different dams:

<table>
<thead>
<tr>
<th>Table 3-5 Summary on dams instrumentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>Concrete Dam</td>
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<td></td>
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</tbody>
</table>
### 3.6.5 Safety of dams

The preoccupations of the PHCN in the matter of safety of dams are summarized as notice for flood pouring out through spillway gate which can cause inundations in the valley at downstream of the work. Generally, when the pouring out by flood spillway gate is planned, letters are sent to the industries which are liable to be subject to inundations. This arrangement is important, but cannot be applied in case of emergency. During our discussions, we noticed that there is no anxiety about the notion of vulnerability of works, within the administration.

There is no human construction which is infallible. The dams represent an intrinsic risk which may be assessed and managed through assessment of the safety of dams, prepared by Engineers as per the prescriptions from the institutions of great dams, such as ICOLD (International Commission on Large Dams).

The department of hydrology relies upon the emptying and filling in graph to manage the reservoir. This method of functioning is quite good since they almost succeed each year to fill the reservoir. It is not however optimum and does not take into account the works at downstream. There is no plan for management of the reservoir on long term basis with provisional models which integrate forecast on water resources and forecast on request for energy.

### 3.7 Synthesis of audit result

The main remarks of the audit which are susceptible to generate environmental and social impacts and affect their management are as follows:

1. The predominance of water related diseases relating to the presence of a reservoir and consumption of non treated water.
2. The non respect of safety measures by the workers at the workshops and units.
3. The mode for management of the reservoir causes periodical inundations at downstream with risks for material and corporal damages (7 times during the last 20 years).
4. The pouring out of liquid waste directly into the river and on the surrounding soils.

<table>
<thead>
<tr>
<th>Dam</th>
<th>Instrumentation</th>
<th>Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backfill Dam</td>
<td>• 10 hydraulic or electronic piezometers</td>
<td>Parement upstream: depression, termites, vegetation, infiltration.</td>
</tr>
<tr>
<td></td>
<td>• 18 standpipe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 52 drainage well</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 3 rooms for percolation gauging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Extension gauge</td>
<td></td>
</tr>
</tbody>
</table>
5. The destruction of the vegetation around the reservoir for domestic requirements and thus backward going of the forest year by year.
6. The ignorance of rejects in the waters and on the soils so far as the qualitative and quantitative view is concerned.
7. The absence of a plan on management of liquid and solid waste.
8. The lack of data enabling to quantify the liquid and solid rejects or prepare a mass report.
9. The practice on filtration of exhausted oil is a recycling technique which minimizes the volume of reject of exhausted oil.
10. The absence of a programme for collection and disposal of dangerous waste (acids, oil, etc.).
11. The non security stocking of consumable products and material in the warehouses is a real risk for the safety of workers particularly in case of incident and fire.
12. The sub-valuation of potentialities for development of socio-economic activities around the reservoir (water crops, fishing, stock farming, etc.).
13. The occupation of lands located at downstream of the drainage for farming and housing requirements, despite the real risk in case of inundation or breach.
14. The present method of management of the reservoir is not optimum for it does not take into account the works located at downstream notably the Jebba dam.
15. The procedure for flood evacuation warning which is not adjusted to emergency situations or breach.
16. The lack of material and human resources for the health and safety department as well as dysfunction which restricts the efficiency.
17. The lack of continuous monitoring of the real environmental et social impacts relating to the operation of the installations.
18. The absence of a service or department exclusively in charge of management of environmental and social impacts.
19. The absence of skilled staff for management of environmental and social impacts of this type of installation.
20. The top management and staff are not very sensitive to the environmental et social issues.
21. The persons shifted at the time of construction still have the bitterness vis-a-vis the project despite all the years which have passed.
22. The people are not at all associated with the management on environmental and social risks which could result from the floods and breaking of the dam.
23. The environmental and social management plan resulting from the audit 2002 has not been implemented due to lack of financial means and willingness of the top management.
24. The auscultation and inspection of dykes and dam is not suitable.
25. The emergency works for maintenance and refection of dykes and dams were not done in time, often due to lack of human and material resources.

26. The lack of funds to undertake the refection and expansion works, such as addition of the 4 missing groups for Kainji.

27. The existing safety measures such as switching off of a piece of equipment for servicing are not documented.

3.8 Environmental management plan

The environmental and social management plan is presented in the following tales. It includes short and mid terms mitigation measures, short and mid term capacity building, institutional capacity building as well as training the mitigation measures described below are corrective measures proposed so as to remedy the shortcomings noted and to reduce the negative impacts on environment. However, it is necessary to put a special emphasis on technical capacity building, the short tem one in particular because, even if all the necessary mitigation measures are implemented, their chances to be successful are almost void if an adequate and appropriate capacity building is not implemented.

3.8.1 Short term mitigation measures

<table>
<thead>
<tr>
<th>Measure 3.1</th>
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</thead>
<tbody>
<tr>
<td>To provide drinking water to the New Bussa population through the construction of a water processing station.</td>
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</table>

<table>
<thead>
<tr>
<th>Measure 3.2</th>
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</thead>
<tbody>
<tr>
<td>To sensitize the riparian populations on the control of water born diseases and their vectors.</td>
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</table>

<table>
<thead>
<tr>
<th>Measure 3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>To provide all the workers with safety equipments and require them to wear them on the work sites.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure 3.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>To mark out a safety perimeter downstream the spillway gate where settlement is prohibited. The existing settlements must be relocated.</td>
</tr>
</tbody>
</table>
Measure 3.5
To install environmental kits with monitoring of the equipment used. To introduce an equipment monitoring system coupled with assumption of responsibility and facing consequences. The utilization of the equipment should be recorded in a logbook and after every duty tour to take stock. In the event equipment is missing, the employees have to pay the said equipment or a fine. All those who took the duty tour together are subject to the fine or must contribute to pay the missing equipment.

Measure 3.6
To install an alarm mechanism which announces flood discharge or qui can give signal ten kilometers away from the site. To develop an information campaign for the neighbouring and concerned populations.

Measure 3.7
To adopt more secure storage practices in conformity with safety norms, including the separation of the zones of new products from those of the used products.

Measure 3.8
To conduct urgent maintenance activities con the dikes and dams: control of termites, injection of cracks and vegetation control.

3.8.2 Mid term mitigation measures

Measure 3.9
To replace the auscultation and instrumentation for dikes and dams surveillance by the adequate and authorized equipment, as quickly as possible, so as to secure the stability of the infrastructures and the safety of the populations located downstream. It will be also necessary to plan a budget for the rehabilitation of the dikes which had not been conducted for several years.
**Measure 3.10**

To develop and implement a dangerous waste collection and disposal program, including the rejection of used batteries.

**Measure 3.11**

To finance income generating support actions around and downstream the dam (off-season irrigated crops: market gardening and rice cultivation, fishing for example) to reduce poverty.

**Measure 3-12**

To develop a basic infrastructural program (roads, water, electricity, etc.) for the populations of the bam region in order to enhance living conditions in the villages. This program must be supported by a community development program.

**Measure 3.13**

To develop and implement reforestation sub-projects

**Measure 3.14**

To get the populations out of the spillway perimeter and t develop, jointly with the populations located downstream, a land development plan.

### 3.8.3 Short term technical reinforcement measures

**Measure 3.15**

To characterize the rejections and to develop a mass summary of each unit of the installation.

**Measure 3.16**

To conduct an analysis on the dam safety as well as a study of breach of dam and the assessment of the related consequences downstream. To develop a plan for the management of the reservoir in the event of high flood as well as a manual for the surveillance of the installations.
**Measure 3.17**

To develop an emergency and contingency measure plan in the event of threat of breach. Who must be evacuated and according to which order? To define the responsibilities of each person in the emergency and contingency measure plan.

**Measure 3.18**

To develop a participatory plan for the management of the flood and inundation evacuation downstream.

**Measure 3.19**

To develop and implement a waste management plan which shall process solid waste, liquid waste, dangerous materials and recycling and which shall integrate spontaneous recycling.

### 3.8.4 Mid term technical reinforcement measures

**Measure 3.20**

To develop a reservoir management plan, using short, mid and long terms forecastings based on the hydrological data of the River Niger upstream and the meteorological forecastings. To be proactive rather than reactive. The reservoir lamination capacity is sufficient to be in a position to forecast floods downstream through a management of the flood spillway. The management should take into account the spillway capacity of the infrastructures downstream. The definition of the management plan must integrate the infrastructures located downstream and enable the optimization of the power production at the Kainji and Jebba plants.

**Measure 3.21**

To documenter and post in the operation room the permission asking procedure for a work which requires to switch on a piece of equipment or to switch it off.
Measure 3.22  
To develop a reference document for health and safety management. This document must contain the mission of the department, its short term and long term objectives as well as all the procedures and activities associated with health and safety, and summary of the work performed each year.

Measure 3.23  
To conduct an environmental and social monitoring coupled with the production of an annual report.

Measure 3.24  
To conduct and environmental and social audit of the installations every 5 years.

Measure 3.25  
To make sure that the basic equipment for fire control is in place and to have the plant analyze by an industrial safety specialist. He must determine the equipment required as well as the right place for each piece of equipment.

3.8.5 Short term institutional reinforcement measure

Measure 3.26  
To create and make operational an environment division which should be directly answerable to the Assistant General Manager (AGM) and which should head all the departments (cf the grey boxes added in the organizational charts of Figure 3-2 and Figure 3-3. this new division shall be in charge of the preparation of an action plan for the implementation of the recommendations made in the environmental audits.
### Measure 3.27
To create and make operational a workers committee in charge of health and security at the work site, headed by the safety department and the focal points of each of the directorates of the enterprise, which, inter alia, shall be responsible for making sure that the employees wear the safety equipment on the work site.

### Measure 3.28
To create and make operational a joint committee «enterprise – community» for the management of the environmental and social impacts of the dam, and more specifically the flood problems.

### Measure 3.29
To finance the implementation of the short term measures of the environmental and social Short term training through PDREPE-BN.

#### 3.8.6 Emergency training

### Measure 3.30
To organize training sessions on the environmental management of hydro-power installations and the monitoring assessment of environmental and social impacts.

### Measure 3.31
To conduct a specialized training session for two high level staff of the firm in environmental management and in safety of hydropower installations.

### Measure 3.32
To organize for the employees training sessions in health and safety at the work site.
Measure 3.33

To organize campaigns so as to sensitize the works in safety using various means. In addition to posters, theoretical courses and documentation, it can be introduce video firms showing examples of accidents. To conduct workshops depicting situations close to reality or to organize conferences with people narrating their experiences, etc. It can also be made use of sensationalism to increase the chances of the sensitization campaign to succeed.

3.8.7 Implementation responsibilities

The responsibility associated with the implementation shall rest with a committee in charge of monitoring the ESMP headed by the AGM and composed of the various officers heading the various departments. This department shall steer the implementation of the ESMP up to the creation of the Division “Environment” attached to the AGM. The chief of the DE shall later on chair the committee.

