1 INTRODUCTION

1.1 GENERAL

Nearly the entire territory of the Republic of Niger is located in the Sahel-Sahara Zone, which is characterised by a very low precipitation and frequent drought periods. Three large natural regions can be distinguished (see Figure 1-1):

1. In the north the Sahara Zone, a desert area with a precipitation hardly attaining 20 mm per year, which covers approximately half of the territory of Niger;
2. In the centre the Sahel Zone with an annual rainfall of 350 to 500 mm, that constitutes the principal zone of animal husbandry;
3. In the south, the Sudanese Zone with an annual precipitation of 500 to 850 mm, taking up about 10% of Niger's total surface and including the principal agricultural areas in the country.

Due to its geographical situation in the Sahel Zone, the Republic of Niger suffers from severe drought since 1970. The lands classified as arable (12% of the total surface) and those presently cultivated (2.5%) are continuously decreasing and their fertility declining due to water shortage, wind erosion, disappearance of vegetation, and demographic growth.

The only important water resource of the Republic of Niger is the River Niger, ranked third in Africa by its length of 4,200 km, which flows through Guinea, Mali, Niger, Benin and Nigeria (see Figure 1-2). The river first takes a north-east direction towards the fringes of the Sahara, on the way it traverses an inner delta where it looses an important part of its discharge by evaporation, then it turns back forming a large bend and flowing south-east to the Gulf of Guinea.

The surface of its catchment area is shared by nine countries (Guinea, Ivory Coast, Mali, Niger, Burkina Faso, Benin, Cameroon, Chad, and Nigeria) and can be divided into four main sections with different physical and geographical characteristics:

1. *The Upper Niger* from its source in Guinea to Ségou, 200 km downstream of Bamako. The upper basin covers a surface of approximately 240,000 km^2.
2. *The Lake Basin or Inner Delta* from Ségou to Tossaye at the Niger bend, with an area of some 80,000 km^2.
3. *The Middle Niger* between Tossaye and Malanville. Its basin covers a surface of around 900,000 km^2 including "theoretical" catchment areas at the left bank, which are practically without discharge.
4. *The Lower Niger* from Malanville to the mouth in the Gulf of Guinea with a catchment area of 720,000 km^2, including Benue River.

Along 550 km the River Niger traverses the south-western part of the Republic of Niger from the Mali border until the frontier with Nigeria. In the downstream part the river forms Niger's border with Benin.

Parallel to the catastrophic deterioration of soils, the surface water resource of the River Niger is strongly affected by the drought that has been striking the Sahel Zone since 1970 (see Figure 1-3):

- Since 1970, the average annual discharge of the Niger River has dropped by more than 30% compared to previous times. The mean flow of the Niger at Niamey, measured over a long period, now amounts to 696 m³/s (period after 1970), whereas it attained formerly 1035 m³/s (period before 1970).
- The changes in the flow regime during the low flow season are still more severe. Formerly the low flow just occurred during the months of May and June, but since 1970 it is observed that the low flow season extends over a period of nearly four months, from April until July.
- At the same time the minimum flow during the low flow season has strongly decreased. The discharges during the driest month in an average year formerly amounted to 70 m³/s, but since 1970 do not reach more than 20 m³/s. In exceptionally dry years, hardly any more flow can be measured. In May 1985, for the first time in living memory, the River Niger at Niamey stopped to run.

This drastic change in the flow regime, the future development of which is unpredictable, implies more and more detriments to the fluvial ecosystems, the perenniality of the irrigation, the public health and the water supply for human consumption, livestock and industry.

As the Republic of Niger does not dispose of alternative water resources of sufficient capacity apart from River Niger, the only possibility to remedy this situation consists in constructing a dam to create sufficient storage capacity to ensure a systematic augmentation of the river's low flow regime, thus stopping further degradation.

