Lake Chad

Experience and Lessons Learned Brief

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1. Introduction

The Lake Chad drainage basin (Figure 1) is located between latitude 6° and 24° N and longitude 7° and 24° E. The drainage basin covers an area of 2,434,000 km^2, an estimated 8% of the total African land surface area (UNEP 2004). Figure 1 also depicts the "conventional basin", which is the geographic limit of the Lake Chad Basin Commission, which was created under the Fort Lamy Convention in 1964.

Lake Chad is situated on the edge of the Sahara Desert, and provides a vital source of water to human, livestock and wildlife communities. Over the past few decades, the region has experienced a series of devastating droughts. The lake is one of Africa's largest freshwater lakes, but has shrunk dramatically over the last 40 years. In the absence of longer-term data (i.e., 80-100 years), however, the present shrinkage can only be regarded as a temporary, rather than permanent change. Within the last century the lake has been as large as 25,000 km^2 and as small as one-twentieth of that size. It is an extremely shallow lake, rarely more than 7 m deep. The lake supports a growing human population, as well as millions of birds and a number of mammals, reptiles, and amphibians, despite the fact that its potential evaporation rate is four times as large as the rainfall rate in the region.

The Lake Chad Basin has extensive floodplains. The World Conservation Union (IUCN) in 1987 reported that the lake's drainage basin holds one of the largest areas of wetlands in the Sahelian region, with more than 10 million ha in Chad alone. The most significant basin floodplains, in terms of size and ecological values, are those on the Chari, Logone and Yobe Rivers. The well-known floodplain sites include the Sategui-Deressia in Chad, the Yaeres in Cameroon and Chad and the Hadejia-Nguru in Nigeria. The fringes of Lake Chad can also be regarded as floodplains, in view of the alternating recession and flooding that occur on the fringes every year.

Back-to-back droughts in the 1970s and 1980s have left the lake basin, as well as the approaches to its management, completely, if not permanently, changed. The negative changes include the shrinkage of Lake Chad and decreased flows in its major rivers; falling groundwater tables; disappearance of specific plant species and reduction of canopy cover; loss of wildlife populations; increased soil erosion and/or loss of fertility; reduction in rain-fed and irrigated crops; and alteration of economic development parameters such as job opportunities, community organization of labor, terms of trade, and rules governing access to natural resources (LCBC 1990).

The combined effects of climate fluctuations and unsustainable water projects led to significant reductions in the flows of the rivers that drain into Lake Chad. In turn, this situation has resulted in the shrinkage of the lake. Projects such as the South Chad Irrigation Project (SCIP) in Nigeria and the MAMDI Polder Project in Chad, which depended on water abstracted from the lake, became stranded by the receding lake shoreline and had to be abandoned. Consequently, conflicts arose among various water users competing for the increasingly scarce water resources.

Due to climatic fluctuation over time, the annual floods that used to inundate large areas that previously served as breeding grounds for fish and other wildlife (e.g., birds) were replaced by severe droughts. These droughts also reduced groundwater recharge, and adversely affected traditional farming. Similarly, poorly-designed dams and unsustainable reservoir operation have resulted in inefficient water use. The disappearance of the large annual floods also caused degradation of the river channels. This is most pronounced where changes in topography are dramatic (e.g., in the Yobe basin), with enhancing siltation and the growth of invasive weeds, such as *Typha*.

Thus, it is not difficult to appreciate the problems regarding the disappearance of many valuable plant and fish species, the loss of wildlife species, and the reduction of canopy cover. Village communities in these formerly-extensive wetlands frequently lament such permanent losses of biodiversity, previously thriving fish festivals and work opportunities.

Loss of canopy cover, a product of both natural and anthropogenic causes, has exposed the land to erosion by water and wind over past decades, producing virtually sterile soils in many areas of the Lake Chad drainage basin. Poor irrigation practices and misuse of chemical fertilizers have further aggravated the loss of soil fertility in the basin.

The intensity of competition between different land and water users (upstream and downstream; crop farmers and nomadic

herdsmen; urban water and irrigation water; etc.) has been exacerbated by the failure of traditional rules governing peaceful relationships. In the absence of new guiding rules and regulations that are equitable and properly enforced, the breakdown of law and order is inevitable.

There is a need to establish a water allocation process in order to formalize existing water use rights and manage water demands within the drainage basin. This calls for the implementation of several policy options, including river channel improvement works, water augmentation and promotion of conservation techniques. Sustainable agricultural practices and sustainable management of natural resources need to be encouraged within the drainage basin.

The ongoing GEF project on the "Reversal of Land and Water Degradation Trends in the Lake Chad Basin" can contribute to this and needs to reinforce the efforts of NGOs in replicating good practices within the drainage basin of the lake.

2. Background

Before the entry of colonial powers, organized states like the Kanem-Borno, and the kingdoms of Bilala, Wadai and Fezzan, tried with varying degrees of success to impose their political domination on the vast depression known as Lake Chad. However, since the introduction of Islam into the Lake Chad area in the 9th century A.D., and the emergence of the Kanem-Borno Empire, Lake Chad has been a unifying factor

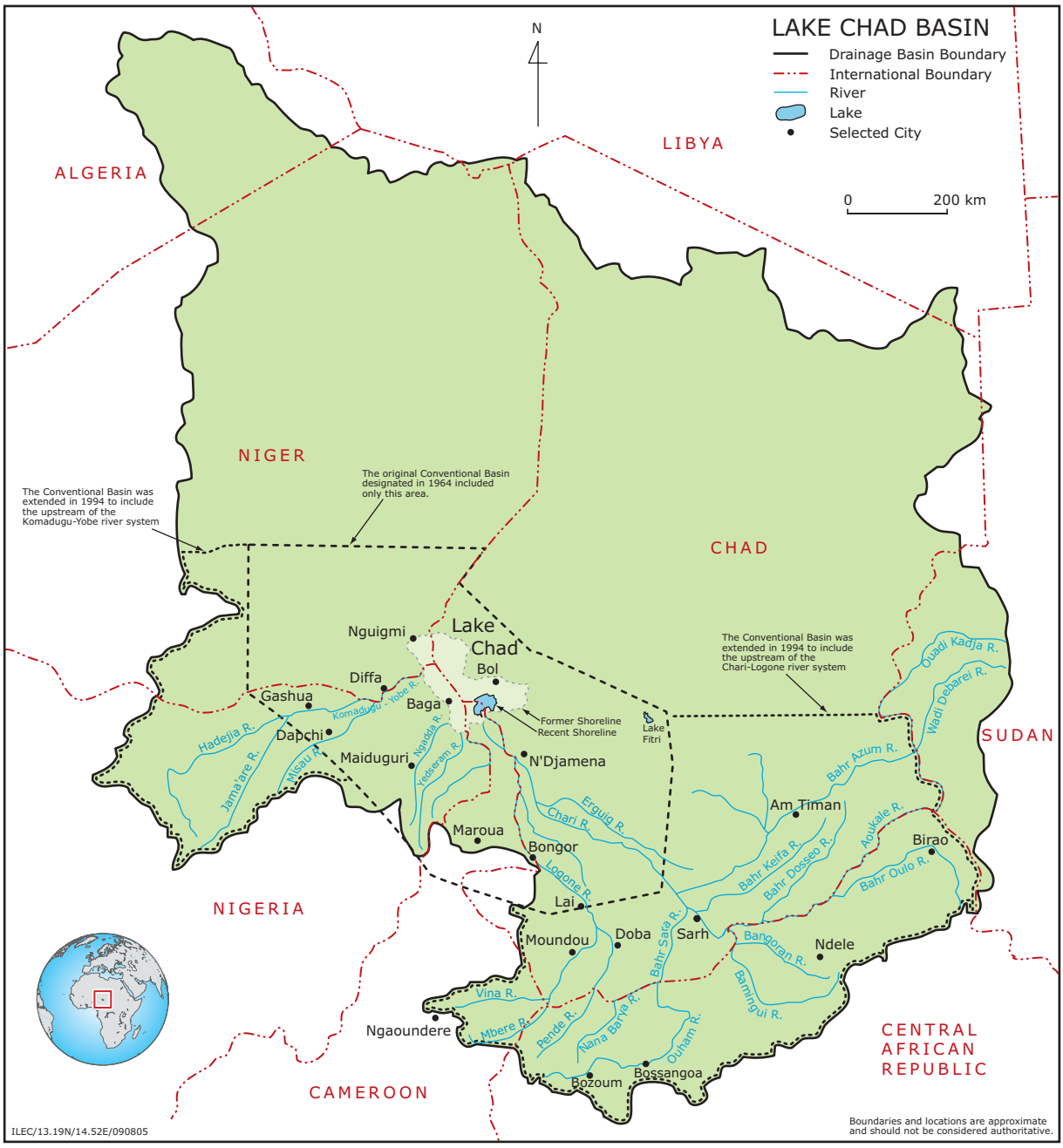

Figure 1. The Lake Chad Drainage and "Conventional" Basins.

for the people living around it. The Kanem-Borno Empire was famous for its culture and learning, and for its commercial and diplomatic links with North Africa and the Middle East, as testified by European explorers.

