Second World Water Forum

LAKE CHAD BASIN COMMISSION

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PROBLEMS AND CHALLENGES ON INTEGRATED RIVER BASIN MANAGEMENT IN THE LAKE CHAD BASIN

March 2000

SECOND WORLD WATER FORUM

OVERVIEW OF PROBLEMS AND CHALLENGES ON INTEGRATED RIVER BASIN MANAGEMENT IN THE LAKE CHAD BASIN

THE HAGUE, 18th MARCH, 2000

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Introduction

In June, 1998, I presented a paper at the International Conference on World Water Resources at the beginning of the 21st Century: Water: A looming crisis? organized by UNESCO Paris. The title of the paper was the "Dwindling Water Resources of the Lake Chad Basin: An alarming trend for the 21st Century". The Second Water Forum is fortunately being organized within the first quarter of the 21st Century and the problems highlighted in that submission are yet to be solved and therefore relevant.

Since the Ministerial Conference of the Second Forum is going to discuss the vision and framework for action with a view to translating them into action, this paper is therefore an update of the earlier submission for the Forum to consider.

Historical background

Situated in the eastern part of the Sahel region of Africa, at the southern edge of the Sahara desert, Lake Chad and its active basin constitutes an important freshwater resource shared by Cameroon, Niger, Nigeria, Chad and the Central African Republic. The surface area of the lake varies considerably with the amount of annual rainfall and run-off. Lake Chad is Africa's fourth largest lake (in terms of surface area) after Victoria, Tanganyika and Nyassa. It is however shallow, with average depth of 1.5 m and is of relatively small volume.

One of the Lake Chad's tributaries, the Chari/Logone System, supplies approximately 95% of the lake's surface water input. The lake is subject to considerable evaporation and yet is not saline. For thousands of years Lake Chad has been a centre of development, trading and cultural exchange between the people's living to the north of the Sahara and those to the South. About twenty two million people depend for their livelihood on activities carried out in the Lake Chad and its active basin. This includes important wetlands and floodplains covering 967,000 km^2. By the year 2025, the population that will depend on the lake and its associated resources is projected to reach 36 million.

The LCBC area of jurisdiction comprises much smaller area of the Lake Chad Basin's geographic limit. This is because the hydrologically active area of the basin is much smaller (967,000 km²) and involve five riparian states but the geographic limits of the basin (2,355,000 km²) cover a large part of desert areas in Niger and Chad and are hydrologically de-coupled from the lake waterbody.

In 1964, four countries bordering the lake created the Lake Chad Basin Commission (LCBC), to handle the water resources management in an area referred to as *"the conventional basin"*. This convention did not include the Central African Republic and excluded the large desert expanses of Algeria, northern Niger and Sudan and, in particular, excluded the upstream part of the active basins of the Chari-Logone and Komadugu-Yobe. This "old conventional basin" covered approximately 427,300 km². Since 1994, the Central African Republic has been a member of the LCBC and *"the new conventional basin"* has been enlarged to include the upper basins of the Chari-Logone and Komadugu-Yobe systems covering about 967,000 km², divided up amongst the 5 countries as follows:

Table 1:

Country	Area in conventional basin (km?)	Population in 1991 (in thousands)	Density in 1991 (in p/km?)
Cameroon	56,800	2,100	37
CAR	197,800	700	3.5
Niger	162,375	240	1.5
Nigeria	188,000	13,856	74
Chad	361,980	5,048	14
Total	966,955	21,944	22.7

Distribution of active basin (or "new conventional basin" according to LCBC (areas) and Harrison and Kolawole (population -Pdf B).

This active Lake Chad basin takes into account almost all the water resources that supplies the lake, the Yaérés floodplain and the aquifers in the basin area.

The economic activities of the region are determined by highly variable and unpredictable rainfall patterns that characterize Sahelian climatology. Furthermore, the soil types that occur across the region exhibit a wide range of water holding and transmitting properties. The production of food, presence of fish, trees and grazing pasture all rely on the shallow circulation of water in the unsaturated and saturated zones. This circulation is maintained by the system of perennial and ephemeral rivers, open water and local and regional aquifers. The use of a supply driven approach, predicated upon averaged resource estimates, to investments to establish Water Development Projects, notably irrigation, has resulted in poor performance of the investments, as well as environmental degradation. The aquatic habitats have been severely impacted and the transmission of externalities downstream has amounted to gross inequities across the basin.

