

Lake Chad in Adversity: Chronicles of Past, Present and Future

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Abstract

Being one of the largest endorheic basins that fluctuate seasonally in Africa, the Lake Chad is geographically spared among four countries; Chad, Niger, Nigeria and Cameroon. The Lake Chad has always being extremely valuable water resource for this region. This resource have facilitates various aspects of growth and development to more than 30 million inhabitants of the region. More recently, several budding natural impacts such as recurring droughts, decline in annual rainfalls and degradation of the vegetation cover have led to various drastic changes to the environmental conditions of the Lake area. Consequently, the recent drying up of the Lake coupled by dessert encroachment, decline in agricultural production, livestock and fisheries is threatens the social and economic well-being of over 22 million people living in the Basin. The United Nations Food and Agriculture Organization (FAO) have called the recent situation of Lake Chad as an “ecological catastrophe,” and also predicted that the lake could possible disappear this century. Therefore, the present study reviewed key factors that contributed to the current harsh conditions of Lake Chad region and recommends necessary measures that can mitigate the impacts of the drying lake on the development of communities around the basin.

Keywords: Africa, Common Resource, Disappearing Lakes, Natural Resource Disaster, Water Resource Management

1. Introduction

Lake Chad is ranked as one of the largest lakes in Africa. This lake surface area covered varies across seasons and years, however, the lake is endorheic and shallow (Hopson, 1967; Tobor, 1973). The general Lake Chad of Africa is shared by countries such as Central Africa, Chad, Nigeria, Niger and Cameroon (Atlas, 2007). The Lake Chad is an extremely valuable resource for this region growth and has also greatly contributed to various aspects of development for this region’ 30 million inhabitants (Alabaster, 1981). This lake has covered a total area of 1,350 km³ with maximum depth of 36 ft (Hopson, 1967).

The Lake Chad formation can be confined or unconfined which are largely dependent on respective regional local conditions. Most of recharge in the Lake Chad general area is through infiltrations by seasonal rainfall with an estimated groundwater recharge of about 4.3 BCM per year (Tobor, 1973; Andriese, 1986). The Chad Basin Aquifer is transboundary shared by Chad, Nigeria, Cameroon, Niger and Central African Republic. This

region is no significant records of water quality issues and also there are only fewer records of water quantity issues in this region recorded largely around few major cities, i.e. Maiduguri (Borno State) Nigeria (Verinumbe, 1990). The aquifers found in this region are the Chad, Gombe and Keri-Keri formation. The Chad formation yields between 2.5 and 30 l/s, the Gombe formation is relatively low permeable and usually yields between 1 to 5 l/s, while only little known is known about the Kerri-Kerri Formation depth (Offodile, 2002).

The great Lake Chad is characterized with numerous cases of annual flood events and also has greatly varied in size over the last centuries. With growing population of the lake surrounding region, low human development index and lack of holistic regional approach, the crying for of this region is just starting. Recently, the general Lake Chad region is facing various budding challenges ranging from naturally induced climatic issues to various anthropogenic problems. Therefore, the present study reviewed key factors that contributed to the current harsh conditions of Lake Chad region and recommends necessary measures that can mitigate the impacts of the drying lake on the development of communities around the basin.

2. Geography and Hydrology of Lake Chad Region

Lake Chad is a freshwater lake located in the Sahelian zone of West-Central Africa located in the interior basin. It is commonly known as the "Mega Chad" which was historically ranked as one of the largest lakes in Africa. However, its surface area varies by season and as well as from year to year. According to Stewart (2009), the name *Chad* is a local word meaning "large expanse of water", in other words, a "lake". This lake gave birth to the country named Chad. It is the remains of former inland sea "paleolake Mega-Chad" that existed during the African humid period (Stewart, 2009). The Mega Chad was estimated to be larger than the present day the Caspian Sea; with total area cover of about 1,000,000 km² during 5000 BC (Stewart, 2009; Drake and Bristow, 2006). However, the Lake Chad basin is spatially spread over many countries, i.e. Chad, Nigeria, Cameroon, Niger, Central African Republic (CAR), Sudan, Libya and Algeria, and covered about 8 percent of the total landmass of African continent (Welcomme, 1976; Adams, and Hollis, 1987).

