

**CHALLENGES OF ADAPTIVE WATER MANAGEMENT IN THE LAKE CHAD
BASIN.****BY****Mohammed Bukar Ngamdu**Department of Geography, Yobe State University
P. M. B. 1144 Damaturu, Yobe State, Nigeria.**ABSTRACT**

The focus of this paper is the Lake Chad Basin in the Sahelian region of Africa. The Sahel, like most dry and arid regions is projected to have reduced rainfall (IPCC, 2007). The Lake Chad is dependent on the flow of two main rivers with over 90% of its source being provided by the Chari-Lagone river basin; the rest is supplied by Yobe river basin (LCBC, 2000). The flow of these rivers has apparently reduced over the years and as a consequence the water levels in the lake has dropped considerably. A number of causes have been identified for the shrinkage of the lake and categorised as environmental and social-economic activities in the area (Ayuba & Dami, 2011); the dominant environmental factor being reduced rainfall. The current situation of the lake is such that efforts are required to protect what remains of it and to possibly regenerate somehow to its original status. One key way of achieving this is through the concept of Adaptive Water Management. The aim of this paper is identify the dominant challenges to applying AWM in Lake Chad by looking at the following key areas: Environmental conditions of the region, Weak Institutional Frame work and Damming of Rivers Upstream of Lake Chad. It has been observed that Climate change and variability has negative impact on the Lake Chad basin. Studies have confirmed that particularly the arid and semi-arid regions of Africa are the most vulnerable areas to climate variability and change because of multiple stresses and low adaptive capacity (Osman- Elasha, 2007; IPCC 2007). The effect of climate change, coupled with several anthropogenic effects, is one of the main causes of the severe depletion of the Lake. Inadequate observation of climatic data limits the regional diagnostic analysis and the dearth of information on climatic change forecasting hinders the capability to detect the negative effects of climate change on non-adapted human communities. One of the greatest challenges of adaptive water management in the lake Chad region is the problem weak institutional framework of the institution that protect water resources in the basin which is the lake Chad basin Commission, LCBC as the only intergovernmental river basin organization in the Lake Chad basin was created on 22 May 1964 and is headquartered in Fort Loamy, now [N'Djamena](#). Another Challenge to adaptive water management is incorporation of the indigenous people in to the management and planning water management in the basin, The Indigenous people has to be taken into consideration in other to have adaptive water management, they have adequate knowledge about various ways in which water is being manage through local indigenous knowledge, the knowledge been used for thousands of years by the indigenous people and passed from one generation to another. Indigenous people live close to the resources, observe activities and are the first to identify any change and adapt to them. Another challenge to adaptive water management in the Lake Chad basin is Dam construction. Which is the artificial modification of river, Most of the dams in the upstream of lake chad basin have been dammed for irrigation and other activities, such as the Logone in Cameroon and the Komadugu-Yobe in Nigeria, further altered the hydrological pattern in the Lake Chad basin.

Keywords: Adaptive, water management, lake Chad

INTRODUCTION.

Global warming is already identified to have mixed impacts on global water resources. A study by Falkenmark (2007) notes that global warming will cause an increase in annual average river run-off, with the result that water availability will increase by 10-40% at high latitudes but decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics. The study continues that drought affected areas will likely increase in extent and confirms Africa as one of the most vulnerable because of multiple stresses and low adaptive capacity. The projections suggest increasing challenges in terms of increased water stress and adverse effects on food productions. A similar study by Appel (2006) shows that less rain will fall annually in parts of Africa within 50 years due to global warming, with a decrease in water availability occurring across about 25% of the continent. If the rainfall decreases by 20%, Southern Africa will be left with only 42% of its river water, and in northern African river water levels would drop below 50% (Appel, 2006).

The focus of this paper is the Lake Chad Basin in the Sahelian region of Africa. The Sahel, like most dry and arid regions is projected to have reduced rainfall (IPCC, 2007). The Lake Chad is dependent on the flow of two main rivers with over 90% of its source being provided by the Chari-Lagone river basin; the rest is supplied by Yobe river basin (LCBC, 2000). The flow of these rivers has apparently reduced over the years and as a consequence the water levels in the lake has dropped considerably (figure, 2). A number of causes have been identified for the shrinkage of the lake and categorised as environmental and social-economic activities in the area (Ayuba & Dami, 2011); the dominant environmental factor being reduced rainfall. The current situation of the lake is such that efforts are required to protect what remains of it and to possibly regenerate somehow to its original status. One key way of achieving this is through the concept of Adaptive Water Management.

Adaptive Water Management (AWM) is defined by NeWater project as management system that ensures that the adaptive capacity of the water system is increased through, essentially, a learning processes from past experiences. It is essentially about using the experiences gained from one management as feed-in to improve the next stage of management (Pahl-Wostl et al. 2007). With respect to the Lake Chad, there is no evidence to suggest that AWP has been applied in any formal way. And even though the potential exists for its application numerous challenges have to be overcome before any meaningful benefits are made from its application. It is a relatively new concept in the water management field. The idea behind it is that water management issues are complex, characterised by uncertainty and change and involve many different stakeholders. Because they cannot be addressed through prediction and control, management needs to be adaptable to new information and changing circumstances. The aim of this paper is identify the dominant challenges to applying AWM in Lake Chad by looking at the following key areas:

1. Environmental conditions of the region
2. Weak Institutional Frame work
3. Damming of Rivers Upstream of Lake Chad.

The paper is divided into five sections including the introduction. Section two gives a literature review on AWM citing cases studies. Sections three is the detail description Chad basin. Section four examines various challenges militating against adaptive management of water in the Lake Chad basin. Section and the paper is concluded in section five.