The present day Lake Chad is only the remnant of an ancient "Mega-Chad" which covered about 350,000 km² during medieval humid periods (TILHO, 1910). This was reduced to about 25,000 km² in the 1960s. Presently, it has been reduced to about 2,000 km² (Fig.1).

It should be pointed out that the Lake Chad is not a continuous free water but a group of morphological entities whose importance vary according to the level of water in the lake. More importantly, the Lake Chad consists of a Northern and a Southern Pool, separated by a "Great Barrier" which roughly goes from Baga Kawa in Nigeria to Baga Sola in Chad. The two pools sometimes separate at lake levels below altitude 279 m.

In actual fact, detailed palynological studies using diatoms and pollen, as well as Carbon-14 dating have provided more information which are summarized in the following table adapted from J. Pias (1970) in Olivry et al. (1996).

Table 2: Different Transgression Periods in the Lake Chad Basin (Adapted from J. Pias, 1970)

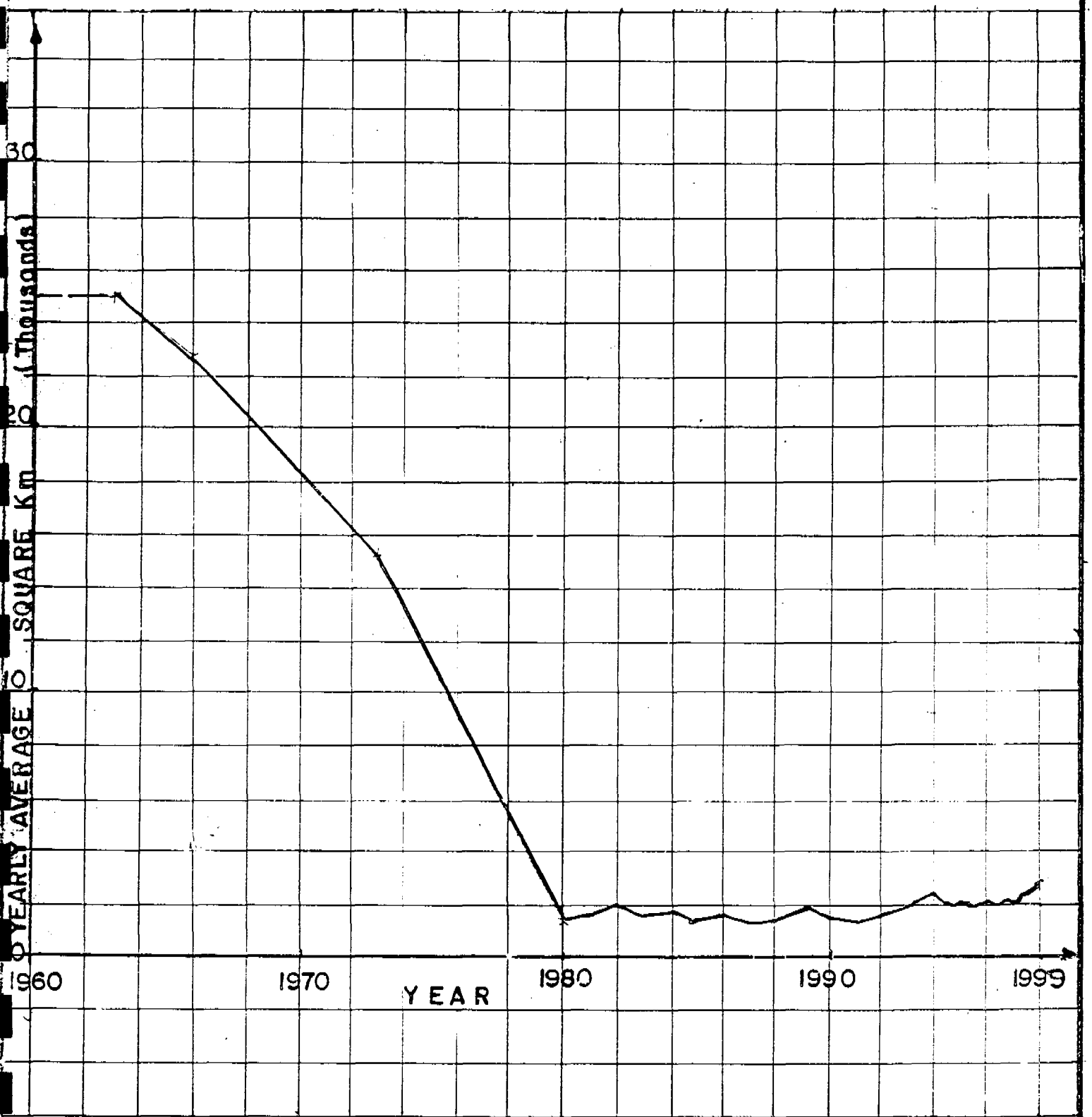
Period	Lake altitude	Sedimentary deposits	Approximate age (B.P.)
Present	282	Clayey deposits	
4th Transgression	287 290	Clay series, 3rd delta of river Chari, sand ridge	1,800 3,200
Regression			
3rd Transgression	320	Recent clayey and sandy series; 2nd delta of river Chari, sand ridge	5,400 12,000
Regression			
2nd Transgression	400 370 350	Ancient fluvio-lacustrine deposits	21,350
Regression			
1st Transgression	400 380	Disturbed ancient series; 1st delta of river Chari	

