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Analysis of the Strategies Employed by Riparian Communities to Cope with Retreating Water Levels in Lake Chad Basin

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Abstract
The problems associated with declining levels of freshwater and water resources inadequacies in the Lake Chad basin of Central Africa are worrisome and growing. The purpose of this paper is to present up-to-date information on the freshwater situation in the basin and analyze the strategies which riparian communities now employ to cope with the decline in freshwater levels of the lake. The physical and hydrological characteristics of the basin as well as the indicators of freshwater decline within the basin were identified and described. Patterns of decline in lake water levels over decades (1963-2015) were x-rayed and the implications of the decline on the socio-economic activities of the people highlighted. The survival strategies adopted by the riparian communities to cope with the decline in water levels as well as the weaknesses of the strategies were discussed. In conclusion, the payer suggests directions for the modification of the coping strategies in order to eliminate observed flaws and improve their efficiency in assisting the riparian populations survive hash environmental conditions.
Keywords: Arid environment, Chad Basin, Indicators, Strategies, Riparian communities, Water level decline.

1. Introduction

Lake Chad is a historically important and endorheic Lake which is located in the far western end of Chad bordering on northeastern Nigeria, between latitudes 12 °and 14 °30 N and longitudes 13 °and 15 °30 E. (see fig 1). The Lake is situated on the edge of the Sahara Desert, and provides a vital source of water to human, livestock and wildlife communities in the lake region The lake is relatively large and shallow, with the depth varying widely from less than 1 to10.5 meters (34ft) at its deepest section (Michael and Foley, 2001). Since the 1970s, the basin area has experienced a series of devastating droughts and desertification.

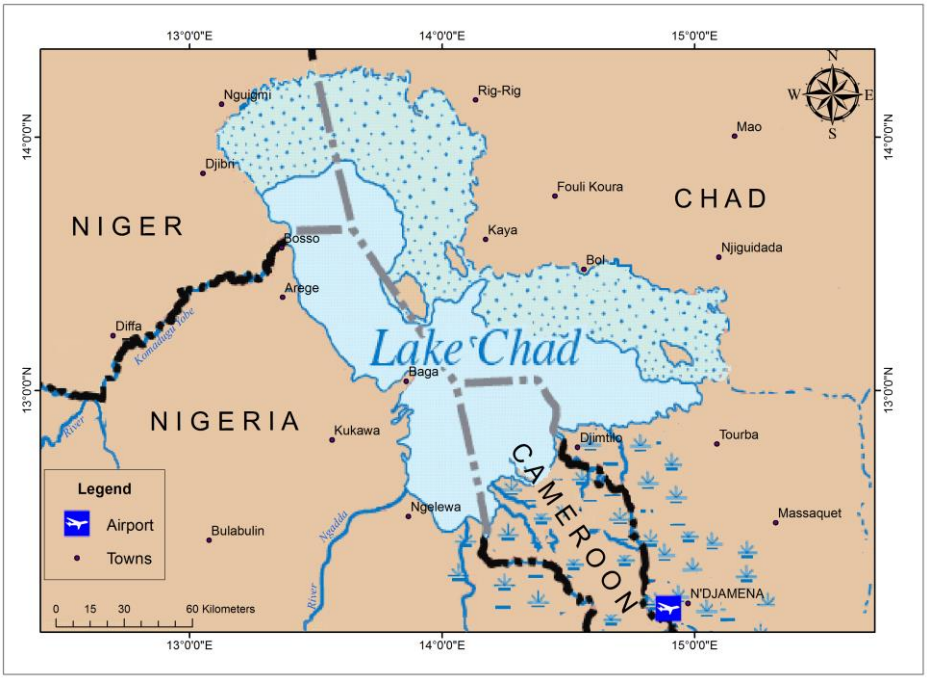


Fig. 1 Location of the Lake Chad Basin

Source: GIS Unit, Department of Geography University of Nigeria, Nsukka

Three main river systems, according to Dami et al (2011) and Ifabiyi (2013), flow into the lake. These are:

1. The Hadejia/ Yobe, Jamarare-Kornadouquo River system which enter the lake from northeastern Nigeria.
2. The Chari River system (fed principally by its tributary, the Lagone) which provides over 90% of the lake s freshwater resources and enters the lake from the north western Chad, and the
3. Yedesteram River system from the Mandara hills. This stream loses most of its water while flowing northwards through a seven kilometer wide flood plain and does not maintain a definite water course to the lake.

