CHAD

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General

Chad - officially the Republic of Chad - is a landlocked country in Central Africa. It is bordered by Libya in the North, Sudan in the East, the Central African Republic in the South, Cameroon and Nigeria in the Southwest and Niger in the West. The area of the country is 128 Mha (million hectares). In 2020 the population was 16.4 million, or 0.13 persons per ha (Wikipedia and United Nations, 2019)

Climate and geography

Chad has several regions: a desert zone in the North, an arid Sahelian belt in the centre and a more fertile Sudanian Savanna zone in the South. Lake Chad, after which the country is named, is the largest wetland in Chad and the second-largest in Africa (source: Wikipedia).

In Chad polders have existed and are still existing along the east coast of Lake Chad (Figure 1) (Dieleman and De Ridder, 1963; Batello *et al*., 2004). This lake has no outlet. In some publications reference is made that crop strategies in areas bordering lake Chad include farming of cultivable lands on the lake bottom, some of which were being cropped. Farming is also done on 'recessional lands,' where the lake water recedes every year and in 'polder' depressions between 'dunes'. Rice, wheat, maize, and vegetables are grown. In a traditional polder, one crop a year was grown as the lake water receded. If dams and pumps are used, up to three crops a year can be grown. Besides fewer fish, a low lake level also means a shorter shoreline and thus fewer polders. Around 1970 Chad's Lac Prefecture estimated that only 10% of its polder areas were being used.