1.2 PROJECT HISTORY

The "Ministry of Public Works" (Ministère des Travaux Publics), and later the "High Commission of Kandadji Dam" (Haut Commissariat au Barrage de Kandadji - HC/BK) initiated several studies since 1976. These studies have convincingly shown that Kandadji is the most favourable site for the construction of a dam along the Niger River reach within the Republic of Niger. The reasons therefore are:

- At the site of Kandadji, the hill of Ourouba with a height of more than 100 m is located at the right bank near to the riverbed and causes an exceptional narrowing of the Niger Valley. The dam can be connected with the hill so that the structure will have the shortest possible length, thus minimising quantities and cost.
- A few kilometres upstream from this site the tributary Gorouol joins the Niger. It widens the valley considerably and provides the potential for a reservoir of large capacity.
- Moreover, this site has the advantage of being located far upstream within the country, thus being able to supply all irrigable lands along the valley. This permits to achieve the highest possible benefit from the low flow augmentation.

The previous studies comprised in particular:

- An "*Etude de Factibilité du Barrage de Kandadji*", carried out between 1976 and 1980 by Sofrelec: This study investigated an ambitious multi-purpose project with the objective to satisfy the long-term energy demands of Niger, to secure the water demands for human consumption, livestock, irrigation and industry, and to improve the navigation on the river. The study recommended a dam with a reservoir capacity of some 14 billion m³, a maximum reservoir water level of 239 m and a crest elevation of 242 m. The reservoir surface would have extended far on the territory of neighbouring Mali.
- Between 1981 and 1982 Sofrelec, Electricité de France and Sir Alexander Gibb & Partners prepared some complementary studies, aiming at optimising the Kandadji Dam and investigating the part it could play in the development programme of the Middle Niger Basin. In 1982 Sir Alexander Gibb & Partners and Electricité de France were the authors of the study "*Extension des Etudes complémentaires*" that examined the site of "W"at Gambou in more detail. These complementary studies presented as best and least-cost alternative a modified Kandadji Dam with a crest elevation of 228 m, that could be raised in a later, second stage to an elevation of 241 m.In a master plan study of the Niger River stretch Timbuktu-Gaya in the Liptako-Gourma region, carried out by Electrowatt in 1983, the dam site of Kandadji was taken into consideration together with the sites of Tossaye in Mali and Gambou in Niger.
- In 1985 and 1986, Lavalin International recommended in its "*Etude du Développement à long Terme du Sous-secteur de l'Electricité au Niger*" from an energetic point of view to abandon the Kandadji Dam in favour of Gambou, a recommendation that was followed by the government at the time.

In spite of all these studies no structure for flow regulation was built up to now on the Niger, and the fluvial ecosystem continued to degradate due to decreasing discharges, severe drought in the Niger Basin, and hydraulic and eolian erosion. The consequences of this situation are now as follows:

- The supply with irrigation water becomes more and more difficult and cost-intensive.
- The water supply of Niamey is ensured by the construction of a sill structure at Goudel, however, siltation menaces its functioning.
- From the point of view of public health, wastewater flowing into the river combined with low flow and standing waters have led to an increase of diseases connected with water pollution.
- The fish resources of the river decrease and the markets traditionally supplied by Niger more and more change to importation from Burkina Faso and Mali.
- River navigation traffic becomes less and is interrupted due to low water levels during the dry season.
- The surface of "Bourgou" cultivation is decreasing due to water shortage and siltation, entailing difficulties in fodder availability for livestock and endangering the survival of hippopotamus.
- The low water levels facilitate the spreading of water hyacinths, which also invade the rice fields.

1.3 OBJECTIVES OF THE PRESENT STUDY

The severity of the present situation has moved the authorities of Niger to revive former plans for the construction of a dam at Kandadji. However, the project should be less ambitious than in the past and have the primary purpose to regulate the flow of Niger River. This has led to a re-definition of the priorities assigned to the project, namely:

- Assuring low flow augmentation to attenuate the degradation of the environment and other problems resulting from water shortage and low water levels,
- Securing the perenniality of irrigation,
- Satisfying the water demands for human consumption, livestock and industry along the valley,
- Generating hydroelectric energy as a sub-purpose to valorise the investment, if economically justified.

It was left to a new study to translate these modified objectives into a new project concept, more modest in its dimensions, and to analyse its technical, environmental, socio-economic and financial feasibility.