The scramble by European powers to colonize Africa at the end of the 19th century adversely affected Lake Chad and its drainage basin. Political boundaries were re-drawn, and the traditional links amongst the people of Kanem, Baguirmi and other kingdoms around Lake Chad disintegrated, with the areas kept in isolation for many years during the colonial period.

However, when the four riparian countries (Cameroon, Chad, Niger, Nigeria) gained independence in 1960, there was a great surge for cooperation and the then-political leaders turned their attention to the development of the Lake Chad area. It was realized that the area formed one ecological unit, and that development activities in one country would affect the other countries. The initiative was taken by Chad in 1962, and a convention and statute (The Fort Lamy Convention) were formally drawn and signed by the four countries on 22 May 1964, establishing the Lake Chad Basin Commission to coordinate the development and promote cooperation in Lake Chad and its drainage basin (Jauro 1994). The Commission was joined by the Central African Republic in 1994, increasing the member countries to five. Sudan also has since been admitted (in 2000), needing only to ratify the Commission's instrument to become a full member.

2.1 Landscape and Natural Habitat

Lake Chad's water area is currently 1,350 km^2, over 90% smaller than its level around the middle of the 20th century. The lake depth varies from 4-8 m in the northern pool, to 2-4 m in the southern pool, with an average of about 1.5 m. The lake is situated on a plateau at an altitude of about 283 m above mean sea level (UNDP/FAO 1972; UNDP/DEWA 2003).

The annual rainfall averages 320 mm, ranging from nearly 1,600 mm in the southwest part of the drainage basin to less than 150 mm in the north. The rainfall is monsoonal, generally being heaviest in August. The 28-year mean rainfall at Bol Dune is 384 mm, of which 342 mm (89%) falls during July-September. The annual temperature averages 21.4°C. The climate of the drainage Lake Chad Basin can be divided into six zones: Guinea zone, Sudano-Guinea zone, Sudano-Sahelian zone, Sahelo-Sudanian zone, Sudano-Saharan zone, and Saharan zone (UNDP/FAO 1972; LCBC 1990).

Because the region is so hot and dry, leading to high rates of evaporation (reaching 2,300 mm per year), the water in the lake would likely be saltwater if not for several factors. One is that the heavier salts flow out through underground passages, preventing salt buildup in the lake. These large aquifers provide the principal water source to dug wells and boreholes for domestic, village and urban use. Another reason for Lake Chad's low salinity is that the lake receives large freshwater inputs from the nearby Adamawa Plateau.

The ecoregion includes the Hadejia-Nguru wetlands to its west. Swamps occupy the margins of the lake, and dense floating vegetation covers the shallow waters of Lake Chad. This lake expands dramatically with seasonal floods and provides a vital refuge for migrant birds and other animals.

The landscape within the conventional basin is very diverse. There are three types of lakes: Piedmont lakes in Cameroon and Chad; interdunal lakes in Chad and Nigeria; and hydrographic lakes, such as Lake Chad. About fifteen landforms have been identified, including active and relict deltas; sand barriers of present and past lake shorelines; ergs, sand dune islands, and other Aeolian landscapes; flatlands derived from Quaternary lagoons; pediments from eroded massifs; fossil valleys and wadis; and incised stream and river beds. Projects designed to protect soils and water supplies, as well as the long-term productivity of the land surface, generally must carefully tailor their technical and social interventions to the specific landscape.

2.2 Political and Socio-economic Features

The conventional basin exhibits a socio-historical unity based on the history shared by the population groups, some of which straddle national boundaries. The main language used in the region (Kanuri) reflects the political linkages during the pre-colonial period. The old states, such as Kanem, Bornu, the Peul Empire of Sokoto, Wadai and Brguirmi, which later converted to Islam, contributed to the present distribution of the population in the Conventional Basin (LCBC 1990).

The status of conservation and development in the basin region is more dependent on the practices and policies in the Member States than on the shared human and natural resources. The primary language of Niger and Chad is French, while that of Nigeria is English. Cameroon is officially bilingual. All countries have opted for a state-led development and natural resources control policy.

The 1991 population census shows that the drainage basin of Lake Chad contained about 22 million people, with an average density of 22 persons/km^2, but ranging from 1.5 to 37 persons/km^2 in the riparian countries. The population of the drainage basin has grown rapidly, currently being estimated at 37 million (UNEP 2004). The average population growth within the basin is quite high, being 2.4-2.6%. The major cities in the lake's drainage basin include N'Djamena, Kano, Maiduguri, and Maroua.

The major contribution of the lake to the well-being of the rural population in the remote area of the lake is the fishing activities on the open lake and in surrounding fishing areas and ponds. The annual fish catch in Lake Chad was 130,000-141,000 tons up to the early 1970s. The present level of production is close to that of 1977, being about 60,000-85,000 tons/year. However, quantifying the fisheries in Lake Chad is difficult in view the fact that very little time series data exists (Jolley *et al*. 2000). There are many important fish species in the lake

and its numerous wetlands, including charachin (*Alestes baremoze*), *A. dentex*, and Nile perch (*Lates niloticus*).

Agriculture is the main economic activity of approximately 60% of the basin population, with the most common crops being cotton, groundnuts, sorghum, cassava, millet, rice and onions. Most of the farming in the drainage basin is rain-fed, harvested by hand and cultivated without the use of fertilizers and other agro-chemicals. Mixed cropping is widely practiced and rice is grown using both traditional and modern methods. Lake Chad provides the water and the agricultural springboard for the production of these and other commodities. Additionally, millions of other people, particularly in Niger, Chad and Cameroon, depend on the lake for most of their economic activities and livelihood. The resulting increasing pressure on the soil and the diminishing water sources, however, present serious sustainability problems for these activities.

At present, out of an irrigation potential of over 1.16 million hectares in the lake's drainage basin, less than 115,000 hectares are actually irrigated. Due to the lowering of the water level of Lake Chad, and of the reduced inflows of its main rivers in recent history, every new irrigation development must be studied very carefully. In 1980, for example, a UN study estimated the maximum potential development to be less than 400,000 ha. Thus, the total potential for the entire Lake Chad drainage basin of 1.16 million ha would require 16.53 km^3 of irrigation water, about 80% of the current total inflow to the lake. Lake Chad is also known for its yield of natural soda, removal of which contributes to keeping the lake water fresh. Extraction of the soda utilizes the labor of hundreds of children, particularly girls, who easily dig it out in areas severely affected by dry season floods, as in the Hadejia-Nguru Wetlands in Nigeria. Natural soda also is abundant in the Central African Republic.

Table 1. GNI Per Capita of Lake Chad Drainage Basin Countries in 1995 and 2003.

Country	GNI Per Capita (US$, Atlas Method)	
	1995	2003
Algeria	1,590	1,930
Cameroon	660	630
Central African Republic	340	260
Chad	210	240
Libya	...	3,036 to 9,385[a]
Niger	190	200
Nigeria	210	350
Sudan	290	460

Source: Table 14 in AFDB (2003) and http://www.worldbank.org
... Not available.
Note: a) GNI per capita for Libya estimated but not confirmed by the World Bank to be "upper middle income".

The Lake Chad drainage basin contains some of the poorest countries in the world. Table 1 shows the per capita Gross National Products (GNI) for the eight drainage basin countries. The riparian countries had an average per capita GNI of only US$355 in 2003. Libya and Algeria have significantly higher GNIs but, as shown in Figure 1, they cover only a small part of the basin. Furthermore, this northern part of the basin is hyper-arid and therefore is not usually hydrologically connected with the lake. Estimates of the annual household income from various sources or activities (in CFA francs) are as follows: fishing (26 billion), crops (15.5 billion), animal husbandry (8.6 billion), small irrigation schemes (6.3 billion), and large irrigated projects (5.5 billion). It is important to protect the lake habitat in order to preserve the values of ecosystem services to the drainage basin inhabitants.

Industrial production activities in the Lake Chad drainage basin are dominated by primary and tertiary sectors, in which technological progress is slow. In general, agro-industries dominate, followed by textiles and tanneries. The basin is less industrialized than the rest of the region, but is expected to become more industrialized with the commencement of oil exploration.

Chad has proven recoverable oil reserves estimated at approximately one billion barrels. The Exxon-Mobil Chad Cameroon Petroleum Development and Pipeline Project involves the development of oilfields in southern Chad, and the construction of a 1,070 km pipeline to offshore oil-loading facilities in Cameroon's Atlantic coast. A refinery will be developed in N'djamena. Over the 25-year production period, the project could generate nearly US$2 billion in revenues for Chad, at an average of US$80 million per year, and US$500 million for Cameroon, at an average of US$20 million per year.

Petroleum exploitation within the basin would give rise to increased urbanization. At the same time, mining activities in the Central African Republic and large-scale agricultural projects would continue to be operated. The Chari-Logone Integrated Rural Development Project would come on-stream, and there may be further loss or complete disappearance of wetlands or lakes. Moreover, the experience in the Niger Delta suggests that oil spills and related hazards could cause severe contamination of the waterbodies, and deplete the biodiversity.