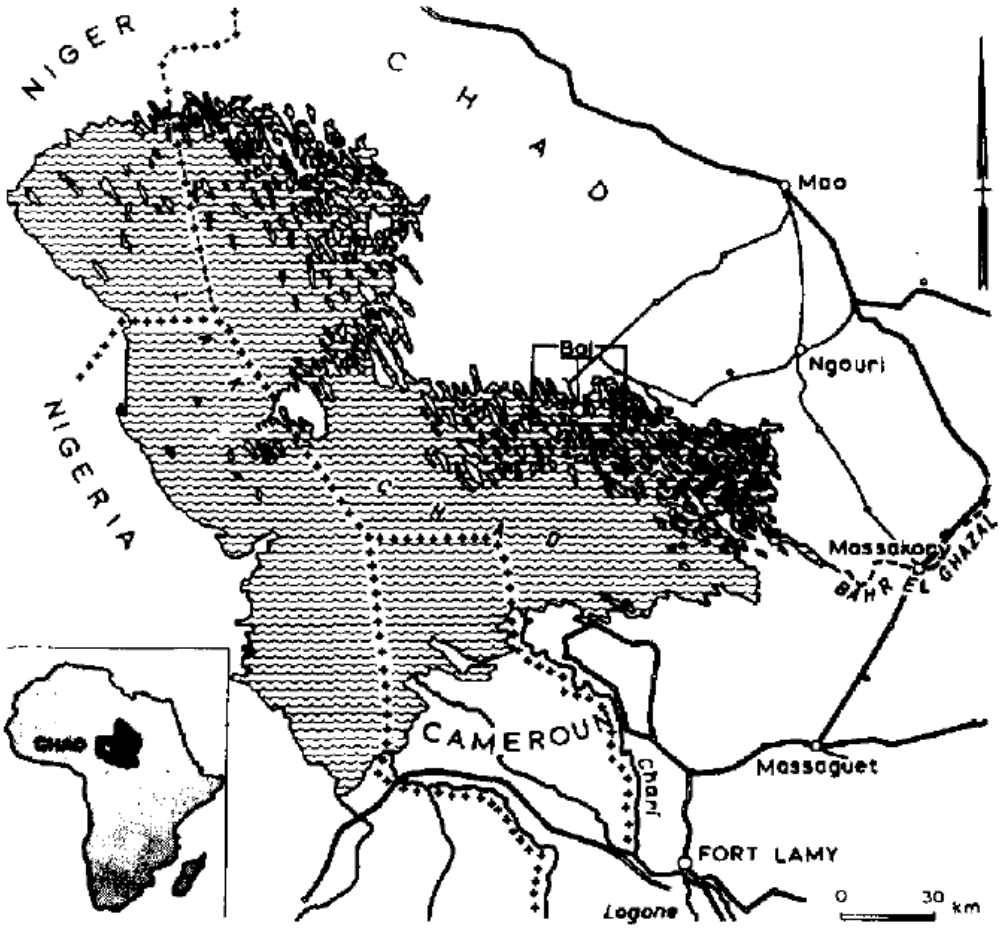


Figure 1. Lake Chad and its surroundings (Dieleman and De Ridder, 1963)

The paper of Dieleman and De Ridder (1963), the report of Kindler *et al*. (1989) and the paper of Visentini and Linoli (1990) (Figure 2) show bed and water levels of lake Chad that are of interest in relation to polder development. They gave the following data:

- bed of the lake about 277 m+MSL (mean sea level);
- high water 283 - 284 m+MSL;
- all time minimum lake level at Bol Dune from 1907 – 1972 is 279.93 m+MSL;
- minimum water level in 1973: 278.12 m+MSL and in 1974: 278.23 m+MSL.

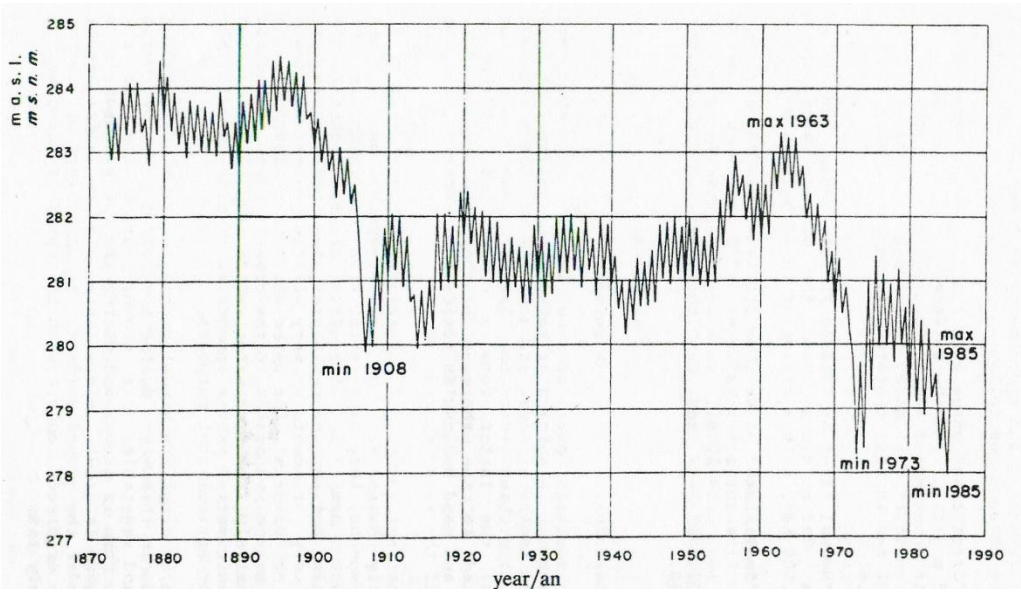


Figure 2. Yearly variation of the water level of Lake Chad at Bol (Visentini and Linoli, 1990)

The National Aeronautics and Space Administration (NASA) has published on its web site maps with the area of Lake Chad from 1963 – 2007 (Figure 3). From these maps it can be derived that in that period on average there has been a continues decline in the lake level.