1.4 STRUCTURE OF THE STUDY

The Government of the Republic of Niger, represented by the Haut Commissariat au Barrage de Kandadji (HC/BK), awarded this new Feasibility Study for Kandadji Dam to a Joint Venture consisting of the Consultants Lahmeyer International GmbH (Germany) and Dar Al-Handasah (Egypt). Financing was secured by the African Development Fund (Fonds Africain de Développement - FAD). The Contract No. 001/99/CAB/PM/HCBK was signed by the two parties on 12 March 1999 and the commencement date of services was fixed for 01 May 1999.

The study programme was divided into two Phases as follows:

- Phase I: Social, Economic and Environmental Diagnosis and Definition of the Reservoir Characteristics (Diagnostic social, économique et environnemental et Détermination des Caractéristiques de la Retenue),
- Phase II: Feasibility Study (Etude de Faisabilité).

The study results are documented in 8 individual reports for Phase I and 5 reports for Phase II:

- **Phase I**: Vol. 1 - Updating of Climatological, Hydrological and Sedimentological Studies (Actualisation des Etudes climatologiques, hydrologiques et sédimentologiques)
  - Vol. 2 - Review of Geological, Geotechnical and Geomorphological Studies (Revue des Etudes géologiques, géotechniques et géomorphologiques)
  - Vol. 3 - Diagnosis of Irrigable Lands (Diagnostic des Terres irrigables)
  - Vol. 4 - Social and Environmental Diagnosis (Diagnostic environnementaletsocial)
  - Vol. 5 - Diagnosis of Water and Electricity Demand (Diagnostic des Besoins en Eau et en Electricité)

Vol. 6 - Modelling and Optimisation of Reservoir Operation
(Modélisation et Optimisation de la Gestion de la Retenue)
Vol. 7 - Diagnosis of Socio-economic Data
(Diagnostic des Données socio-économiques)
Vol. 8 - Definition of Unit Prices
(Détermination des Prix unitaires).

- **Phase II**: Vol. 1 - Dam Concept (Conception du Barrage)
Vol. 2 - Concept of Hydropower Plant
(Conception de la Centrale Hydroélectrique)
Vol. 3 - Study on Hydro-agricultural Developments
(Etude des Aménagements Hydro-agricoles)
Vol. 4 - Environmental Impact Study (Etude d'Impact sur l'Environnement)
Vol. 5 - Cost/Benefit Analysis and Project Justification
(Analyse Coûts/Avantages et Justification du Projet)
Annex : Set of Drawings (Cahier des Plans).

The present "Summary Report" was prepared in French and English and provides a synopsis of all important findings and conclusions. For more detailed information, reference should be made to the individual reports.

1.5 OVERVIEW OF SIMILAR PROJECTS EXISTING IN THE SUB-REGION

Climatically large parts of the Sahel and central parts of Africa are characterised by a long annual dry season and a rainy season concentrated on several months. The more moving to the north towards the fringes of the Sahara, the lower becomes the rainfall and the shorter the rainy season. Life in this region thus depends to a large extent on the management of the existing water resources, among which the surface water is of vital importance for all agricultural and pastoral development. Since more than fifty years, the construction of dams has become a widely applied solution to ease the severe problems resulting from water shortage.

In the West-African sub-region a large number of dams are in operation since many years. A lot of them are located in the catchment area of the River Niger. These dams have successfully contributed to development and their benefits were considerable. Mostly they are multipurpose projects (low flow augmentation, drinking water supply, irrigation, hydropower), similar to Kandadji Dam, which will be the first project of this kind in the Republic of Niger.

The following list gives an overview of the existing large dams in the region, however making no claim to be exhaustive:

- **Mali**: - **Markala Dam**: The Markala Dam is located on the River Niger, some 40 km downstream of the city of Ségou. The dam has been commissioned in 1947. Like Kandadji, the principal structure is an earth dam with a length of 1.8 km and a height of 8 m. A concrete weir with a length of 818 m accommodates 14 bays; each equipped with 35 flaps. Since more than 50

years, the project fulfils its purpose remarkably, i.e. it assures by gravitational force the irrigation of 60,000 ha on the right bank of the river. A rehabilitation program for the civil structures and the mechanical equipment was carried out between 1995 and 1998.