The Lake Chad has no apparent outlet, therefore, water of this lake mainly percolate into the "Soro" and "Bodélé" depressions (Tobor, 1973). The climate is dry most of the year, with moderate rainfall from July through September. According to the Global Resource Information Database of the United Nations Environment Programme, it shrank by as much as 95% from about 1963 to 1998, but "the 2007 (satellite) image shows significant improvement over previous years (Verinumbe, 1990). The water of this great lake have fluctuated between 1,000,000 and 2,500,000 ha prior to the 1972/73 drought. Though, a study by Hughes and Hughes (1991) reported that this lake falling below 250,000 ha around 1973 to 1975. Hence, the flood events of 1988-1989 have significantly contributed to resurgence of the lake to area of about 1,000,000 ha (Sagua, 1991). The Lake Chad remained central and the most strategic source of freshwater for the livelihoods of the people of this region (Hughes and Hughes, 1991).

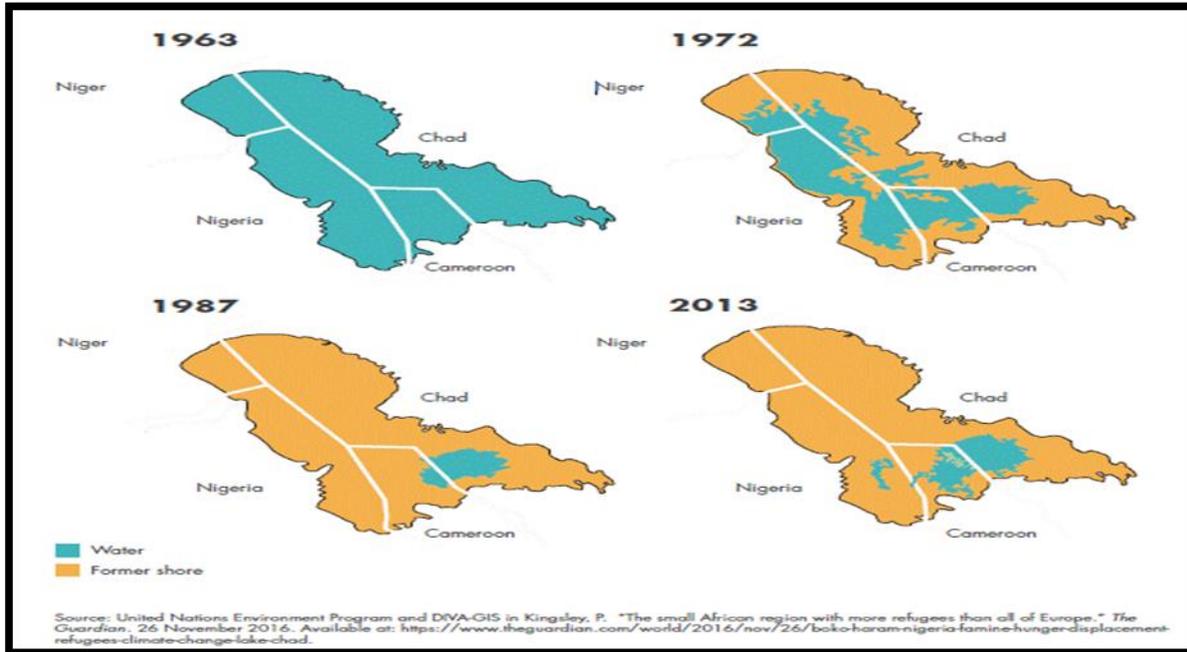
3. Historical Perspectives of Lake Chad

For more than a century, the people living around the Lake Chad region personalized their lifestyle and livelihood in accordance to the rhythms of the region annual flood (Ita and Petr, 1983). The coastlines of this lake fluctuates temporarily shift inward and outward with season every year as well as permanently after certain years. The annual shift in water level of the lake happened during rainy season (water level rises) and during dry season (water level drops). The surrounding communities are well-adapted to coping with the changes through overlapping farming and other crop production with raising cattle and fishing (Hughes and Hughes, 1991). As a main source of food security and livelihood of the region, Lake Chad socioeconomic system and the region public health are threatened by a number of hazards, such as climate change, variability, and aquifer contamination (FEPA, 1991).