3.8.8 Estimation of the implementation costs

The total budget for the implementation of the environmental and social management plan of Kainji is US$ 2 135 000 over a period of 5 years, including US$ 845 000 for the short term measures and US$ 1 275 000 for the long term measures. It is recommended that the short term plan be covered by the PDR/PRE to enable the quick commencement of the implementation of the ESMP and promote environmental issues with the enterprise. This amount is relatively small compare the value of the project of US$ 100 000 000 and it can really make a difference on an environmental and social point of view.
<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-1</td>
<td>DE/Entreprise</td>
<td>250 000</td>
</tr>
<tr>
<td>Measure 3-2</td>
<td>DE/ONG</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 3-3</td>
<td>DSS/DE</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 3-4</td>
<td>DE/CS PGES</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 3-5</td>
<td>DSS/DE</td>
<td>10 000</td>
</tr>
<tr>
<td>Measure 3-6</td>
<td>DE/Entreprise</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 3-7</td>
<td>DSS/DE</td>
<td>5 000</td>
</tr>
<tr>
<td>Measure 3-8</td>
<td>DSS/Entreprise</td>
<td>20 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>435 000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-15</td>
<td>DE/Consultant</td>
<td>30 000</td>
</tr>
<tr>
<td>Measure 3-16</td>
<td>DE/Consultant</td>
<td>75 000</td>
</tr>
<tr>
<td>Measure 3-17</td>
<td>DE/Consultant</td>
<td>40 000</td>
</tr>
<tr>
<td>Measure 3-18</td>
<td>DE/Consultant</td>
<td>40 000</td>
</tr>
<tr>
<td>Measure 3-19</td>
<td>DE/Consultant</td>
<td>40 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>225 000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-26</td>
<td>CS PGES</td>
<td>100 000</td>
</tr>
<tr>
<td>Measure 3-27</td>
<td>CS PGES</td>
<td>-</td>
</tr>
<tr>
<td>Measure 3-28</td>
<td>CS PGES</td>
<td>10 000</td>
</tr>
<tr>
<td>Measure 3-29</td>
<td>CS PGES</td>
<td>-</td>
</tr>
</tbody>
</table>
### Emergency training

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-30</td>
<td>DE/Consultant</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 3-31</td>
<td>DE/Consultant</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 3-32</td>
<td>DE/Consultant</td>
<td>15 000</td>
</tr>
<tr>
<td>Measure 3-33</td>
<td>DE/DSS</td>
<td>10 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>75 000</strong></td>
</tr>
</tbody>
</table>

### Table 3-7 Estimation of the implementation costs of the mid term measures

#### Mid term mitigation measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-9</td>
<td>DE/Entreprise</td>
<td>100 000</td>
</tr>
<tr>
<td>Measure 3-10</td>
<td>DE/Consultant</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 3-11</td>
<td>DE/PHCN</td>
<td>250 000</td>
</tr>
<tr>
<td>Measure 3-12</td>
<td>DE/PHCN</td>
<td>300 000</td>
</tr>
<tr>
<td>Measure 3-13</td>
<td>DE/Entreprise</td>
<td>15 000</td>
</tr>
<tr>
<td>Measure 3-14</td>
<td>DE/PHCN</td>
<td>250 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>965 000</strong></td>
</tr>
</tbody>
</table>

#### Mid term technical reinforcement measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 3-20</td>
<td>DE/DH</td>
<td>-</td>
</tr>
<tr>
<td>Measure 3-21</td>
<td>DE/DSS</td>
<td>-</td>
</tr>
<tr>
<td>Measure 3-22</td>
<td>DE</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 3-23</td>
<td>DE</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 3-24</td>
<td>DE/Consultant</td>
<td>100 000</td>
</tr>
</tbody>
</table>
3.8.9 Overall cost of the Kainji dam mitigation measures

- Emergency mitigation measures: US $ 435 000
- Mid term mitigation measures: US $ 965 000
- Short term technical capacity building: US $ 225 000
- Mid term technical capacity building: US $ 325 000
- Emergency institutional capacity building: US $ 110 000
- Emergency training: US $ 75 000

- Total short term: US $ 845 000
- Total mid term: US $ 1 290 000

- Grand total: US $ 2 135 000
4. JEBBA DAM

4.1 Institutional framework

Since the change of NEPA into PHCN, the organizational chart evolved and it is the one in figure 4-1 which is present in force. The whole of the organization is now divided in three sections headed by the Chief Executive Officer: the Head Plant Services, the Head Production and the administrative services represented by Principal Managers (PM): PM Audit, PM (P&A) and PM (F&A). This new structure further promotes autonomy and personal initiative.
Figure 4-1  Organizational chart of Jebba hydropower plant

* Recommended modification
4.2 Description of the installations

4.2.1 Localization and description

The Jebba hydropower plant is approximately located between the coordinates of latitude 9° 31’ N and 9° 50’ N and between the coordinates of longitude 4° 30’ E and 5° 00’ E. It is also at 100 km downstream the Kainji plant and about 450 km North Lagos. Cf Map 3.1 Geographic situation of the Kainji and Jebba Dam (Source : NBA Observatory of the Niger Basin Authority).

To close the River Niger valley at the level of Jebba and form the reservoir, the main dam, an earth and rock-fill dam, is coupled with several auxiliary dams and infrastructures. As indicated in figure 4-3, the main dam is located in the south of the management and its imperviousness is secured by an upstream blanket. It is followed by the lock and the auxiliary dams 4, 3 and 2. Between these auxiliary concrete dams there is the spillway and the Powerhouse with its water inlet. Then we have the emergency reinforce spillway and the auxiliary dam 1 composed of a dike of the same type as the main dam principal. Finally, a saddle dam, of the same type as the main dam, closes a secondary valley. The normal operating level is 103.0 high.

The reservoir is located in a very deep gorge of the River Niger Valley. Its maximal depth is more than 100 m. As compared to the Kainji Lake, the Jebba reservoir is characterized by an unusable volume which corresponds to about 67 % of the total volume of water but with an average depth similar to the one of Kainji lake. The surface area of the reservoir is 303 km² which provides a useful volume of about 1 billion cubic meters. During a year of exploitation, the tide level of the reservoir is lower than that of the Kainji Lake.

The powerhouse is an imposing building of 206 m long and 36 m large. It is equipped with six water of 12.4 m high and 10 m large, and the same number of turbine-alternator groups. Each of the propeller turbines produces 96.4 MW for a high of net nominal fall and 102 MW for a net maximal fall. The total nominal power installed is 578 MW. During our visit, all the generator sets were operating at full regime.
Figure 4-3  Jebba power house management plan
Annex infrastructures such as the administrative building, the starting post, the transmission lines and a permanent camping for the employees with residences, schools and one hospital constitute the development of the Jebba.

The following tables give technical information relating to the Jebba development perimeter.

### Table 4-1  Morphological characteristics of the Jebba reservoir

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longueur moyenne</td>
<td>100</td>
<td>Km</td>
</tr>
<tr>
<td>Largeur maximale</td>
<td>12</td>
<td>Km</td>
</tr>
<tr>
<td>Largeur moyenne</td>
<td>3</td>
<td>Km</td>
</tr>
<tr>
<td>Superficie</td>
<td>303</td>
<td>km²</td>
</tr>
<tr>
<td>Profondeur moyenne</td>
<td>11</td>
<td>M</td>
</tr>
<tr>
<td>Profondeur maximale</td>
<td>105</td>
<td>M</td>
</tr>
<tr>
<td>Volume maximal du lac</td>
<td>3 880</td>
<td>Hm³</td>
</tr>
<tr>
<td>Volume utile du réservoir</td>
<td>1 000</td>
<td>Hm³</td>
</tr>
<tr>
<td>Volume mort</td>
<td>2 880</td>
<td>Hm³</td>
</tr>
<tr>
<td>Niveau d'eau minimal dans le réservoir</td>
<td>99,0</td>
<td>M</td>
</tr>
<tr>
<td>Niveau d'eau maximal dans le réservoir</td>
<td>103,15</td>
<td>M</td>
</tr>
<tr>
<td>Niveau d'eau normal dans le bief aval</td>
<td>76,4</td>
<td>M</td>
</tr>
<tr>
<td>Chute brute</td>
<td>27,72</td>
<td>M</td>
</tr>
</tbody>
</table>

### Table 4-2  Main characteristics of the dams

<table>
<thead>
<tr>
<th>Dam</th>
<th>Type</th>
<th>Élévation en crête (m)</th>
<th>Largeur en crête (m)</th>
<th>Longueur en crête (m)</th>
<th>Hauteur maximale (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam principal</td>
<td>Zoné en terre et enrochement</td>
<td>108,0</td>
<td>10,0</td>
<td>670</td>
<td>40,0</td>
</tr>
<tr>
<td>Dam de col (vallée secondaire)</td>
<td>Zoné en terre et enrochement</td>
<td>108,0</td>
<td>7,0</td>
<td>540</td>
<td>29,0</td>
</tr>
<tr>
<td>Dam auxiliaire 1</td>
<td>Zoné en terre et enrochement</td>
<td>108,0</td>
<td>7,0</td>
<td>275</td>
<td>14,0</td>
</tr>
<tr>
<td>Dams auxiliaires 2,3 et 4</td>
<td>Gravité en béton</td>
<td>108,0</td>
<td>n.d.</td>
<td>337</td>
<td>26,5</td>
</tr>
</tbody>
</table>
Table 4-3  Characteristics of the Jeba powerhouse

<table>
<thead>
<tr>
<th>Reservoir</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Niveau normal d’opération</td>
<td>103,0</td>
<td>m</td>
</tr>
<tr>
<td>Niveau minimal d’exploitation</td>
<td>99,0</td>
<td>m</td>
</tr>
<tr>
<td>Superficie au niveau 103,0 m</td>
<td>303</td>
<td>km²</td>
</tr>
<tr>
<td>Réserve utile (approx.)</td>
<td>1 000</td>
<td>hm³</td>
</tr>
<tr>
<td>Longueur</td>
<td>100</td>
<td>km</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Principales quantité lors de la construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume total des excavations</td>
</tr>
<tr>
<td>Volume total de remblai</td>
</tr>
<tr>
<td>Volume total de béton</td>
</tr>
<tr>
<td>Volume total des fondations compactées</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dam principal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type : zoné en terre et en enrochement</td>
</tr>
<tr>
<td>Élévation en crête</td>
</tr>
<tr>
<td>Largeur en crête</td>
</tr>
<tr>
<td>Longueur en crête</td>
</tr>
<tr>
<td>Hauteur maximale</td>
</tr>
<tr>
<td>(au-dessus du niveau le plus bas de la fondation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tapis d’étanchéité amont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type : Remblai imperméable</td>
</tr>
<tr>
<td>Longueur depuis le pied amont du dam</td>
</tr>
<tr>
<td>Épaisseur maximale</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dam auxiliaire 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type : zoné en terre et en enrochement</td>
</tr>
<tr>
<td>Élévation en crête</td>
</tr>
<tr>
<td>Largeur en crête</td>
</tr>
<tr>
<td>Longueur en crête</td>
</tr>
<tr>
<td>Hauteur maximale</td>
</tr>
<tr>
<td>(au-dessus du niveau le plus bas de la fondation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dams auxiliaires 2, 3 et 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type : gravité en béton</td>
</tr>
</tbody>
</table>
## Élévation en crête

<table>
<thead>
<tr>
<th>Élévation en crête</th>
<th>108,0 m</th>
</tr>
</thead>
</table>