- **Sélingué Dam**: The multipurpose project of Sélingué is on the River Sankarani, 60 km upstream of its confluence with the Niger. Commissioned in 1984, the dam serves for the irrigation of agricultural perimeters, energy generation, flood protection, increase of fishery potential, and the improvement of navigation on the Niger by flow regularisation. The project consists of a central concrete gravity dam with spillway (capacity: 3,500 m^3/s) and hydropower plant (installed capacity: 48 MW), and two lateral earthfill dams of 16 m height and 2.3 km length. The storage covers a surface of 430 km^2 and its active capacity amounts to 1.93 billion m^3.

- **Manantali Dam**: The project of Manantali on the River Bafing is an integral part of the "River Senegal Project" (Projet du Fleuve Sénégal), planned for irrigation and energy production. Although the dam itself is completed since long, the construction of the hydropower plant underwent long delays. Once the plant will be completed, the scheme will dispose of a capacity of 200 MW and supply electricity to Mali (52%), Senegal (33%) and Mauritania (15%).

- **Burkina Faso**:
  - **Bagré Dam**: The dam of Bagré on the River Nakanbé, in the catchment area of the Volta, is a multipurpose project comprising a zoned earthfill dam with a height of 30 m and a storage capacity of 1.7 billion m^3. The project serves for irrigation, energy production (16 MW), and the improvement of pisciculture. Bagré Dam was commissioned in the year 1992.

  - **Ziga Dam**: Ziga Dam, also located on the River Nakanbé, secures the water supply for the city of Ouagadougou. The project is in operation since 1998 and consists of a homogeneous earth dam with a length of 3.5 km and a height of 14 m. Its reservoir capacity amounts to 207 million m^3.

- **Nigeria**:
  - **Kainji Dam**: The Kainji Dam on the River Niger, 102 km to the north of Jebba, is also a multipurpose project. It produces hydroelectric energy and serves for irrigation, flood protection, and for the improvement of the navigation on the Niger.

    Commissioned in 1968, the Kainji Project consists of three parts:

    (1) a 550 m long concrete gravity dam, which incorporates the spillway and the hydropower plant,
    (2) a 7,8 km long rockfill dam at the right bank,
    (3) an additional saddle dam to close the reservoir.

    The gravity dam section has a maximum height of 64 m. The reservoir extends over a length of 136 km and disposes of a total capacity of 15

billion m³. The project caused the resettlement of 44,000 people.

The spillway is equipped with 4 radial gates (15,3 m x 15,3 m) having a total spilling capacity of 7,900 m³/s.

Two shiplocks with an intermediate pond secure the maintenance of navigation.

Eight units with a total installed capacity of 760 MW (4 x 80 MW, 2 x 100 MW, 2 x 120 MW) generate hydroelectric energy. In combination with other projects, Nigeria produces 43% of its energy by hydropower. An average annual energy of 6,990 GWh was generated between 1988 and 1998 for the domestic supply as well as for export to Benin and Niger.

Apart from the projects described above, it must be noted that in all these countries a lot of other small multipurpose dam projects are in operation, which have considerably contributed to the national economic development and have become indispensable.

Many additional projects are at present in different stages of planning.

2 THE SECTORS AND SUB-SECTORS AFFECTED

The "Haut Commissariat au Barrage de Kandadji", assigned to the Prime Minister, will be charged with the implementation of the project which - redefined in function of its new priorities - is a multipurpose structure and thus concerns different important sectors of the Republic of Niger.

This chapter gives an overview of the following most relevant sectors and sub-sectors affected by the project:

- Water Resources,
- Environment,
- Agriculture,
- Livestock,
- Fishing,
- Public Health,
- Energy.

The preservation of water resources and environment is assigned to the *Ministère de l'Hydraulique et de l'Environnement* and the *Ministère de l'Environnement et de la Lutte Contre la Désertification*. The irrigation of agricultural land along the valley of River Niger is under the responsibility of the *Direction du Génie Rural* and the *Office des Aménagements Hydro-Agricoles* which is part of the *Ministère de l'Agriculture*. The project also concerns the *Ministère de la Santé* with regard to epidemic water-related diseases. Due to the project's generation of hydroelectricity as a sub-purpose, the energy sector is also affected, of which the *Société Nigérienne d'Electricité (NIGELEC)* takes charge of. The *NIGELEC* is assigned to the *Ministère des Mines et de l'Energie*.