Lake Chad is mainly in the far west of Chad, bordering on North Eastern Nigeria. The Chari River, fed by its tributary the Logone, provides over 90 percent of the lake's water, with a small amount coming from the Yobe River in Nigeria/Niger. Despite high levels of evaporation, the lake is fresh water. Over half of the lake's area is taken up by its many small islands (including the Bogomerom archipelago), reedbeds and mud banks, and a belt of swamp land across the middle divides the Northern and Southern halves (Dunn, 1989). The shorelines are largely composed of marshes. At its largest, sometime before 5000 BC, Lake Mega-Chad was the largest of four Saharan paleolakes, and is estimated to have covered an area of 1,000,000 square kilometres (390,000 sq mi), larger than the Caspian Sea is today, and may have extended as far northeast as within 100 km (62 mi) of Faya-Largeau (Offodile, 2002).

Historically, the Lake Chad region have low human development index; lack equitable access to water and sanitation services and was characterized as one of the region with highest population growth rates in the world (Juo and Lowe, 1986; Ita and Sado, 1984). The need for investments in development projects and infrastructure is highly essential in his region.

Figure 1: Evolution of Lake Chad over Time



Source: UNEP and DIVA-GIS, 2016

According to United Nations report, during the last two decades, the annual growth rate of this region's population ranged between 2.5 and 3.0 percent. The report further revealed that the population of communities around the drainage basin as of 2004 was estimated to be about 37 million people with a higher average annual growth rate of 2.5 percent. This shows that the population of this region is rapidly growing and at a faster rate. With about 60 percent of this region's population engaged in agricultural activities, agricultural production remains the backbone of this region's livelihood and economy (Sagua, 1991). Hence, it was understood that agricultural activities are the primary occupation that engages about 60 percent of the population of the region (FEPA, 1991). However, the annual average rainfall over the entire Lake Chad region is believed to be low (320 mm); though this figure varies drastically within the region from about 1,500 mm (Southern parts) to less than 100 mm (Northern parts) (Sagua, 1991). Until during 1964, countries within this great lake watershed area created the Lake Chad Basin Commission (LCBC) with the aim of regulating and controlling the use of water and other natural resources in the basin (Ita and Petr, 1983). This commission was devised to resolve prospective disputes and conflicts associated with the lake and other relevant resources in this region (Ita and Petr, 1983).

The area and level of Lake Chad have been fluctuating for decades and centuries, responding to changes in global temperature and regional precipitation (Sagua, 1991). The geographic location of Lake Chad, in the fringe of the Sahara desert, is characterized by higher mean temperatures and evaporation rates, and the lake's water levels are high (estimated at 2000 mm/year) (Sagua, 1991). Most rivers flowing into Lake Chad emanate both from the central highland and from some rivers flowing into the lake that originate from the Cameroon Mountains and

high plateau and converge to form the Yobe River just before flowing into Lake Chad (Hopson, 1967). Though, only a small portion of the Lake Chad lies within Nigeria, however, along the Nigerian border, the lake is little more than a vast swamp and few passages of cut-through the reeds and tall grasses for movement of canoes to open water (Hughes and Hughes, 1991). The major inflow into the Lake Chad originated from the Logone/Chari system is estimated at about 95 percent, inflow into from the El Beid River was estimated at about 2.5 percent, inflow from Rivers such as the Komadugu Yobe, Yedseram, Ngadda and other smaller rivers and streams was estimated about with another 2.5 percent (Hughes and Hughes, 1991).