## Longueur en crête

<table>
<thead>
<tr>
<th>Longueur en crête</th>
<th>337 m</th>
</tr>
</thead>
</table>

## Hauteur maximale

<table>
<thead>
<tr>
<th>(au-dessus du niveau le plus bas de la fondation)</th>
<th>26,5 m</th>
</tr>
</thead>
</table>

## Centrale

<table>
<thead>
<tr>
<th>Nombre de groupes turbine-alternateur</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puissance nominale totale</td>
<td>578,4 MW</td>
</tr>
<tr>
<td>Longueur de la centrale</td>
<td>206 m</td>
</tr>
<tr>
<td>Largeur de la centrale</td>
<td>36 m</td>
</tr>
<tr>
<td>Capacité maximale du pont-roulant</td>
<td>450 tonnes</td>
</tr>
<tr>
<td>Nombre de vannes de prise d’eau</td>
<td>6</td>
</tr>
<tr>
<td>Hauteur des vannes de prise d’eau</td>
<td>12,6 m</td>
</tr>
<tr>
<td>Largeur des vannes de prise d’eau</td>
<td>10 m</td>
</tr>
</tbody>
</table>

## Turbines

<table>
<thead>
<tr>
<th>Type : Turbines à hélice (pales fixes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chute nette nominale</td>
</tr>
<tr>
<td>Chute nette maximale</td>
</tr>
<tr>
<td>Puissance nominale de sortie</td>
</tr>
<tr>
<td>Puissance maximale de sortie</td>
</tr>
<tr>
<td>Vitesse</td>
</tr>
</tbody>
</table>

## Alternateurs

<table>
<thead>
<tr>
<th>Type : synchrone à axe vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge de base nominale</td>
</tr>
<tr>
<td>Charge continue nominale</td>
</tr>
<tr>
<td>Voltage</td>
</tr>
<tr>
<td>Facteur de puissance</td>
</tr>
</tbody>
</table>

## Évacuateur de crues

<table>
<thead>
<tr>
<th>Capacité au niveau normal d’opération</th>
<th>13 600 m³/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacité au niveau 106,0 m (incluant la capacité du déversoir d’urgence)</td>
<td>16 400 m³/s</td>
</tr>
</tbody>
</table>

## Évacuateur de crues principal

<table>
<thead>
<tr>
<th>Type : vanne de fond avec une cuillère de dissipation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Élévation du seuil</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Nombre de vannes radiales</td>
</tr>
<tr>
<td>Dimensions de chaque vanne :</td>
</tr>
<tr>
<td>• Hauteur</td>
</tr>
<tr>
<td>• Largeur</td>
</tr>
</tbody>
</table>

**Évacuateur d’urgence**

<table>
<thead>
<tr>
<th>Type : seuil déversoir en béton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longueur du déversoir</td>
</tr>
<tr>
<td>Élévation en crête</td>
</tr>
</tbody>
</table>

**Édifice administratif**

<table>
<thead>
<tr>
<th>Type de construction : béton armé</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nombre d’étages</td>
</tr>
<tr>
<td>Superficie totale de plancher</td>
</tr>
</tbody>
</table>

**Écluses**

<table>
<thead>
<tr>
<th>Longueur du canal</th>
<th>200 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largeur du canal</td>
<td>12,2 m</td>
</tr>
<tr>
<td>Hauteur de levée maximale</td>
<td>30,0 m</td>
</tr>
<tr>
<td>Tirant d’eau maximal</td>
<td>3,0 m</td>
</tr>
</tbody>
</table>

**Vanne amont**

| • Hauteur | 18,5 m |
| • Largeur | 12,2 m |

**Vanne aval**

| • Hauteur | 18,5 m |
| • Largeur | 12,2 m |

**Vanne de vidange et de remplissage**

<table>
<thead>
<tr>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hauteur de chacune</td>
</tr>
<tr>
<td>• Largeur de chacune</td>
</tr>
</tbody>
</table>
Figure 4-5  Reservoir area and volume curves according to the level

Figure 4-6  Spillway discharge capacity through one gate (full aperture) according to the level in the reservoir
4.2.2 Description of the equipments and procedures

The figures on the following pages show a model work and a diagrammatic section of the Jebba powerhouse. The water of the reservoir is captured by a water intake, then it rushes into the gully up to the feed tank where it makes the turbine turn. It is then rejected in the downstream portion through the aspirator.

Contrarily to water in the reservoir, once produced, the electric power cannot be stored and must be consumed. One therefore needs to have good control of the waters so as to produce just the electricity needed. That is why each hydraulic passage has a water intake gate and an aspirator gate which enables the isolation of this passage. Furthermore, the turbine is equipped with driving rods mounted a circle of sluice gates so as to control the rotation speed of the turbine. When the aperture of the driving rods is maximal, the production of energy by the turbine is maximal while when the complete aperture of the circle of sluice gates isolates the turbine so as to avoid racing for example. The control of the driving rods make it possible to adjust the quantity of water passing through the turbine and thus to meet exactly the electricity demand.

On its way through the hydraulic passages, the potential energy of the water accumulated in the high of the raw fall (difference between the upstream water level and the downstream water level) is transformed in electric power by the action of the turbine. The energy of the turbine is transmitted to the alternator through the shaft. It is the alternator with its rotor and stator which
generates electricity. At the Jebba powerhouse, the electricity is generated at 16 kV, but to enable the transportation of this electricity over a long distance while minimizing losses, the tension must be brought to 330 kV by the power transformers of the powerhouse. These 170 MVA transformers are located on the upstream apron of the powerhouse, between the powerhouse and the dam. At the exit of the transformers, the energy is channelled to the starting post located close to the powerhouse through aerial lines and supplies the main transmission lines.

![Figure 4-8 Model of the Jebba powerhouse](image-url)
4.2.2.1 Management of the reservoir and discharge through the spillway

The basin of the Jebba has a surface area of 630 800 km² and the average flow is 1 454 m³/s. As the infrastructure is located downstream Kainji, the flow it receives is substantially laminated.
by the Kainji reservoir, except for the flood of the intermediate basin over the 100 km which separate Kainji from Jebba. As the flow is already regulated, the management of the Kainji reservoir is simplified and the tide level is less important. Allowing for exception, the tide level is the Jebba reservoir is at maximum 3 meters and occurs between the levels 103.15 m and 100.0 m. The level never exceeds 103.15 m, i.e the level of the emergency reservoir.

The Jebba infrastructure has an emergency reservoir which is occasionally used. It makes possible the discharge of a slight surplus without opening the spillway gates. The management of the reservoir is done jointly with the management of the Kainji reservoir and the discharges through the spillway are rare and planned long time in advance. When the opening of the gates is planned, a letter is sent to the downstream industries in order to warn them of a possible flood.

The spillway is composed of 6(?) radial gates situated far below the normal operating level. The discharge is done with an important hydrostatic pressure.

The spillway is not equipped with an energy dissipation element other than its spoon shape and there erosion problems in the dissipation channel despite the fact that the faces are formed in the rock through dynamiting. Erosion is above all present at the downstream end of the channel.
• There is no warning system or procedure before the opening of any of the gates of the spillway.
• General rule: as the flow is regulated by the reservoir and the Kainji dam, the entire flow is grafted away. The discharges through the spillway are planned several days in advance and letters are sent to inform mostly the industries located downstream Jebba that there will be an opening of the spillway.

4.2.2.2 Observations and monitoring

The hydrometric data collected are analyzed and interpreted and they make it possible to obtain a detailed description of the dam operation. The hydrology department monitors very carefully the evolution of all the parameters measure and utilizes them to secure a good management of the Jebba reservoir.

The observations relate to rainfalls, temperatures, dominating winds, evaporation, water inputs of the River Niger, and other tributaries of the Jebba Lake, turbinated flows and discharged flows. All these data are analyzed and noted in the annual report.

The report also takes note that data collection is sometimes difficult because the staff does not have adequate vehicles to reach the gauging instruments and maintain them.

4.2.2.3 Alternators floor

At that level are located the alternators as well as the access to the set of transformers, the upstream and downstream aprons. The Jebba powerhouse is more recent than the Kainji one and cleaner. Nothing on this floor really holds up circulation and everything seems well maintained.
Photo 4-1  Overall view of the alternators floor

Photo 4-2  Alternators covers
4.2.2.4 Turbines floor

- Oil and air systems are not confined in the basins.
- The floor in the turbines wells is very slippery because of the oil. There is no absorbing carpet. The well is still clean but oily. Therefore, there must be on the occasion a cleaning session for the turbines well.
- The air compressors have no system of recuperation from the condensation.
- The extinguishers are of the B-C type.
- The floor is clean, regularly cleaned with water. The water is discharged in the drains of the floor.
- The turbines wells (and probably the whole draining system) can be discharged in a pit common to the 6 generators.
- Different oil barrels and cans are on the floor. No temporary recuperation basin.
- The generator set makes it possible to support the auxiliary services when the powerhouse is at complete stop, in such a way that the cooling water of the oil and air systems do not contaminate the oil. The oil consumption is thus reduced.
- For the time being there is storage room for the oils and the oil barrels are randomly stored in the powerhouse, with no recuperation basin. The construction of an oil storage room is part of their planning.
- They make use of spot remover agents for cleaning but not in a big quantity.
- The consumption of oil associated with the operation of a turbine is estimated to about 30 barrels per year.
Photo 4-4  Oil reservoir of an oil an air system

Photo 4-5  Floor for turbines
Photo 4-6  Air compressor

Photo 4-7
Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams
Photo 4-10  Passage around the turbines well and the driving rods

Photo 4-11  Vertical axis in the turbines well
4.2.2.5 Apron of the transformers

- The apron of the transformers is located at the center of the river between the powerhouse and the dam.
- The apron is drained in the gutter of recuperation of the infiltration water of the dam which pour into the river.
- On this apron, there is the water processing system for the consumption of the powerhouse.
- There is also a generator set with a reservoir of fuel. On trouve aussi un groupe électrogène avec un réservoir de carburant. A concrete low wall forms a basin around the fuel reservoir but this basin has an opening which can allow flow on the apron.
- There are 6 powerful transformers (16 kV – 330 kV) and 3 tension reduction transformers (downsizing tx) (16 kV – 11 kV), associated to the odd Tx (1,3,5), and an auxiliary services transformer (11 kV – 415 V).
- All over the apron, there are oil barrels and cans, but no temporary recuperation basin.
- The power and auxiliary services transformers are located in basins closed by concrete low walls.
- Firebreak walls isolate each transformer.
- Each basin is covered with a wire net and locked with a key.
- The basins are drained towards the drainage system of the powerhouse.
- One the basins contains the three reservoirs enabling to filter the oils of the transformers during the maintenance. The total volume of oil in these reservoirs is 33 000 litres (11.93 + 16.11 + 8.55 kl).
- The original oil processing unit is no longer operational and was replaced by a mobile one.
- The filter is either cleaned with Electra Clean, or thrown away. The approximate dimension of a filter is 4 po diameter by 2 pi long.
- There are also several fire protection units on the apron.
- The power transformers contain 30,000 l of oil.
- The oil utilized is the Tellus 68.
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Photo 4-12 Apron of the transformers

Photo 4-13 Power transformer
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Photo 4-14  Auxiliary services transformer

Photo 4-15  Mobile Unit for processing transformers oil (in the adjacent concrete basin, there is the old oil processing system)
Reservoirs for the storage of the oils undergoing processing

Drain in the basin of oil reservoirs
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Photo 4-18 Storage of oil barrels on the apron

Photo 4-19 Storage of oil barrels on the apron
4.2.2.6 Batteries room

- The batteries room is not closed by low wall at the entry point.
- It is located in an administrative building, close to the documentation center and a gallery of cables, and not in the powerhouse.
- All the batteries are in the same room (central battery and telecommunications batteries).
- In the room there are 220 cells for the banks A and B of the powerhouse and 24 cells for telecommunications.
- Each cell is 2 Volts.
- The type of acid utilized is plumb acid and hydrochloric acid.
- What happens to the cells when they are out of use is not well defined.