Although the drainage basin contains many minerals, they have not been extensively exploited. The principal mineral resource is natron (a complex of sodium carbonate), which is dug up and used as salt, and in the preparation of soap and medicines. There also is gold mining reported in the Logone River Basin in Southern Chad and the Central African Republic.

Health standards in the region are generally low. However, there is great disparity between the northern states (Algeria and Libya), which have higher standards than the rest of the countries in the region. The life expectancy also varies widely. In the north, the estimated life expectancy is 71 years (comparable to 74 years in Europe). However, estimates for

the region vary from 43 years in the Central African Republic to 56 years in Sudan. Infant mortality is also high. Chad, Niger and the Central African Republic report that up to 9% of the children may die before the age of one.

In most of the basin countries, up to 28% of the population are undernourished. Acute malnutrition is experienced by about 8% of the people living in the rural areas. The percentage of children exhibiting stunted growth also is high, being 40% in the year 2000. The high child mortality rates are mostly attributed to malaria, diarrhea, acute respiratory infections, measles, tetanus, yellow fever, diphtheria, and chicken pox. Vaccination coverage is low (15%). The prevalence rate of HIV/AIDS continues to increase in the Lake Chad drainage basin.

Illiteracy is a hindrance to development in the Lake Chad region. School enrollment is low (31%) in most of the countries. There is sharp disparity between girls and boys. In the Sudan area of the basin, for example, the enrollment for boys is 68.4%, while that for girls is 20.2% (World Bank 2002). The factors discouraging school enrollment include the long distance to school, low quality of education, and a low probability of being hired in the modern sector upon graduation.

2.3 Institutional and Managerial Features

The Lake Chad Basin Commission, an intergovernmental agency was established by the Fort Lamy (now N'djamena) Convention and Statutes on 22 May 1964, by the heads of the four riparian countries. As originally formed, the Conventional Basin covered 427,300 km^2 (Chad 42%, Niger 28%, Nigeria 21%, and Cameroon 9%; see Figure 1), or approximately 18% of the total drainage basin area (2,434,000 km^2). In 1994, Central African Republic was admitted as the fifth Member State and the coverage of the Conventional Basin was also expanded to include the upstream areas of the Chari-Logone and Komadugu-Yobe river basins, thereby increasing the Conventional Basin area to 966,955 km^2. Finally, Sudan was admitted as a member during the 10th Summit of the Heads of States, held on 28 July 2000. The admission of Sudan increased the Conventional Basin area to 1,035,000 km^2 in 2000, which effectively covers the hydrologically active part of the drainage basin. However, Sudan has yet to ratify the Convention establishing the Commission, a necessary precondition for partaking in the activities of LCBC.

According to Convention and Statutes of the Lake Chad Basin Commission (LCBC), its primary responsibilities are to regulate and control the utilization of water and other natural resources in the basin; to initiate, promote and coordinate natural resources development projects and research within the basin area; to examine complaints; and to promote the settlement of disputes, thereby promoting regional cooperation. In December 1977, the LCBC signed a protocol for harmonization of regulations relating to the fauna and flora in the four (then) Member States. It thus adopted plans for the multi-donor approach towards major integrated development for the Conventional Basin. In 1994, Member States approved a Master Plan for the Development and Environmentally Sound Management of the Natural Resources of the Lake Chad Conventional Basin. A Strategic Action Plan (SAP) with a long-term vision (20 years) for the Lake Chad Basin, prepared with funding from the Global Environmental Facility (GEF), was discussed and adopted by the Member States in 1998. In March 1999, a three-year inland fisheries project was started in Lake Chad, financed by the European Union (GIWA 2002).

During the 1980s, the LCBC oversaw diagnostic studies of the lake basin area, resulting in the Lake Chad Master Plan, which was finalized in 1992 (LCBC 1992) and ratified in 1994. The LCBC also has driven the PDF-B activities of the GEF, which achieved consensus on a "Strategic Plan" to address basin degradation. The Fort Lamy Convention recognizes the sovereign rights of the Member States over the water resources in the basin, but forbids any unilateral exploitation of the lake water, especially when such use has a negative effect on the interests of the other states. It also recognizes the right of the Member States to plan projects, provided they first consult the LCBC. Moreover, the Member States are supposed to refrain from adopting any measures likely to alter the lake's water balance, its exploitation by other riparian states, the quality of its water and the biological characteristics of the basin's fauna and flora. The Member States must inform the LCBC of all projects planned within the Conventional Basin.

After reforms in 1990, the LCBC was trimmed in size, and now has an annual budget of US$1,000,000. Fifty percent of budget is used for operational activities, and 40% for development activities. The budget consists of contributions from the five Member States, as follows: Nigeria (52%), Cameroon (20%), Chad (11%), Niger (7%), and Central African Republic (4%). National, sectoral and environmental plans exist for each country. National institutions are officially in charge of coordinating the implementation of Action Programme 21 in Chad, Cameroon, Niger and Nigeria. At the national level, the relevant environmental institutions (UNEP/DEWA 2003) are:

- Cameroon: The National Consultative Committee on the Environment and Sustainable Development (CCNEDD, established in 1997), which includes the Prime Minister, various ministers, professional associations and NGOs);
- Chad: The National High Committee on the Environment (HCNE, established in 1995), which includes the Prime Minister and various ministers;
- Niger: The National Council for the Environment and Sustainable Development (CNEDD, established in 1997), which includes the Cabinet leader, ministers, civil society, university and NGOs); and,
- Nigeria: The Federal Environmental Protection Agency supported by the National Advisory Council comprising governmental organizations, private sector, NGOs, community organizations, university; and the National Council on the Environment.

Almost all of the States in the Federation have prepared a long-term Environmental Action Plan. In addition, a Basin Committee for Strategic Planning (BCSP) has already been created through the LCBC to assist in the creation of the local initiatives. The BCSP comprises senior country officials, across key ministries such as environment, agriculture, and finance, to increase the likelihood that, where necessary, policy and administrative changes and funding priorities could be made to ensure replication of the most promising locally driven enterprises.

3. Biophysical Environment

3.1 Lake Environments

3.1.1 Hydrology, Hydrogeology and Water Resources

Existing in an arid region including the Sahara Desert, the Lake Chad drainage basin naturally has limited water resources. River inflow comes mainly from the Chari-Logone (96%) and the Komadugu-Yobe (2%) river basins, which drain areas in the southern area of the basin, where precipitation is relatively higher. The total annual mean river inflow decreased from a pre-drought volume of 39.8 km^3 to the present volume of 21.8 km^3, a decrease of 47%. During this same period, the total lake water input (including direct rainfall on the lake) decreased by 50%. These decreased inflows largely reflect the dry conditions that affect all the river systems in the basin.

The surface of the lake is characterized by a mixture of island archipelagos (23%), reed beds (39%), and open water (38%). The area of open water persists in the southern basin/pool, mostly near the Chari River inflow.

According to Magnet (1996), the annual average temperature of Lake Chad water varies between 25.5°C and 27.5°C. The water transparency is clearest in the southern open waters in December to January (100 cm), and most opaque in August (20 cm). The pH levels in the Chari River and in the southern pool of the lake are between 7 and 8, but can reach 9 in the northern pool. The water conductivity averages 450 µS/cm, but increases with increasing distance from the Chari delta. The salinity varies between 40-70 mg/L in the Chari River, 60-120 mg/L in the open waters of the southern pool, and an average of 700 mg/L in the northern pool. Close to the Chari delta, the water has low calcium and magnesium carbonate concentrations, but exhibits considerable seasonal variation. The concentration of minerals in the water increases northwards because of evaporation.

Groundwater resources of regional importance within the Lake Chad drainage basin are represented by two aquifer systems (Olivry 1996).

- The phreatic aquifer contained within the Quaternary sand or clayey-sand deposits. The aquifer can be found at depths ranging from a few meters to about fifty meters. Its electrical conductivity varies between 50-5,000 µS/cm. The water is of the calcium bicarbonate type, with low mineralization, essentially similar to surface water quality. Nitrate concentrations up to 300 mg/L, attributed to agricultural or fecal origin, have been reported for the aquifer.

- The confined, and often artesian, Pliocene aquifer, sometimes called the middle aquifer of the Chad formation, has been recognized only in the central part of the basin, and encountered at a greater depth (sometimes between 250-400 m). It is well exploited in Nigeria and the extreme north of Cameroon, where many boreholes constructed in the 1960s constitute permanent drains of this aquifer. The aquifer has a lesser geographic extent, compared to the above-noted water table aquifer, and its water is older and more mineralized (700-4,000 µS/cm). This water was

Table 2. Drainage Areas, Inflows into Lake Chad, and the Overall Water Balance of the Lake.

	Catchment Area (km^2)	Inflows and Outflows (km^3/yr)	
		Pre-1970 mean	1971-1990 mean
Inflows			
Chari-Logone	590,000	39.8	21.8
Komadugu-Yobe	147,840	1.0	0.45
Yedseram-Ngadda-Ebeji	53,720	0.89	0.12
Other Rivers		1.2	0.2
Total River Inflows		42.89	22.57
Rainfall on open water surface		6.0	2.1
Total Input		48.89	24.68
Outflows			
Evapotranspiration		43.0	23.1
Infiltration		3.0	1.4
Total Outflow		46.0	24.5

Source: Oyebande (1997), UNEP/DEWA (2003).

classified as a bicarbonate type, with total dissolved solids (TDS) concentrations greater than 700 mg/L.