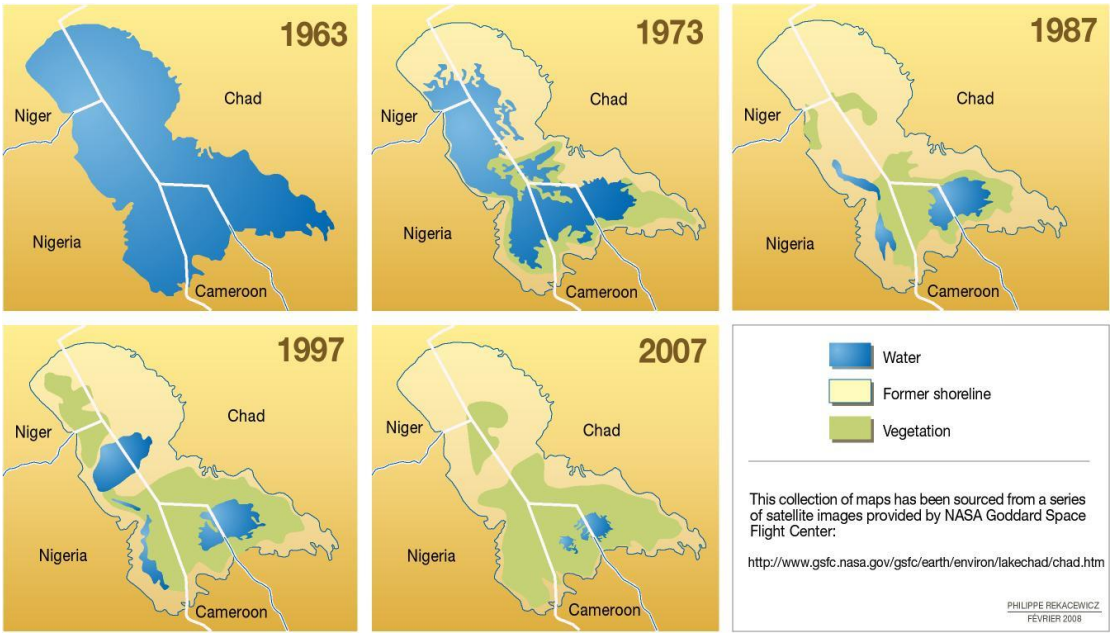


Figure 3. Declining of the area of Lake Chad from 1963 – 2007 (NASA web site).

A little more detailed map for the situation in 2010 has been given by Lemoalle and Magrin (2014) (Figure 4).