A small threshold should be added to the door so as to contain a possible discharge of the electrolyte liquid of the batteries.
Photo 4-23  Front door of the batteries room (no low wall for confinement)

Photo 4-24  Inside the batteries room
4.2.2.7 Workshop

- There is no strictly speaking mechanic workshop.
- The surface area located at the East of the powerhouse at the level of the turbines floor serves as mechanic workshop.
- There is a lot of waste at that pace and the floor is very greasy.
- There are also several floor drains which probably pour in the drainage pit of the powerhouse.
- To clean the tools, equipment or appliance, they are all put in a bucket with a leaning product. Once the cleaning is completed, the contents of the bucket is pour in the drain.
- There is no waste management procedure at the powerhouse.
Photo 4-26  View of the workshop

Photo 4-27  View of the workshop
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Final Report

Photo 4-28  Floor drain in the workshop

Photo 4-29  Recycling of various parts of equipment
Photo 4-30  Storage of waste and dangerous products in the workshop

Photo 4-31  Non identified products to be discharged in the drain
Photo 4-32  Example of waste management in the workshop

Photo 4-33  Fire control equipment in the workshop
4.2.2.8 Warehouse

- The warehouse is located at about 200 m from the powerhouse.
- The first item purchased is alum for the processing of consumption water.
- Inside the warehouse, there are some dangerous products (oil, paint…).
- The oils barrels are stored all over the place.
- The soil is contaminated on several locations.
- The oxygen carboys are placed in a container close to the warehouse, which represents a danger of explosion and fire.
- The equipment and material are placed in disorder.
- There is no waste management.
- On the ground, there are barrels of used oil, clean oil and empty barrels, which depicts a lack of organization and structure.
- The warehouse is also the place where the defective equipment is sent. This equipment is stored and occasionally serves as spare parts.
- The materials placed outside is not sufficiently protected from bad weather.

![Photo 4-34 Storage of alum (processing of drinking water)](image-url)
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Photo 4-35 Storage of spare parts

Photo 4-36 Inappropriate storage of oil
Articles stored any Id how.

Various articles...
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Final Report

Photo 4-39  Storage of additional parts and equipment outside

Photo 4-40  Storage of oil barrels
Contaminated area

Storage of used barrels of oil
Photo 4-43  Storage of carboys close to the main building (danger of explosion)

Photo 4-44  Ventilation of the container
Photo 4-45  Storage of an abandoned vehicle

Photo 4-46  Obvious contamination of the soil
Photo 4-47  Highly contaminated barrels and soil

Photo 4-48  Another surface area contaminated
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Photo 4-49  Unused oil barrels

Photo 4-50  Effect of contaminated soil
4.2.2.9 Main sources of impacts

The exploitation of the Jebba dam installations includes activities likely to have significant impacts on environment. The main activities which are sources of impacts are

- Dam management;
- Turbines cooling
- Groups operation
- Transformers maintenance;
- Batteries maintenance;
- Operation of the mechanical workshop
- Storage of various products
- etc.

4.3 Description of the installations environment

4.3.1 Biophysical Environment

4.3.1.1 Water resources

The north-eastern part of the basin drains in the Lake Jebba via the rivers Kontagora and Eku and all the north-western part of the basin, including the national park of Kainji to the border between Nigeria and Benin draining in the Lake Jebba via the Oli river. These local rivers experience a high flow pattern during the rain season and contributes to the local flood (White Flood).

The management of the reservoir is carried out so that during one year, the intrants equalize the extrants, i.e. the level of the reservoir is maintained without it being necessary to use the crest gate of floods. The peak of the floodings occurs in October that is 1 month after the peak of rainfall. One observes also a peak of less importance in February, due to the high water level in Mali (Black Flood). The low water level occurs in July during the dry season right before the beginning of the local flood (White Flood). The five last years were marked by a high hydraulicity. Year 2005 is ranked 8th in terms of average annual flow and peak flow pattern over the 22 years of recording to the power station of Jebba. The peak flow of the five last years is given in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak flood (m³/s)</th>
</tr>
</thead>
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<tr>
<td>2001</td>
<td>2 573</td>
</tr>
<tr>
<td>2002</td>
<td>1 970</td>
</tr>
</tbody>
</table>

Tableau 4-4 Peak flow between 2001 and 2005
Since more than one about fifteen years, the level of the lake is maintained between levels 100,39 and 103,05 and never it was not lowered under the minimum level of operation to the dimension 99,0 m.

The management of the reservoir, for the production of hydroelectricity, is closely related to one year of hydrological cycle (rainfall and evapotranspiration) which is described as follows:

- arid Phase: November at January
- pre-wet Phase: February at April
- wet Phase: April 23 at September 23 (150 days)
- post-wet Phase: September to October

Waters have high turbidity due to the presence of particles of clay and silt in suspension. This turbidity is less important during flood in the Mali area and increases considerably during local flood. Local rainfalls entail the discharge of many small particles in suspension. The following tables (table 4-5, table 4-, 9 and tableau 4-) present the characterisation of waters upstream and downstream the dam for several months between July 2005 and September 2006. Generally speaking, water remains of very good quality, especially for agricultural activities. But it should be noted that a certain level of pollution between the upstream and downstream areas in terms of oil and grease, TSS and sustainability. On the contrary, the concentrations are below the norms of refuse in the river.

### Table 4-5  Physico-Chemical characteristics of Jebba Dam Water Resources (June 2006 – August 2006)

<table>
<thead>
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<td>24.00</td>
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<td>25.00</td>
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<td>Conductivité (µScm⁻¹)</td>
<td>NS</td>
<td>54</td>
<td>54</td>
<td>61</td>
<td>62</td>
<td>64</td>
<td>64</td>
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<tr>
<td>pH</td>
<td>6-9</td>
<td>5.20</td>
<td>7.10</td>
<td>6.00</td>
<td>7.20</td>
<td>6.01</td>
<td>7.10</td>
</tr>
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</table>

Legend of the following tables

| NS | Not specified |
| ND | Not detected  |
| NDO | Non degradable organics |
### Acidité

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<td>Turbidité</td>
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<td>TS (mg/l)</td>
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<td>Total Hardness (mg/l)</td>
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<td>6.82</td>
<td>11.40</td>
<td>7.80</td>
<td>11.22</td>
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<tr>
<td>Huiles/Graisses (mg/l)</td>
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<td>0.49</td>
<td>0.42</td>
<td>0.59</td>
<td>0.48</td>
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<td>PO₄³⁻ (mg/l)</td>
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<td>0.93</td>
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<td>NO₃⁻ (mg/l)</td>
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<td>Cl⁻ (mg/l)</td>
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<td>0.14</td>
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<td>Zn (mg/l)</td>
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<td>&lt;0.02</td>
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<td>Pb (mg/l)</td>
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### Table 4-7  Physico-Chemical characteristics of Jebba Dam Water Resources  
(March 2006 - May 2006)

<table>
<thead>
<tr>
<th>Paramètres</th>
<th>Limite FME</th>
<th>Mai 2006</th>
<th>Avril 2006</th>
<th>Mars 2006</th>
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<tr>
<td>Ph</td>
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<tr>
<td>Acidité</td>
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<td>10.12</td>
<td>9.00</td>
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<td>DO (mg/l)</td>
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<td>8.42</td>
<td>9.21</td>
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<td>TSS (mg/l)</td>
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<td>3.79</td>
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<td>TS (mg/l)</td>
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<td>TDS (mg/l)</td>
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<td>Huiles/Graisses (mg/l)</td>
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<td>0.33</td>
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<td>4.03</td>
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Tableau 4-9  Physico-Chemical characteristics of Jebba Dam Water Resources
(February 2006, December 2005 and November 2005)

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<th>Paramètres</th>
<th>Limite FME</th>
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<th>Novembre 2005</th>
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<td>27.20</td>
<td>24.50</td>
<td>26.50</td>
</tr>
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<td>Conductivité (uScm⁻¹)</td>
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<td>69</td>
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<tr>
<td>Acidité</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>30</td>
<td>35</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td>Turbinité</td>
<td>NS</td>
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<td>84.00</td>
<td>123.00</td>
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<tr>
<td>TS (mg/l)</td>
<td>NS</td>
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<tr>
<td>Total Hardness (mg/l)</td>
<td>NS</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>THC (mg/l)</td>
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<td>0.55</td>
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<td>HCO₃⁻ (mg/l)</td>
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</tr>
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<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
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<td>K⁺</td>
<td>NS</td>
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<td>0.44</td>
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<td>Na⁺</td>
<td>NS</td>
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<td></td>
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<tr>
<td>Cr³⁺ (mg/l)</td>
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<td>0.03</td>
<td>0.04</td>
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**Table 4-11 Physico-Chemical characteristics of Jebba Dam Water Resources**

<table>
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<th>Paramètres</th>
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<td>27.20</td>
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<td>60</td>
<td>68</td>
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<td>pH</td>
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<td>Acidité</td>
<td>NS</td>
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<td></td>
<td></td>
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<tr>
<td>TDS</td>
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<td>133</td>
<td>33</td>
<td>41</td>
</tr>
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<td>Turbidité</td>
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<td>138.00</td>
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</tr>
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<td>DO (mg/l)</td>
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</tr>
<tr>
<td>TS (mg/l)</td>
<td>NS</td>
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<td></td>
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</tr>
<tr>
<td>Total Hardness (mg/l)</td>
<td>NS</td>
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<td></td>
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<td>Huilises/Graisses (mg/l)</td>
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</tr>
<tr>
<td>CO₂⁻ (mg/l)</td>
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<tr>
<td>Ca²⁺ (mg/l)</td>
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<td>8.50</td>
<td>11.00</td>
<td>17.98</td>
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<td>5.00</td>
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<td>NDO (mg/l)</td>
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<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>K⁺ (mg/l)</td>
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</tr>
<tr>
<td>Na⁺ (mg/l)</td>
<td>NS</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cr³⁺ (mg/l)</td>
<td>&lt;1</td>
<td>0.04</td>
<td>0.31</td>
<td>0.03</td>
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</table>
4.3.1.2.  Geology and soil

The geological complex of the basin is composed of metamorphic rocks of cambrian origin. The granites of similar origin, are found in the North of the basin. Subjacent Nupes are tributary in north of the river. The sediments infiltrated during cretaceous process tend to mask the complex of metamorphic rocks subjacent in the axis of the dam. Limonites make border upstream dam. One distinguishes 3 grounds of the dominating types originating from the subjacent rocks (granite and gneiss). Texture on the surface varies according to the sablo muddy grounds well drained on the argillaceous sandy ground in the surfaces invaded by water.

