INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY
Monthly Peer-Reviewed, Refereed, Indexed Journal
Volume - 06, Issue - 03, March - 2022

ISSN: 2456-6683
[Impact Factor: 5.743]
Publication Date: 20/03/2022

DOIs:10.2017/IJRCS/202203004 --:-- Review Article

A Review on Biophysical Environment, Study of Shrinking Lake Chad, Africa

[1] Umara Zulum, [2] Dr Malini Prava Sethi
[1]Dep't of Geography School of Liberal Art, Noida International University, Noida, Uttar Pradesh, India
[2]Assistant Professor Dept. of Geography School of Liberal Art, Noida International University, Noida, Uttar Pradesh, India
Email - zulumumara@gmail.com[1], malini.pravasehthi@gmail.com [2]

Abstract: *A lake's ability to support plant and animal life defines its level of productivity, or trophic state. Lakes are commonly classified based on their productivity. Low productive oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep-bottom water during late summer to support cold water fish, such as trout and whitefish. By contrast, high productive eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish, such as bass and pike. Lakes that fall between these two classifications are called mesotrophic lakes. Lakes that exhibit extremely high productivity, such as nuisance algae and weed growth are called hyper-eutrophic lakes. (Michigan inland partnership 2017).*

Key Words: *GIS Biophysical, Environnent.*

1. INTRODUCTION:

Lake Chad is the biggest transboundary lake which is located in the Sahel as well as in the West and the Central Africa subregions. It is shared border between Chad, Niger, Cameroon, and Nigeria. It is estimated that a total of about 45 million people could benefit from its natural resources (fishing, livestock farming, agriculture, hunting and gathering). The Lake Chad system has been characterized by its strong cross-border dynamics rooted in history and strong cultural and language connections. A potential net exporter of food and a provider of seasonal jobs, the Lake Chad region previously also contributed to the food and job security of its residents including those in the two regional metropolises, Ndjamena and Maiduguri, as well as the regions of the lake's Sahelian hinterlands (Borno Adamawa and Yobe States in Nigeria; Diffa and Zinder in Niger, the Far North Province in Cameroon and the regions of Lac, Kanem, Hadjer Lamis, and Chari Baguirmi in Chad). If the lake area represents such a potential food production hub, it is because it offers a relatively secure source of water, fodder, and fertile land. Moreover, those mostly family fishing and farming systems are labor intensive and generate significant indirect employment (processing, trade, crafts, and transport).

All lakes are temporary over geologic time scales, as they will slowly fill in with sediments or spill out of the basin containing them. Many lakes are artificial and are constructed for industrial or agricultural use, for hydro-electric power generation or domestic water supply, or for aesthetic or recreational purposes or even for other activities. (Pertti Heionen 2000)

2. Lake Shrinking :

Shrunken lakes are natural lakes that have reduced significantly in size through time, often to the point where they split into two or more smaller lakes. Not only have lakes diminished throughout recorded history, but they are also known to have shrunk in prehistoric times. If a lake has permanently vanished, it is referred to as a past lake; if a lake periodically refills, such as Lake Eyre, it is referred to as a present lake. Because the lake water returns, neither shrunken lakes nor former lakes return to their pre-shrinkage levels. (Campere and colleagues, 1993).

3. Causes of environmental problem to the Lake :

Drought, irrigated agriculture, dam construction, population, industry, and reduced rainfall across the lake's surface are the main causes of lake drying up.

a. A Drought

Drought is defined as a lack of precipitation over a long period of time, usually a season or more, resulting in a water deficit that has negative consequences for vegetation, animals, and/or people. It is a common, recurring aspect of climate that can be found in almost all temperate zones, ranging from extremely wet to extremely dry. Drought is a transient deviation from typical climatic conditions; therefore, it varies widely from one place to the next. January 2008, National Weather Service) Three generally used definitions are as follows:

i. Meteorological Drought: Meteorological drought is often described by the degree of dryness (as compared to a "normal" or average) and the length of time that the dry period lasts. A meteorological drought usually precedes the commencement of a drought.