The Lake Chad major mechanism for recharge is the annual rainfall (Hopson, 1967). The average annual rainfall around the Lake Chad general area was estimated to about 300 mm/yr while evaporation is estimated at 2,000 mm/year (Hughes and Hughes, 1991). Human activities around the lake area is mainly agricultural activities that requires huge amount of water be withdrawn for irrigation activities and other purposes since the average annual months of rainfall within this region is three to four months only (Barbier *et al.*, 1991). At the same time as the population's demand for water is increasing, the climate in the region has been changing in ways that have apparently not been seen in a thousand years or more (Powell, 1990).

The open water area of Lake Chad is reported to have fluctuated between 1,000,000 and 2,500,000 ha prior to the 1972-73 drought (Hughes and Hughes, 1991). Between July 1973 and November 1975 the lake level fell to below 250,000 ha (Hughes and Hughes, 1991). There has been a significant increase in flooding since the 1988-89 season which leads to the resurgence of the lake total area to an estimate of about 1,000,000 ha (Sagua, 1991). However, most economic activities within this region were to certain degree dependent on the Lake Chad; be it for transportation, Irrigation, crop production, rearing of animals or transportation (Kinako, 1990). For instance, most communities on the fringes of the lake engaged are farmers but resorts to various forms of fishing activities during the peak of flooding season which were mainly between the months of September and February. However, these people still in farming activities during farming season (FEPA, 1991). However, most of the fish caught are either smoked or sundried after cutting into small chunks distance from the fishing communities to neighbouring towns where major markets are located (such as Baga and Doro) (Bukar and Gubio, 1985).

4. Present Lake Chad

The recent drying out of the Lake Chad apparently started in the early 1960s and since then, this trend continued up to date (Stewart, 2009). By early 20th century, the Lake Chad only covered a mere less than one-fifth of that area (Stewart, 2009). This drying out is attributed the recent fluctuations in weather events such as decrease in annual rainfall and increasing temperatures within the Lake Chad area (Offodile, 2002). Recently, it was reported that the surface area of the Lake Chad area barely reaches 1350 square kilometres (Mayell, 2010). Moreover, the current fish production of this region from recent extrapolation from the quantity of fish marketed

by two major markets in Nigeria (Baga-Kawa) is about 25 percent and Cameroon (Blangoua) is about 75 percent of the total fish production of the lake (Okafor, 1990).

4.1 Recent weather events and climate changes

For more than four decades now, the Lake Chad region is facing recurring droughts coupled by decreasing vegetation cover and general decrease in rainfall that consequently led to the recent drastic changes in the environmental conditions of this area (Smith *et al.*, 2005). However, the shrinking of this lake is threatening the socioeconomic well-being of about 22 million people living in the Basin (Smith *et al.*, 2005). The drying up of Lake Chad has accelerated many anthropogenic and natural activities such as the declining in agricultural productions, rearing of livestock and fisheries as well as the recent encroachment by desert.

The climate in the general Lake Chad basin is semiarid in the south and arid in the North (Hopson, 1967). This region experiences annual maximum temperature is as high as 35° to 40°C particularly in the Northern parts of the region and also received an annual average rainfall over the entire basin is 320 mm varying between 1,500 mm in the southern parts of the region to less than 100 mm in the Northern parts of Chad (Verinumbe, 1990). The Lake Chad is under the influence of the Inter-Tropical Convergence Zone (ITCZ) that oscillates seasonally between about 15°N and 15°S. Within the North of the ITCZ high pressured air blowing from the Sahara desert suppresses rainfall, however, the region low rainfall is mainly accompanied by excessively high temperatures in all arid lands. According to IPCC, the Sahel have being experiencing the most substantial and sustained declining in rainfall recorded anywhere over the past 30 years (UNEP, 2000).

Most of the recent dramatic decrease in the volume and surface area of the general Lake Chad region has been attributed to the regions' climate change and water resource management practices (Verinumbe, 1990). The climate change thus remained the major determinant of the future of the lake's volume and surface area. Another key consequences climatic fluctuation in this region is the reduction in economic activities such as fishing. The Lake Chad is a home to over eighty different species of fish (Hopson, 1967). However, the drought event of 1972-1973 has lead to disappearance of many species of this fish species in this region (Ita, 1984; Ita, 1986).