- Temporarily flooded grounds

They cover 45% of surface and are found on the level of the easily flooded plain. One meets fine gravels there coming from the granitic arena with quite polished quartz grains observed on the surface. They are the poorly drained sands which cover the underground clay.

The vegetation which develops is made up mainly of shrubby savannas whose dominant species are Azadirachta indica, Acacia hockii, Burkea africana, Pterocarpus erinaceus, Daniellia oliveri, Vitellaria pardoaxa, Parkia biglobosa, Vitex doniana, Khaya senegalensis, Detarium microcarpum, Lania spp, Entata africana, Mitragyna inermis, Acacia albida, Acacia spp, Cassia siamea, Albizia lebbeck, Albizia spp, Western Anacardium occidentale, Mangifera indica, Andropogon gayanus, Hyparrhenia spp, Schizachyrium sengineum, Rottboellia cochinchinesis, Téphrosia spp, Crotalaria spp, Indigofera spp. The herbaceous vegetation is very often grazed. The cultivated species are: Arachis hypogea, Sorghum spp, Zea mays, Ipomoea batatas, Oriza sativum. The reared animals are bovine, sheep, and caprine, etc.

- Well-drained grounds

They cover approximately 40% of surface and extend from the village of Mazhi up to the level of the campings. They are reddish grounds, deep, sandy and sablo-argilo surfaces some in-depth.
They are used for agriculture: Arachis hypogea, Sorghum spp, Zea mays, Ipomoea batatas, Oriza sativum, Manihot esculenta and Musa spp at the edge of the river.

- Skeletal grounds on the slopes (peaks) of the granites
They cover 10% of the portion of the basin and are made of colluvium, of granites and primary quartz, gneiss. They are wet and are sandy with a quantity of fine gravels higher than 70%. The vegetation is scattered and unsuitable for agriculture. They moderately support a strong population of ground worms.

The arable grounds used for agriculture cover 85% of the surface of the basin.

4.3.1.3. Vegetation and flora
The flora of the basin of Jebba was identified according to the types of vegetation met in the various settings which are: aquatic environment and terrestrial environment. In the aquatic environment, the macrophytes met are: Lemmna paucicostata, Pistia stratiotes, Salvinia nymphaenula, Ceratophyllum demersum, Echinochloa pyramidalis, Polygonium senegalense, Ludwigia willstolonifera, Ludwigia erecta, etc.

As for the terrestrial flora, it is made up mainly of the species like: Acacia hockii, Burkea africana, Combretum glutinosum, Combretum nigricans, Combretum hypopilinum, Daniella oliveri, Detario microcarpum, Khaya senegalensis Lennea spp, Parinari curatellifolia, Plistigma thonningii, Sterospermum kunthianum, Strychnos spinosa, Strychnos innocua, Terminalia avicennoides, Vitellaria paradox, Vitex doniana, Andropogon gayanus, Hyparrhenia spp, Pennisetum spp, Rottboellia cochinchesis, Schizachyrium sanguineum, Setaria pumila, Chamaechrysta mimosoides, Tephrosia braceolata, Vigna racemosa.

4.3.1.4. Faunic Resources
Watery fauna is dominated by the following species: Mormyrus sp, Heterobranchus bidorsalis, Gymnus niloticus, Synodonits spp, Chrysistys auratus, Citharinus latus, Citharinus spp, Tetraodon sp, Alestes macrolepidetus, Hydrocynus spp, Hemichromis fasciatus, Labeo spp, Lates niloticus, Tilapia spp. As for wild fauna, it is diversified enough and all the categories are represented. These categories are:

- Mammals:
  Hippopotamus amphibius; Adenota kob Redunca redunca, antilopes, Loxodonta africana, Panthera leo, Panthera pardus, Thiyonornys swinderianus). Antherurus africanus, Cercopithecus elythrogaster (monkey with white belly), Erythrocebus patas, etc.

- Reptiles:
Crocodylus niloticus, Varanus niloticus, Varanus spp, Testudo sulcata, Geochelone sulcata Pytho sebae, Python religiosa, Bitis gabonica, etc.

- Birds:

  Egretta alba, Leptoptilos crumeniferus, Balaeniceps rex, Sagittarius serpentarius, Ephippiorhynchus senegalensis, Comatibus eremita, Pseudogyps africanus, Aegyptius monachus, Torgos tracheliotus, Egretta ssp, Ciconiidae ssp, Ardeola ibis, Scopus umbretta, Platalea alba, Phoenicopterus spp, Agelastes meleagrides, etc.

Note that the Cercopitecus erythrogaster which is an endemic specy is threatened of disappearance.

The activities of fishing are also practised there but one notes a constant fall of the productivity.

4.3.1.5. Air

The air around the basin is of excellent quality. According to the measurements taken by the audit environmental 2002, the concentrations authorized by the Department of the Environment for Nox, SOx, NH3, organic and inorganic particles in suspension, VOC (Carbon Organic Volatile) are largely below the limit. We have respectively: 100, 300, 200, 600 mg/L and 20 pp for these elements.

4.3.2. Socio-economic environment

The socio-economic situation and the level of poverty prevailing with the displaced populations and the neighbouring populations is the same at Jebba as at Kainji and the socio-economic specific to Jebba are described below: The rural electrification program refers also the localities located in the vicinities of Jebba because if some more important cities have electricity, a high number of small localities are left in the darkness.

4.3.2.1 Health for the populations

The construction of Jebba dam took place in 1984. At the time, the displaced population would be about 100 inhabitants in the village of Mazhi. Today, this population would be about 900 inhabitants.

The realization of the dam did not give place to a particular programme of health protection in the locality. The health conditions are consequently identical to the other localities of the country. Jebba is the main center of the region having a medical infrastructure for the populations of the zone.

The populations have neither water supply nor boreholes. They drink the water of the river without treatment, which is a potential source of waterborne diseases. The waterborn diseases
are very present in the region and reported in the annual report of the Health Center but, no case of epidemics of diseases of this type was announced.

4.3.2.2. Health and safety of workers

- **General**
  - Total number of employees: 458, of which 209 technical employees and 249 clerical employees
  - the access to the dam and the power station is far from protected. Even the doors which closed the access to the apron of the crest gate of flood were dismounted and rest on the ground.

- **Safety Equipment**
  The safety equipment, whether it is boots, track suit, helmet and glasses, are provided to the workers of the power station free. In spite of the public awareness campaigns and the training which is given on the places of work, very few workers are equipped suitably. Many workers have a civil dress with sandals in the feet and do not carry the safety cap nor the glasses.

- **Emergency equipment and protection against fire**
  The emergency equipment, of the ocular shower kind, is non-existent and would be essential at the places where dangerous products are handled, such as the room of the batteries and the machine shop. One finds however several fire protection equipement (e.g.: extinguishers), which, according to information's obtained are checked and inspected regularly. We could not consult any register concerning the follow-up of the maintenance of this equipment. In the annual report of 2005, it was planned a project of handing-over in a state of its fire protection equipment, which must be operational soon.

- **Training and sensitisation**
  In addition to the documentation and handbooks relating to health and safety of the workers, the Management carries out the systematic training of the new employees and offers continuous training for the employees and their family. During the year 2005, several training activities took place. The Management is very sensitive to the importance of health and safety to work and carries out much sensitizing near its employees by the means of campaigns, training and posting. The program seems adequate but it is necessary to continue to reinforce its implementation.

There is a committee of health and safety within the company, but the composition of this committee is not known. To increase the effectiveness of this committee, it should include at least a working representative for each department of the company.
Health center and health care

The PHCN has a health center in the city of the employees, at the exclusive disposal of the employees of the station and of their family. A dispensary affiliated to this hospital is operated on the place of work even of the station for the care of less importance or urgent in the event of accident.

In the power station, one on the spot finds no case of help in the power station. Those which were already installed were stolen quickly.

4.3.2.3. Socio-economic activities

The bordering zone of the Jebba dam has an agricultural vocation. The agriculture practised there is of food prevalence. It ensures food self-sufficiency and the surplus makes it possible to women to undertake a small food trade.

The zone has vast wide of cultivable lands. The land does not constitute a constraint for the agricultural development. On the contrary the input are often inadequate and insufficient while technology is experiencing substantial delay, which considerably limits the agricultural output;

Fishing is practised on banks of the Niger river by the autochtone populations or by professionals of yoruba ethnic group or by immigrants from Ghana, Niger and Mali. Like in Kainji, the potential of fisheries in the Jebba reservoir is poorly exploited.

The products of fishing are sold fresh or smoky by the women of fishermen on the local markets.

The breeding of bovine, caprine, ovine and poultries is practised in the zone.

4.3.2.4. Social Organisation

The life of the company is organized around the economic activities which are agriculture, fishing and small trade.

The family field is cultivated by all the members of the family under the responsibility of the head of the family. Women ensure traditional work of sowing and harvesting of crops.

For fishing, women sell fresh fish or smoke them before selling it on the local markets.

At the professional level of the organization, one notes the existence of some groups of savings activities set up by women. Groups of farmers are also announced but those are not likely to improve truly the living conditions of the populations owing to the fact that the economic activities around which people gather are not very developed.

Associations for the development of the localities exist to solve problems of a social nature. This is the case of the village of Patizhico which has undertaken for a few years the construction of the school of the locality.
4.4. Impacts on the biophysical environment

The potential impacts to the biophysical environment and the measures suggested appear in the table entitled "Matrix of the potential impacts and measures proposed at the level of Kainji and Jebba dams".

4.4.1. Water resources

4.4.1.1 Hydrological regime

The impact on the hydrological regime of the construction of the Jebba dam, though very important, is less than the construction of the Kainji powerhouse. It is not a question of a construction on a virgin river, but of a construction which is added on a river already regularized. The major change is on the section between Kainji and Jebba where the lake replaced the river. But this transformation is now well integrated into the environment and to analyze the current impacts on the water resource it is necessary to observe the mode of management of the reservoir of Jebba.

The positive impact of the mode of management of the reservoir on the water resource is double. By rolling, the reservoir makes it possible to limit the impact of a discharge by the crest gate of flood of Kainji by producing a reduction of the amplitude of flood and their negative effects. Moreover, it creates an easily accessible water scheme which constitutes a reserve. The amplitude of the variation of the level of water in the reservoir is less important than in Kainji, which makes the water resource more available and easy of access during all the year.

On the other hand, the mode of management of the reservoir has also some negative impacts on the water resource which are identical to those of Kainji. The availability of water downstream from the power station is tributary to the operations of the power station. For example, if discharges and the treatment by turbine action are reduced to support the filling of the reservoir, there can be a significant reduction in the flow in the level downstream. Contrary, the arrival of an important flood can require the opening of the crest gate of floods, which will increase considerably the flow in the level downstream and will cause floods. Even if a flood is never desirable, it should be remembered that they are of less importance compared to what they would be without the presence of the dam.