ii. Agricultural Drought: Agricultural drought focuses on precipitation shortages, soil water deficits, lower ground water or reservoir levels needed for irrigation, and other aspects of meteorological (or hydrological) drought that have an impact on agriculture.

iii. Hydrological Drought: Hydrological drought occurs when there are prolonged periods of low precipitation, affecting water supply (stream flow, reservoir and lake levels, ground water), and potentially causing substantial socioeconomic consequences. The impact of meteorological dryness may spread much beyond the limits of the precipitation-deficient area since these regions are linked by hydrologic networks. Drought Mitigation Center of the United States.

b. Climate Change

Climate change is a long-term shift in weather patterns that affects the inflow to the lake, resulting in a 65 percent fall in water levels (including its averages). It could manifest itself, for example, as a change in climate normal (anticipated average values for temperature and precipitation) from one decade to the next for a specific location and time of year.

Climate change is a natural element of the Earth's natural variability, which is linked to interactions between the atmosphere, ocean, and land, as well as variations in the amount of solar energy reaching the planet. Significant evidence for large-scale climate changes in Earth's past can be found in the geologic record. Changes in Greenhouse Gases Caused by Humans: The greenhouse effect occurs when certain naturally occurring gases, such as carbon dioxide (CO2) and water vapor (H20), trap heat in the atmosphere. The combustion of fossil fuels such as oil, coal, and natural gas releases carbon dioxide into the atmosphere.

Effects of Climate Change

Climate change could have a wide range of consequences. Climate change is being studied extensively around the world, including at NOAA, to establish the amount to which it is occurring, how much of it is caused by anthropogenic (man-made) processes, and its potential consequences. There is no consensus among scientists in several of these topics, and there are frequently contradictory points of view and studies. However, with more research, many issues about repercussions will undoubtedly be answered in the future. The effects on sea level, drought, local weather, and storms are among the most studied potential implications by scholars. General Circulation Models provide for the majority of our present understanding of global change (GCMs). GCMs are currently capable of providing us with a dependable mean yearly temperature for the world. GCM data on regional and local temperature and precipitation is currently unreliable. The goal of much of the global change research is to improve these models." (http:/Iwww.giss.nasa.gov/research)

I., Soil Erosion: One of the first issues that dams cause is land erosion. Dams hold back the sediment load that typically flows through a river, depriving those downstream. The downstream water erodes its channels and banks to compensate for the sediments. The riverbed is being lowered, posing a threat to vegetation and river species. Dams are created for a variety of reasons, one of which is to prevent flooding. Most ecosystems that endure flooding, on the other hand, have evolved to it, and many animal species rely on floods for various lifecycle stages including reproduction and hatching. Floods dump nutrients and refill wetlands on an annual basis. (Lal et al., 1994)

ii., Species Extinction: As fisheries become a more significant source of food, the negative impacts of dams on many fish and marine mammal populations are receiving increased attention. The great majority of large dams lack suitable bypass mechanisms for these creatures, disrupting their life cycles and, in some cases, causing species extinction.

ii., Disease Spread: Dam reservoirs in tropical climates are literally breeding grounds for mosquitoes, snails, and flies, the vectors that bring malaria, schistosomiasis, and river blindness, due to their slow movement.

iii., Changes in Earth's Rotation: NASA geophysicist Dr. Benjamin Fong Chao discovered evidence that huge dams alter the earth's rotation by shifting water weight from oceans to reservoirs. Since the 1950s, the Earth's daily rotation appears to have sped up by eight-millionths of a second due to the number of dams erected. It is the first time, according to Chao, that human activity has been proved to have a measurable effect on Earth's orbit (NASA 2016)

iv., Changes in Earth's Rotation: NASA geophysicist Dr. Benjamin Fong Chao discovered evidence that huge dams induce changes in the earth's rotation due to water weight shifting from oceans to reservoirs. The Earth's daily rotation appears to have sped up by eight-millionths of a second since the 1950s as a result of the number of dams built. The first-time human activity has been proved to have a measurable effect on Earth's orbit, according to Chao (NASA 2016) It's a decrease in the land's ability to produce ecosystem products and services and maintain their functions over time for the people who benefit from them. In dry-land environments, land degradation affects enormous areas and many people. During protracted rainy times, increased population pressures and excessive human development into thy-lands leave an increasing number of people stranded there. If not adjusted for, such changes might cause the entire manufacturing system to fail. Ploughing, extensive grazing, and deforestation, all of which remove the protective cover to reduce competition for water and nutrients, leave the soil very vulnerable to wind erosion, especially during severe droughts. Heavy grazing near water sources or during lengthy droughts limits or delays vegetation regrowth, favoring primarily undesirable bushes.