Water balance

The contributing sub-basins to the Lake Chad are underlain by basement complex in the upper source areas and by a progressively thick sequence of sedimentary deposits toward the lake. The hydro-stratigraphy in the sedimentary aquifers underlying the lake are only partially understood and the hydro-dynamic linkages to the Lake Chad waterbody therefore conjectural. However, it is apparent that the close interaction between rainfall, evaporation, the generation of lateral inflow to

Fig. 1

SURFACE AREA OF THE LAKE CHAD (1963–1999)



SOURCE: LCBC DATA BANK

CALCULATED FROM REMOTELY SENSED DATA

the lake and the groundwater leakage under the body of the lake influence the overall lake balance. A distinction has to be made between hydrological and hydrogeological context of each influent tributary and the aggregate water balance of Lake Chad itself. Equally there is a marked distinction between a humid period (prior to 1973) and the current drought regime that has persisted over the last thirty years.

The significant feature of the hydrological context is the persistent change in the rainfall patterns over the basin as a whole. In the two decades isoheytal contours of mean rainfall have shifted to the south by about 180 km. The results of this shift are that areas that have experienced a mean rainfall of 320 mm (for example, over the lake itself) now receive less than 210 mm.

In the upstreams, the decrease in mean rainfall of hundreds of mm/year, has brought about a proportionally larger decrease in basin yield as river runoff and effluent groundwater flow. This persistence in the rainfall variation regime is therefore resulting in a very attenuated basin yield and has to be set against burgeoning human demands upon the land and water resources of the system generally. The Lake Chad Conventional Basin comprises three sub-basins:

a) The Komadugu-Yobe sub-system has a basin area of 148,000 km^2. The upper basins contribute a total long-term yield of approximately 7 km^3/yr, the bulk of which is impounded at reservoirs within Kano State. Consequently the major part of this resource has not been able to establish a natural regime through the downstreams for more than 20 years. However, prior to impoundment, a large volume of flood-water nourished an extensive sub-system of flood-plains and wetlands. This sub-system provides about 1.5 km^3/yr when exiting the upper basin at Gashua and only 0.45 km^3 arrives at the Lake Chad. Below Gashua, flows maintain Hadejia-Nguru wetlands, where effluent flow from the watercourse recharges alluvial aquifers. Pumping and diversions for small irrigation schemes are prevalent. In this sub-system drought conditions and development of irrigation by pumping have exacerbated the water-stress. The current contribution of the Komadugu-Yobé to the Northern part of Lake Chad wetlands is locally significant but minor, in terms of the overall balance;

b) The Chari-Logone sub-system, has a basin area of approximately 590,000 km^2, and feeds an extensive wetland, the Yaérés floodplain (up to 6000 km^2 of active floodplain in wet years) and goes on to input an average of 37.8 km^3/year to Lake Chad (discharges have been regularly measured at N'Djamena since 1932). However, in the last decades the mean Chari discharge for the 1971-1990 period has fallen to 21.8 km^3/year due to the persistent change in rainfall patterns over the contributing catchment (Table 3). While the Chari-Logone sub-basin provides more than 95% of the total river inflows to Lake Chad, human consumptive use are currently estimated at less than 3% of the basin yield and are not considered to impact the waterbody itself.

c) The Lake Chad Water-balance: This has shown marked variation with geologic, historic and living memory and the open water surface of the lake has responded accordingly, exhibiting dramatic expansion and contraction. In the second part of the 15th Century, the open water surface of Lake Chad was said to have dried out completely during a generation, but there were very high levels in the 11th, 12th and 17th Century. Within the 20th Century, it has been possible to observe an irregular succession of wet and dry periods that can be explained by climatic change and to a certain extent by regional hydrological

persistence. In general, after five to ten years a new mean level equilibrium is established for each persistent period of "humid", "normal" or "dry" conditions. In an inter-annual balance established in 1984, the following breakdown of the hydrological balance terms are illustrated under steady state assumptions (no change between initial and final levels). This illustrative water balance applies to "intermediate conditions" or "middle Chad" at a level of 281.5 m (surface maximum of 18,000 km²) and also for a small waterbody at lower levels under much drier conditions.

