The Northern Cameroon Floodplain: influence of hydrology on fish production*

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Résumé

Influence de l'hydrologie sur la production de poisson dans la plaine d'inondation du Nord Cameroun

Dans le Bassin Tchadien, de nombreuses espèces de poissons effectuent des migrations longitudinales et/ou latérales pour exploiter trois types de milieux: le lac Tchad, les fleuves et les zones inondées, en particulier la plaine d'inondation du Nord-Cameroun ('Yaéré'), reliée au lac par l'El Beïd où des pêcheries traditionnelles s'exercent sur les juvéniles qui quittent la plaine au moment de la décrue. Les rendements de ces pêcheries ont été utilisés comme indice pour étudier l'influence de l'hydrologie sur la production du Yaéré. De 1968 à 1978, des crues d'amplitude moyenne à très faible ont fourni les conditions d'une expérimentation naturelle sur les effets d'une éventuelle réduction artificielle des crues. La sécheresse sahélienne de 1972-1973, en supprimant l'inondation deux années de suite, a provoqué l'assèchement des mares résiduelles. Par ailleurs, par l'abaissement du niveau du lac Tchad, elle est à l'origine d'une régression lacustre du Tchad Normal en Petit Tchad (marécages prédominants) et d'une restructuration de la composition des stocks lacustres.

L'influence de la crue annuelle se manifeste à un niveau global par une corrélation positive entre production et volume d'inondation. Au niveau spécifique, les fortes crues favorisent la croissance individuelle; elles permettent également un allongement de la période de reproduction qui se traduit chez certaines espèces par l'individualisation d'une 2e cohorte de jeunes.

Dans le cadre d'une succession régulière des crues, la relation production/crue paraît indépendante de la composition spécifique du peuplement du Yaéré et du faciès lacustre. Les Tilapia-Sarotherodon (sédentaires) sont à l'origine d'une distorsion de cette relation. A la suite de l'assec 1972-1973, ils constituent l'excédent de la production attendue lors de la faible crue 1974. L'assec paraît favoriser la production de l'année suivante de façon comparable à l'évolage pratiqué dans les étangs.

A partir de ces éléments et malgré des statistiques de pêche très limitées, nous avons tenté d'aborder le problème régional de la gestion des pêches dans le contexte d'un aménagement hydro-agricole du Yaéré.