4.2 Security challenges, crisis and conflicts

The Lake Chad Basin and it immediate surroundings are facing one of the most severe humanitarian emergency in the history of the world. This region is facing numerous security challenges ranging from issues of Boko Haram to conflicts between pastoralists and farmers. The protracted conflicts within the region has uprooted more than 2.4 million people and exposes them to extreme hardship, high level hunger, poverty and poor hygiene (Mayell, 2010). The insecurity happening in the region, explicitly, the Boko Haram sects' activities of killings, kidnapping as well as the destructions of lives and properties have been hampering the growth and

prosperity of the local populous. However, pastoralists-farmers related conflicts also led various clashes and consequently resulted to destructions of properties worth million of naira (Nigerian currency) and loss of lives.

Within the crisis ridden region around the Lake Chad region, resumption of normal life significantly depends on the humanitarian assistance rendered by Governments and NGOs for survival. However, food insecurity remains high priority across the conflict-hit region of Chad basin (Mayell, 2010). Within this region, it is estimated as of 2017 about 5 million people are believed to be food insecure following the poor rainfall season in the year. Recently, thousands of civilians have been freshly displaced and relief operations disrupted as armed attacks persist, particularly in the North East of Nigeria and some fringes region of Cameroon. Moreover, even far Northern region of Cameroon's, recently witnessed the resurgence of terrorists attacks and suicide bombings.

5. Future of Lake Chad

Once Africa's largest water reservoir in the Sahel region has now shrink to some patches of surface water, the Lake Chad future is highly uncertain, and also the future of the dependent population of this region seem like legend. For instance, from Nigeria as you approach the Lake Chad basin from Maiduguri in the Northeastern, it is observed that the atmosphere fiercely look so desolation with dusty air and unrelenting wind with sparse vegetation that are mostly broken by withered trees and shrubs.

Being agriculturally dominated region (Hassan and Hussain, 2018), lives of herders, fisher folk and farmers are teetering on the edge as the lake dries up before their eyes. The staple of livelihood for the Lake Chad populous is vanishing and was projected to possibly vanish completely within this century (Moses, 1990; Hughes and Hughes, 1991). The UN Food and Agriculture Organization (FAO) have recently referred the situation in the Lake Chad as an "ecological catastrophe" and also affirmed that prediction that the lake could possibly disappear this before 2100 (FAO, 1973). According to FAO Director of Land and Water Parviz Koohafkan, the Lake Chad basin is one of the most important agricultural heritage sites in the world, providing a lifeline to nearly 30 million people in four countries Nigeria, Cameroon, Chad and Niger (FAO, 1973).

5.1 Rising tensions and conflicts

With recent shrinking of Lake Chad total, this study believed there are high chances of more conflicts in this region since almost all the key stake holders sources of livelihood in the region significantly depends on the common water resource of this region (the lake) (Hassan et al., 2018). The impact of the drying lake is continuously causing tensions among numerous communities around fringes of Lake Chad. There are repeated conflicts among nationals of different countries over control of the remaining water, therefore, conflicts of this nature will continue to more likely with the increasing difficulty in accessing the lake largely as a result of shrinking of the lake. For example, Nigerians and Cameroonians in Darak village frequently clashes and fights over access to water resource in this region (Drake and Bristow, 2006). Within this region, both occupants from

the two countries usually claimed to be the first settlers whereas others claimed that the village was located within the Cameroonian territory. Fishermen also want farmers and herdsmen to cease diverting lake water to their farmlands and livestock (Drake and Bristow, 2006).

5.2 Economic activities

Being predominantly farmers and fishermen, the hope of the people of the around the Lake Chad general area lies in the survival of this great lake. Disappearance of this lake will not only render the people of the region redundant. This study also understand that besides being a source of livelihood, the lake also provides enormous amount of agricultural products to other parts of the countries, examples, smoked fish, livestock and production of various types of crops in addition to being sign cultural identity to the most communities residing around the lake. Though, no major frame survey of the fishing communities has been reported for the lake, however, most processed fish are packaged in cartons and transported to major town in Nigeria, Cameroun and Chad (Hopson, 1967). The disappearance of this lake will also result to extinction of many dominant fish species within this region such as the *Lates*, *Gymnarchus*, *Clarias*, tilapias, *Alestes*, *Bagrus*, *Labeo*, *Distichodus*, *Protopterus*, *Malapterurus*, *Synodontis* spp., *Mormyrus* and *Hyperopisusbebe* (Hopson, 1967). Though, there is no exact information on the fishing activity within these floodplain areas. The area is, however, known to be intensively grazed as the floods recede.