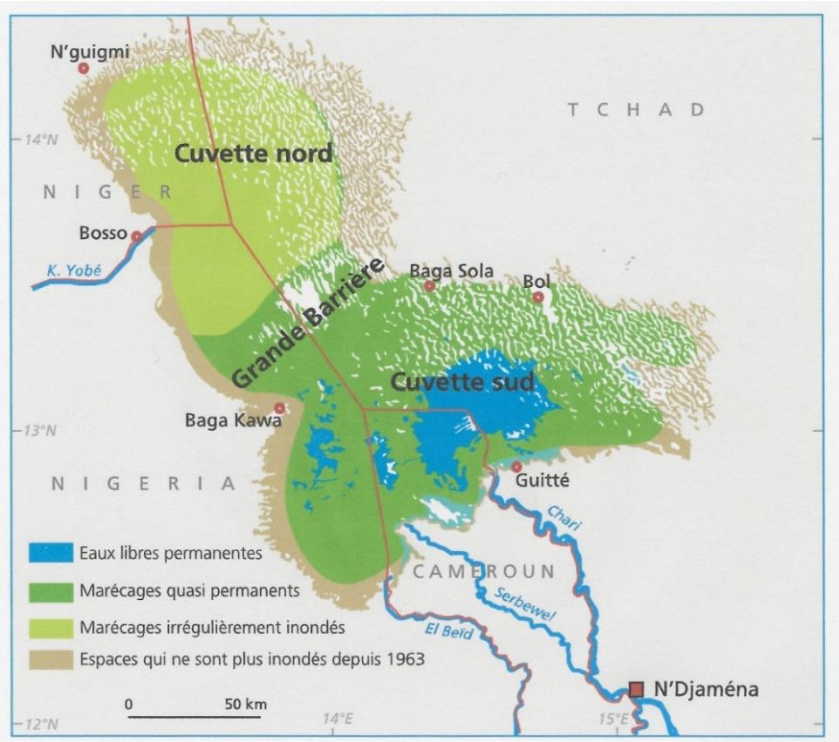
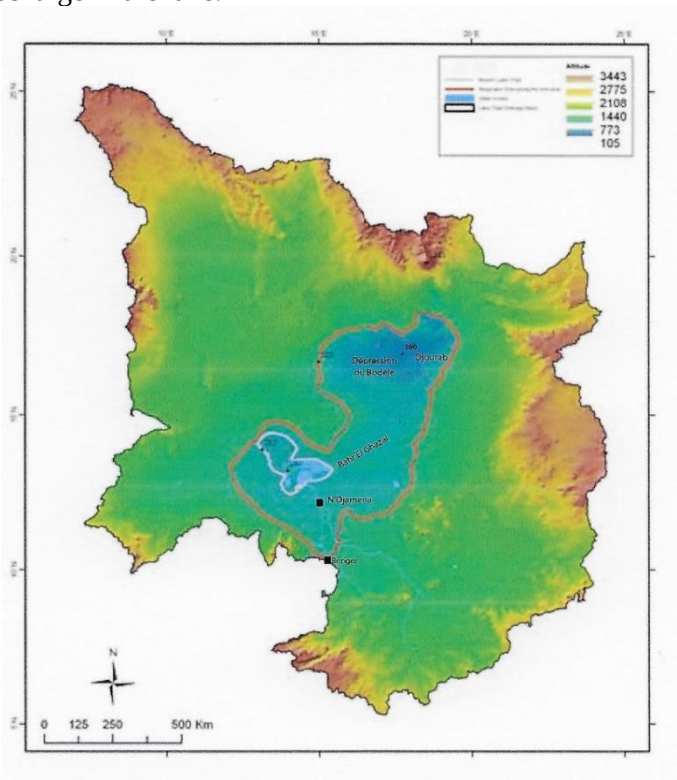


Figure 4. Situation of Lake Chad around 2010 (Lemoalle and Magrin, 2014)

Lemoalle and Magrin (2014) show the minimum and maximum area of Lake Chad, as well as the river basins that discharge in the lake.



Legend: The black line delimits the river basin covering 2.5 million km^2, the red line delimits the extension of Mega-Lake Chad to the Holocene covering 340 000 km^2 with an altitude of 320 m, the pink line delimits the Middle Lake Chad at 282 m. The image was made with GTopo3 and Hydro1k data (source: United States Geological Survey (USGS)) (Lemoalle and Magrin, 2014)

Figure 5. Lake Chad and its river basin.

Based on observations, simulations and satellite observations Pham-Duc *et al*. (2020) present the fluctuations in the water level of Lake Chad (Figure 6). From Figure 6 it can be derived that since 1980 the lake level has more or less stabilised.