The total land area of Lake Chad Basin (2, 434, 000, square kilometers) covers almost 8% of the African Continent and spreads over seven countries, as show below in table 1

TABLE 1: COUNTRIES WITHIN LAKE CHAD BASIN.

Country	Total area of the country (km^2)	Area of the country within the basin (km^2)	As % of total area of country (%)	As % of total area of country (%)
Nigeria	923770	179,282	7.5	19.4
Niger	1267000	691,473	29.0	54.6
Algeria	2381740	93,451	3.9	3.9
Sudan	2505810	101,048	4.2	4.0
Central Africa	622980	219,410	9.2	35.2
Chad	1284000	1,046,196	43.9	81.5
Cameroon	475440	50,775	2.1	10.7
Total for lake Chad basin		2, 381,635	100.0	

Sources: LCBC, (2008) pp. 09

About 20% of the total land area of the Lake Chad basin or 427,500km^2 is called the conventional or active basin area (Kolawole et al, 2012). This conventional basin area in shared by 4 countries, viz: Chad (42%), Niger (28%), Nigeria (21%) and Cameroon (9%) (Coe and Jonathan, 2001). These four states, according to Olaniran (2002), formed the Lake Chad Basin Commission (LCBC) in 1964, with the objective of promoting the most rational use of water, land and other natural resources of the basin as well as to coordinate regional development.

Lake Chad has shrunk considerably in size over the centuries. At its largest, sometime before 5000BC, the lake was the 4th largest lake in Africa and 6th in the world , and was estimated to have covered an area of about 1,000,000km^2 (390,000sq.mi)(FAO, 1997,2009). The lake has however shrunk in size in as much as 95% between 1960 and 1998 (Ifabiyi 2013). In 1983, the lake was reported to have covered between 10,000 to 25,000km^2 (3,900 to 9700sq.mi), had a maximum depth of 11meters (34 ft) and a volume of 17 cu mi (LCBC, 2007). By 2000, its extent had fallen to less than 1,500 km^2 (58sq.mi). Presently, recent drought occasioned by climate change may have worsened the situation.

Previous workers (Coe, 2001; Odjugo, 2005, 2006; Molega, 2006; Ifabiyi 2013) have blamed the lake's retreat on physical and a number of anthropogenic factors, namely,

I. Over-grazing in the areas surrounding the lake, which accelerates desertification and a decline in vegetation.
II. Inefficient damming and unsustainable irrigation practices by riparian communities in countries bordering the lake
III. Frequent diversion of water from the rivers (feeding the lake) to irrigation projects/fields
IV. Rapid increases in the quantities of the lake's water demanded by the increasing riparian local population.
V. Aggressive and unregulated water abstraction for irrigation and other purposes by upstream communities of the river feeding the lake, particularly since the 1980s and 1990s.
VI. Climatic factors particularly increasing variability and irregularity in rainfall, dry spell, excessive evaporation and sand dunes that have impacted negatively on the water body.

Lake Chad is economically significant. It provides water to more than 68 million people living in riparian communities of four countries surrounding it (Chad, Cameroon, Niger, and Nigeria) and sustaining the ecological diversity of the lake region (Coe, 2001; Ifabiyi, 2015).The drastic reduction in water resources availability in the region has remarkably impacted on the socio economic lives of the people in the basin (Coe, 2001). The objective of this paper, therefore, is to assess the survival strategies employed by the riparian communities to cope with declining levels of freshwater in the lake region and in addition, suggest innovative strategies which may assist to replenish and/or restore freshwater to earlier levels in the region.