Table 3

Type of persistent climatic conditions	INFLOWS IN KM^3/YEAR				Direct rainfall inflows km^3/yr	OUTFLOWS KM^3/YEAR			Area of lake and wetland surface km?
	Chari sub-syst.	Komadugu-Yobe	El-Beid & other	Total in-flows		Evapotranspiration	Infiltration (est)	Tot.out flow	
Long term mean rainfall	37.8	1.0	1.2	40.0	6.0	43.0	3.0	46.0	18,000
Mean of period 1971-90	21.8	0.4	0.2	22.4	2.1	23.1	1.4	24.5	9,400

Tentative illustration of the theoretical water balance of Lake Chad under steady state assumptions for two climatic scenarios (Adapted from Olivry, Mott Mac Donald and Pdf-B projects).

Drought and desertification

Rainfall deficits: first noticed in 1972 and 1973 in the basin have continued to date although there may be variations in intensities and extent from year to year. In actual fact, some authors have introduced the concept of abrupt climatic change located at around 1968 (Demarée, G.R., 1990).

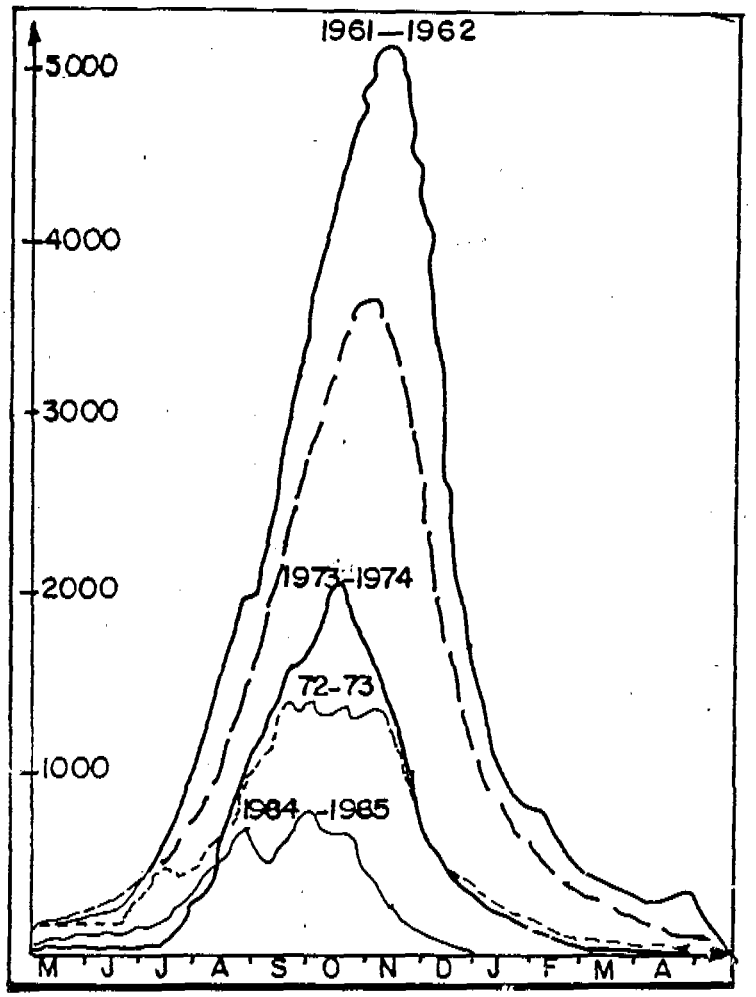
From 1973 with the exception of some occasional overflows of short duration towards the northern pool, the Lake Chad can be considered to have reduced and confined only to the southern pool. This is a very serious drought problems that can be appreciated in Fig. 1 above. In 1983-84; inflow from Chari/Logone fell to less than 17 km³ while in 1984-85 which was a very dry year, maximum discharge was below 800 m³/s at Chagoua along Chari river. The annual inflow was only about 6.7 km³. Similarly, inflow from the Chari/Logone rivers into the Lake Chad in 1987-88 was estimated at less than 10 km³ (Fig.2). The cumulative effect of these drought years resulted in virtual drying up of the lake in early 1988 (Fig.3).