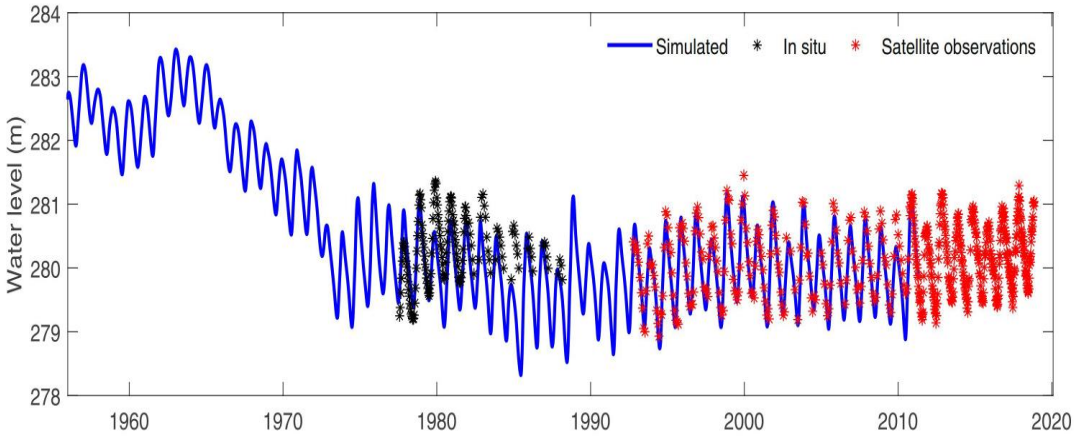


Figure 6. Water level in Lake Chad from 1955 till 2020, based on observations, simulations and satellite observations (Pham-Duc et al., 2020)

Kindler *et al.* (1989) mention in their report that the northeast border of Lake Chad contained small interdunal valleys that flooded seasonally as Lake Chad did rise. Others became moist from a rising groundwater table, corresponding to the rise in the lake level. When Lake Chad receded or trapped water infiltrated and evaporated, these 'polders' became fields for the cultivation of wheat, maize, cotton and potatoes. They stated that a complex series of events might occur with polder development. On one hand, the lake surface is restricted and marginal salt deposit areas reduced. On the other hand, any localized increase in salt concentrations will limit crop production and long-term soil fertility. At this point polder development may not be large enough to impact salinity in wet years.

According to Visentini and Linoli (1990) the traditional polders were located along the Chad shoreline, in particular between the villages of Baga Sola and Konlodin, where a series of islets and sand dunes stretch into Lake Chad. In the driest months the local population created polders by constructing sand dams between the peninsulas. They also describe that every 2 to 4 years the farmers broke the sand dams when the water level in the lake was high, to leach the accumulated salts through the soil and letting in water from the lake. Three types of polders were distinguished:

- *lowest polders*. The groundwater table either appears to the ground surface or the water is raised by capillary forces just until the surface;
- *slightly higher polders*. The capillary rise goes as far as the rootzone of the crops but never reaches the surface;
- *highest polders*. The surface level is so high that the roots of the crops are not reached by the capillary rise.

On Google Earth it can be observed that there are still several polder areas in the east coast of Lake chad.

Existing polders

Halfway the twentieth century two 'modern' polders were created by constructing dikes between the peninsulas (Figure 7) (Dieleman and De Ridder, 1963; Visentini and Linoli, 1990; Batello *et al*., 2004). The first one was the *Bol Guini Polder*, 500 ha. The construction of this polder started in 1951, when the main part of the area was surrounded by dikes. In 1954 the water in the endiked area was evaporated and the lake bottom emerged. The soils are clayey, rich in organic matter and minerals. The land use is agriculture with wheat and maize as main crops. A typical cross-section of the polder is shown in Figure 8 (Group Polder Development, 1982). The other polder was the *Bol Berim Polder*, 1,000 ha. This polder

was reclaimed in 1954. It is rather similar to Bol Guini Polder (Group Polder Development, 1982).