4.4.1.2. Sedimentation and erosion

The Jebba reservoir also has an incidence on the sedientology of the River Niger which can have impacts on fishing activities and t the operations of the powerhouses. On that issue, one can consult the diagnosis conducted on sedimentation in the Kainji and Jebba dam reservoirs. According to this study, it seems that sediments are not contaminated and that they have limited impacts on fishing activities. On the opposite side, it constitutes a problem for powerhouses exploitation. Furthermore, the fact of retaining sediments in the reservoirs rather than allowing
them to go freely can have impact on the sediment regime downstream, up to the confluent with the Benue River and in the maritime Delta. There is data or information enabling to assess the positive or negative extent of this impact. However, one can think that, though real, this impact is limited, because the local flood waters (White Flood) have the same appearance both upstream and downstream dams. They therefore lose only a small part of their concentration in sediments.

The evacuations through spillway, because they represent substantial quantity of water with an important energy to dissipate, can also have an impact on banks erosion and sedimentation. In Jebba, the opening of the spillway cause an erosion downstream the discharge channel. This relates to a local problem to be corrected through the dissipation of energy the restoration of eroded banks. These modifications shall reduce the negative impact associated with the opening of the gates. The enhancement of the reservoir management shall make it possible to reduce this impact through the release of small quantities of water over a longer period.

4.4.1.3. Quality of surface waters

The oil and air systems, the cooling of the stages of the turbines, the activities of filtration of the oil of the transformers and the workshop of general mechanics have oil rejections which are found directly in water downstream from the dam. All the drains are forwarded to the river and there is no system of collection and effective separation of oil. In addition there is no data on volume of rejection nor the volume of consumption of the various components.

A follow-up of the quality of water is made in each month based on instantaneous samples which also does not make it possible to measure the real impact on the concentration of oil and grease of water of the river downstream. There is certainly an effect of dilution, but there can be, at the moment of the rejections, high concentrations being able to exceed the standards of rejection.

The maintenance of the batteries, which requires the periodic addition of acid electrolyte, also constitutes a source of discharge in water of the river. The mixture of the acids is made on the spot. Any accidental discharge will be found directly in the river and will affect the quality of the resource. The data available do not make it possible to quantify or to even consider the rejections acid of the installations. The same applies to the activities on the apron of the transformers. Any oil discharge, or another dangerous matter, will be found in the longitudinal gutter that throws itself directly to the river.

4.4.1.4. Ground waters

The immediate consequence of the presence of the dam reservoir is the increase in the ground water level in the region. The ground waters are therefore more vulnerable to contamination. The practices consisting in storing the empty containers and rejecting liquids (used oil) are a source of potential contamination of ground waters which can deteriorate their quality. No data is
available on the monitoring of these ground waters, which does not make it possible to appreciate and quantify the scope of such an impact.

4.4.2. Soils
The rainfed agricultural activities increased in the immediate environment of the dam, both upstream and downstream. The population of the zone faced a considerable growth, which results in a higher increase in the demand of lands. These lands are relatively portioned and faced high pressures which overtime, led to their gradual impoverishment. A problem of bank erosion associated with the management of the dam waters was also noted, especially in the downstream area.

In the warehouses, the utilised products are directly stored on the immediate floor with risks of contamination. (see photo).

4.4.3. Fauna and flora
The demands by populations of the zone for new lands led to an important deforestation around the reservoir. The vegetation, which then was in the form of forest gallery, has now changed into a tree savannah. But the phenomenon is relatively limited as compared to the huge forest potentialities of the region.

With the destruction of its habitat, the fauna drew back to most favorable zones and is no longer very present in the immediate vicinities of the dams.

The halieutic fauna also grew meager downstream but its increase in the reservoir compensates that reduction. However, the filling up of the reservoir with deposit of sediments reduces the development of its halieutic potential.

The proliferation of the aquatic vegetation (water hyacinth, water lettuce, etc.) in the reservoir is very limited which is beneficial for the halieutic fauna and the operation of the installations.

4.5. Impacts on the human environment

4.5.1. Population health and safety
The neighbouring populations, like those of Jebba city, drink the river water without any processing. The stagnation of the waters in the reservoir for months favours the development of the waterborne diseases vectors. The consumption of such a water presents risks the populations' health. These populations report that the proliferation of waterborne diseases is one of the key health problems experienced in the region. But there is no available data to support this hypothesis.

Flood evacuation is an activity which concerns the populations' health and safety. In fact, the release of important volume of water can cause material damage and also human damage.
through drowning, if the populations are not sufficiently informed. In fact the fishermen come up
to a few meters of the spillway and agricultural activities are conducted on the perimeter located
immediately downstream the develop perimeter. Presently, the populations are informed through
written letters and a warning system before they are evacuated. But in the event of emergency,
this procedure can not be complied with. It is obvious that in case of dam breaking, the situation
could be critical with considerable damage.

4.5.2. Workers’ health and safety

Work and movement in the various workshops are source of accidents which can have physical
body consequences as the staff does not respect the instructions on the wearing of the safety
equipment. Practices as regards the management of oil which sometimes spills on the ground is
another important source of accident. Statistics on accidents are not available which does not
make it possible to assess the scope of their impact. But this impact is of high importance since
it threatens the workers’ health.

In the warehouses, the products are stored pell-mell including dangerous products with all the
related risks, especially in the event of fire. The workers’ health is threatened by exposure to
dangerous products, and more particularly in the event of fire.

4.5.3. Socio-economic activities

Large surface areas of lands are sacrificed downstream for the sake of flood evacuation. In fact,
even if some unconditional persons continue to cultivate a portion of these lands, it is a fact that
such persons are taking the risk of facing floods and therefore losing their crops at any time.

Flood evacuation during cropping season is also source of conflicts among farmers in the event
of loss likely to entail legal prosecutions as was the case in Jebba during the 2001 flood.

The reservoir presence favoured the development of animal rearing and fishing but, these
economic activities remain limited as compared to the existing potentialities.

4.6. Environmental management framework

4.6.1. Environmental management plan

The Kainji powerhouse had no plan for environmental and social impact management plan
(ESIMP). It seems in fact, that the environmental issue is relatively new and that the dam didn’t
go through a detailed environmental assessment at the time of the technical studies. The
environmental management at the Jebba powerhouse can basically be summarised as the
management of the health and safety of the workers in service at the powerhouse. The
environmental management is thus diffused in the various departments because there is no
service or directorate fully in charge of this component. The following departments
(organisational charts are presented in article 3.1: Figure 3.1, Figure 3-2 and Figure 3-3) which
are in charge of the environmental management :
• Production and operation
• Hydrology
• Medical services
• Fire protection

Environmental management is mainly based on health and safety at the work site as well as on management of floods and inundations. In 2002, an environmental and social audit of the installations was conducted and contained the development of an environmental management plan. But this plan was not implemented due to lack of funds and will from the management. There was no monitoring of the environmental and social impacts. There was a monthly monitoring of water quality which was assigned to a private firm since 2002 after the environmental audit. It was planned to conduct an environmental and social audit every three years, but it will be difficult to achieve the objectives aimed at if there is no data.

4.6.2. Management of waste

At the powerhouse, like in many places in the community, there is no waste management plan. Therefore, it is not possible to conduct an assessment or to make have an idea of the quantity of waste generated. There was no organised waste collection, no collection for recycling, no management of dangerous waste. On the contrary, the scarcity of resources led to a spontaneous recycling, which if often beneficial but can sometimes be dangerous and have negative impacts on environment. This is the case, for example, of batteries which, when they are no longer utilised at the powerhouse, are thrown away, then recuperated by private individuals and probably, sold at the market where they find a second life.

During this process, the electrolyte solution, a dangerous substance, shall perhaps be thrown anywhere and contaminate the environment. Without prohibiting this practice, it would be desirable to define the way to get rid of waste in the powerhouse while taking into account the spontaneous recycling.

The empty containers of dangerous products are stored for years in the warehouses pending collection and disposal by the main firm. Furthermore, the barrels of utilised oil are piled up on the floor around the warehouse and the warehouse has reached a high rate of contamination are can be seen on the Photo 4-6 and the following ones. These barrels, empty or full, constitute thus a source of contamination of environment, notably lands and water resources.

4.6.3. Fire protection, health and safety at the work site

The management of the activities associated with fire protection is covered by the fire protection and safety department. Their annual report shows that the officers in charge of this management are conscious of the strengths and weaknesses within this department from all points of view: emergency equipment, staff equipment, training, staff competence. The plan relating to the update of the fire protection equipment at the powerhouse should be pursued and implemented.
The Jebba Hydro Power Business Unit has a fire and safety department. On the basis of the documents consulted, it can be said that this department is very active within the enterprise and is making a lot of efforts to enhance fire protection and safety. Workers’ health and safety is a real concern for the enterprise and several concrete actions were conducted in 2005. These efforts were fruitful as in the JHPBU awarded the Prize of the Best Overall Safety Conscious Station among the powerhouses of the PHCN in the country.

One of the objectives set by the department is to maintain the powerhouse in a very good state of cleanliness. On the basis of our observations on the site this objective is achieved and maintained. This is a very good achievement in terms of environmental health and safety.

The management of the enterprise has a policy on which we have no copy. This policy should be distributed and visible within the enterprise so that each worker strives for its implementation.

4.6.3.2. Dam maintenance and surveillance

In the annual report, it can be read that the monitoring of the various gauging instruments and appliances is regularly conducted for all the dikes and dams composing the Jebba hydropower business unit. On the opposite side, major problems such as longitudinal cracks are mentioned but the related repairs are yet to come. When major problems are identified, it is necessary to proceed to repairs within the shortest time possible. The stability of the infrastructure depends on it.

In addition, pressure gauging appliances are not operational. These gaugings are very important so as to know the evolution of the dam and analyse the stability of the infrastructures.

4.6.3.3. Safety of dams

The reservoir is equipped with overflow spillway which occasionally serves as emergency spillway. Its height is 103.15 m, that is 15 cm the normal operation level. This spillway seems regularly used because there is no monitoring of the water level 24 hours a day and the opening of the spillway gate is planned several days in advance. For the unforeseen forecasts, there is the emergency spillway. That is the safety system.

The PHCN concern in terms of dam safety are the notice on discharges through the spillway gates which can caused floods in the valley downstream the infrastructure. Generally, when the discharges through the spillway gates are planned, letters are sent to the industries likely to face floods. This approach is important but can not apply under emergency situation. During our discussions, we noted that there is no awareness as regards the notion of vulnerability of the infrastructure within the administration.

No human construction is infallible. Dams represent an intrinsic risk that needs to be assessed and managed through an assessment of dam safety conducted by engineers, in conformity with
norms related to the construction of major dams, such as ICOLD (International Commission on Large Dams).

The hydrology directorate relies on the emptying and filling curve to conduct the management of the reservoir. This method operates fairly well as it maintains the level of the reservoir each year. However, it is not optimal and does not take into account the downstream infrastructure. There is no long-term plan for the management of the reservoir with forecasting models which integrate the forecasting of the water resources and forecasting of demands for energy.