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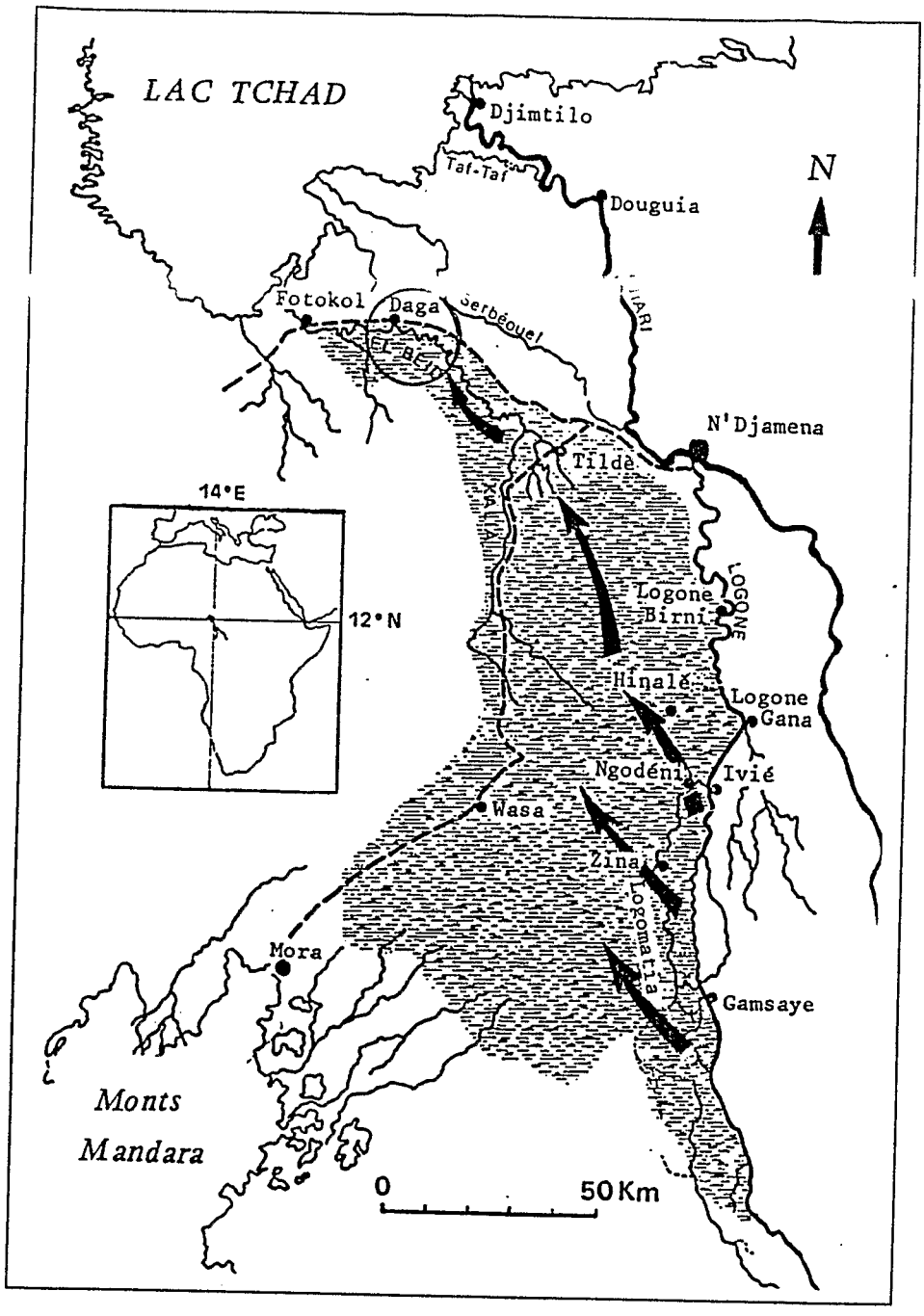

Figure 1 Location map. The sampling site is encircled. Migrations of young fishes towards the El Beid are represented by arrows, and the road network is represented by broken lines

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Introduction

The Lake Chad Basin experiences great annual variability of rainfall and consequently of flood volume. The shallow water expanses such as Lake Chad and the floodplain of Northern Cameroon ('Yaérés', Figure 1) are particularly sensitive to flood variation which may result in significant ecological disturbance.

The floodplains of Northern Cameroon provide a particularily important nursery for fish. As floodwaters subside at the end of the flood season, part of the flow does not recede to the Logone River channel but instead moves towards Lake Chad by the El Beid River. Significant numbers of juvenile fish reach the Lake by this route. A good many species use these interconnected biotopes via fluvio-lacustrine migrations which are important in maintaining fish production in the Chad Basin. The adults go upstream into the river system to reproduce on the floodplain where the alevins first grow. The juveniles meet the traditional fishery in the El Beid River during their downstream migrations towards the Lake Chad (Durand, 1970 and 1971; Benech and Quensière, 1982 and 1983a,b). The dry season is spent in the lake, which is an important feeding ground

The catches of the El Beid fisheries were used to study the influence of hydrology - and of an eventual situation of flood regulation - on the fish production of the Yaérés. The study period (1968-1978) was particularly favourable because the hydrological variations over this time provided a natural experiment that allowed determination of the influence of the state of the lake and the impact of a drying-up of the Yaérés as well as the effect of the flood in the case of a normal flooding occurrence.

Hydrology and definition of the flood index

The Yaérés spread over about 8,000 km^2. Every year they are flooded by rainfall and the overflow of the Logone River. LANDSAT imagery allowed examination of the seasonal dynamics and the hydrological variability of the Yaérés (Benech *et al.*, 1982).