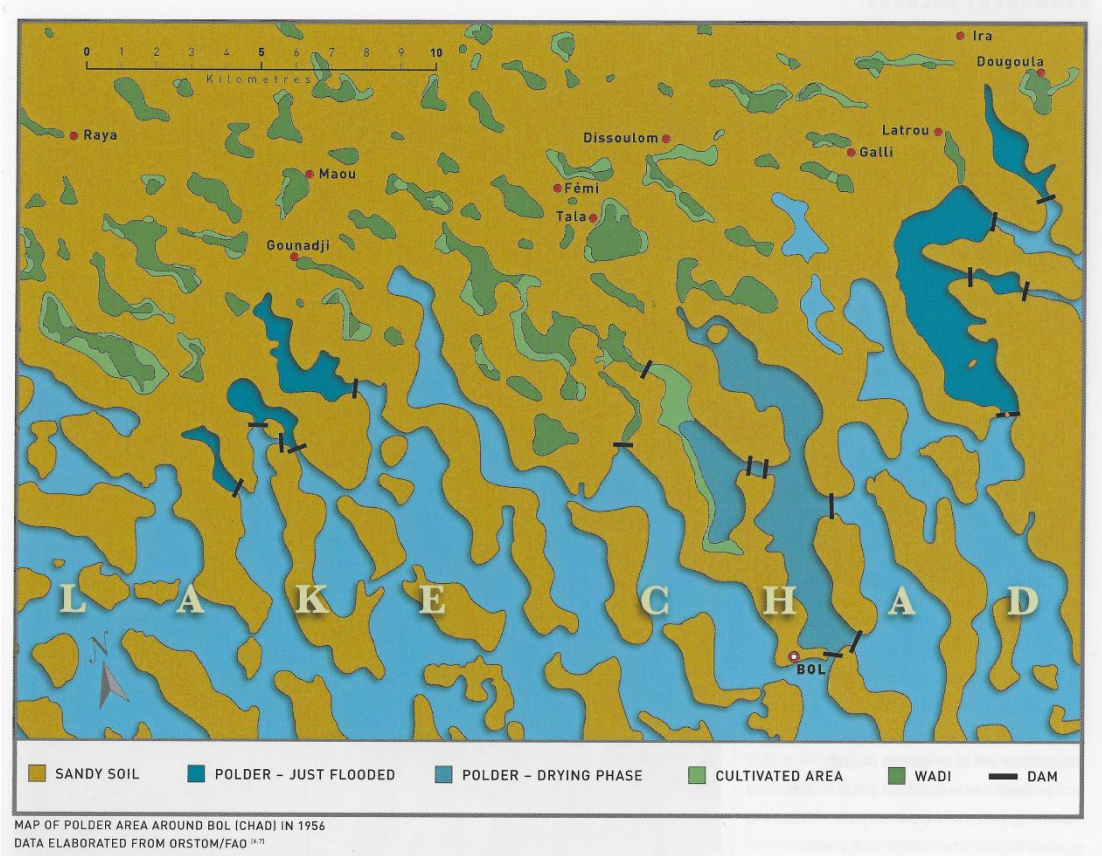


Figure 7. Map with polders along Lake Chad (Dieleman and De Ridder, 1963; Batello et al., 2004)

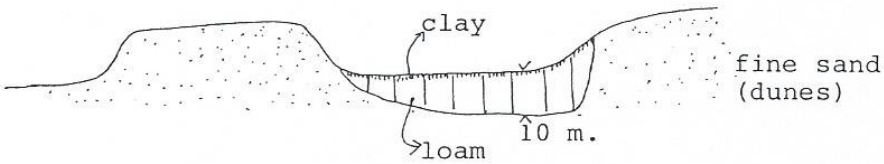


Figure 8. Typical cross-section of the Bol Guini Polder (Group Polder Development, 1982)

There has been the Lake Chad Polders Project, consisting of: i) rehabilitating and completing the irrigation and drainage networks of the *Bol Guini Polder* (370 ha net area); ii) constructing the irrigation and drainage networks for *Bol Berim polder* (800 ha net area); iii) establishing a commercial agricultural development section which would have to prepare the way for farmer settlement, and be responsible for the first year of operation on all newly developed land; iv) providing a package of services (resettlement assistance, training extension, credit, and marketing) to the farmers who would take up cultivation of the polders; v) constructing necessary service centres and houses for project staff; vi) expanding adaptive agricultural research at the Matafo Research Station; vii) providing consultant services to reorganize the Société de Development du Lac Tchad (SODELAC). The project appraisal report by the World Bank (1975) describes the envisaged improvement of the Bol Guini, Bol Berim and Mamdi polders. Schematic representations of these polders are shown in the Figure 9.

In the project evaluation report by the World Bank (1987) it is shown that the project indeed started in 1975, but was stopped in 1979. The report stated that most of the project works were not completed and that those that were completed were destroyed during the civil war.