In doing this, we relied heavily on information obtained from The Federal Ministry of the Environment, Abuja; Nigerian staff of Lake Chad Basin Commission (LCBC) based in Baga; household heads in 4 lakeside settlements(Doro, Doro Baga, Doban Masara and Darak), as well as from published research reports that is pertinent to the Lake. This study is, indeed necessary, considering the wide spread concern/worry over the lakes near-extinction and the need to find sustainable solutions to the age-old problems associated with the utilization of the lake's water resources.

1.2 Peoples of the Lake Chad Basin

The Lake Chad drainage basin covers an area of 2,434,000 km, while active or "Conventional basin", which is the geographic limit of the Lake Chad Basin Commission, lies between Nigeria, Chad, Niger and Cameroon is about 427,500 square kilometers (LCBC, 2007). The indigenous people that inhabit the lake basin area are the Kanuris of Nigeria, Cameroon, Niger and Chad; the Gboya of Chad and Central Africa Republic; the Kotoko who are of Afro-Asiatic origin; the Sara of Chad and migrant Arabs who are largely herdsmen (Nyong, 2001). Collectively these nations in the basin have a combined population of 237million people projected to reach 390million by 2025 (Coe, 2001; Ifabiyi, 2013). Urbanization in the basin is about 50%, it is projected to reach 70% in 2030(Dami et al, 2011). The lake still supports a growing human population, as well as millions of birds and a number of mammals, reptiles, and amphibians, despite the fact that its potential evaporation rate is four times as large as the rainfall rate in the region. The Lake Chad Basin has extensive floodplains.

1.3 Hydrological Characteristics of Lake Chad Basin

The hydrological and/or meteorological indices which characterize the Lake Chad basin according to Kolawole et al (2012) are:

1.3.1 Low , Irregular /Variable Rainfall

The Lake Chad basin is particularly susceptible to low, variable and irregular rainfall (Olaniran, 2002). The mean annual rainfall of the basin area is just 415mm (LCBC, 2000). Precipitation in the area occurs only when the depth of the humid air is sufficiently great but the depth of the air mass varies daily as well as seasonally accounting for low and wide variations in precipitation levels. Table 2 provides a summary of the rainfall pattern in the area.

Table 2; Average Annual Rainfall Pattern in the Chad Basin in mm

Country	Minimum	Maximum	Average
Nigeria	285	1330	670
Niger	0	635	105
Algeria	0	135	20
Sudan	70	1155	585
CAR	760	1535	1215
Cameroon	365	1590	1010
Chad	0	1350	400
Lake Chad area	0	1590	415

Source: Olaniran, (2002) p 55

The countries that most dry, with exceedingly low rainfall and low runoffs are Niger, Algeria and Chad

1.3.2 High Rate of Evaporation

Generally, extreme high temperature characterize the lake Chad region, as a result evaporation and transpiration losses from soils and plants in the area are high(Michael and Foley, 2010). The evaporation rate is estimated to be in excess of 2000mm/year (Kathryn, 1999), while the average annual potential evapo-transpiration is in excess of 800mm due to the dominance of the dry continental air mass in the basin area. During the harmattan, a dry dust-laden wind reduces visibility for days in most of the riparian communities.

1.3.3 Low Runoff

The extreme low runoff regime which characterizes the Lake Chad basin naturally leads to low runoff rates. Low rainfall of about 1500mm/year in the south and 100mm in the north of the basin is common (Michael and Foley, 2010). Low runoff is a common phenomenon that results from the low rainfall and the high degree of both spatial and temporal rainfall variability. Variability during the year is high, and variability from year to year is also high and droughts are frequent (Dami et al, 2012).

1.3.4 Extreme High Temperature

The extreme temperature discussed above has been described as the major characteristic feature of the basin from historic times (Kathryn, 1999) .Generally, temperature is high in the Chad basin, particularly, during the dry season. In October and November, during the transition to the dry season, daily highs rise above 90F (32^oC). April is usually the hottest month of the year, with temperature occasionally reaching 110^oF (40^oC) (Molega, 2006).