Land degradation, or the deterioration of land quality as a result of human activity, was a major global concern in the twentieth century and will continue to be on the international agenda in the twenty-first. The influence of land degradation on global food security and environmental quality has elevated the relevance of land degradation among global challenges. High population density is not always associated with land degradation; the level of deterioration is determined by what a population does to the land. People can play a critical role in correcting a downward trend. They must, however, be healthy and politically and economically motivated to care for the land, as subsistence agriculture, poverty, and illiteracy can all contribute to environmental and land degradation. 2016 (Sing).

c. Land degradation

Land degradation is defined as the loss of current or potential productivity or value as a result of natural or human-made forces; it is the deterioration of land quality or production. Land degradation is caused by a mismatch between land quality and land usage in terms of production. Physical, chemical, and biological factors all contribute to land deterioration (Lal, 1994). A deterioration in soil structure leads to crusting, compaction, erosion, desertification, anaerobic, environmental pollution, and unsustainable use of natural resources, among other physical processes.

Causes of land degradation

Acidification, leaching, salinization, a decrease in Cat ion retention capacity, and fertility loss are all significant chemical processes. Biological processes include a decrease in total and biomass carbon, as well as a loss in total and biomass carbon.

Deforestation, overgrazing, poor land management, mining, and industrialization are some of the causes of land degradation that have an impact on our ecosystem.

Deforestation is the process of removing trees and other vegetation from a certain area (for firewood, commercial logging or to clear land for fanning and settlements).

a. Overgrazing: Allowing farm animals to eat all of the foliage that covers the land until the soil is exposed and the plants are unable to regenerate.
b. Inappropriate farming methods for the type of land soil; farming that is too intensive (forcing the land to produce food crops year after year without allowing it to ‘rest' to replenish nutrients; using chemical or no fertilizers instead of natural fertilizers such as animal dung or organic matter).
c. Fires: This includes human-caused bush and wildfires that deplete the soil of plant material that inhibits soil erosion.
d. Pollution: This is caused by the disposal of scrap metal, plastics, and packaging, as well as construction debris.
e. Mining: This degrades the soil and the land's underlying structure. Soil and water courses are polluted by chemicals used or mined.
f. Neglect: Not caring for local flora, trees, and biodiversity. Neglect indicates that the soil will not be organically fertilized and preserved, and as a result, it will be unable to support various forms of life. (Singh et al., 2016)

d. Industrialization

The most significant contribution to environmental degradation has been rapid industrialization. According to data gathered from a variety of sources, the majority of industries use technologies that have a high environmental impact. These technologies necessitate a high level of resource and energy consumption as a result of the current rate of industrialization, natural resources such as fossil fuels, minerals, and timber are being depleted, and water, air, and land are being contaminated. All of these things are wreaking havoc on ecosystems and posing health risks. (Betal 2O5l, McCubin s.)

4. Lake Chad: Issues at Glance

The Lake Chad, the epicanthic of human, animal and plant life in the entire region, is the third freshwater lake in the world and the fourth largest lake in Africa after lakes (Victoria, Tanganyika and Nyasa. In 1964) when the Lake Chad Basin Commission (LCBC) was established, the Lake Chad water stretched over 25 000 km2. But today the Lake has continuously shrunk since the great draughts of the 70s, and now it covers an area of less than 1000 km2 during the annual lowest water levels of the region (LCBC, 2008)

4.1 Factors responsible for the drying up of the Lake Chad

There have been numerous reasons and hypotheses proposed to explain the factors that have caused Lake Chad, Africa's largest inland lake, to dry up. Human reasons such as growing population and significant water abstraction for irrigation, as well as natural variables such as climate change, are some of these factors. Despite the fact that the Lake Chad area is a rich environment that attracts a diverse range of users, with over 20 million people relying on it for a variety of livelihoods such as fishing, pastoralism, crop cultivation, transportation, and mining, the area is vulnerable due to high climate variability and weather extremes, as well as unsustainable human activities.