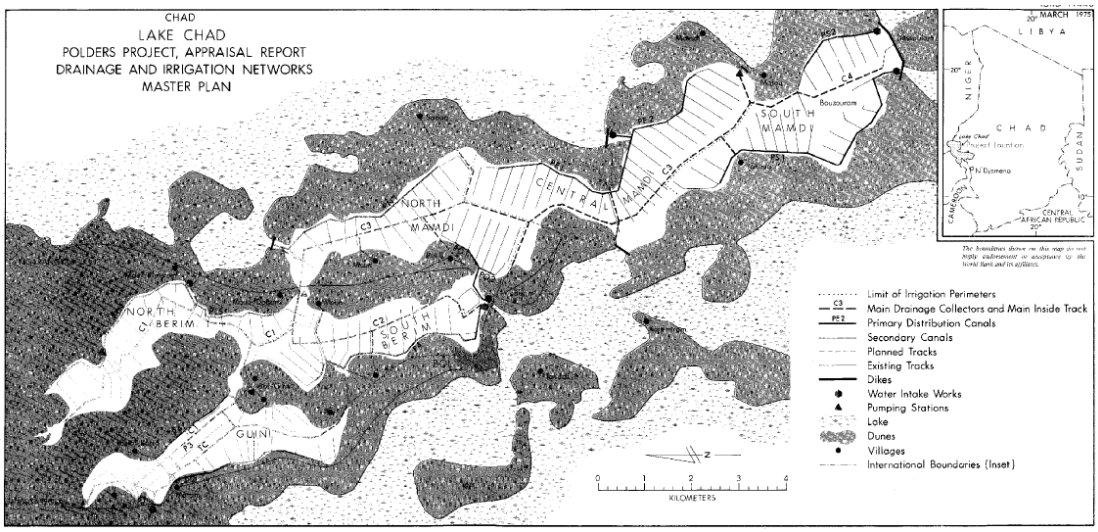


Figure 9. Envisaged lay out of the Bol Guini, Bol Berim and Mamdi polders (World bank, 1975)

Visentini and Linoli (1990) describe that they identified 44 traditional polders with a total area of about 19,000 ha, of which in 1986 only 15 with a total area of about 7,700 ha were still cultivated. They also describe that under the Italy-Chad Rehabilitation and Development Programme, among others 11 polders with an existing area of 4,800 ha were selected for rehabilitation and enlarging to in total about 7,800 ha. Most of the surface in these polders is below 279.80 m+MSL.

In addition to the work on the Bol Guini and Bol Berim polders, as mentioned above, there has also been the intention of the development of the Mamdi Polder (1600 ha) that is adjacent to these polders (World Bank, 1975). However, in the framework of this project no activity has taken place with respect to the Mamdi Polder (World Bank, 1987). Neverthesess, this polder is shown on Google Earth. It is not clear to me when it has been made. It could have been in the framework of the project supported by Italy (Visentini and Linoli, 1990).

In addition on Google Earth several other small polders in the area can be identified.

Proposed polders

No proposed polders have been identified.

Various

In order to compensate for the drop down in the water level of Lake Chad there have been serious plans to transfer water from the Congo River to Lake Chad, called the *Transaqua Project*. An overview of these plans is given by Marcello Vichi (2011). In addition there has been a feasibility study on the transfer of water from Oubangui River to Lake Chad (Cima International, 2011). In this study it was concluded that there was a technical feasibility of an average transfer of about 5.4 km^3/year. As far as it is known, so far the plans have not been implemented.

References

Buma, Willibroad Gabila, Sang-Il Lee and Jae Young Seo, 2016. Hydrological Evaluation of Lake Chad Basin Using Space Borne and Hydrological Model Observations. *Water*, 8, 205.

CIMA International, 2011. *Étude de faisabilité du projet de transfert d'eau de l'Oubangui au lac Tchad, Document-synthèse: principaux résultats de l'étude de faisabilité*, Laval, N'Djaména, Chad (in French).