1.3.5 Fierce Wind and Sand dunes

Apart from the characteristics mentioned above, the Chad basin also experiences fierce wind, especially during the dry season. When this happens, the soil turns into hot sand dunes, which hinder numerous human activities (Molega, 2006).

1.3.6 Fluctuation in Water Levels

Lake Chad and streams within the basin are variable water bodies. The measured surface area of the lake typically fluctuates seasonally, peaking in late October or early November, then shrinking by more than half by late April or early May (Kathryn, 1999). The same applies to the streams which discharge into the lake. The volume of the lake often reflects its characteristics low local precipitation level.

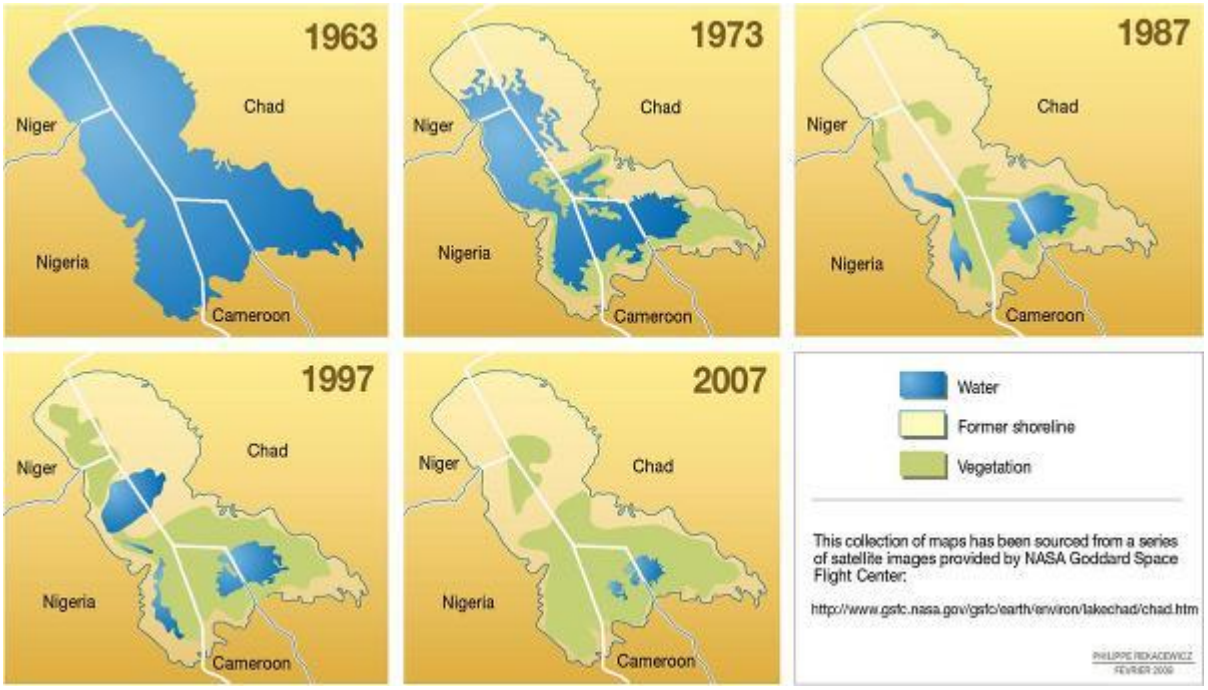
1.4 Indicators of Declining Freshwater Levels in the Basin

The signs, magnitude and severity of decline in freshwater resources in the Lake Chad basin was established from the under listed indicators:

1.4.1 Reduced area of Freshwater Bodies:

Records available at the Federal Ministry of Environment indicate that the lake was once Africans largest water reservoir in the Sahel region, covering an area of about 26,000km^2. By 2001 the lake shrunk to about 1,500km^2 or one-fifth of its initial size (Molega, 2006).About 50% of the decrease in the size of the lake is attributed to human activities such as over-grazing and diversion of the lakes water while the remainder is attributed to shifting climate patterns(Ifabiyi,2013). Figure 2 presents summary images of the shrinking size of the lake.