The chances of a hydraulic continuity between the two aquifers are remote. Apart from these two aquifers, there are other artesian layers at great depths, whose extent and capacities are not well known (e.g., Continental Terminal, Continental Hamadien, Continental Intercalaire). Except for the continental terminal aquifer, which outcrops south of Chad, these are probably highly mineralized fossil waters, used for limited purposes. It appears these horizons have the same hydraulic head as the Pliocene aquifer, although exchange with the latter is presumed to be extremely small or non-existent. The continental terminal aquifer is of the sodium bicarbonate type, with associated deep waters having a TDS concentration in the range of 75-600 mg/L. In southern Chad, where the aquifer outcrops, the water quality is fresher, being characterized by TDS concentrations less than 200 mg/L. In the Kousseri area, high temperatures (40°C-46°C), as well as high conductivity values, are observed. This water may be geothermal in origin.

3.1.2 Flora, Fauna and Wildlife Resources

The major wetland plant communities present in the lake comprise three broad categories: floating "sudd" communities, permanent reed swamps, and seasonal herbaceous swamps (edaphic grasslands). A swamp belt—the great barrier—separates Lake Chad into a north and south pool. Vegetation in the south pool consists of *Cyperus papyrus*, *Phragmites mauritianus*, *Vossia cuspidate*, and other wetland plants. *Phragmites australis* and *Typha australis* grow in the more saline north pool. Occasionally, the floating plant Nile lettuce (*Pistia stratiotes*) covers large areas of the lake's open waters. Vast expanses of dark, cracking Pleistocene clays line the southern shore of the lake. Grassland communities dominate where flooding is extensive, because most tree species cannot tolerate prolonged flooding conditions. Woody communities, dominated by Acacia species, grow interspersed with the grasslands. These woody communities vary in density, ranging from scattered trees and bush grasslands to woodlands and thickets. Xeric woodland species found around Lake Chad include baobabs, desert date palms, African myrrh, and Indian jujube (Mockrin and Thieme 2001).

Sahelian large mammal species that used to be common in the Lake Chad ecoregion include red-fronted gazelle, dama gazelle, and dorcas gazelle (*Gazella rufifrons*, *G. dama*, *G. dorcas*), patas monkey (*Erythrocebus patas*), striped hyena (*Hyaena hyaena*), cheetah (*Acinonyx jubatus*), caracal (*Felis caracal*), and the endangered wild dog (*Lycaon pictus*). Other species found in the ecoregion include the African elephant (*Loxodonta africana*), two species of otter (*Lutra maculicollis*, *Aonyx capensis*), hippopotamus (*Hippopotamus amphibious*), sitatunga (*Tragelaphus spekei*), and kub (*Kobus kob*). Two near-endemic rodent species, *Mastomys verheyeni* and the Lake Chad gerbil *Taterillus lacustris*, are also found.

The sitatunga is now considered extinct in Niger, while only a few declining populations remain in the Lake Chad region of Nigeria. A reduced hippo population is still present, and otters remain common. Nile crocodiles are now uncommon in the lake.

Up to a million wintering ducks congregate on Lake Chad each year, making it the third most important area for migratory water birds in West Africa. Some 49 of the 83 major Palaeo-arctic species attracted to the Sahel depend on wetlands, and wetlands are the preferred habitat for another ten species. The actual numbers of birds varies from year to year, depending on the size of the lake and on wetland conditions elsewhere in West Africa. The eco-region supports two near-endemic birds, the rusty lark and the river prinia. Other birds include the marbled teal, which is occasionally seen on Lake Chad and in northern Chad, and is thought to be declining worldwide. Ruffs are common here, with over one million seen on the lake at one time. A few populations of elephant, kob, and red-fronted gazelle still live in sections of the Lake Chad Basin. Although human hunting activities have essentially wiped out other large mammals and crocodiles, smaller mammals (e.g., the endemic Lake Chad gerbil), smaller reptiles, and amphibians remain.

Table 3 depicts the number and distribution of birds, as related to the extent of the surface water (wetlands) in the Hadejia Nguru wetlands of Nigeria between 1994 and 1997. Overall, the open-water bodies contain over 300 species of water-related birds, largely palaeo-arctic migrants, but also including Afro-tropical migrants as well as resident species. The number of birds and the extent of flooding are strongly correlated. However, the relationship is not exact because, in addition to the extent of flooding, flow regime characteristics, such as frequency, depth of water and duration of specified flows, also are important (Oyebande 2001). As shown in Table 3, poor flooding results in low numbers of waterfowl.

Table 3. Number of Water-related Birds and the Extent of Flooding in the Hadejia-Nguru Wetlands, Nigeria.

	1994	1995	1996	1997
Marma Channel and Nguru Lake (birds)	45,715	120,709	61,853	202,440
Flood area (km²)	106	349	334	335
Kafin Hausa (birds)	9,378	49,452	113,754	67,995
Flood area (km²)	17	78	74	135
Total Number of Birds	55,093	170,161	175,607	270,435
Total Flood Area (km²)	123	427	408	470

The Lake Chad Conventional Basin encloses one of the most productive regions of freshwater fish in Africa. Some 130 species are found within the lake basin. Significant biodiversity loss has been noticed in the fish populations during the past decade or so. Some fish species, such as *Alestes* and *Shilbe spp*., whose pattern of migration and spawning is triggered by the rising floods, are more severely affected by the change in the flood cycle than species such as *Claris* and *Tilapia*. A comparison of the extent of flooding and fish catches in 1992, 1993, 1994 and 1996 (the last two years regarded as good fishing years), together with the information obtained on the fishermen's perception of flood impacts, led to the conclusion that the minimum area of annual flooding required to sustain the fish ecosystem and fishing industry in the Hadejia-Nguru Wetlands is 800 km^2 (Oyebande 2001).

As a result of climate variability and unsustainable water projects, five to eight species of fish have disappeared from different parts of the Lake Chad drainage basin in Nigeria. The experience in the Logone Valley, south of the Semry Irrigation Project, is similar: Fish yields collapsed by 90% because of the lack of water inundations. Further, the collapse of the floating rice farming has produced a battalion of unemployed Kotoko youths who are unable to work with other rice varieties and collapsible fish cages. Thus, these youth need re-training and empowerment in this direction.

3.2 Environmental Degradation History

The lake is reported to have nearly occupied the whole of its drainage basin about 10,000 years ago. It has since experienced fluctuating conditions, having completely dried out four times between 1400 and 1910. Lake Chad covered 25,000 km^2 in 1963, compared to 1,350 km^2 today (Figure 1). In addition, the vegetation of the northern part of the lake has disappeared, and sand dunes have begun to form on the dry lakebed. The lake's shrinkage is attributed to the combination of a drier climate and growing human water demand.

A significant decrease in direct lake rainfall since the 1960s has largely been responsible for the shrinkage of the lake. A severe drought in 1973 had major effects on the area with the Sahel moving approximately 100 km south as a result. Overall, there has been a decrease in the number of large rainfall events and river inflows (47%). The lake, being very shallow, responds rapidly to changes in rainfall and river inflows. The need for water for irrigation in the four countries that share the lake has increased about fourfold over the same period, further draining the lake. The problem is expected to worsen in the coming years as population and irrigation demands continue to increase. The low water-use efficiency (about 11%) that characterizes the region's irrigation needs to be revisited and drastically improved. If this trend in the shrinking of the lake continues, it is very possible that migration of some of the most active fishing and agricultural communities might occur, since they may wish to seek a better life elsewhere.

Addressing the problems associated with Lake Chad requires an enormous degree of commitment and regional cooperation. For many years, countries in the LCBC have been taking steps to institute a process of water transfer so as to effectively recharge the lake, and revive it sufficiently well to continue to benefit its user-countries. The decrease in river flow has led in places to the degradation of the river channels and its hydrology. Accelerated siltation and weed growth, particularly *Typha australis*, have done great damage in the Hadejia-Jama'are-Yobe basin and elsewhere. Irrigation channels have been clogged and river channels blocked by siltation and *Typha*, the end result being that water does not reach the lower parts of the catchments and Lake Chad. The twin pests of *Typha* and quela birds that flock in large numbers inflict additional loss of rice and other grains, further aggravating the already unstable livelihoods in the basin.

The environmental impacts of pollution are transboundary in nature, an example being nutrient loads from upstream developments (irrigated and urban discharges) having negative impacts on downstream populations and communities. Contamination by agricultural and industrial chemicals, solid wastes, and sedimentation has local, as well as transboundary implications. Crop residues left after harvesting in different parts of the drainage basin also contribute to the pollution of waterbodies to some degree (Oguntola 2003).

3.3 Resource Conflicts and Their Resolution

Approaches to resource management in the Lake Chad region have been largely inadequate. Environmental degradation has continued unabated, while resource conflicts have become common. Access to natural resources and their use are poorly managed. The drainage basin communities and groups are not assured of a fair, stable set of management rules for water access and use. Droughts, civil strife and population movements have placed further constraints on the sustainable management of the vital resources of the region.