4.7 Synthesis of the audit results

The main observations of the audit likely to generate environmental and social impacts and to affect their management are:

27. The prevalence of the cases of waterborne diseases associated with the presence of the reservoir and the consumption of non-processed water.
28. The failure of workers to respect safety measures in the workshops and units.
29. The reservoir management mode leads to periodical floods downstream with risks of material and human damages (7 times over the last 20 years).
30. The discharge of liquid waste directly in the river and the neighbouring lands.
31. The destruction of the vegetation around the reservoir for domestic needs leading to a degeneration of forest from one year to the other.
32. The ignorance of the existence of the refuse in the waters and lands both from the qualitative and quantitative points of view.
33. The absence of a liquid and solid waste management plan.
34. The insufficiency of data enabling to quantify the liquid and solid refuse or even to conduct a mass assessment.
35. The utilised oil filtration practice is a recycling technique which reduces the volume of refuse of utilised oil.
36. The absence of a programme for collection and disposal of dangerous waste (acids, oil, etc.)
37. The non-secured storage of consumable products and materials in the warehouses and the real risk for the works’ safety, notably, in the event of accident or fire.
38. The under-rating of potentials for development of socio-economic activities around the reservoir (recessional cropping, fishing, animal rearing, etc.)
39. The occupation of lands located downstream the spillway for agricultural and habitation needs, despite the real risk in the event of flood and dam breaking.
40. The current method of the reservoir management is not optimal because it does not take into account the infrastructure located downstream, especially the Jebba dam.
41. The flood evacuation warning system not adapted to emergency of dam breaking situations.
42. The insufficiency of material and human resources at the health and safety department as well as a dysfunctioning which reduces its efficiency.
43. The insufficiency of the continuous monitoring of the environmental and social impacts associated with the exploitation of the installations.
44. The absence of a service or department exclusively in charge of the management of environmental and social impacts.
45. The absence of senior staff specialised in the management of environmental and social impact of this type of installation.
46. The management and the employees are not very sensitive to environmental and social issues.
47. The persons displaced during the construction still have bitterness vis-à-vis the project despite the number of years gone by.
48. The population is not at all involved in the management of environmental and social risks likely to results in floods and dam breaking.
49. The environmental and social management plan resulting from the 2002 audit was not implemented because of the lack of financial means and will of the management.
50. The auscultation and inspection of dikes and dams are not adequate.
51. The urgent activities relating to the maintenance and repair of dikes and dams are not conducted in due time, often because of the lack of human and material resources.
52. The lack of funds to conduct the repair or expansion activities such as repair of leakage of the spillway.

4.8. Environmental management plan

4.8.1. Mitigation measures

The mitigation measures described below are corrective measures proposed to remedy the shortcomings observed and to reduce negative impacts on environment.

4.8.1.2. Short-term mitigation measures

**Measure 4.1**

*To provide drinking water to the New Bussa populations through the construction of a water processing station.*
<table>
<thead>
<tr>
<th>Measure 4.2</th>
<th>To sensitise the riparian population on the control of waterborne diseases and their vectors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 4.3</td>
<td>To equip all workers out of safety equipment and to require the obligatory wearing of them in the work premises</td>
</tr>
<tr>
<td>Measure 4.4</td>
<td>To set a perimeter of safety downstream from the crest gate of flood in which any dwelling is prohibited. The existing dwellings must be relocated.</td>
</tr>
<tr>
<td>Measure 4.5</td>
<td>To install the environmental cases with follow-up of the material used. To found a system of follow-up of the material with responsibilities and consequences: it is necessary to indicate in a register the use of the material and with each quarter work to make an inventory. If material get lost the employees must pay for it, or a fine, all who worked are being imposed a fine or the replacement of the stole material.</td>
</tr>
<tr>
<td>Measure 4.6</td>
<td>To put in place a warning system which indicates the evacuation of floods and which can make alarm from a site located at tens of kilometers. To put in place a sensitisation campaign for the surrounding and involved populations.</td>
</tr>
<tr>
<td>Measure 4.7</td>
<td>To adopt more safer practises in conformity with safety norms, like separation of new products from used products.</td>
</tr>
</tbody>
</table>
**Measure 4.8**

To undertake urgent maintenance works at the digs and dams installation: treatment of insects, filling of cracks and control of vegetation.

4.8.1.3. Long-term supportive measures

**Measure 4.9**

To replace the equipment of sounding and instrumentation for the monitoring of dams and digs by adequate and automated equipment, within the shortest deadlines to ensure the stability of the works and the safety of the populations downstream. It will also be necessary to envisage a budget for the repair of digs which has not been made adequately for several years.

**Measure 4.10**

To develop and execute a programme for collection and storage of dangerous waste of which rejections of worn batteries.

**Measure 4.11**

To finance income generating supportive actions around and upstream the dam (irrigated dry season crops: market gardening crops and rice, fishing for instance).

**Measure 4.12**

To develop a basic infrastructural program (roads, water, electricity, etc.) for the populations of the Bam region in order to enhance living conditions in the villages. This program must be supported by a community development program.

**Measure 4.13**

To develop and execute sub-projects for vegetation regeneration.
<table>
<thead>
<tr>
<th>Measure 4.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>To pull out the populations from the area of flood evacuation and develop, in consultation with the populations upstream the river, a land exploitation scheme.</td>
</tr>
</tbody>
</table>

### 4.8.2. Measures for technical reinforcement

#### 4.8.2.2. Short-term measures

<table>
<thead>
<tr>
<th>Measure 4.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>To categorise the waste and make a mass balance of each unit of the infrastructure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure 4.16</th>
</tr>
</thead>
<tbody>
<tr>
<td>To analyse the safety of the dam as well to conduct a study on the breaking of the dam and assess the consequences upstream. To develop a plan for the management of the reservoir in the event of important flood and to develop a manual of monitoring of the infrastructure as well.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure 4.17</th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop an emergency and contingency plan in the event of threat of breaking. Who should be evacuated and in what order? to define the responsibilities of each actor in the emergency and contingency plan.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure 4.18</th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop a participatory plan for the management of the floods and inundations downstream.</td>
</tr>
</tbody>
</table>
**Measure 4.19**

To develop and execute a plan for the management of waste. The said plan shall deal with solid and liquid waste as well as dangerous matter, recycling and integration of spontaneous recycling.

### 4.8.2.3. Mid-term measures

**Measure 4.20**

To develop a plan for the management of the reservoir by using forecasts in the short, medium and long run, based on hydrological data of the river Niger upstream and the meteorological forecasts. To be rather proactive than reactive. The capacity of tuning of the reservoir is sufficient enough to be able to prevent floodings downstream through a management of the crest gate of flood. The management should take into account the capacity of evacuation of the works downstream. The definition of a management plan should include the works downstream and should allow the optimisation of the power production at the Kainji and Jebba powerhouse.

**Measure 4.21**

To document and post in the order room, the procedures of request for authorisation, for an activity that requires the to put on or of motion an equipment.

**Measure 4.22**

To develop a provisional document of the management of health and safety. This document should deal with the mission of the department, its objectives in the short, medium and long run, as well as all the procedures and activities related to health and safety. It shall include also the annual work assessment. The document should be updated each year.

**Measure 4.23**

To conduct an environmental and social monitoring with production of an annual report.

**Measure 4.24**

To conduct an environmental and social audit of the installations each five-year period.
Measure 4.25

To ensure that the fire protection equipment is in place and to make an audit of the powerhouse by an Expert in the industrial safety. The expert should determine the required equipment as well as the place of each part of the equipment.

4.8.3. Short-term measures for institutional capacity building

Measure 4.26

To create and operate a division of environment under the direct supervision of the Assistant-Director of Production (ADP) which shall cover all the departments (see the grey box added to the charts of Figure 3-2 and Figure 3-3). This new division would be in charge of the drafting of an action plan for the implementation of the recommendations made in the environmental audits.

Measure 4.27

To create and operate a committee of workers in charge of health and safety at work which shall be steered by the department of safety and focal points from each division of the company. This committee will be, among others, in charge of enforcing the measures on the wearing of safety equipment.

Measure 4.28

To create and operate a company-community joint committee for the management of environmental and social impacts of the dam and most especially, flood issue.
### Measure 4.29
To finance the implementation of short-term measures of the environmental and social management plan by the Project PDREPRE for its duration period.

### 4.8.4. Short-term training

#### Measure 4.30
To organise training sessions on the environmental management of the hydroelectric installations and the monitoring/evaluation of environmental and social impacts.

#### Measure 4.31
To organise a specialised training session of to senior experts of the company in the environmental management and safety of hydroelectric installations.

#### Measure 4.32
To organise training sessions for workers on health and safety at work.

#### Measure 4.33
To organise the campaign of sensitisation for workers on safety using different means. In addition to the postings, theoretical courses and documentation, video film on accidents for instance can be shown, some workshops on dealing with various situations, or organisation of conferences with people sharing their experience, etc. One can also ressort to a sensational situation to increase the chance of success of a sensitisation campaign.

### 4.8.5. Responsibilities in the execution
The responsibility for the setting of the environmental and social management plan (ESMP) will fall at a committee of follow-up of the ESMP directed by the Assistant-Director of the production and gathering the persons in charge for the various departments. This committee will control the setting of ESMP until the installation of Environment Division attached to the MGA. The chief of Environment Division will take the chairmanship of the committee thereafter.
4.8.6. Estimates of the implementation costs

The overall budget of the implementation of the Kainji environmental and social management plan is US $ 1,615,000 for five years, including US $ 790,000 for short-term measures and US $ 825,000 for the long-term measures. It is recommended that the short-term plan should be covered by the PDR/PRE so as to enable a quick start of the implementation of the ESMP and promote environmental issues within the enterprise. This amount is relatively small compared to the value of the project of US$ 100,000,000 and it can really make a difference on an environmental and social point of view.