Dieleman, P.J. and N.A. de Ridder, 1963. Studies of salt and water movement in the Bol Guini Polder, Chad Republic. *Journal of Hydrology*. Volume 1, Issue 4. p.p. 311-343.

Batello, Caterina, Marcio Marzot and Adamou Harouna Touré, 2004. *The future is an ancient lake*. Food and Agriculture Organization of the United nations (FAO). Rome, Italy.

Group Polder Development, Department of Civil Engineering, Delft University of Technology. *Polders of the World, 1982. Compendium of polder projects*. Delft, the Netherlands.

Kindler, J., P. Warshall, E.J. Arnould, C.F. Hutchinson and R. Varady, 1989. *The Lake Chad Conventional Basin. A diagnostic study of environmental degradation.* United nations Environmental Programme (UNEP) and United Nations Sudano-Sahelian Office.

Lemoalle, Jacques and Géraud Magrin, 2014 *Le développement du lac Tchad Situation actuelle et futurs possibles*. Institut de Recherche pour le développement. Marseille, France.

Luxereau, Anne, Pierre Genthon and Jean-Marie Ambouta Karimou. *Fluctuations in the size of Lake Chad: consequences on the livelihoods of the riverain peoples in eastern Niger*. Regional Environmental Change, September 2012, Volume 12, Issue 3, pp 507–521 National Aeronautics and Space Administration (NASA). Maps with the area of Lake Chad from 1963-2007.

National Aeronautics and Space Administration (NASA). *Maps with the area of Lake Chad from 1963 - 2007*. http://www.gsfc.nasa.gov/gsfc/earth/environ/lakechad/chad.htm

Pham-Duc, Binh, Florence Sylvestre, Fabrice Papa, Frédéric Frappart, Camille Bouchez and Jean-FrancoisCrétaux, 2020. The Lake Chad hydrology under current climate change. *Nature, Scientific Reports*.

Rieu, M., 1975. *Les polders du lac Tchad: milieu naturel et formation des sols, conséquences de la sécheresse*. Orstom, N'Djaména, Chad (in French).

United Nations, Department of Economic and Social Affairs, Population Division. 2019. *World Population Prospects, medium prognosis. The 2019 revision*. New York, USA.

Vicentini, G. and A. Linoli, 1990. Polders in the lake Chad area: a special example of measures to combat drought and guarantee agricultural production. In: Proceedings of the 14th Congress of the International Commission on Irrigation and Drainage (ICID) Q43.R3. p.p. 29-38.

Vicentini, G. and A. Linoli, 1990. I polders del lago Ciad: un esempio particolare di lotta alla siccità e di garanzia della produzione agricola. *Irrigazione i Drenaggio*. Vol.37 No.4. pp.15-19 (in Italian).

Vichi, M., 2011. Transferring water from the Congo to Lake Chad: the Transaqua Project. *EIR*, Vol. 38, No. 28. 22 July. p.p. 31-36

World Bank, 1975. *Appraisal of Lake Chad polders project, Chad.* Report 828a-CD (restricted availability). Washington DC, USA.

World Bank, 1987. *Project performance audit report. Lake Chad Polders Project.* Operations Evaluation Department, Report no. 6751 (restricted availability). Washington DC, USA.

Table I. General characteristics of existing and proposed polders in Chad

Name	Reclamation	Area in ha	Type *)	Latitudes	Longitudes	Elevation in m+MSL	Land use
Existing polders							
Bol Guini Polder	1951-1954	500	RLL	13° 30’ N	14° 41’ O		Agriculture
Bol Berim Polder	1954-1956	1,000	RLL	13° 29’ N	14° 42’ O		Agriculture
Mamdi Polder		1,600	RLL	13° 25’ N	14° 44’ O		Agriculture
Italy-Chad Rehabilitation and Development Programme		7,800	RLL			Below 279.80	Agriculture
Total		10,900					

*) RLL = reclaimed low-lying land; LGS = land gained on the sea; DL = drained lake