2.1 WATER RESOURCES

The River Niger and its right bank tributaries represent the country's only major surface water resource. The river's mean annual flow at Niamey amounts to approximately 22 billion m³. As already mentioned in the Introduction (Chapter 1), the problem does not lie in the quantity, but in the irregular flow regime and the low flow season during the months of May and June, when the discharge drops to a few m³/s only. Due to climatic changes this phenomenon has intensified over the last three decades and constitutes now a serious danger jeopardising human, wildlife and environmental conditions.

Apart from Niger River, surface water is only available in small quantities in some southern parts of Niger, e.g. in the regions of Ader-Doutchi Maggia, Maradi and in the Komadougou Valley.

In Niger, artificial reservoirs represent a very important water resource. Nevertheless, there are only around 20 of them, all with limited volumes, providing a total storage capacity of around 100 million m³. Some twenty new reservoirs are presently in the planning stage.

Renewable underground water resources are less important compared to surface water. They come up to 2.5 billion m³, less than 20% among them are exploited by villagers, herdsmen, city dwellers or are used for small irrigation. To this potential have to be added the non-renewable underground water resources in the desert areas in the north of the country, estimated at around 2,000 billion m³, from which just a tiny part is exploited by the mines.

2.2 ENVIRONMENT

Scientific knowledge as well as the various environmental diagnostics carried out in Niger agree in the existence of a relationship between climatic change, desertification and the sustainability of the existing production systems. In this context, the present consensus of opinion is that there is an increasing tendency towards drought and desertification (which is continuously gaining ground) and that the west of Niger should experience more frequent drought periods. Hence, it is expected that water becomes an increasingly rare resource in the Niger basin.

From the biological diversity point of view, the Niger presents a large floral, faunal and fish wealth, in addition to numerous terrestrial as well as semi-aquatic ecosystems. However, this wealth in biodiversity is subject to a progressive degradation, in spite of the conservation efforts deployed by the authorities through political and strategic measures. The particular case of the forest resources is alarming with around 100,000 ha of forest area lost annually under the combined effects of uncontrolled timber cutting, bush fires, overgrazing, expansion of cultivated areas and recurrent droughts.

In fact, a severe reduction is expected in the future in the surface area and productivity of the natural ecosystems that support the majority of these species in all their diversities and that provide a wide range of goods and services to the community.

In the specific case of the Niger River Valley, this latter fosters large areas of humid zones on either side of the river offering enormous potentials for natural reproduction and multitudes of habitats and biotopes following their marling. Currently we are observing their continuous degradation mainly due to severe drought periods, which are occurring earlier and for longer durations putting their sustainability in danger.

Therefore, the biggest challenges to overcome remain:

- The preservation of the environment, which is subject to drought and desertification.
- The establishment of a sustainable management system of the natural resources.

As to the legislative and institutional framework, the judicial setting of the environment management in Niger is characterised by a well-integrated plan with principally:

- The enactment on 29 December 1998 of Law 98-56 about the environmental management regulations, the text of which is being elaborated.
- The creation of a "National Council for the Environment for a Sustainable Development" (NCSD).
- The elaboration of a "National Plan of the Environment for Sustainable Development" (NPESD).
- The elaboration of a programme to fight against poverty.
- The implementation of the "Programme for Economic Recovery" (PRE).
- The creation of a ministry responsible for the preservation of the environment and the fight against desertification, including the BEEEI.
- The Prime Minister's political declaration.

A part from the conventions and agreements dealing exclusively with environment, Niger participated as well in conventions that led to the creation of the "Authority for the Niger Basin" (ABN), the "Authority of Liptako Gourma" (ALG) and the "Mixed Commission for Nigero-Nigerian Co-operation". Certain provisions in these conventions concern the Kandadji dam as well as the control and preservation of the environment through the establishment of standards and measures applicable to the member countries for water use in the basin, preservation and reduction of water pollution and the preservation of public health and genetic resources (fauna and flora).