Various reasons have been adduced to explain the prevailing drought. These include such mechanisms as:

i) Biogeophysical feedback mechanism, brought about by vegetation removal which invariably increases the surface albedo.

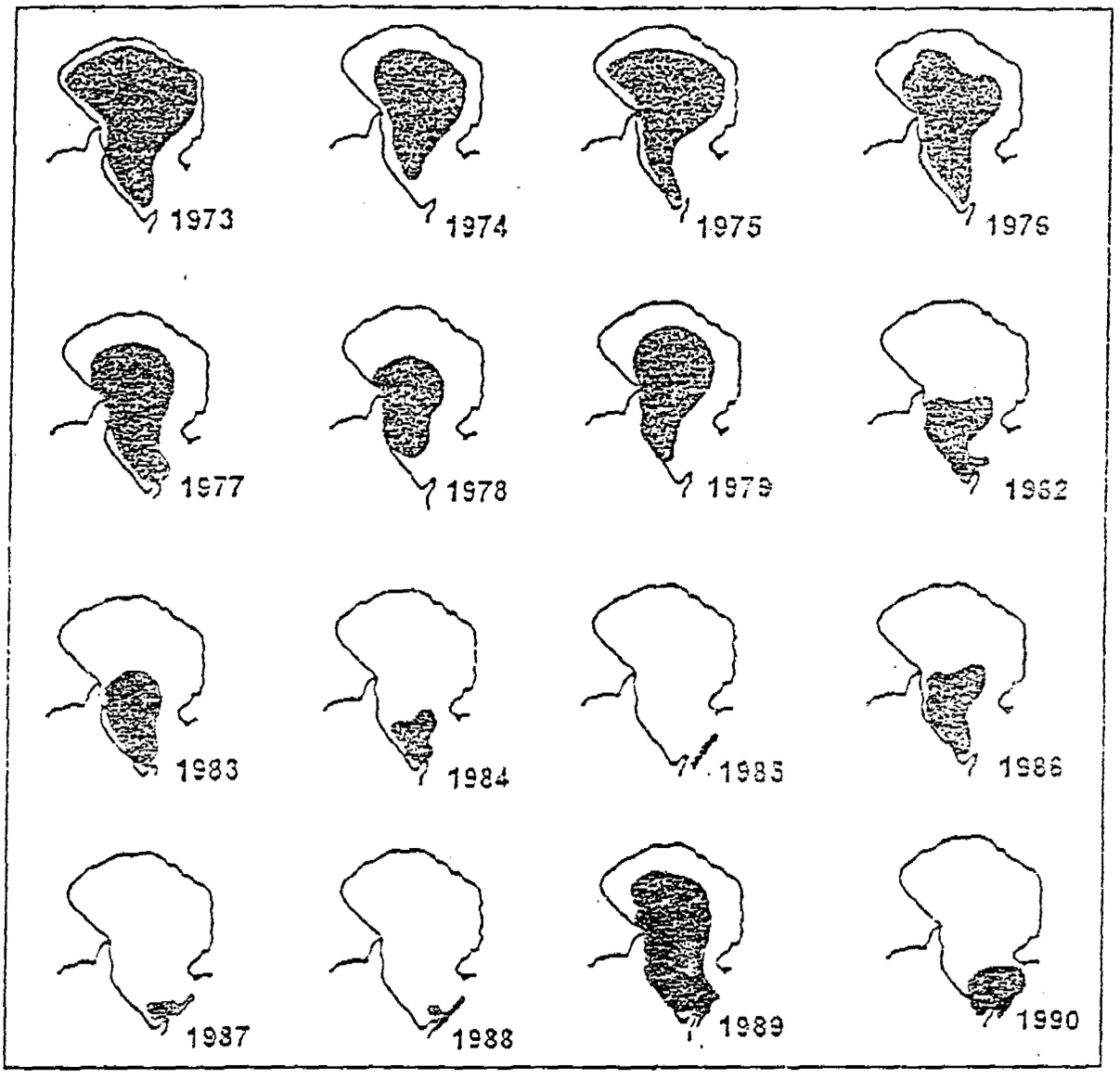
Fig. 2

CHANGE IN CHARI FLOOD HYDROGRAPHS AT NDJAMENA



SOURCE: OLIVRY ET AL, 1996

Fig. 3



Source : Elements sur la situation hydrobiologique du Lac Tchad (fin 1989 - début 1990).- Rapport ORSTOM.

ii) Global climate change attributed to causes such as volcanic activities, gas flaring, emission of greenhouse gases, depletion of the ozone layer, etc.