<table>
<thead>
<tr>
<th>Table 4-6</th>
<th>Estimation of the implementation costs of the short term measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short term mitigation measures</strong></td>
<td></td>
</tr>
<tr>
<td>Measures</td>
<td>Responsible</td>
</tr>
<tr>
<td>Measure 4-1</td>
<td>DE/Entreprise</td>
</tr>
<tr>
<td>Measure 4-2</td>
<td>DE/ONG</td>
</tr>
<tr>
<td>Measure 4-3</td>
<td>DSS/DE</td>
</tr>
<tr>
<td>Measure 4-4</td>
<td>DE/CS PGES</td>
</tr>
<tr>
<td>Measure 4-5</td>
<td>DSS/DE</td>
</tr>
<tr>
<td>Measure 4-6</td>
<td>DE/Entreprise</td>
</tr>
<tr>
<td>Measure 4-7</td>
<td>DSS/DE</td>
</tr>
<tr>
<td>Measure 4-8</td>
<td>DSS/Entreprise</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
</tr>
</tbody>
</table>

| **Short terms technical reinforcement measures** | |
| Measures | Responsible | Estimated Cost $US |
| Measure 4-15 | DE/Consultant | 30,000 |
| Measure 4-16 | DE/Consultant | 75,000 |
| Measure 4-17 | DE/Consultant | 40,000 |
| Measure 4-18 | DE/Consultant | 40,000 |
| Measure 4-19 | DE/Consultant | 40,000 |
| **TOTAL** | | 225,000 |
### Short term institutional reinforcement measure

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 4-26</td>
<td>CS PGES</td>
<td>100 000</td>
</tr>
<tr>
<td>Measure 4-27</td>
<td>CS PGES</td>
<td>-</td>
</tr>
<tr>
<td>Measure 4-28</td>
<td>CS PGES</td>
<td>10 000</td>
</tr>
<tr>
<td>Measure 4-29</td>
<td>CS PGES</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>110 000</strong></td>
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</table>

### Emergency training

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 4-30</td>
<td>DE/Consultant</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 4-31</td>
<td>DE/Consultant</td>
<td>25 000</td>
</tr>
<tr>
<td>Measure 4-32</td>
<td>DE/Consultant</td>
<td>15 000</td>
</tr>
<tr>
<td>Measure 4-33</td>
<td>DE/DSS</td>
<td>10 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>75 000</strong></td>
</tr>
</tbody>
</table>

### Mid term mitigation measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 4-9</td>
<td>DE/Entreprise</td>
<td>100 000</td>
</tr>
<tr>
<td>Measure 4-10</td>
<td>DE/Consultant</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 4-11</td>
<td>DE/PHCN</td>
<td>250 000</td>
</tr>
<tr>
<td>Measure 4-12</td>
<td>DE/PHCN</td>
<td>150 000</td>
</tr>
<tr>
<td>Measure 4-13</td>
<td>DE/Entreprise</td>
<td>10 000</td>
</tr>
<tr>
<td>Measure 4-14</td>
<td>DE/PHCN</td>
<td>250 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>810 000</strong></td>
</tr>
</tbody>
</table>
Mid term technical reinforcement measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Responsible</th>
<th>Estimated Cost $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure 4-20</td>
<td>DE/DH</td>
<td>-</td>
</tr>
<tr>
<td>Measure 4-21</td>
<td>DE/DSS</td>
<td>-</td>
</tr>
<tr>
<td>Measure 4-22</td>
<td>DE</td>
<td>15 000</td>
</tr>
<tr>
<td>Measure 4-23</td>
<td>DE</td>
<td>50 000</td>
</tr>
<tr>
<td>Measure 4-24</td>
<td>DE/Consultant</td>
<td>100 000</td>
</tr>
<tr>
<td>Measure 4-25</td>
<td>DSS/PHCN</td>
<td>120 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>285 000</strong></td>
</tr>
</tbody>
</table>

4.3.2 Overall cost of the Kainji dam mitigation measures

- Emergency mitigation measures: US $ 305 000
- Mid term mitigation measures: US $ 810 000
- Short term technical capacity building: US $ 225 000
- Mid term technical capacity building: US $ 285 000
- Emergency institutional capacity building: US $ 110 000
- Emergency training: US $ 75 000

- Total short term: US $ 715 000
- Total mid term: US $ 1 095 000
- Grand total: US $ 1 810 000
CONCLUSIONS

At first sight, both Kainji and Jebba powerhouses seem to be well maintained. Waste is collected and the floors cleaned, etc. Even if the workers do not wear their safety equipment, it is noted that workers’ health and safety is a real concern for the management. However, it is necessary to put in more efforts and human, material and financial resources to maintained and boost the already existing programmes. It is necessary to continue enhancing the equipment and conducting sensitisation campaigns.

As for the biophysical and economic environment as well as dam safety, much remains to be done. The same work conducted in the health and safety area should be implemented as regards the preservation of the biophysical environment and the enhancement of the economic situation. It is a big challenge to be raised. But to face this challenge, it is necessary to have the will of the PHCN management in order to invest the required human, material and financial resources. The first stage is to implement the recommendations of this report. It is necessary to devote the next five years to the implementation of these recommendations so that at the next audit one can note the progress made and go ahead instead of starting afresh. From the audit conducted in 2002, none of the changes or measures recommended was applied, especially due to the lack of financial resources. It should therefore be kept in mind that the financial factor is determinant. The present audit is part of a project which has the necessary funds because it is integrated in the rehabilitation of the infrastructure and the cost of the measures proposed (US $3.3 billion represents a very low percentage of the US $ 100 billion of investment planned for the two powerhouses. It is therefore of prime importance to integrate this budget to the cost of the works so as to ensure the implementation of the mitigation measures proposed.

In order to enhance the chances of success, it also necessary to initiate changes and start with the conscientisation of each and all of the workers including their families. The PHCN management understood it since it has already started conducting health and safety training sessions for the employees and their families. It is now necessary to expand the notion « environment » to everything around us. One should look around himself and appraise the beauty of what is around us and then ask oneself what one can do so that our children and grandchildren could benefit from such a beautiful environment. It is by initiating changes within the enterprises that mentalities shall evolve within the community. Firm such as PHCN should set the example for others to follow.
ANNEX 1

Kainji
ANNEX KAINJI

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      2341 – 16/11kV Transformer Deluge System
   c) Operating Manuals – Volume 16
      1300 – Headworks
      1400 – Turbines
d) Operating Manuals – Volume 21
   2520 – 11kV/415V Transformers

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   4300 – Filtered cooling water system

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ANNEX 2

Jebba
ANNEX JEBBA

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ANNEX 3

World Bank Operating Policy

OP 4.37
ANNEX 4

World Bank Procedures

WBP 4.3
ANNEX 5

Questionnaire for the technical audit of dams
ENVIRONMENTAL AUDIT IN NIGERIA – KAINJI & JEBBA DAMS

67. Applicable Laws and Regulations concerning:
- Water Management
- Environment
- Dam Safety
- Health and Safety at Work
- Public Health

Dams Management organisation
- Director
- Head of Environmental Dept.
- Head of Operation and Maintenance Dept.
- Head of Electrical Dept.
- Head of Mechanical Dept.
- Others
- Structure Diagram
- % Women in management staff
- % Women in general

Layouts and drawings
- General layout for the dam and power house
- Dam and spillway “As Built” drawings
  (or, if not available, detailed engineering drawings)
- Power house “As Built” drawings
- Drainage system drawings
- Manufacturer drawings of main mechanical and electrical equipment
  (such as turbines, generator, transformers, etc.)

Main characteristics of the dam and spillway
- Year of construction / commissioning
- Normal operating level
- Maximum operating level
- Minimum operating level
- Dam type
- Foundation type
- Crest Width
- Height
- Number of gate / Dimension
- Type of gate
- Invert elevation
- Total Spillway capacity
- Each gate capacity
- Bottom gate capacity
- Invert elevation of the bottom gate
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Provisional Report

- Storage curve

**Main characteristic of the power house**

- Years of construction and year of commissioning
- Normal operating level
- Maximum operating level
- Minimum operating level
- Number of units
- Turbine type
- Total installed capacity
- Installed capacity per unit
- Total turbines flow
- Turbine flow per unit
- OM Manuals
- Number of gantry or crane
- Gantry or crane capacity

**Dam and Spillway**

- Spillway gates hydraulic units (Bottom gates)
  - Technology
  - List of used products (contaminants)
  - Contained Quantity
  - Change frequency
  - Consummation rate
  - Waste management system description
  - Description of potential risk
  - Previous accident
  - Actual mitigation measure
  - Efficiency of actual MM
  - Proposed solution

**Dam Safety**

- Erosion or sedimentation problems
- Overtopping waters
- Other observed problems or potential risks
- Emergency Plan
- Previous emergency situations
- Evaluation of emergency plan

**Power House – Mechanical equipment**

- Turbine pit
  - Technology
  - List of used products (contaminants)
  - Contained Quantity
  - Oil change frequency
  - Consummation rate
  - Waste management system description
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstallation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Provisional Report

- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Pneumatic-oil System**
- Technology
- List of used products (contaminants)
- Contained Quantity
- Oil change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Oil Room**
- Technology
- List of used products (contaminants)
- Contained Quantity
- Oil change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Mechanical Shop**
- Technology
- List of used products (contaminants)
- Contained Quantity
- Oil change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Other mechanical equipment :**
- Technology
- List of used products (contaminants)
- Contained Quantity
- Oil change frequency
NIGER BASIN AUTHORITY (NBA)
Project of Water Resources Development and Preservation of Ecosystems in Niger Basin

Environmental and Social Management Framework (ES.M.F), Framework of Population Reinstalation Policy (F.P.R.P), social and economic study and environmental audit of Kainji and Jebba dams

Provisional Report

- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

### Power House – Electrical equipment

**Batteries Room**

- Technology
- List of used products (contaminants)
- Contained Quantity
- Change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Power transformers**

- Technology
- List of used products (contaminants)
- Contained Quantity
- Change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Other electrical equipment**:

- Technology
- List of used products (contaminants)
- Contained Quantity
- Change frequency
- Oil change frequency
- Consumption rate
- Waste management system description
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

**Waste waters and Drainage**
Waste waters

- Number of employees
- Estimation of daily water consummation
- Waste water sewerage system
- Other effluents from power house activities in sewerage system
- Treatment system
- Discharge point
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution

Power house drainage system

- Description (mix with waste waters)
- List of used products (contaminants)
- Oil / Water Separator
- Discharge point
- Description of potential risk
- Previous accident
- Actual mitigation measure
- Efficiency of actual MM
- Proposed solution
- Washing area and drainage system

Environmental Management Plan

- Responsible
- Organisation of EMP execution
- Evaluation of EMP execution
- Description of the organisation of the monitoring
- Person in charge of the monitoring
- Copy of the Environmental Monitoring Plan
- Information on Staff Health
- Monitoring Reports

Health and Safety at Work

- Health and safety plan
- Accidents
- Accidents report
- Monitoring
- Observed security problems
- Proposed solutions
ANNEX 6

Guide for interview in the localities of Kainji and Jebba dams
GUIDE FOR INTERVIEW IN THE LOCALITIES OF KAINJI AND JEBBA DAMS
GUIDE D’ENTRETIEN DANS LES LOCALITÉS DES BARRAGES DE KAINJI ET JEBBA

- Irrigation schemes and water demand / Projets d’irrigation et demande en eau

- Chemical pollution related to agricultural production / Pollution chimique reliée à la production agricole

- Livestock water points / Points d’eau pour l’abreuvement du bétail

- Socio-economic conditions / Conditions socio-économiques

- Soil occupation (cultivated lands, irrigated lands, pasture land, land ownership) / Occupation des sols (terres cultivables, terres irriguées, paturages, système foncier)

  - Land exploitation / mode d’exploitation des terres

  - Local and regional economy (agriculture, commerce, services, fishing, ecotourism, etc) / économies locale et régionale (agriculture, élevage, commerces, services, pêche, écotourisme, etc.)

  - Organizational structures (co-operative, private irrigation schemes, etc.) / Structures organisationnelles (coopératives, périmètres privés, etc.

- Positive and negative impacts before and after the dam / Impacts positifs et négatifs avant et après le barrage
- **population resettlement** / relocalisation des populations

- **population in the area** / population dans la zone

- **cultivated area by crop** / superficies exploitées par culture

- **livestock population (heads) by category** / nombre d’aniiaux par catégorie

- **fishing volumes** / volumes pêchés

- **service development** / développement des services

- **business, agribusiness and other economic activities** / commerce, agro-industrie et autres activités économiques,

- **use conflicts** / conflits d’usagers

- **job creation** / création d’emplois

- **land and property value** / valeur des terres et des propriétés

- **Actions undertaken to mitigate socio-economic conditions** / Actions menées pour atténuer les conditions socio-économiques