Lake Chad was formerly the world's sixth largest lake, but drought has reduced it to a tenth of its original size since the 1960s. The Shari River, which supplies 90 percent of Lake Chad's water, is currently only about half of what it was in the 1930s and 1960s, when it flowed 40 billion cubic meters per year. The Lake Chad Basin Commission and others have been monitoring the current low levels using satellites and other methods. Furthermore, the region has been subjected to an increasingly arid climate, with rainfall levels dropping significantly since the early 1960s. The greatest drastic reduction in lake size occurred in the fifteen years between January 1973 and January 1987

The amount of water utilized for irrigation began to grow around 1983. Massive irrigation projects in the region have relied on water from Lake Chad. Between 1983 and 1994, the volume of water diverted for irrigation more than doubled compared to the previous 25 years. This is exacerbated by an increase in the number of dams built on the headwaters of Lake Chad's tributary rivers. The river Yobe in Nigeria, for example, provides around 3% to the upkeep of Lake Chad, and various dams have been built on its tributary rivers. This includes the Challawa Gorge Dam, the Tiga Dam, and the Karfin Zaki Dam, which is just under construction. (Oruonye, 2011).

The impact of human diversion of water from Lake Chad is exemplified in the (UNEP report), where it is stated that "human needs for water near Lake Chad have expanded dramatically since the 1960s." The number of people living in the lake's catchment area quadrupled from 13 million to 37 million between 1960 and 1990." Because of the increased need for water, massive irrigation projects and dams have been built along the rivers that feed Lake Chad. "The upper basin used to supply roughly 7 km3/yrs. to Lake Chad," the paper says of the Komadugu-Yobe river system. The majority of this water is now stored in reservoirs in northern Nigeria's Kano province, and the system only provides 0.45 km3/yr." According to this figure, there is enough impounded water each year to double the Lake's current volume. The Chari-Logone River brings the most water to Lake Chad from the south. However, the Chari-Logone stream flow has been dramatically altered since the 1970s. The construction of the Maga Dam, which spans 30 kilometers and creates Maga Lake, as well as 80 kilometers of dykes along the Logone River downstream of the dam, has had a significant impact.

The effect on Lake Chad. This structure was built as part of the well-intentioned SEMRY irrigation project, which aimed to expand agricultural (primarily rice) and fish farming opportunities. The diversion of water from the Chari River for agricultural purposes has had a significant impact on stream flows, discharges into Lake Chad, and the lake's extent. The most significant immediate reason of reduced stream flow into Lake Chad, according to experts, is growing river diversion and the resulting unsustainable use of water resources.

5. Shrinking of lake Chad

In the 1960s, North central Africa's Lake Chad was larger than the state of Vermont but is now smaller than Rhode Island. NASA-funded researchers using computer models and climate data now understand why Africa's freshwater Lake Chad has been disappearing over the last 30 years. Michael T. Coe and Jonathan A. Foley of the University of Wisconsin-Madison cite a drier climate and high agricultural demands for water as reasons why what was once one of Africa's largest freshwater lakes is shrinking. Lake Chad and the Chari/Logone river system, which transports 90 percent of the runoff generated in the area basin, are important water resources for the local population. The lake is 820 feet (250 m) above sea level and is shared by Chad, Cameroon, Nigeria and Niger. Lake Chad has always undergone seasonal and inter-annual fluctuations because it is less than 23 feet (7 m) deep. In recent decades, during wet periods the lake expands up to 10,000 square miles (25,900 square km). The warming climate and increasing desertification in the surrounding Sahel region have dropped water levels far below the average dry season level of 4,000 square miles (10,000 square km) to only 839 square miles (1,350 square km). (Michael T., et al 2001)