5.3 Water access and health

Within the Lake Chad region, 1 in 3 people do not have access to safe drinking water (Mayell, 2010). The crisis has caused a massive displacement, with 1.3 million uprooted children who face a complex humanitarian situation. This study believed that as the Lake Chad continues to shrink, there are possibilities of more difficulties in accessing water resources as well as health services. Though, the recent improvement of the security situation in some of the islands of the Lake Chad, displaced populations are starting to come back but the quality of the water remains very low with over 80 percent of the population of this still practice open defecation (Stewart, 2009). Moreover, there is also expectation of increasing cases water-borne diseases are widespread, putting these areas at high risk of cholera epidemics.

5.4 Management and development of the lake

Since the establishment of Chad Basin Commission (LCBC) by the leaders of Chad, Nigeria, Cameroon and Niger in 1964 and later joined by the Central Africa Republic in 1994, this initiative have promoted the mitigation of numerous anthropogenic activities that have capabilities of accelerating the shrinking of the lake. Despite various attempt by this commission to effectively managed this region finite resources "lake". However, the development of surface and groundwater systems with data from multiple organizations has help in established foundation for informing better management of the Lake Chad basin's water (Offodile, 2002). The

management and development of this lake have capability for a sustainable, balanced basin would be in terms of abstractions from surface and groundwater for numerous development purposes (Ita and Petr, 1983; Hughes and Hughes, 1991). The monitoring water resources is essential to better inform development decisions because you need to know what you have in order to properly manage it well. Even in future, the LCBC will contributed to a stronger and more informed water management at the basin scale for ensuring equitable sharing of common water resources in the Lake Chad can be utilized to sustainably alleviate poverty, protecting and preserving them.

5.5 Dams and irrigation replenishment plans

The Lake Chad Basin Commission (LCBC) and United Nation Environment Program (UNEP) were identified as regional bodies that regulate the use of the basin's water and other natural resources, maintenances of dam efficiencies as well as promotion of numerous irrigation methods (FEPA, 1991). As parts of measures of minimizing the impacts of the drying up lake, most of the farmers, fishermen and cattle herders have been moving towards greener areas to compete for virgin land resources with host communities. This also creates what is known as simple scarcity and fear of marginalization (Hassan, *et al.*, 2018).

Though, various Governmental institutions as well as NGOs have been providing significant financial; for instance, the World Bank has provided about \$10.6 million for a project to reverse land and water degradation in parts of the lake, and also the LCBC has initiated numerous programs to livestock herders on gaining access to grazing and watering areas. However, the LCBC members also planned a project of replenishing the lake through building a dam with about 60 miles of canals to pump water uphill from the Congo River to the Chari River and then on to Lake Chad (UNEP, 2000; Stewart, 2009). Hence, this replenishment projects were believed to be the first of its kind in the whole of Africa and was estimated to engulf more than 5 million dollars for only feasibility study; however, the total cost of this project will only be known when the project was finally completed.

6. Conclusion

One of the world greatest inland reservoir which is covering an area of about 26,000 square kilometers, about the size of the US state of Maryland and bigger than Israel or Kuwait, the Lake Chad area have now shrink to only area of about 1350 square kilometres as reported by various studies (UNEP, 2000; Stewart, 2009). The present study concludes that one of the key factors that greatly contributed to the recent Lake Chad adversity is both natural as well as anthropogenic in nature. The series naturally induced difficulties ranges from climatic variability such as widespread of annual rainfall excesses and deficiencies, increasing temperature that are associated with failing recharge and increasing evaporation. However, the anthropogenic factors also include the increasing population growth that stimulates the higher water demands for domestic and agricultural activities. Moreover, another mechanism is the low human development index in rampaging the entire Lake Chad region

of Africa. Historically, this region has strong need for development projects to improve access to water for agriculture, energy, industry, and health and sanitation. The study further believed that lack of holistic information about both groundwater and surface water dynamics in the region has also contributed to this region.