By the end of the 1960s, drought conditions started to develop, with the water level of Lake Chad beginning to drop drastically. Within a decade, the lake had shrunk to about one-tenth of its normal area. The lake water receded for more than 150 km from its northern and eastern shores, and by more than 80 km from its western shoreline. Some of the natural fauna and flora disappeared, and sand dunes have appeared on the dry lake bed. All economic activities, such as fishing, livestock rearing and farming, were adversely affected and the population had to migrate as environmental refugees. This phenomenon started a major transboundary crisis in the Lake Chad drainage basin. People whose economic activities were dependent on water (e.g., fishermen) kept following the receding water across boundaries without consideration of the national borders. By 1983, a crisis had developed. Such migrants found themselves in other countries without fully realizing the change, as the lake has no boundary markers. Territorial disputes also erupted between some member countries over emerging islands in the lake (e.g. Darak).

This transboundary problem led the LCBC Member States to resort to their sub-regional organization, which has a mandate for examining complaints and promoting the settlement of disputes. Under that forum, the Heads of State issued specific directives to the Commission to address security issues regarding Lake Chad. The regional organization has provided a very vital forum for conflict resolution. Two committees were immediately constituted, one on security and the other on the border demarcation exercise. The Security Committee held a series of meetings, finally coming out with a recommendation that "to ensure lasting peace and security in the zone, a joint patrol system should be introduced." This recommendation was subsequently adopted, with every member country contributing security agents who jointly patrolled specifically-demarcated areas of Lake Chad.

A major gap in the LCBC Convention is its failure to prescribe any water allocation rule. The FAO was requested to assist the Commission in the formulation of common regulations for the apportioning of the surface water in the Conventional Basin among Member States. Following its review at the 13th Session, the draft agreement prepared by FAO's legal office on water utilization and conservation was referred to the legal departments of Member States for detailed study. The report has yet to be completed.

In the absence of international monitoring or sanctioning bodies, adherence to a number of the past agreements between the riparian countries on the conservation and development of the basin's resources could not be enforced. As a result, the agreements remained voluntary. Examples include the 1970 Moundou Agreement between Cameroon and Chad, specifying limits of water level changes in the Logone, permissible with the creation of control structures. Another failed agreement by the four LCBC Member States is the 1977 Agreement on Common Regulation of Flora and Fauna.

Improperly designed dams and poor, uncoordinated operation of the dam reservoirs has led to numerous conflicts within and between member countries. A large dam (Kafin Zaki) under construction in the basin had to be suspended when the totality of its negative potential impacts on the basin's water balance became clear. Communal uprisings (downstream versus upstream riparians) have become more frequent in recent times, although application of science and advocacy has helped resolve some of the conflicts. For example, the dry season test releases in 1996 from Tiga and Challawa Dams (which control over 80% of the flow of the Hadejia River) revealed important lake impacts. The results showed that virtually no water from the Hadejia River system leaves the Hadejia-Nguru wetlands into Komadugu-Yobe due to weed blockages (*Typha* reed beds), and siltation of the riverbed in the zone of the wetlands. Yet the test releases flooded most of the floodplains along the Hadejia River system, perfectly simulating the wet season conditions, proving that the dam outlets and Hadejia barrage are adequate to generate artificial flooding in most of the wetlands. The implication of these results for the downstream ecology has been grave, leading earlier to disputes between upstream and downstream communities (HNWCP 1996).

The absence of an integrated drainage basin management strategy is partly responsible for the conflicts regarding Lake Chad. Examples are the inefficient use of huge quantities of water in large irrigation projects (e.g., Kano and Hadejia River irrigation projects), to the neglect of the needs of the more productive downstream water projects and requirements. Another reason is the present inefficient way of meeting the water demands of the Kano City Water Supply, by filling the pit of the water supply intake with higher than optimal levels toward the end of the dry season, at a time when there are not many other demands (Diyam Consultants 1996). Although feasible technical solutions are known, the River Basin Development Authority in charge has lacked the will to implement them (Oyebande 2003).

On the main Komadougou-Yobe River around the Mamouri area of Niger Republic, the conflict over the use of the river flow had reached a crisis proportion. In the late 1980s, Niger authorities constructed a water intake structure on the left bank of the Komadougou-Yobe River, upstream of some existing irrigation schemes exploited by Nigeria on the right bank around Yau. This led to reduced water availability in the Nigerian Borno State irrigation schemes. The operators of the scheme, in turn, created a canal some distance upstream of the Mamouri scheme intake structure to get more water to their scheme in the spirit of the riparian doctrine that asserts, "prior in time is prior in right." The conflict was eventually resolved at the bilateral level by the Nigeria-Niger Joint Commission for Cooperation.

Inter-ethnic conflicts over the use of natural resources are a common occurrence in the Lake Chad drainage basin. Many casualties from these conflicts have been recorded in recent years in most countries within the basin. The main cause of the conflicts is lack of water for livestock, as well as lack of agricultural land, leading to the encroachment of farmers into pasture lands, and vice versa.

LCBC Member States have developed large irrigated areas along the rivers that feed the lake, with the intention of supplementing traditional rice growing. The production of irrigated rice in Chad, for example, represents only 4% of national cereal production, as opposed to traditional rice growing, which represents 75%. In Cameroon, irrigated production has been reduced for marketing reasons. On the whole, current irrigation projects are still very weak. Unfortunately, analysis of water use in the Logone River floodplain reveals huge losses in the traditional floodplain agricultural production in recent decades, due to climate variability and human activities. The construction of both the Yagoua-Tekele dyke (on the Logone River) and the Maga River in 1979 has had severe negative impacts: recession rice cultivation decreased to 75% and cotton to 33% (Mott MacDonald 1999; Oyebande 2001).

In Nigeria, the planned irrigation area under the existing water management works is estimated at 185,000 hectares. Of this area, only about 32,000 hectares have been completed and irrigated. The total identified irritation potential has been evaluated at 356,000 hectares. However, even an attempt to complete the development of the first 185,000 hectares has already caused water shortages and related conflicts. Nigeria also plans the development of 146,000 hectares of fadamas (floodplains). Fortunately, the approved master plan for the Lake Chad Conventional Basin proposes to concentrate future developments on small-scale irrigation projects.

Lake Chad poses a unique challenge for fishing regulations because it lies within four different countries. Recently, rules and regulations of access to fishing activities were created. The regulations are very complicated and haphazardly enforced, however, with confusion among different administrative agencies over regulation and taxation (WWF 2001). Some major issues contributing to dwindling fish catches, apart from rainfall and river inflow deficits driven by the back-to-back droughts of the past four decades, include:

- Over-exploitation of fisheries, a major problem for Lake Chad, an international waterbody that hosts many fishing vessels, some originating from other countries outside the riparian countries (e.g., Mali), which harvest Lake Chad fish;
- Smaller mesh sizes and increased juvenile catches that contribute to significant resource waste and depletion;
- Destructive fishing practices;
- Decreased viability of stocks through contamination and disease; and,
- Impacts on biological and genetic diversity.

4. Management Environment

4.1 Institutional Roles and Management Strategies

4.1.1 Protected Areas

Acquisition and development of grazing reserves began in the 1960s, when the Northern Nigerian Government began placing emphasis on the nutritional disease control and water development aspects of livestock management. It also encouraged the nomadic population to opt for gradual settlement. Areas acquired in the Lake Chad drainage basin included Borno Emirate (219,000 hectares) and parts of Kano (42,485 hectares).

The Lake Chad Game Reserve is currently the only protected area around Lake Chad. It occupies 7,044 km^2 along 150 km of the western lakeshore in Nigeria, more than half the Nigerian shoreline of the lake. However, this reserve is a conservation area only in theory, and local communities have claimed the land for settlements, farms, and cattle grazing and for use as bases for fishing. A similar situation exists in the Hadejia-Nguru wetlands, where there are some forest reserves and small areas under National Park status, but with local populations also heavily using these areas. It is necessary, therefore, to formulate and enforce access rules for adherence locally, nationally and regionally.

There is an urgent need for regional initiatives for data monitoring, database creation and establishment of early warning systems. Such systems should be established for surface and groundwater, as well as for invasive weeds and associated pests. The ongoing efforts in the West and Central Africa in HYCOS (Hydrological Cycle Observing System) provides lessons and opportunities for such challenging endeavors.

4.1.2 Ramsar Sites

Within the framework of a strategy to save Lake Chad, the LCBC Heads of State took note of the efforts being made by the Ramsar Convention Secretariat and the World Wide Fund for Nature on the lakes' conservation and restoration. At its July 2000 meeting, following the declaration of Lake Chad as a Transboundary Ramsar site of International Importance (in Cameroon, CAR, Chad, Niger and Nigeria), the LCBC urged all the Member States that had not yet ratified the Ramsar Convention to accelerate actions to accomplish the ratification. A Global Environmental Facility (GEF) project also has been approved for Ramsar designation, including a management plan for the lake and the basin (WWF 2001). The sum of US$9.6 million has been approved for the project, which commenced in September 2003.