The flooding can be seen only in September (Figure 2). The waters enter the plain both upstream and downstream of N'Godéni (Figure 1). The upstream overflowings increase when the flood is strong whereas the downstream ones remain approximately constant. The depth of the water which pours into the Yaérés at the flood maximum is not related to the magnitude of the flood which declines from upstream to downstream at fixed rates. The fall which starts in October (Figure 2) is a regular interannual event. The flood of the El Beid outlet reaches a maximum at the end of November at Tildé indicating

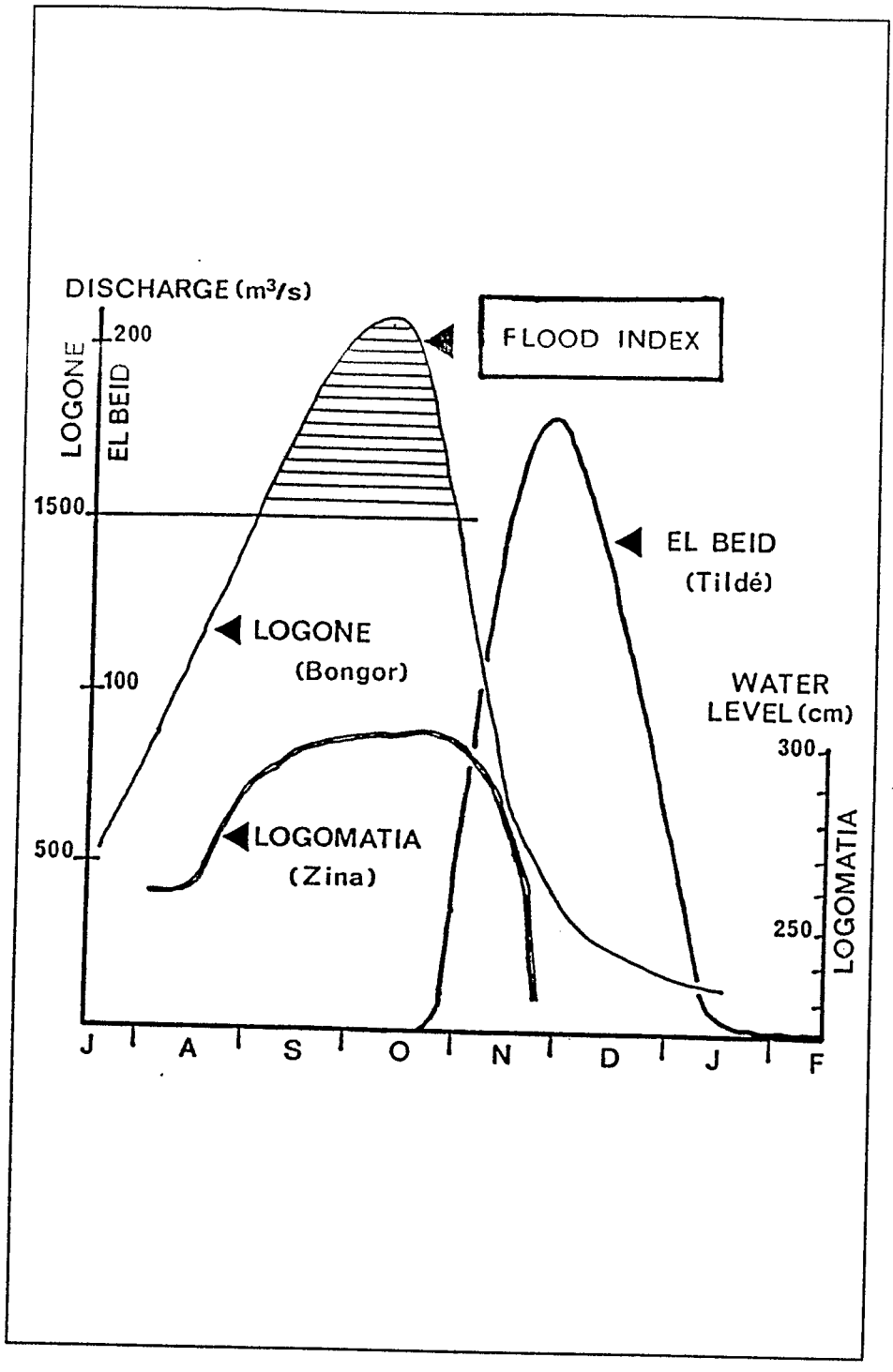

Figure 2 The flood in different sites

drainage of the Yaérés (Figure 2). In January, flooded areas still remain around the upper part of the El Beid River; and are drained finally towards the end of February.