The water of Lake Chad has been swiftly shrinking since 1960, however, with current climatic volatility, weather events and other relevant indices, various anthropogenic processes coupled with recent climatic changes will possibly results to the complete disappearance of Lake Chad in near future. However, this disappearance will threaten not only the region habitat, ecosystem, endangered fish species, but also the socioeconomic activities of the inhabitant of this region. Therefore, this study suggested the need for urgent and immediate actions for sustainable integrated water resource management plans and execution in addition to provision of sufficient funding for various revival projects. Finally, the study also called for climate resilience projects that incorporated the dynamics of sustainable anthropogenic activities. Therefore, this study affirmed the need for LCBC and its partners to devote measures of tackling several impacts associated to climate changes and dam control so as to necessitate early impact detection and planning within the region.

References

- Adams, W. M. and Hollis, G. E. 1987. Hydrology and sustainable resources development of a Sahelian floodplain wetland. Report to Hadejia-Nguru Wetlands Conservation Project, Nguru, Nigeria.
- Alabaster, J. S. 1981. Review of the state of aquatic pollution of East African inland waters. CIFA Occasional Paper, No. 7, FAO Rome.
- Amu, L. A. O. 1979. Nigerian hydroelectric development and provision for multi-purpose large dams. In: Proceedings of the International Conf. on Kainji Lake and river basin development in Africa. (1), pp. 94–112. KLRI, New Bussa, Nigeria.
- Andriessse, W. 1986. Wetland area and distribution. In: A.S.R. Juo and J.A. Lowe (Eds). The wetlands and rice in Sub-Saharan Africa, IITA, Ibadan, Nigeria. pp. 15–30.
- Atlas of Our Changing Environment. United Nations Environment Programme. 2007.
- Barbier, E. B., Adams, W. N. and Kimmage, K. 1991. Economic valuation of wetland benefits: The HadejiaJama'are Floodplain, Nigeria. Report to Hadejia-Nguru Wetlands Conservation Project, Nguru, Nigeria.
- Bukar, T.A. and Gubio, A. K. 1985. The decline in commercially important species of fish and predominance of Clariaslazera in Lake Chad. In: Fisheries Society of Nigeria (FISON) Proceedings (Ita, et.al., Eds.), pp. 35–41.
- Dunn, I. G. 1989. Development of inland fisheries under constraints from other uses of land and water resources: Guidelines for planners. *FAO Fisheries Circular* No. 826, pp. 53.
- Drake, N. and Bristow, C. 2006. "Shorelines in the Sahara: geomorphological evidence for an enhanced monsoon from palaeolake Megachad" (PDF). *The Holocene*. **16** (6), pp. 901–911.
- FAO. 1973. Aquaculture Development in Nigeria, *FAO Aquac. Bull.*, 5(2), pp. 12.

FEPA. 1991. Guidelines and standards for environmental pollution control in Nigeria. Federal Environmental Protection Agency (FEPA), Nigeria.

Hopson, A. J. 1967. The fishes of Lake Chad. In: Fish and fisheries of Northern Nigeria, Reed, W. et.al. (Eds.), Ministry of Agriculture, Northern Nigeria.

Ita, E.O. and T. Petr, 1983. Selected bibliography on major African reservoirs. CIFA (FAO) Occasional Paper, No. 10, pp. 53.

Hughes, R. H. and Hughes, J. S. 1991. A directory of African wetlands, IUCN, Gland, Switzerland.

Hassan, Y. and Hussain, N. 2018. Agricultural Pollution: An Assessment of Synthetic Fertilizer Application in Sudano-Sahelian Zone of Nigeria. *Annals of Social Sciences Management Studies*, 2(1), pp. 55579.