The Memorandum of Cooperation of November 2002 between The Bureau of the Convention on Wetlands (in accordance with the Ramsar Convention of 1971) and the Lake Chad Basin Commission (LCBC) identifies a number of objectives, including the following:

- Reinforcing the role of wetland ecosystems for sustainable development;
- Reinforcing the institutional partnerships at basin level and national level between all stakeholders, that is, governmental entities, Intergovernmental Organizations (IGOs), Non Governmental Organizations (NGOs), and other stakeholders concerned with the conservation and sustainable use of wetlands;
- Establishment of a coherent national and regional network of Ramsar sites at the basin level, as the basis for their sustainable management; and,
- Taking into account innovative approaches to transboundary wetland management in the Lake Chad Basin subregion, by promoting partnerships between the Partners, Conventions (CBD, UNCCD, UNFCCC, etc.), regional and sub-regional organizations, Governments, IGOs, NGOs, etc., as models for global replicability.

In a related development, the establishment of a giant transboundary protected area by Nigeria, Cameroon and Birdlife International was announced at the then-ongoing World Parks Congress in Durban, South Africa. Elements of the ecosystem to be protected include:

- Mountain forests, grasslands and savannas of the Gashaka Gumti National Park in Nigeria (6,670 km^2), and Tchabal-Mbabo (300 km^2) in Cameroon Mountains;
- Endemic and important bird areas, including 28 bird species of the Afromontane ecosystem, 13 of which are found only in the area; and,
- Large mammals, including endangered Chimpanzee species.

Gashaka Gumti is protected, but suffers encroachment by cattle grazers and farmers, while Tchabal-Mbabo is not currently protected at all. The strategy is intended to provide effective and sustainable protection for the newly-created areas.

4.1.3 Monitoring and Assessment

As a general observation, there is insufficient knowledge of the lake's water resources, and specifically, how its aquatic systems function. There is no systematic system for monitoring the quantity and quality of its freshwater resources, nor are there effective water quality protection programs. The available water quality data series date back to the 1960s and 1970s. Some Lake Chad basin organizations established in member countries such as Nigeria made substantial contributions in this area up to the late 1980s. However, lack of political will and funding has resulted in the collapse of the previous monitoring networks. Fortunately, however, most of the available datasets have been retained.

4.2 Capacity Building and Stakeholder Participation for Reducing Stress

4.2.1 Lake Bed Farming

At the local level, people living near the lake, particularly in the northern parts of its basin, developed strategies for taking advantage of the opportunities provided by it. Basin farmers used both traditional and improved technologies to adapt to the changing water levels. The receding Lake Chad left behind an estimated 0.5 million hectares of cultivable land, some of which was being cropped. Farming also is done on "recessional lands," where the lake water recedes every year, and in the "polder" depressions between dunes. Rice, wheat, maize and vegetables are grown. In a traditional polder, one crop a year is grown as the lake water recedes. If "dams" and pumps are used, up to three crops a year can be grown. In addition to fewer fish, a low lake water level also means a shorter shoreline and, therefore, also fewer polders. It is estimated that only 10% of the lake's polder areas were being used.

Over the past few years, the lake and river water levels have been slowly rising. If this trend continues, it will present new challenges and opportunities to the local people who depend on the lake and its surrounding lands for their livelihoods (Nami 2002).

4.2.2 Stakeholder Participation in Transboundary Protected Area

The transboundary protected area in Gashaka Gumti Park (Nigeria) and Tchabal-Mbabo (Cameroon) were previously noted. A study to develop the capacity of the stakeholders to provide fully-effective protection to the area has been designed.

4.2.3 Community Projects

A UNEP/Belgium Mega-Chad Project, titled "The Promotion of Renewable Energy Resources and Conservation of Threatened

The Lake Chad Vision for 2025 and the Region's Principal Objectives

The Lake Chad Vision for 2025 highlighted a number of important issues deduced from the existing situation in the lake's drainage basin. These include problems associated with (a) climatic changes resulting from rainfall deficits, reduced runoff in the major rivers, considerable shrinkage of the areal extent of Lake Chad, lowering groundwater table levels, declines in perennial vegetation, and increases in vulnerability to soil erosion; (b) poor decision-making, development policies focused on short-term solutions, as well as unsustainable development decisions, leading to construction of large dams upstream without adequate consideration for downstream users and ecosystems, abandonment of costly investment due to lack of water, etc.; (c) lack of water and environmental policies (effective monitoring system for water resource quantity and quality, facilities for early warning and preservation measures, management of water demands, etc.); (d) weak coordination through a low level of stakeholder participation and unsuitable institutions; and (e) weak economic growth in Member States, based on poor rural economy and high population growths responsible for increasing water demand pressures, and continued declines in the biodiversity in the region.

The subsequently presented vision of the Lake Chad Region identified three major objectives; namely, (i) maintenance of Lake Chad and other wetlands of the region at sustainable levels for the economic security of the freshwater ecosystem resources, sustained biodiversity and aquatic resources of the basin and their equitable use, and the alleviation of poverty; (ii) acceptance of responsibilities for freshwater, ecosystem and biodiversity conservation and judicious integrated river basin management by regional and national authorities; and (iii) equitable access by Member States to safe and adequate water resources to meet their needs and rights.

Source: Lake Chad Vision for 2025 presented at Second World Water Forum 2000; UNEP/DEWA 2003.

Flora Species in the Dryland of Mega-Chad of the West African Sub-Region," is being implemented. The goal of this community-based project is to promote the use of renewable energy resources (solar, biogas), fuel-efficient wood stoves, and water-harvesting techniques as well as to conserve threatened flora species.

The Mega-Chad project is based on replication of best practices in land degradation control. This 3-year project on land degradation control with a strong socio-economic component has been under implementation since November 2001, in collaboration with the University of Maiduguri, Nigeria, and the LCBC. The project will address the propagation of diminishing tree species for biodiversity conservation, training and implementation of renewable energy technologies (solar energy for cooking and extraction of underground water), water harvesting and promotion of youth clubs for environment conservation.

4.3 Financial Investment for Management Programs

Given the region's limited financial resources, it is certain that much political will and commitment will be required to raise substantial funds for the much-needed regional development. Even so, enormous financial inflow from external support agencies will be indispensable. LCBC Members realized this challenge as far back as 1977, and adopted plans for a multi-donor approach directed to major integrated programs in the Lake Chad drainage basin.

Thus, in the final communiqué issued at the end of the Tenth Summit of the Heads of State and Government of the Lake Chad Basin Commission, held on 28 July 2000 in N'djamena, the Heads of State urged the international community and all donors and assistant agencies to team up with GEF and its implementation agencies to save Lake Chad and its teeming population from the adverse effects of drought and desertification. The Heads of State unanimously mandated President Olusegun Obasanjo of Nigeria to assist in making contacts with potential donors and mobilizing them for the planned donors' conference.

Some of the donors, the LCBC, ongoing and planned investments, and their status, real and potential impacts are outlined in the following sub-sections.

4.3.1 Reversal of Land and Water Degradation Trends in the Lake Chad Basin Ecosystem: Environmental and Social Impact Assessment

The objectives of the LCBC/GEF Project, "Environmental and Social Assessment" (EAISA, October/November 2001), were to identify, qualify and, to the extent possible, quantify the likely negative and positive environmental and social impacts of the project as designed, and to propose mitigating measures to avoid negative impacts. The study showed that there were no significant negative environmental or social impacts to be expected. However, many of the pilot proposals focused on further community planning initiatives, with few on-the-ground interventions. The study recommended initiating community-based development interventions as a high priority component of the pilot projects (The Natural Resources Group 2001).

In a recent meeting, the Heads of States of the LCBC countries noted with satisfaction the progress on the LCBC/GEF project. They expressed their appreciation to the GEF and urged the implementation agencies (i.e., UNDP, World Bank) to expedite action on the technical design of the recently-approved pilot projects. The issue of pilot project technical design has since been addressed by the GEF's PDF-C, which commissioned consultants to prepare documents on the implementation details of the pilot projects. However, further enrichment of the existing project documents, to include more relevant activities, may still be desirable during the first year of project implementation.

4.3.2 Survey of Lake Chad, Wetlands and their Conservation

The ongoing work of the WWF Living Waters Campaign with the governments of Chad, Cameroon, Nigeria, Niger and the Central African Republic is to carry out a survey of Lake Chad and other wetlands, as well as promote their national conservation efforts and wise use of wetlands.

With similar objectives, IUCN's West African Regional Office also is supporting an ongoing survey of wetlands in the region. The portions of the Lake Chad drainage basin in Nigeria, Niger and Chad are covered by the survey. Among its particular objectives, the project plans to apply the conclusions of the World Commissions on Dams to lift the threat on wetlands in the region.