The Northern Africa Sahel region has experienced numerous devastating droughts over the last three decades. "Climate data has shown a great decrease in rainfall since the early 1960's largely du e to a decrease in the number of large rainfall events," Coe said. Lake Chad's primary source of water comes from the monsoon rains that typically fall in June, July and August. Meanwhile, the use of water for irrigation has increased, in response to the drier climate. Over the last 40 years, the discharge from the Chari Logone river system at the city of N'Djamena in Chad has decreased by almost 75 percent, drastically reducing the input into the lake. Between the increase in agricultural water use and the drier climate, there has been a massive decline in the amount of water in Lake Chad. (Coe et al 2001)

With a drier climate and less rainfall, agricultural areas become more desperate for water to irrigate their crops, and will continue draining what is left of Lake Chad. Foley said, "The problem is expected to worsen in the coming years as population and irrigation demands continue to increase."

Regional officials have noticed the dramatic effect the shrinking lake is having on its surrounding inhabitants. In the summer of 1998, the President of Chad hosted the 10th Lake Chad summit with leaders from Nigeria, Niger, the Central African Republic, Cameroon and Sudan to discuss how to boost water levels.

NASA's Earth Observing System funded the Lake Chad study. The overall goal of NASA's Earth Observing System is to advance the understanding of the entire Earth system on a global scale by improving our knowledge of the components of the system, the interactions between them and how the earth system is changing. (NASA 20015)

5.1 Causes of Lake Chad shrinking

There is no confirmed evidence that shows any single factor which causes the shrinking in Lake Chad but many factors are determined as factors responsible for the shrinkage at various levels, some of them are as follows;

a. Dams and irrigation

The UN Environment Programmed (UNEP) and the Lake Chad Basin Commission (LCBC), a regional body that regulates the use of the basin's water and other natural resources, maintain that inefficient damming and irrigation methods on the part of the countries bordering the lake are partly responsible for its shrinkage. Emmanuel Asuquo-Obot of the World Wildlife Fund (WWF), an organization devoted to wildlife conservation, points to the diversion of water from the Chari River to irrigation projects and dams along the Jama'are and Hadejia Rivers in northeastern Nigeria and other members of the countries. (UNEP 2014). Human and animal populations came to rely more and more on water from the lake. Massive irrigation projects to combat the drier climate diverted water from both the lake and the two main rivers that empty into it, the Chari and the Logon.

The situation is a "domino effect," the researchers say. Overgrazing reduces vegetation, which in turn reduces the ecosystem's ability to recycle moisture back into the atmosphere. That contributes to the retreat of the monsoons. The consequent drought conditions have triggered a huge increase in the use of lake water for irrigation, while the Sahara has gradually edged southward. Lake Chad is not likely to be replenished to its former size in our lifetime, the researchers say.

The lakes decline and the climate change have had an enormous impact on the 9 million farmers, fishermen, and herders living in the region. They have experienced crop failures, dying livestock, collapsed fisheries, and There is no single cause for the drastic shrinkage of Lake Chad: natural fluctuations as part of a long-term cycle, heavy human use through the pumping of water for irrigation and deforestation have all been cited. Climate change has also been given as a major reason for why Lake Chad has been reduced from 25,000 square kilometers in 1963 to 1,300 square kilometers today. As a symbol of global warming, however, Lake Chad is seen in the context of Africa being the continent most vulnerable to climate change, facing rising temperatures and increased drought. This despite Africa being the least responsible for global greenhouse emissions, which cause global Warming. The consequences of Lake Chad drying up are dire. The lake is estimated to provide a lifeline to nearly 30 million people in Nigeria, Cameroon, Chad and Niger. It has led to a massive reduction in fishing, which many people relied on for income and has caused tensions at community level between different land and water users and regionally between countries competing for the resources of the lake. The shrinkage has a negative impact on, among other things, large scale irrigation schemes in Nigeria. The lake serves as a critical, strategic area for global biodiversity, home to 120 species of fish as well supporting 372 bird species. The countries within the region are among the poorest countries in the world. Based on the 2007/2008 UNDP Human Development Index (HDI) for 177 countries the LCBC countries rank amongst the lowest globally.

b. Drought

The tremendous importance of water in society and nature underscores the necessity of understanding how a change in global climate is affecting the availability and variability of regional water resources. Lake Chad for instance, located in one of the poorest and most drought-prone regions of the world — the Sahel region of sub-Saharan Africa — has shrunk from around 25,000 square-kilometers in the early 1960s to less than 2,000 square kilometers today (Grove,

1996). The Sahel region today may receive just enough precipitation. The lessons from the current drought in Horn of Africa, however, is a reminder of the potential threat facing the more than 30 million inhabitants of the Lake Chad Basin (LCB).