Desertification can also be explained by the southern movement of the isohyets which are demonstrated from annual data observed and reconstituted for the periods 1951-1970 (wet period) and 1971-1989 (deficit period). The figures revealed a clear southward shift in the isohyetal contours shifting from 550-220 mm to 400-150 mm (Fig.4).

High evaporation

This is a very important component of the hydrological balance. The table below gives annual values obtained for two stations using various methods:

Table 4: Annual Evaporation Ranges in the Lake Chad Basin

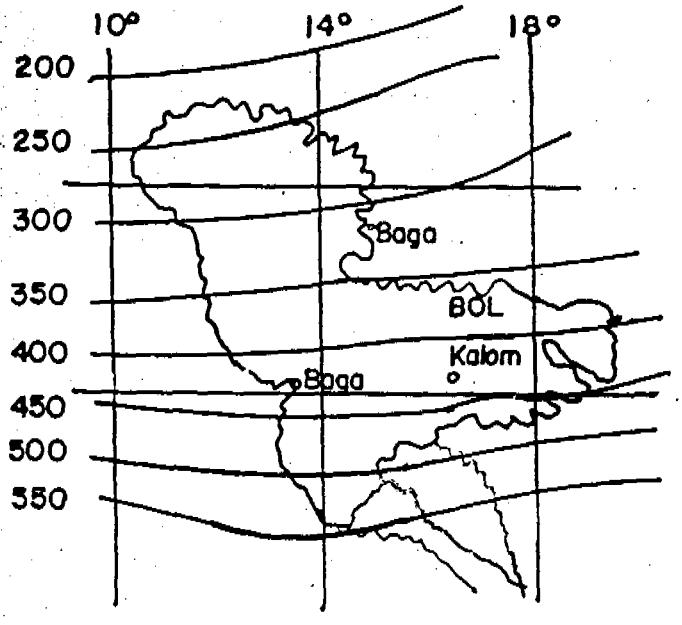
Method	N'Djamena(ORSTOM)	Bol Dune	Bol Matafo
Piche evaporation	2,27 (1964-73)	2,672 (1965-70)	2,836 (1965-77)
Colorado Pan evaporation	2,574 (1964-73)	3,296 (1965-70)	3,186 1965-77)
Class A Pan evaporation	2,824	3,780	3,585
Penman formula	2,284	2,290	2,689

Diminishing base flow

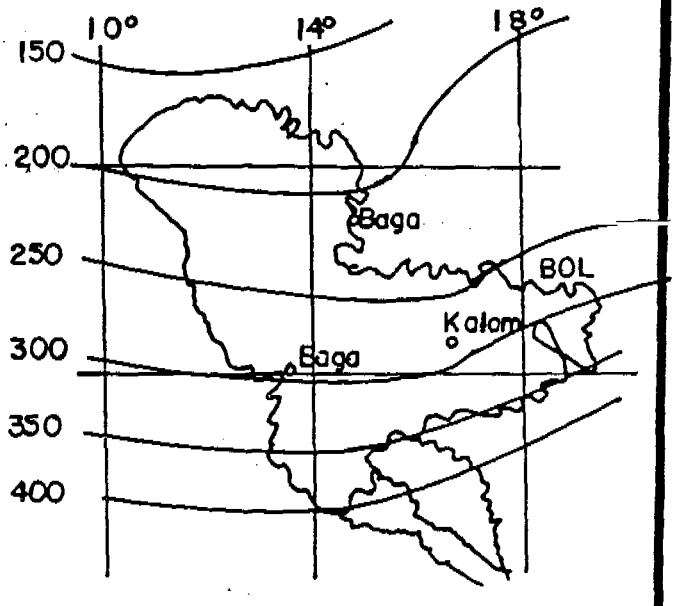
The natural regime of the low flow of the Chari/Logone river system, like any other systems in the soudano-sahelian belt, has also been reported to be seriously affected by the recent persistent drought. The absolute low flow during the last two decades has turned out to be the lowest in records. The changes in the base flow constitute the main causes for depletion. The considerable increase in the groundwater recession coefficient during the drought years essentially correspond to a reduction in the extent of the aquifers and insufficient recharge, thus the thickness of the basin aquifers.