FIG. 2: DWLINDING SURFACE AREA OF LAKE CHAD



Source: Google Images adapted from Ifabiyi,(2013),p 200.

Presently there is no certainty about how much longer the lake will remain.

1.4.2 Increase in Water-related Conflicts by Riparian Communities:

The scramble for the available freshwater resources in the basin is causing frequent tensions and conflicts among the riparian communities and professional groups in the basin (Kathryn 1999:'FAO, 2009). Repeated conflicts among nationals of Nigeria, Cameroon and Chad over the control of the basin water resources date back to several decades. For instance, Cameroonians and Nigerians in Darak village have constantly fought over the lakes freshwater since 1968. Nigerians claim to be the first settlers in the village while Cameroonians claim that the village falls within Cameroonian territory. Fishermen, farmers and herdsmen also clash frequently. The farmers and herdsmen, for instance, want the water for their crops and livestock and are constantly diverting the lakes water while the fishermen want the remaining water in the lake to stay so that they can continue to fish and sustain their family (Ifabiyi 2013).

1.4.3 Environmental Degradation (Accelerated soil erosion, etc):

As one approaches the Lake Chad from Nguigmi (Niger) or from Maiduguri (in north eastern Nigeria) or Mao (Western Chad), the evidences of despair arising from limited water availability are unmistakable. The air is dusty, the wind is fierce and dry, the plants are wilting and sand dunes are everywhere. The vegetation especially on the Chadian and Nigerian borders are sparse and vanishing. Withered trees and shrubs are everywhere. Dead cows are occasionally seen and the living herders appear malnourished. All these result from the reduction in surface area of the lake, which in turn, heightens droughts and desertification.

1.4.4 Decline in Fish Production:

The next indicator of the decline, in freshwater levels, is the basin in the noticeable decline in fish production, in the area. According to Ifabiyi (2013) the annual fish catch in 1972 was between 130,000 to 141,000 metric tons. This has reduced to a current estimate of 50,000 to 70,000 tons. Local fishermen report that some 27 year ago, they caught as large as man, but now things have changed. Today the fishermen are grappling with tiny catfish which is what is available. Findings revealed that the once busy Baga market in Maiduguri, where truck loads of fish from the lake used to be processed and then transported daily to other parts of Nigeria, in new quiet/deserted. Some workers estimate that annual fish production from the lake has declined by more than 58% (Vichi, 2011).

1.4.5 Intervention by LCBC & the World Bank:

The Lake Chad basin Commission and World Bank have continued to make efforts to save the lake from extinction and/or to mitigate the impacts of the lakes shrinkage on the lives of the riparian population. These agencies have plans to replenish the lake by building a dam and 60miles of canal to pump water uphill from the Congo River to the Chari River and then on to lake Chad.

1.4.6 Sedimentation in Rivers and Water Bodies:

Some workers such as Vichi (2011) and Ifabiyi (2013) have reported reduced inflow to the lakes and colonization of silted sites by water hyacinth as important consequences of the decline in water levels within the basin.. These two phenomena have encouraged silt trapping in the lake. This has reduced the bank full capacity of Lake Chad. Unsustainable farming activities have further worsened the incidences of sedimentation in the LCB.

1.5 Effects of the Decline in Water Levels on the Local People

Since 1963, the lake has shrunk to nearly a twentieth of its original size, due largely to factors discussed earlier such as climatic changes and high demands of water for agricultural and other uses. The surface area of the lake has decreased from approximately 25,000km^2 in 1963 to 1,350km^2 in 2001 (Molega ,2006). The consequences of this dramatic decrease in the size of the lake were found to include the following:

1.5.1 Wide Spread Poverty in the Basin

This reduced access to water has culminated in crop failures, livestock deaths, collapsed fisheries, destroyed wetland, services, loss of means of livelihood, caused unemployment, increased poverty, criminality, facilitated forced migration, and increased despair within and around the LCB (Ifabiyi, 2015).These consequences are very apparent in Nigeria, Niger Cameroon and Chad.