4.3.3 Hadejia-Nguru Wetlands Conservation Project (HNWCP) in Nigeria

The HNWCP project was established in 1987. IUCN managed Phases II and III of the project, from 1992 to 2000 before handing it over to the Nigerian Conservation Foundation (NCF). Thus, it is currently in a state of abeyance. Nevertheless, based on a Memorandum of Understanding between DFID-JEWEL Project and the NCF, the Information Centre at the Project Office in Nguru remains open for all users. While it existed, HNWCP promoted the integrated management of the water resources of the Komadugu Yobe Basin (KYB), in which the Hadejia-Nguru Wetlands (HNWs) are situated, as a means of attempting to safeguard the ecological, hydrological and economic integrity of the wetlands. It also promoted public awareness and education, preparation of management plans and guidelines, advocacy and the wise use of the wetlands' natural resources (IUCN 1997).

has another project that is planned to start implementation in late 2003, focusing on water governance in the entire Komadugu-Yobe Basin. It is a component of IUCN's Water and Nature Initiative (WANI), a global program. The project will be implemented in partnership with NCF and the Federal Ministry of Water Resources (FMWR). Its ultimate objective is to assist the FMWR to develop and implement an integrated water

resources management plan for this part of the Lake Chad drainage basin in Nigeria (Oyebande *et al*. 2003).

DFID-JEWEL's livelihoods project, supported by the United Kingdom's DFID, also is working in the basin. Its ultimate objective is to contribute to poverty reduction in the HNWs, through the improved management and utilization of the common property natural resources of the HNWs. A 10-month inception phase was completed at the end of July 2003, with a 3-year and 3-month implementation phase expected to start by 1 October 2003 (Oyebande *et al*. 2003).

4.3.4 Inter-basin Water Transfer Project

The 49th Session of the LCBC Council of Ministers, held in Yaounde, Cameroon during 8-18 January 2002, emphasized the need to accelerate the feasibility study of the Lake Chad restoration project. The project goal is to bring water to the lake from the Congo River drainage basin. The invitation to this conference of delegates from the International Committee of the Congo-Oubangui-Sangha Basin, demonstrates the commitment of member countries to safeguard the Lake Chad drainage basin. The chair of LCBC and President of the Central African Republic has obtained the non-objection of the Republic of Congo, Brazzaville, leaving only the Democratic Republic of the Congo remaining to give its non-objection for the implementation of the project. Recent information sources have indicated the Democratic Republic of Congo and the Republic of Congo already have approved it. The LCBC has submitted requests for funds to donor countries, both directly and through the New Partnership on African Development (NEPAD). It plans to begin feasibility studies soon to examine the social, economic and environmental impacts of the proposed inter-basin water transfer project. The Members of the LCBC are reported to have acquired US$1 million in counterpart funds, and are waiting for donors to contribute the remaining US$5 million required for the studies.

This proposed project, still in the conceptual stage, envisions moving 900 m^3/s of water annually from the Oubangui River in a navigable canal about 100-150 km in length. It involves constructing a dam at the donor basin at Palambo, which would then be used to produce about 30 to 35 GWh of electricity, as well as improve navigation downstream of Bangui. This water supply, along with the oil to be produced in Chad, would contribute towards meeting the sub-region's energy requirements. The canal to be used to transfer water from the Oubangui also is expected to facilitate the transport of goods and services within the region. When there is enough water, irrigation will boost agricultural production, fishing as well as reforestation. In fact, an area between 50,000-70,000 km^2 in the Lake Chad drainage basin would be put into extensive irrigation development as a result of this inter-basin water transfer project. Finally, an area of between 5-7 million hectares could be put under intensive irrigation development in the receiving basin (Jauro, undated). Overall, it will provide an opportunity to rebuild the ecosystem, rehabilitate Lake Chad and re-constitute its biodiversity. It also would safeguard the lake, since the surrounding population, if properly educated, informed and empowered, would no longer see the need to cut wood for energy.

4.3.5 The Mega Chad Project and the Transboundary Protected Area Between Nigeria and Cameroon

As already described in Section 4.2 are the Mega Chad Project and the Transboundary Protected Area, which straddles Nigeria and Cameroon. The former is supported by UNEP and the Belgium Government, while the latter (the transboundary protected area) is being supported by UNDP/GEF funds totaling US $390,000 and will take 15 months to complete. In both cases, the goal is to reduce environmental and ecosystem degradation, and to promote sustainable resource utilization through provision of necessary investment funds.

5. Lessons Learned

5.1 Political Will and Commitment

Because it defines the Conventional Basin, the LCBC is the most relevant international organization in regard to the sustainable use of Lake Chad. Until recently, evidence of the Commission's presence has been virtually nonexistent in the Conventional Basin, apart from some scattered infrastructure. Member States must vest the Commission with more power to enable it resolve water and land disputes and conflicts. A basic weakness in all river basin organizations and regional economic communities in Africa is a lack of strong evidence of supernationality. In fact, a key factor of the success achieved by similar organizations in developed countries is the preparedness of their members to be bound by decisions made by the regional institutions (ECA 2001). It is not just a matter of getting a protocol or convention ratified that makes such an agreement work, but particularly the degree to which it is binding on Member States. Such a step depends on the political will and commitment of the members to the regional organization and its goals.

The compelling evidence of the degradation of Lake Chad and its drainage basin, and the urgency of the need for restoration of the lake, has stimulated LCBC member countries to muster some political will to cooperate with the Commission. Moreover, within their limited resources, there is evidence of improved commitment by Member States to their financial obligations.

5.2 Need for Sustainable Institutions and Effective Stakeholder Participation

Most of the policies and institutions required to prevent environmental degradation, and promote sustainable development, are similar throughout the lake's drainage basin.

Stakeholder participation is gradually being encouraged. A number of community projects are ongoing, or planned, in which stakeholders are involved at various stages. A good example is the rehabilitation of the Logone wetland in

Cameroon in 1993. The embankments of the barrage along the river were modified over eight years. Stakeholders and local community members were involved in planning and designing the project. Small-scale fishing has recommenced, and potable water from groundwater sources has been supplied to 33 villages.

The World Bank-aided Agricultural Development Projects (ADPs) in the Yobe basin (Nigeria) facilitates wetland (fadama) farming through the promotion of fadama users associations (FUA). Each consists of 25 fadama farmers. There were 276 such associations registered in Yobe State by 1996. The FUAs facilitate securing and recovery of loans and other service charges. They also facilitate training of members in bookkeeping, agronomic practices, as well as pump repairs and maintenance. In addition, there were also 46 water users associations (WUAs), which managed rural water supplies in the State and maintained the facilities while the local government assisted with repair of major breakdowns (Oyebande 1997). Similar WUAs have also recently emerged belatedly in the Kano River Irrigation Project and the Hadejia River Barrage Project, to facilitate recovery of charges and fees and for taking over some functions, such as clearing the troublesome invasive *Typha* reeds and desilting of irrigation canals.

The advocacy brokered by IUCN in the Komadugu Yobe basin, which led to broad-based stakeholder participation in the resolution of upstream-downstream conflicts, is a good example of needed cooperation. It led to the dry season test water releases from Tiga and Challawa Gorge dams among others. There is need to involve both domestic and international NGOs effectively at all crucial stages of water management practices.

LCBC and member countries need to streamline and replicate such user associations for activities such as fisheries, livestock farming, crop farming, etc., in other parts of the basin.

5.3 Legislative Frameworks and Financing Strategies

Integrated river basin management requires an appropriate and effective legal framework, in order to achieve the desired goals. LCBC is yet to accomplish this prerequisite. The LCBC member countries need enabling legislation to guide integrated and sustainable water utilization and management. LCBC will do well to assist members in achieving such a water code. For example, although Nigeria's National Water Decree 101 of August 1993 as water law is fairly detailed, the mechanism for its implementation, as well as the political will necessary to enforce it, has yet to be demonstrated. There also are other policies approved by the National Water Resources Council, which are currently in use. These include charges for water from dams and irrigation infrastructure provided by the River Basin Development Authorities (RBDAs).

A draft policy for reservoir operation presented to the National Water Resources Council in Nigeria was recently discussed, but could not be agreed on because upstream and downstream stakeholders' views could not be reconciled. A committee established to resolve the matter was inaugurated in early 2003 to apply the policy to all water infrastructures. This should be finalized not only in Nigeria, but also in all member countries, and adopted as a regional policy to solve the problems of water allocation.

Further, the draft agreement prepared by FAO's Legal Office on water utilization and conservation, which was referred to in the Legal departments of LCBC Member States for detailed study at its 13th Session, should be updated and implemented.

The financing strategy for Lake Chad was previously discussed in Section 4.3. LCBC member countries are more financially committed to basin programs, as demonstrated in the case of the inter-basin water transfer to replenish Lake Chad. External support agencies and donors, such as World Bank, UNDP/GEF, IUCN, WWF, DFID, ADB, and some national funding agencies are already actively involved in the basin situation. The LCBC should continue to reach out, both directly and through NEPAD and the African Union to the various potential donors (e.g., EU, Islamic Development Bank, FAO, World Food Programme, UNEP). It should mobilize them within a wider framework of multilateral support to Member States and LCBC in restoring Lake Chad's water resources and ecosystems of global importance, an undertaking currently beyond the means of the chronically poor countries comprising the region.

5.4 Broadening Lake Basin Management: Linking Local, National, Regional and International Entities

Poor coordination is perhaps the most critical managerial problem confronting the Lake Chad drainage basin and its national components. The sub-basins are often granted limited autonomy, which produces artificial divisions and precludes basin-wide long-term planning. Consequently, the project approach to development in the basin area involves schemes developed in isolation of each other.