The plain is flooded when a discharge exceeds 1,200 m^3/s at Bongor (a site located on the Logone River upstream from the overflows in the Yaérés), but the flood wave reaches the El Beid River only during the years when the flow exceeds 1,500 m^3/s. It did not occur in 1972 and 1973 and the El Beid River was not supplied in these two years. A flood index has been established. It corresponds to the water volume determined by the enclosure of the curve of the Logone River discharge at Bongor beyond 1,500 m^3/s (Figure. 2).

The 1972-1973 Sahelian drought limited the flooding of the Yaérés in the Logone River floodplain which resulted in the drying-up of the residual ponds distant from the river. As these small floods accelerated the lowering of the lake level, they hasten the change from the 'Normal Chad' (18,000 km^2) to the 'Lesser Chad' (9,000 km^2) characterized by the development of vast marshy areas at the expense of open water areas and archipelagoes (Carmouze and Lemoalle, 1983).

Influence of hydrology on fish production

Definition of an index of fish production

The El Beid fisheries are the main traditional fisheries of the Yaérés. Their average annual production amounts to 1,400 tonnes of fresh fish sold after being sun-dried. About 300 fishing dams are found along the river. Standing in front of a dam, the fishermen use a triangular net which is periodically lifted and checked. The fishing season extends from November to February.

The Daga Dam catches were observed over six years (Figure 1); first in 1968, the Normal Chad period, and from 1974 to 1978, the Lesser Chad period. A sampling method based on traditional fishing technique was worked out and maintained regularly during the six fishing seasons. Every three days, twelve two-hour fishings were conducted on a diel cycle and this was maintained for the whole fishing season.

The weight of our sampling catches from November 27th to February 10th was given as the Yaéré fish production index every year. This stands as a good index insofar as this catch per unit effort is a linear function of the production. According to the analysis of the migratory movements and the sampling conditions (Benech and Quensière, 1982 and 1983a,b), we may consider that this condition was fulfilled. During the study period there was no exceptional flood to modify the fishing conditions.

Influence of the annual flood volume

Except for 1974 (a year following the drought and marked by a great abundance of *Tilapia-Sarotherodon*), a positive correlation between fish production index and the flood index was noticed (Figure 3). If the very high catch of *Tilapia-Sarotherodon* species in 1974 is not considered, then the catch for other species that year also fits well with the new relationship (Figure 3, 'without *Tilapia*').

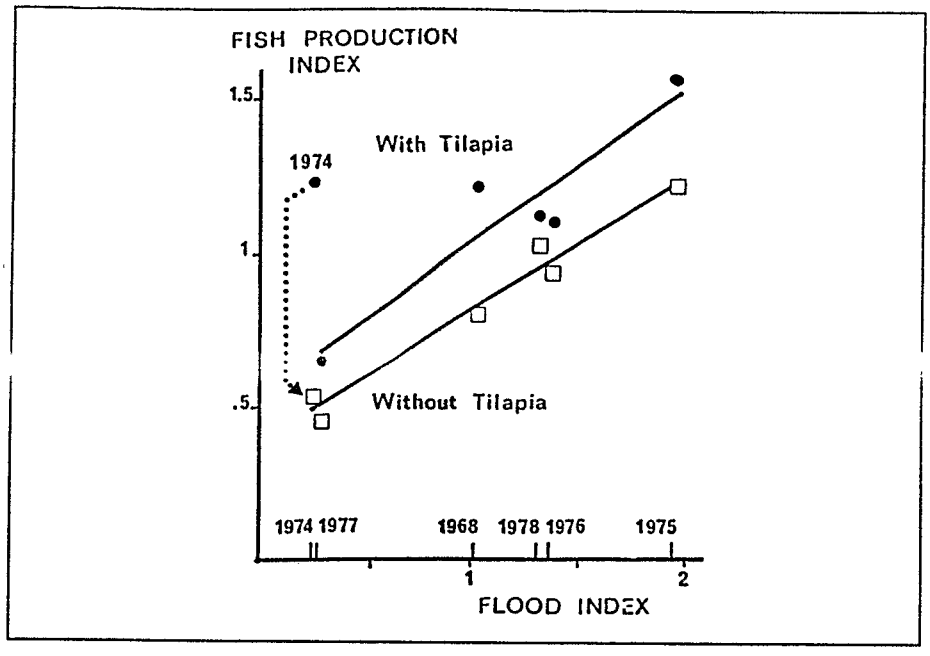

Figure 3 Relation between the fishing yield at the Daga Dam and the importance of the Logone flood