The effects of rainfall deficits and high evaporation and diminishing baseflow in the basin invariably accelerated the desertification process. Sand dunes move southwards taking over the lake-bed. This phenomenon which respects no political boundary constitutes not only a problem but a major challenge to integrated river basin management in the Lake Chad Basin.

INTERANNUAL ISOHYETS CHANGES(1951-1989)



INTERANNUAL ISOHYETS CALCULATED OVER THE SURPLUS PERIOD.1951-1970 (AVERAGE: 320m)



INTERANNUAL ISOHYETS CALCULATED OVER THE SHORTFALL PERIOD 1971-1989 (AVERAGE: 207m)

SOURCE: OLIVRY ET AL, 1996

Environmental degradation

These natural causes along with man-made causes such as upstream dam construction, land degradation, soil erosion, deforestation and bush burning created very serious environmental degradation. The phenomena led to the total destabilization of the entire ecosystem of the sub-basin. As a result of drought and desertification, people moved out of their areas in search of job opportunities, thereby becoming environmental refugees. Fishermen have to follow the water for over 100 km to fish. There has been the general depletion of livestock, wildlife, vegetation and general fauna and flora.

Evidence of the persistent drought and desertification have been demonstrated in reduced runoff of the Chari/Logone system, high evaporation rates, rainfall deficits and desertification as well as the southward shift of the isohyets. Furthermore, groundwater recharge and base flow of perennial rivers have been deficient. General decline in agriculture, livestock and fisheries production and of course the biodiversity depletion generally. Recently, basin fisheries have suffered from a combination of influences and practices that include drought, over-fishing, diversion or blockage of instream flows, increase juvenile catch through use of smaller mesh sizes, and the near complete disappearance of the lake's northern pool.

In addition to the fishery, the basin contains other significant wildlife of regional and global importance. Over 370 species of birds have been inventoried in the basin, a third of the bird species being migratory. Concerns for the health of existing birdlife include a diminishing of nesting areas for the black-crowned crane and wintering grounds for intercontinental migrants such as the ruff. Other wildlife species in the basin include the oryx, damas gazelle, dorcas gazelle, slender-horned gazelle, elephants, black rhinoceros, the Lake Léré manatee, and other water dependent species such as crocodile, hippo, sitatunga and waterbuck. Concerns about these species revolve around poaching, the drought, and lack of trained cadre to protect, maintain and restore certain species.

The effects on biodiversity are very clearly seen in the various parks and reserves within the basin.

Population

Population growth is another major problem in the basin. As indicated in table 1, the population is almost 22 million which is projected to be over 36 million by the year 2025. Unless there is a change either in the climatic situation or by some artificial restoration or both the negative effects of demand on the limited water resources of the basin could best be imagined than described. 85% of the population being rural, rural-urban drift has become the vogue as a result of desertification and environmental degradation. This again leads to rapid urbanization process within the conventional basin. Cities like N'Djamena, Maroua and Maiduguri are good examples of such urban centres where urban water supply remains problematic.

Population explosion and migration in pursuit of means of livehood by the pastoralists, fishermen and indeed the environmental refugees as a result of desertification, invariably lead to competition for scarce water resources in the basin resulting into conflicts. Conflicts between farmers and graziers are of frequent occurrence. However they only become prominent when two centres are involved. Conflicts also occurred on emerging islands in the lake. An example was the case between Nigeria and Chad in 1983, when the two countries virtually went to war. Thanks to the role of the LCBC on conflict resolution whereby the Commission could listen to complaints and

resolve conflicts. A special Ministerial Session had to be convened in Lagos in 1985 to give the Commission the political mandate to find a solution to the problem. By providing fora for dialogue and discussions, a lasting solution was found through joint security patrols and eventual demarcation of the borders.

Poverty level

The cumulative effect of all the problems is poverty. The five countries are among the last forty on the human development classification. Three countries are among the last twenty: two among the last ten while one of them occupies the last but one position (1998: UNDP Human Development Report).

Challenges to Integration River Basin Management

The challenges to Integrated Management in the basin are many. The natural phenomenon of persistent drought and desertification within the basin has totally destabilised the entire ecosystem. While the lake is shrinking sand dunes are taking over the lake-bed, fishing is diminishing, the fishermen have become environmental refugees, food production is declining and biodiversity is being deciminated, the first challenge is joint action on how to conserve the little available water resources in the basin.