1.5.2 Other Effects

Other major effects reported by workers such as Michael and Foley(2001), Vichi(2011) and Ifabiyi (2015**)** include decreased viability of biological resources;, biodiversity loss, water scarcity, increased soil salinity, damages to ecosystems, reduction in ecosystem productivity, modification of ecosystem, increased desiccation, and endangered wetlands of the LCB., In addition, rice cultivation has been drastically affected ,weed of different types and pest of diverse origin are now presenting in the LCB. Common examples are the typha grass, water hyacinth which block rivers, divert flows, destroy infrastructure, and encourage quela bird. All these have worsened the situations and poverty margin and peoples livelihood in the LCB.

1.6 Strategies Adopted by Riparian Communities To Cope with Declining Fresh Water Levels in Lake Chad Basin

As noted in earlier sections, rainfall is low and its distribution in the basin is highly variable- both temporally and spatially. Nearly 90% of the annual rainfall is received between June and November. As a result, droughts and desertification are common and every year the riparian populations suffer due to either of those. The people (fishermen, herdsmen, farmers etc) do not access enough water even to meet their basic needs. As a result, they

employ various strategies to deal with the spatial and temporal mismatch of water availability and demands. The strategies commonly adopted are discussed below:

1.6.1 Out Migration

A as a result of the growing lake dry up, many farmers, herdsmen and fishermen have migrated out (of the lake area) southwards in search of greener areas. Some of these migrants settle in communities where they compete for land resources with host communities, while other move to big cities (Kano, Abuja, Lagos, Kaduna, Port Harcourt etc) where they settle for menial jobs or roam the streets as begs

1.6.2 Fadama Farming

Many of the farmers living around the rapidly contracting Lake have devised new farming strategies to adapt to the emerging realities of the lake. Part of the strategies the farmers have adopted is fadama (lake bed) farming. This is a local level stakeholder management strategy involving the farming of the exposed lake floor as floodwater recedes. Through this method, the farmers take advantage of the new opportunities offered by the exposed (usually fertile) lake floors (fadamas) to cultivate their crops. They employ both traditional and improve technologies to farm on the thousands of hectares of cultivable lands which the receding waters have exposed.

1.6.3 Irrigation Agriculture

In an attempt to maximize the use of available water resources in the Lake Chad basin, the riparian communities have resorted to harnessing large amounts of water for irrigation through dam construction. A few large scale irrigation schemes now exist in the region, especially on the Nigerian side of the lake. Many of the farmers now rely on these earth dams and water pumps for crop and even livestock production.

1.6.4 Change in Life Style

The traditional style of relying exclusively on fishing, especially by riparian communities on the major lake islands (Doron Baga, Daban Masara, Darak etc) has been changing in response to the contraction of the lake. The residents of these communities have shifted from relying entirely on fishing to farming emergent lake floor as water recedes.

1.6.5 New Means of Survival

The menace of water scarcity, in the Lake Chad basin has had a remarkable impact on the socio economic lives of the people in the region. Findings revealed that one of the most remarkable outcomes of this environmental challenge is the realization by the basin residents that they need to develop new survival skills. The era of relying solely on one occupation such as fishing, rain fed or irrigated farming appears to be over in the basin. The basin residents have been forced to device new strategies to cope the dwindling size of the lake Some of them now combine farming with buying and selling agricultural goods; some combine fishing with weaving ,mat making and other means of survival; some now rely on foods stored or imported from other areas while some have turned to hunting or selling of fuels as new means of survival.

1.6.6 Local legislations

A number of actions have now been initiated at local community levels by diverse groups to slow down the rate of water reduction in the basin. Such actions include controlled fishing and grazing, and prohibition of water diversion at particular areas at particular times of the year.