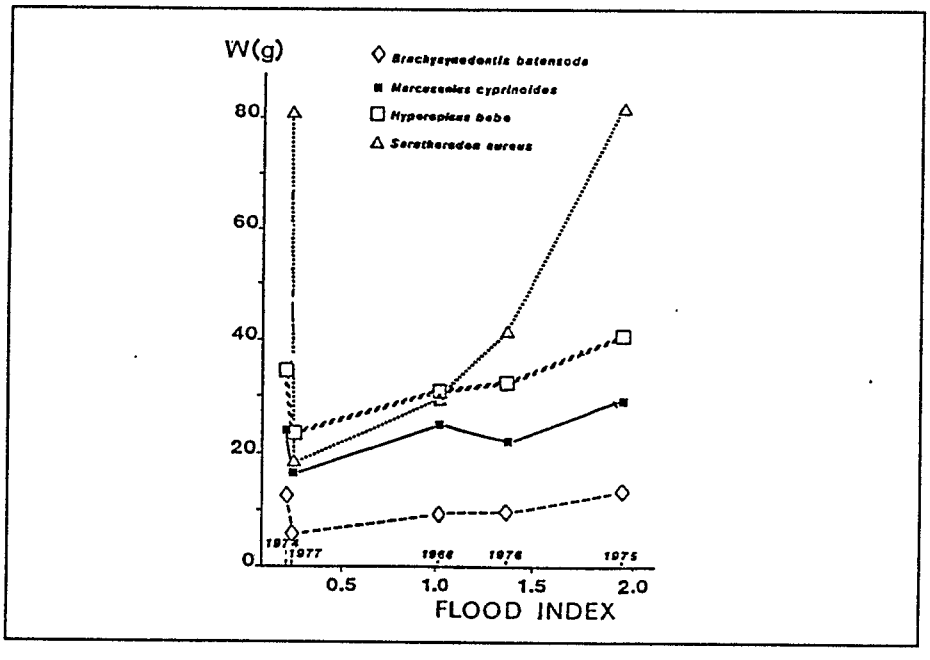

Figure 4 Relation between the mean specific individual weight (w) of catches collected at the Daga Dam and the importance of the Logone flood

The fish production is a function of both the number of fish and their average weight. In fact, at a species level, strong floods promote individual growth (Figure 4); 1974 is once again not taken into consideration, (see below); floods also allow a longer spawning period which results in the production of a second cohort of juveniles by some species (Benech and Quensière, 1983b).

The year 1968 (Normal Chad period) fits well with the relationship (Figure 3) which is based mainly on data of the Lesser Chad period. The production-flood volume relationship therefore seems independent of species composition and of lake state. In fact, the lake recession has disturbed the structure of the lacustrine fish communities by reducing the stocks of the species, especially the migrators, which were not adapted to the hypoxic conditions. Consequently, the upstream spawning migrations have been affected. An analysis of the components of the catches of the El Beid fisheries revealed that the structure of the Yaérés fish community has changed markedly after the drought period; species diversity is being reduced and the migratory species are becoming less abundant.

Influence of the drying-up of the Yaérés

With the exceptional drought of 1972/1973, only areas adjacent to the river were flooded. This limited flooding prevented the juveniles from entering the main part of the plain for two consecutive years and suppressed the migrations down the El Beid. It also caused the drying-up and the destruction of the fish stocks in the residual ponds which are remote from the river.

In 1974, with normal flooding, the *Tilapia-Sarotherodon* (the larger part of sedentary species) increased considerably in the El Beid catches, very probably because of the absence of competition. The phenomenon declined the following years as the residual pond populations were restored; the abundance of the *Tilapia-Sarotherodon* decreased and the species diversity increased again.