1. Conservation

This is a major challenge for integrated management of the basin. It is necessary that integrated conservation programmes are embarked upon to conserve the limited available water resources. This could be done through programmes such as revegetation cover to improve the soil texture thereby reducing evaporation and trans-evaporation. Creation of protected areas such parks is essential. Industrial activities including rapid development of mining upstream of the basin and oil drilling prospects are signs of economic development, but they also put some threats to fishing and biodiversity. Measures have to be taken to protect the rivers, aquifers, aquatic ecosystems and the lake itself against the risk of cross border pollution.

The richness of the basin's floodplains support a wide range of economic activities - recession agriculture, irrigation, pastoralism, forest regeneration, fish breeding and production drought fallback security, and tourism potential. Because no species appear to be restricted to the lake, regeneration of the fishery is possible as long as floodplain habitat remains accessible and fishing is controlled, particularly during dry periods.

2. Restoration

Another challenge to the Commission is the restoration of the lake level and its ecosystem. As indicated above the most pronounced feature of the Lake Chad Basin has been its wetlands. Lake Chad itself is the 2nd largest wetland in Africa and hosts biodiversity of global significance. The Yaeres floodplains, the Hadejia-Nguru wetlands, lakes Lere and Fitri are all ecosystems that require some restoration. Improvements naturally through heavy rainfall or artificially through cloud seeding or intra- or inter-basin water transfer options have to be considered. A process of restoration has been started by the Waza-Logone Project whereby the Yaeres ecosystem is being re-flooded by opening the Maga dam and dykes of the Logone river.

3. Desertification control

It is a big challenge to integrated management to halt desert encroachment. Desertification is by nature a transboundary phenomenon. Sand dune fixation and revegetation programmes have to be tackled regionally to be effective. Of course restoration artificially could also arrest desertification and facilitate socio-economic activities of the teaming population of the basin.

4. Data collection

Water resources data collection, the means and system of collection is another challenge. Data collection, collation, storage and dissemination systems in the basin leaves much to be desired. It is absolutely necessary that they are updated, modernized and made effective and adapted to fit the information revolution.

5. Regional cooperation

In shared water resources management the fundamental prerequisite is cooperation. It should be pointed out here that with $ emphasis on political sovereignty, and the fact that most riparian countries have only a small portion of their countries that falls within the basin, it is very difficult for them to change their national laws to suit the requirements of the basin. Moreso when the international laws on shared water resources management have been for too long in the process. What is being used is still their principles rather than internationally accepted laws. Promotion of regional cooperation by an instrument such as a statute, protocol or conventions acceptable to all the riparian countries is a necessity. Conflicts cited above could only be resolved through dialogue and cooperation.

Thanks to the LCBC statute which stipulate a role for promotion of regional cooperation. By providing a forum for dialogue and exchange of ideas the countries have been able to maintain close contact and high level cooperation. What is required is strengthening of the regional institution (organization).

The problems and challenges cited above are by nature regional covering the entire river basin shared by the five riparian countries.

Fortunately, long before Madel Plata forum where global water issues were first addressed by the International Community, the Heads of State of the Lake Chad Basin Commission have realized that they have a shared water resource that necessitate cooperation and joint management strategies. Hence the creation of the Lake Chad Basin Commission by a statute and convention in 1964. This, therefore, provided a legal framework and an institution for promotion of cooperation and joint-management of the resources. The functions of the Commission amongst others include planning and management of water resources, promotion of regional cooperation and indeed conflict resolution.

To tackle the problems and challenges enumerated above the LCBC adopted an integrated management strategy which considers the whole basin as a unit as proposed by the Dublin Conference and approved by the Rio World Conference on Water and Environment. In fact since 1985 persistent drought and desertification in the basin led the Commission to start considering a holistic approach to its river basin management. That was when the conventional basin was

theoretically extended to its present day active hydrological extent of 967,000 km?. In 1994 the Central African Republic joined the Commission thereby actualizing the scheme.

Ironically the date the Central African Republic officially joined the Commission was the very day a Master Plan for Environmentally Sound Management of the old conventional basin was approved by the Heads of State. That portion of the basin which was hitherto not under the LCBC jurisdiction was then taken into account in preparing the Strategic Action Programme of the Commission.

The challenge for basin-wide integrated management was therefore tackled in the preparation of that programme with full support and active participation of the stakeholders: the member countries, NGOs, Water Users Associations and the LCBC Secretariat, with the financial assistance from GEF and technical support of UNDP-UNDESA. The Strategic Action Programme is holistic, integrated, participatory and indeed sustainable. The details of this will form the subject of the LCBC Regional Vision and its Framework of Action.

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