Since the LCBC Abuja Summit in 1994, each member country has been trying to apply the main recommendations of the Summit in relation to the Master Plan. The first recommendation is preparation of medium and long-term databases for planning, and establishing early warning systems for rational water use and the environment, including environmental impact assessment for large projects within the basin. The second is the promotion of integrated multi-purpose projects. The last is the integration of the environment in all education systems as a training, information and awareness tool.

The LCBC/GEF Project on the integrated development of Lake Chad has lofty objectives, having already achieved a measure of success in some of the fundamental areas. It has established a Project Management Unit (PMU), which involves lead agencies in member countries. Some of the relevant plans and achievements (UNEP/DEWA 2003) include:

- Fifteen completed community-endorsed plans for access to, and sustainable use of, natural resources;

- A completed trans-boundary diagnostic analysis (TDA) and established monitoring systems and models of the hydroecological functions within the drainage basin;

- Six pilot projects, implemented with feedback from implementation supporting the development of the Transboundary Diagnostic Analysis (TDA) and Strategic Action Program (SAP), including five important wetlands distributed in all member countries, and registration of Lake Chad as a Ramsar site; and,

- The formulation of a GEF SAP that includes necessary baseline and additional actions to address the priority transboundary issues and the provision of monitoring and evaluation tools for implementation, as well as design of a set of sub-programs and identification of resources for their implementation.

Some of the actions that need urgent attention as part of the integrated water/basin development and management are:

- Improvement of dam design, coordination and efficient operation of the reservoirs. LCBC might look into the possibility of promoting adaptation by other Member States of the draft policy for reservoir operation being processed by the National Water Resources Council in Nigeria;

- Reversing the channel degradation resulting from blockages by silt and invasive weeds, which is a major cause of water scarcity in downstream areas and, hence, a topic of disputes and conflicts. The solutions identified in the Yobe basin include strategies to remove/clear the weeds (a regional endeavor is required here), improved reservoir operation and a water-apportioning structure at crucial locations (an option that has been stalled). *Typha* grows to full cycle within three weeks after it has been harvested, thereby frustrating such efforts. A non-structural approach, such as using reservoir operation for attacking the weed, holds greater promise. It is known that *Typha* cannot survive during periods of pronounced dry seasons. This is the case in the Jama'are basin where dam regulation is lacking, but pronounced dry season period occurs annually;

- Promotion of water resources augmentation through inter-basin water transfer and rainwater harvesting. The LCBC is already seriously committed to recharging the Lake Chad water volume through water transfers from the Congo River Basin. Further, rainwater harvesting for animals and crops is being practiced at an informal scale in parts of the lake's drainage basin. The communities could be empowered to more scientifically apply this technique. Rational exploitation of groundwater needs to be similarly promoted; and,

- Management policies and legislation that would articulate water quality and effluent standards, protection zones, necessary buffer capacity, approved method of waste treatment and discharge, etc., need to be developed and enforced at national and regional levels to forestall pollution within the lake drainage basin in the future. Although Nigeria and most of its 36 states have established elaborate standards, for example, an effective strategy for enforcement remains a main bottleneck.

5.5 Role of Scientific Research, Data and Capacity Building

The survival of Lake Chad and its resources depends on multi-sectoral, integrated water resources management efforts, based on good scientific data and local knowledge. There is a strong recommendation for implementation of regional initiatives for data monitoring and database creation and multi-purpose early warning system, with lessons from the ongoing effort in the West and Central Africa HYCOS (Hydrological Cycle Observing System).

The two associated research institutions in the basin are the Lake Chad Research Institutes at Maiduguri (Nigeria) and N'Djamena (Chad). The Institute in Maiduguri had established ten stations/experimental sites. However, it had to downsize its ambitious mandate in 1987, to become a crop-based research institute focusing on three programs: wheat-barley, millet and farming systems. There also was a program on extension feedbacks to end-users on farming practices, soils, integration of livestock, agroforestry, etc., through on-farm extension linkage projects. It had a breakthrough in 1980-90 in developing some high-yield and early maturing varieties of wheat. These and other research institutions need to be partners in progress as well, being properly equipped to deliver results that will lead to breakthroughs in knowledge and management practices.

Although it is not a research institute, the North East Arid Zone Development Programme (NEAZDP) was established by the European Development Fund of the Lome Convention, to promote integrated rural development in the area north of latitude 12°N in northeast Nigeria. Having already achieved a great deal, with its EU funding fully restored, it could be effectively used as a member of LCBC's PCU. This program's accomplishments include a semi-detailed natural resources inventory, with an easily updatable database, 15 specialized socio-economic surveys to produce indicators that facilitate sustainable rural development interventions, feasibility studies to enhance agricultural productivity, intensification of small scale irrigation, awareness raising, and improved water supply.

The LCBC and member countries should strengthen such good examples, replicate them, and use them to link local level development to national and regional integration.

5.6 General Lessons

Policy. A UNDP Study ("Planning and Management of the Water Resources of the Lake Chad Conventional Basin") projected irrigation within the basin to the year 2000. It suggested that 2.7 billion m^3 of water would be required, representing about 10% of the average potential water available during the period studied. Thus, it was concluded that the overall availability of water in the basin did not represent a major constraint to irrigation development. Similarly, no physical action could be taken within the basin that would make a marked difference to the water availability and affect the lake's water level. The policy recommended for the basin, a *laissez faire* policy to-date, may require a review.

Coordination. There is lack of coordination at the national level between the various tiers of government, the private sector and the organized civil society in the Lake Chad drainage basin. There is need for the authorities of the basin countries to evolve necessary mechanisms for coordination, for listening to and consulting with various stakeholders to ensure the awareness of and involvement in policy formulation, implementation, monitoring and decision-making. There also is a need for better environmental education at different levels.

Large-scale Irrigation. Large-scale irrigation developments in the Lake Chad drainage basin under-utilize completed dams, as exemplified by the use of the existing reservoir capacity, estimated at only 20% in the Komadugu-Yobe sub-basin in Nigeria, and even less for the Maga dam in Cameroon. This is attributed to the lack of proper management, as well as non-completion of downstream developments for which the dams were constructed. This problem often gives rise to insufficient water flows to floodplains downstream of existing dams. Furthermore, government interventions in large-scale developments often disregard existing water users, and continue to degrade the environment. Governments do not comply with the Fort-Lamy Convention that requires them to notify LCBC before undertaking such projects. They only comply when the projects are funded by donors.

Domestic and Industrial Water Supplies. Several key lessons have emerged from the Nigerian experience with respect to domestic and industrial water supplies, including:

- Water systems should respond to local demands and utilize appropriate technology;
- Community involvement in water and sanitation project planning is a crucial component of successfully planning;
- Governments must improve the efficiency and sustainability of system operation and maintenance; and,
- Water should be treated as an economic, ecologic and social good paid for by its users.

Management. Management of water resources in the drainage basin has many aspects, one being the achievement of more efficient use of rainwater by increasing groundwater recharge, increasing soil water-holding capacity and reducing evaporative loses from lakes, floodplains, reservoir surface, as well as irrigation fields. Water conservation also should include installation of valves on the free-flowing artesian boreholes draining the regional confined aquifers of the basin. With respect to petroleum exploitation, main areas of concern should include: salt-water contamination of groundwater through poor casing; inadequate well abandonment procedures; oil releases or spills; and improper disposal of saline water produced with the oil.

Groundwater Recharge. In the Sahelian zone, direct infiltration from rainfall through the non-saturated zone is usually very small. This is the case in the Lake Chad drainage basin, where recharge into the phreatic aquifer is due mainly to infiltration from the water courses, floodplains and from the edges of Lake Chad. For example, for a normal Lake Chad condition at 280 m altitude, it was estimated that the water volume removed annually from the lake via seepage is 8.8 billion m^3 (i.e., 18% of the mean annual water inflow into the lake).

Evaporation. Most of the available studies relate to surface evaporation, with no evaluation of direct evapotranspiration from soil and plants as part of the water balance estimate. While the average annual water evaporation rate at N'Djamena can be as high as 2,528 mm, the reported value of 2,200 mm for Lake Chad is believed due to the effects of the micro-climate.

GEF-funded projects. GEF-funded projects usually place their implementing agencies (World Bank, UNDP, UNEP) in "the driver's seat", rather than the beneficiary organizations being the primary driving force. Projects often are directed from thousands of kilometers away, resulting in unnecessary project delays. The Lake Chad GEF PDF-B project, for example, took over 3 years to develop a report, instead of the anticipated 8 months. Further, even after 3 years, the quality of the output was far less than the basin stakeholder expectations. The Lake Chad PDF-C project has followed the same pattern since 2000; pilot project titles were approved and changed many times, while the Project Implementation Manual (PIM) was prepared and rejected twice.

Performance Indicators. The Lake Chad GEF project document needs to incorporate newly-established program performance indicators for GEF International Waters Programs, particularly the process indicators, stress reduction indicators and environmental status indicators. These indicators also need to serve as the basis for benchmarking between the various GEF projects in Africa.

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