The *Tilapia-Sarotherodon* peak in 1974 distorted the production/flood volume relationship, i.e. they supplemented the low production predicted as a result of the small flood of 1974 (Figure 3). The drying-up of the Yaérés, therefore, had a beneficial impact on the following year's production especially by increasing growth (Figure 4). However, it was the *Tilapia-Sarotherodon* which benefitted most in this situation.

Discussion

The regulation of the Logone River, and subsequent change in the flood pattern would seem, *a priori*, to be harmful to fish production because the biology of many species is related to the natural hydrology of the basin. In the light of development plans for the basin, the determination of water management operations allowing irrigation without threatening the fisheries potential - an actual richness which is well integrated to the socio-economic life of the area - is therefore required urgently.

Recent hydro-agricultural works in the Yaérés, especially those of the SEMRY II rice project, have revealed that some water reservoirs used for irrigation constituted an important fisheries

potential spontaneously exploited by the local populations. Thus for the Maga Lake (30,000 ha) fish production was estimated as 2,800 t/year (Artidi et al., 1983) which is twice the production of a fishing season for all El Beid fishing dams.

Although the production of Lesser Chad is lower [about 100,000 tonnes regularly from 1975 to 1977 (Durand, 1980)], the yield is higher than that of Normal Chad especially in relation to the quantity of water required (Benech and Quensière, 1987). On the contrary, flood reduction is detrimental to the El Beid fisheries; this may, in the extreme, suppress totally the production in absence of discharge in the El Beid River as happened in 1972 and 1973. However, the yield increase which follows these drought years is a favourable aspect which deserves attention in the planning of new schemes. The desiccation appears to promote the next year's production in a similar manner as the periodic drying-up of managed ponds.

This information on fisheries production suggests that the artificial maintenance of the Chadian fluvio-lacustrine system in its Lesser Chad state must be planned carefully, because this situation may cause long-term harmful effects without necessarily bringing sustainable benefits. Among the possible unfavourable effects are side effects on the regional climate owing to a reduction of evaporation. Reduction of the flooding will also suppress nutrient enrichment of the plain with possible effects on vegetation and the wildlife of the Yaérés which are a natural resource to be protected because of their ecological and economic interests. And last, the perpetuation of Lesser Chad is especially harmful to fluvio-lacustrine migrator fish whose survival strategy is based on the combined exploitation of the lake, rivers and floodplains. It cannot be guaranteed that reduction of these stocks to a very low level might be compensated forever by an increased productivity of the other species along the floodplain, and Lake Chad and Lake Maga. Do the 100,000 tonne annual productions of 1975-1977 correspond to a sustainable production or to a short-lived glut comparable to the phenomenon found in newly built tanks?

The data required to provide a comprehensive answer to this question is not available at this time, although the Lesser Chad state has persisted naturally for a decade. A number of recommendations can, however, be made on the water management needs for fisheries in this fluvio-lacustrine system.

It is known that at present the lacustrine production of the upstream migrators (especially the 'salanga' species) is negligible because their exploitation strategy of the lake-river-floodplain is maximal only in the Normal Chad conditions. Under present conditions it is therefore not possible to improve production of these species simply by allowing downstream migration through the El Beid River following regular and a sufficient flooding of the Yaérés. The fact that the absence of recruitment through the El Beid River in 1972 and 1973 did not have any quantitative effect on production of Lake Chad supports this hypothesis.

Under the conditions of Lesser Chad, a reduction in flooded area along the Yaérés may therefore have a limited impact upon fisheries. Further, if the water is stored in small reservoirs such as Maga Lake, this can be used for both agriculture and fisheries. The biomass and fish production of a river-floodplain system do not depend only on the flooding area but also on the quantity of residual water in the dry season (Welcomme, 1979). The artificial water stocks fulfil this role as a small scale model of Normal Chad.

In other words, the Maga Lake shelters important populations of species such as *Lates, Alestes, Hydrocynus, Schilbe* (de Kimpe, 1983), which characterise the fish community of Normal Chad. Thus, under the conditions of Lesser Chad, these reservoirs may play an important role in conserving fish stock density, and providing a resource for rebuilding the potential of the Normal Chad system.

Editor's note

After the work reported upon here, the fishery of Lake Maga has been heavily overfished. The optimism expressed here therefore needs to be re-examined.

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