Hassan, Y., Hassan, A. A. and Hussain, N. 2018. Occupational Politics Myths and Realities in Nigeria: A Case of Farmers-Pastoralists Conflicts. *International Journal of Technical Research and Science*. 3(10), pp. 329-337.

Ita, E. O. 1984. Some guidelines for the drafting of the inland fisheries laws and regulations for Nigeria. Paper presented at FISON '84 held at Port-Harcourt. Pp.15.

Ita, E. O. 1986. Reservoir, lake and river fisheries management and investment opportunities. In: Fisheries enterprises and information, Brochure in commemoration of the 5th Annual Conference of the Fisheries Society of Nigeria (FISON) sponsored by Kainji Lake Research Institute, New Bussa. pp. 3–8.

Ita, E.O. and Sado, E. K. 1984. Inventory survey of Nigerian inland waters and their fishery resources with special reference to ponds, lakes, reservoirs and major rivers: surface area survey and potential yield estimates. Kainji Lake Research Institute 1983 Annual Report, pp. 99–109.

Kinako, P. D. S. 1990. The structure and function of some Nigerian wetland ecosystems. In: T.V.I. Akpata and D.U.U. Okali (Eds.) Nigerian Wetlands. UNESCO/MAB. Port Harcourt, Nigeria.

Mayell, H. 2010. Shrinking African Lake offers lesson on finite resources. National Geographic News; http://news.nationalgeographic.com/news/2001/04/0426_lakechadshrinks_2.html.

Moses, B. S. 1990. Distribution, ecology and fisheries potentials of Nigerian wetlands. In: T.V.I. Akpata and D.U.U. Okali (Eds.) Nigerian wetlands. UNESCO/MAB. Port Harcourt, Nigeria. Pp. 35–46.

Offodile, M. E. 2002. Groundwater study and development in Nigeria. (2nd ed) Mecon Geology and Engineering Service Limited, Jos, Nigeria.

Okafor, L. I. 1990 Soils of some Nigerian savanna and forest wetlands. In: T.V.I. Akpata and D.U.U. Okali (Eds.) Nigerian Wetlands. UNESCO/MAB. Port Harcourt, Nigeria. pp. 35–46.

Powell C. B. 1990. The ecological effects of human activities on the value and resources of Nigerian wetlands. In: T.V.I. Akpata and D.U.U. Okali (Eds.) Nigerian wetlands. UNESCO/MAB. Port Harcourt, Nigeria. Pp.35–46.

Smith, L. C.; Sheng, Y.; MacDonald, G. M. 2005. Hinzman, L. D. Disappearing Arctic lakes. *Science*. 308, pp. 1429.

Sagua, V. O. 1991. The current status of the fishery resources of the Lake Chad Basin and a program for its management and conservation. In: Management strategies for inland fisheries in the Sahel. *FAO Fisheries Report*, No.445, pp. 42–53.

Stewart, R. 2009. Dustiest places on Earth dead and dying seas. *Environmental Science in the 21st Century. A New Online Environmental Science Book for College Students*.

Tobor, J. G. 1973. A survey of the fisheries of the Lower Yobe in the North Western Basin of Lake Chad. Annual Report of the Fed. Dept. of Fisheries. pp. 82–89.

UN Office for the Coordination of Humanitarian Affairs. From <https://www.unocha.org/>. N.a

Verinumbe I. 1990. Wetlands in the Sahelian north-eastern Nigeria. In: T.V.I. Akpata and D.U.U. Okali (Eds.) Nigerian wetlands. UNESCO/MAB. Port Harcourt, Nigeria. Pp. 35–46.

Welcomme R.L., 1975. The fisheries ecology of African floodplains. CIFA (FAO) Tech. Pap., (3), pp. 51.

Welman, J. B. 1948. Preliminary survey of the freshwater fisheries of Nigeria. Government Printer, Lagos, Nigeria.

Welcomme R. L. 1976. Extensive aquaculture practices on African floodplains. CIFA Tech. Pap., (4) (Suppl.1), pp. 248–255.