United Nations estimates that 12 million people have been affected in East Africa by the worst drought in more than half a century. The urgency of the humanitarian assistance needed to save more than 3 million internally displaced and starving populations (UN, 2011) has raised the question of reliability of early warning mechanisms and water question in drought prone regions of Africa.

Unlike Somalia, will an effective mechanism be put in place to detect onset of drought in LCB? Most importantly, what needs to be done to minimize adverse effects of drought in LCB? In this essay, scientific perspectives will be applied to explain and compare the complex nature of the current drought in Somalia and Lake Chad Basin (LCB). The similarities between hydro-meteorological variables in both cases were analyzed. The objective of the study is to provide a comparative analysis of spatial and temporal variability of drought indices in Somalia and LCB with the view to identifying trends and Onset of drought. The result from this comparison will hopefully serve as timely input for policy makers in LCB and international organizations for sustainable water.

6. Pitins for replenishment

The member countries of the commission intend to replenish the lake by constructing a dam and 60 miles of canals to pump water uphill from the Congo River to the Chari River, and ultimately to Lake Chad. According to Martin Gbafolo, the LCBC's head of water resources and environment, the replenishment project "will be the first of its sort in Africa." For a feasibility study, the commission has raised more than $5 million. Although the total cost of the project will not be known until the investigation is completed, experts such as Professor Mohammed believe that saving the lake will necessitate a large infusion of dollars. The World Bank has already committed $10.6 million to a project aimed at reversing land and water deterioration. The LCBC is also training livestock herders on how to acquire access to grazing and watering places. Water users are taught effective water-use procedures, while fisherman is taught more appropriate fishing techniques. In October 2010, at the opening of the African World Forum on Sustainable Development in N'Djamena, Chad, Nigerian President Goodluck Jonathan emphasized the LCBC member countries' collective determination to save the lake. However, the 30 million people who rely on it are unsure how long the lake will be present and when they will be able to receive relief. (United Nations of Africa, 2012).

REFERENCES:

1. Hydrology and limn logical aspect of lake monitoring (Pertti Heinoneon) textbook published in 2000, Page 4-6
2. Michigan inland lake partnership: http://michiganlakes.mSUe.mSU.edO/lakee clogy/lake classifications.
3. National Drought Mitigation Center, http://www. drought. uni. Edu/what is/conceyt. htin)
4. Lal R (1994) Tillage effects on soil degradation, soil resilience, soil quality and sustainability. soil tillage research, pp,1 8-27.
5. Michael T et al., 2001 human and natural impact the water resources of the Lake Chad Basin. Journal of
6. Geography research, vol 106 no. D4 on, pages 3349-3356, Feb 27, 2001.
7. Prof Savindra Singh Environmental Geography Pravalika publications Allahabad University, pages 339-351.
8. Food and Agriculture Orgamsation (FAO) 2012, Climate change implications for fishing communities in the
9. Lake Chad Basin. Food and Agriculture Organization Fisheries and Aquaculture Proceedings 25, Rome, Italy.
10. McCubbin, S., B. Smit, and T. Pearce. 2015. Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. Global Environmental Change 30: 43—55
11. Giwa 2012, Global International Waters Assessment Lake Chad Basin, GIWA Regional assessment 43. Published by the University of Kalmar on behalf of United Nations Environment Programmed
12. Victoria, Tanganyika and Nyassa, 1964. The Lake Chad Basin Commission (LCBC)
13. World Meteorological Organization (WMO).
14. http://www. ncdc noaa. gov/acclimate/globalwarmin2.htflll
15. http://www. giss. NASA. gov/research/
16. Encyclopedia Britannica dictionary (2015)