2.3 AGRICULTURE

Climate remains the most important factor influencing agricultural production in Niger. It was noticed that the growth of the agricultural sector has been restrained by various factors (including water) resulting particularly from the combined effects of the extensive production systems in an unfavourable physical environment, a high demographic growth rate and economic factors of which the terms of trade are most outstanding. Hence, the development tendencies in the rural sector have mostly been negative.

The economic damages caused by drought periods can be important as experienced during the 1968 – 1973 period, which caused the loss of 600,000 tons of cereals in the Sahelian countries, which corresponds to around 15 % of the average annual revenue.

Moreover, it is inevitable that the construction of new irrigation developments in a situation of limited natural resources coupled with the growth of the rural population and the herds' size generates conflicts between the different land and water users, especially between livestock raisers and farmers.

It is also evident that in the long-term the sector will not be able to escape the harmful consequences of climatic changes. Hence:

- Intensifying the exploitation of the large potential of irrigable lands in the Niger Valley (122,000 ha) will be compromised by the drastic reduction of the river flow, especially during dry season, which corresponds to the period of high crop water requirements.
- Intensifying the production will lead to the increase in use of fertilisers and pesticides, with potentially negative effects on the environment.
- The decrease of the river water level will lead as well to an increase in cost of water resources mobilisation and pumping and measures needed to fight soil degradation, which will render some developments non-viable from financial perspectives.
- The food insecurity will become an ever-increasing problem even in areas relatively rich in resources. Land degradation and desertification will be linked to poverty, migration and food insecurity, generating different conflicts.

In conclusion, it is expected that all other constraints that restrain the development of the agriculture sector can be mitigated by implementing various strategies and national policies by the Government of Niger. However, without a parallel water resources management and control politic, especially with regards to climatic hazards and increasing tendencies of droughts, the agriculture sector

development and the sustainable improvement of the populations' food security will be doomed to fail.

2.4 LIVESTOCK

Niger is a country with an vocation for pastoral production. However, fodder availability is the main constraint. Indeed, the nutritive needs for the upkeep of the livestock are not available all year round. This is mainly observed in the agricultural areas, particularly along the riverbanks. The grazing areas are decreasing and degrading. There is an increasing reduction in grazing areas due to either overgrazing or water deficit.

In the past, the long-term exponential growth of the number of herds had always been impeded by catastrophic events (droughts or epizootic diseases such as the plague). If for the years to come the sanitary situation could be controlled, the sub-region countries still live under the fear of the recurrence of droughts, and its particular consequences related to the complete loss or decrease in the number of livestock.

Nowadays as well, a strong increase in the numbers of heads is improbable considering the important decrease in the potential land for grazing. On the other hand, livestock raising could be subject to an important increase with the increasing raise in demand. It is believed that the number of heads will be subject to a decrease following extensive exploitation, important migration or drought. The traditional and extensive method of livestock breeding with poor livestock productivity will always remain to dominate.

Hence and in view of the importance of livestock breeding and its socio-economic functions at the regional and national levels, namely that

- Livestock breeding occupies the 4th rank in the components of the GDP and the 2nd rank after uranium in export products,
- Livestock breeding concerns a large portion of the rural population (more than 80% of the families are livestock owners),
- Livestock is a main constituent of capital and savings. The livestock capital of the study zone was estimated at around 83 billion FCFA in 1998,
- For the producers, breading has an importance that exceeds its economic value,

it is necessary that a balance between numbers, nutrition availability, social peace and environment preservation be sought and that a breeding system less dependent on climatic hazards be envisaged, which is almost impossible to realise with the present trends.

2.5 FISHING

The adversity of the Sahelian climate recorded during the last 30 years and the consecutive degradation of the aquatic ecosystems have considerably affected the biological diversity and the fisheries' productivity. To these natural causes are added the environmental effects of the sector programmes for hydro-agricultural developments on the flood plains that constitute the main grounds for fish production and spawning.