1.7 Assessment of the Strategies

The Chad basin replenish project, in our view, is a bold and an appropriate project which can rejuvenate the severely depleted lake and promote sustainable development in the region. There are currently many successful water transfers in the world, including Africa. Water transfer to the lake region will bring several attendant benefits. Bossche et al(1990), LCBC(2000), FAO,(1997;2009) Kolawole et al (2012),and Ifabiyi (2013) indentified reduced temperature and evaporation rates, increases in rainfall amounts in the lake region, decreased frequency of droughts, reduction in the frequency of bush fires, reduced rate of land degradation and loss of forest cover and biodiversity , and decrease in. desertification .Also , decreased in weather related disasters and decrease in the frequency and intensity of unusual or extreme and unpredictable/erratic rainfall pattern were identified by Molega (2006).However, the problem with Chad basin water replenish project is the estimated cost. The feasibility study of the project is estimated to cost over 10 million US dollars. The project is expected to cost 15 billion Euros (23 billion USA dollars). The possible donors such as UNDP, EC,French Development Agency and EU are all skeptical concerning the project because of the fact that the level of information available is still low and that the cost is very high (Ifabiyi, 2013).There is a general belief that members of LCBC are financially and technologically weak to develop and manage the project (FAO, 2009).

The problem without migration of herdsmen from the Chad region to southern greener areas is the constant conflicts between the herdsmen and the farmers in the host communities .Conflicts' between farmers and herdsmen, searching for pasture and water resources have been reported in every part of west Africa such as the downstream half of the Niger between Nigeria and Niger :the southern parts of Nigeria, in the Volta region between Ghana and Burkina Faso, in the Middle Belt states of Benue , Nasarawa and Plateau in Nigeria and in the Cameroon(Niasse,2005,Olaniran ,2002).The direct consequences of the frequent conflicts are the weakening of the bond of unity between the diverse coexisting cultural groups, the loss of human lives, the massive destructions and the high cost of policing and resolving such conflicts. In Nigeria, this problem is further complicated by the apparent division between the largely northern Muslims and the southern Christians as well as by the prevailing harsh economic conditions facing the people.

The problems with fadama and irrigation farming in the lake Chad region currently is that the region is presently the most volatile portion of west Africa, where Islamic terrorism and suicide bombing has been featuring very frequently in the last two decades. These violet jihadist militants, known locally in Nigeria as the Book Haram group, have made farming and other economic activity in the Chad region risky and unprofitable. More worrisome in the use of this strategy is the report that the intensive fadama farming which has operated in the Chad region since 1975 is depleting the areas ground water resources of the basin area. The situation is worsened by the fact that the numerous dams constructed across the streams draining into the lake is preventing much water from reaching the lake. These effects have been documented in a number of reports, especially, Bossche et al (1990), FAO, (1997), Dami, et al (2011), and Ifabiyi, (2013).

1.8 Conclusion

The results of this study have clearly demonstrated that the massive dwindling of water levels in Lake Chad is affecting the survival of man and animals in the Lake Chad basin. The basin residents have adopted a variety of strategies to cope with the difficult environmental conditions facing them. Some of the survival strategies are commendable as they are geared towards prolonging the availability of water, or towards reducing the impacts of water scarcity on the people. These strategies, however, cannot sustain the rapidly growing population of the basin or save the lake from extension. They cannot also guarantee/ sustain the development of the basin area in the long run. They can at best be described as water-saving land use practices. Something urgent needs to done to save the now severely depleted lake. Its extinction will lead to catastrophic human and ecological outcomes. Our findings indicate that strategies which can restore the dwindling water of the lake and/or guarantee the sustainable development of the basin area are beyond the capacity of the riparian communities and their governments. The way forward, therefore, is for international donor agencies and governments to come to the assistance of the basin communities by funding the Lake Chad Replenishment Project (LCRP). This project is an interbasin water transfer initiative agreed upon by members of LCBC at Yaoundé, Cameroon in 2002. The objective is to rejuvenate the lake by damming the Oubangni River (a tributary of Congo River) and subsequently channeling some $900m^3/s$ of water annually from the Congo-Oubangui Basin through a navigable canal of about 100-150km to Lake Chad. This proposed project will halt the fast decline in volume of the lake.

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