Hence, the fish production, which was estimated in 1969 at around 7,177 tons has recorded a fall of approximately 6,277 tons, i.e. 88% in 17 years. Although this drop was attributed to an overexploitation of the fish stock, it is also recognised that fish production in a river is directly related to the variability of the flow, which determines the flooded area of the alluvial plain.

The pisciculture potential of the Niger River Valley is of two sorts: the fishery sites in ponds and the fishery sites in floating cages. Pumping, used for the water supply, constitutes a major constraint for the development of the pisciculture in ponds due the large variability in flow of the Niger River.

In conclusion, the fishing sector has experienced a severe degradation during the last 30 years of drought. Emergency measures, such as a regulation of the river flow, are necessary to safeguard the abundance and sustainability of the fishing resources in the Niger River.

2.6 PUBLIC HEALTH

The Niger River is presently used to discharge a large portion of the liquid wastes of the communities along the riverbanks, particularly the city of Niamey. To the ecological consequences linked to the water pollution, especially in dry season, is added the risk of a severe deterioration in public health and life expectancy. The contamination of the river and consequently the water tables and food products (especially during cultivation, harvesting, treatment, stocking, transport and final preparation) by the different faecal germs will increase the risk of exposure to infectious diseases (cholera, dysentery, diarrhoea, leprosy, scabies, hepatitis, etc.)

To these risks linked to the deterioration in water quality are added the serious health problems with which Niger is confronted: weak public health cover, insufficient health infrastructure, weak human health resources, etc.

The deterioration of the environmental quality, in particular, will become an increasingly important factor negatively influencing the public health conditions of the concerned population, reducing their quality of life and compromising a sustainable development.

2.7 ENERGY

Traditionally, wood and coal are the principal energy sources in more than 90% of the households. With an increase of energy consumption proportional to the demographic growth rate of 3,2% per year, a strong degradation of vegetation in the surroundings of settlements can be observed. Electric energy does not make up more than 2% of the energy balance of the Republic of Niger.

The supply with electric energy is mainly secured by the "*Société Nigérienne d'Electricité (NIGELEC)*", a mixed company with 95% of its shares hold by the government. Founded in 1968 with its headquarter in Niamey, NIGELEC is responsible for all activities concerning production, purchase, transport and distribution of electric energy on the territory of the Republic of Niger. The transfer of the present responsibilities of NIGELEC to a private company is being considered.

Since 1976 NIGELEC has reduced its own production and is concentrating on energy purchase, transport and distribution. Presently more than 80% of the electric energy distributed by NIGELEC is imported from Nigeria (2 lines of 132 kV from Birnin Kebbi to the zone "Fleuve", 2 lines of 123

kV from Katsina to the zone "Centre Est") (see Figure 2-1). Tariffs are revised each 3 years and are negotiated on a US$ basis. The electricity system of the Republic of Niger is thus characterised by a strong dependency on imports from abroad.

Since 1975 the company "Société Nigérienne de Charbon (SONICHAR)" is working as a new utility on the electricity sub-sector to supply the mining companies and the cities of Agadez, Arlit and Tchirozérine. SONICHAR has constructed a thermal power plant with a net capacity of 2 x 16 MW which is fired by coal from a mine at Anou Araren, which is exploited by SONICHAR.

Sixty communities in Niger are presently electrified. Twenty-three of them are connected to the distribution system in the zone "Fleuve", eleven to the system in the zone "Centre Est", and twenty-six dispose of independent thermal plants. The systems connected to the transmission lines or fed by diesel plants do not supply more than 6% of the national population. Less than 40% of the inhabitants of the capital Niamey, presently numbering 627,000, are connected to the grid. The total electricity consumption in Niger amounts to about 250 GWh/year, i.e. 25 kWh/year per capita.

To initiate a process of economic development on a long-term basis, Niger has defined the following strategic goals within its "Programme for Economic Recovery" (Programme de Relance Economique – PRE):

- Boosting the country's electrification by increasing the connecting rate and securing access to electricity for all inhabitants in order to promote socio-economic development, especially in the industrial and commercial sector,
- Reduction of dependence on energy imports by promoting national resources,
- Incentives for the efficient use of energy,
- Establishment of an appropriate energy planning system.