Fig. 1. Shows the lake chad basin: Source: Wikipedia (2012)

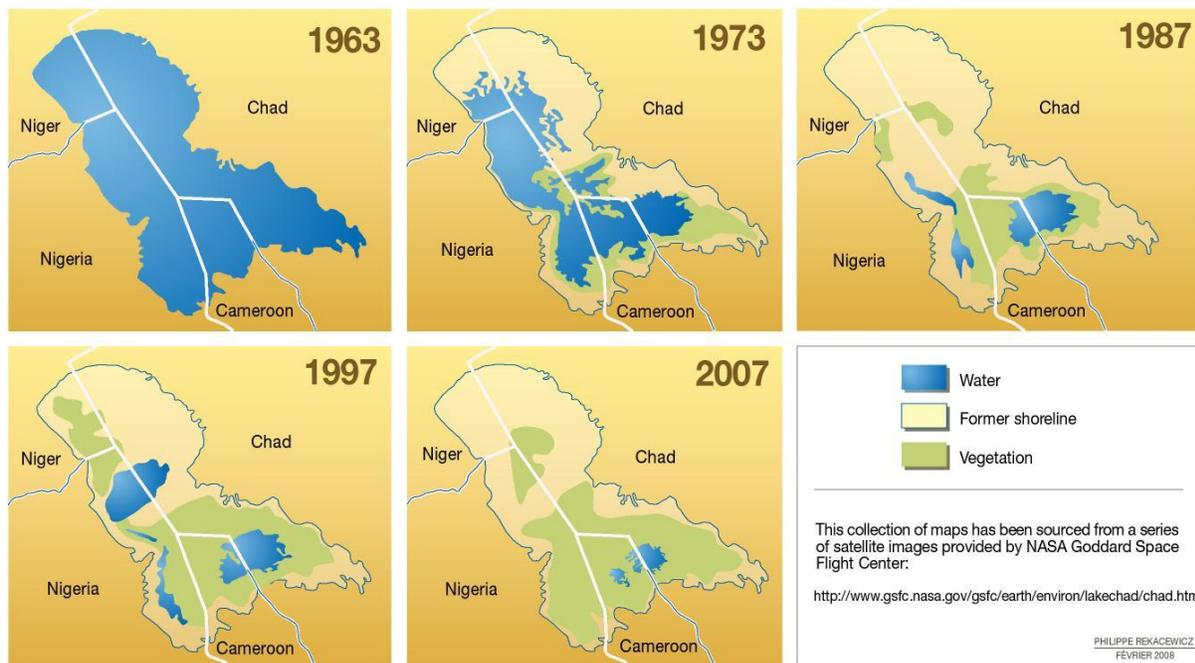


Fig. 2. Shows How The Lake Chad Basin has been shrinking: Source: UNEP (2008)

2. LITERATURE REVIEW

Looking at the Orange River basin as a case study, there is a pressing need for the Orange River system to be managed equitably as a whole system. The river flows through four countries of Botswana, South Africa, Lesotho and Namibia. The basin being a trans boundary in nature, the project will contribute to a better understanding of how the basin can be effectively managed. Numerous Challenges to water management in the orange river basin have been Identified, They are the over use of the ground water which leads to shortfall in supply and local depletion and also problem due to inadequacy in development of the distribution network. Other management challenges are inter catchment transfer have brought potential impact on ecological integrity as a result of river habitat changes in the basin. Also the inadequacy of tariff structure which eventually results to inability to fund infrastructure and carry out maintenance of the Orange River basin. There is the possibility of conflict between development and sustainable use of the resources as a result of significant pollution and institutional management constrains, the surface water source in the basin is subject to high variability of flow and seasonal shortages. There is also the problem of inability of the meeting the rapidly increasing water demand being that the basin is the major economic hub in southern Africa and there is high movement of population into the rapidly growing cities and urban areas around. The orange case study has the developing a motivation and frame work for incentive based wetland in the basin and enhancement of the basins management by building preparedness for the possible future basins scenario as its themes (Newater, 2005)

Another case study is the Nile, which is one of the world's longest river and greatest asset. It is trans boundary in nature and shared by ten African countries of Egypt, Eritrea, Rwanda, Sudan, Tanzania, Burundi, Democratic republic of Congo, Ethiopia, Kenya and Uganda. It has an estimated population of 160 million and its catchment area covers 10% of African Landmass, out of the riparian states, five are among the world's ten poorest countries. Wide spread Poverty and coupled with growth in population are among the key drivers in socio economic development and this increases pressure on the water resources through diversion of surface water and storage in order to serve the increase agricultural and energy demand, which has ecological effects such as reduction in sea flow and riparian habitat. In the upstream catchment of the countries, numerous problems have been identified such as erosion of soil resulting in reduction in crop yields, non-sustainable livelihood, forest are cut down and wet land drained. The Trans boundary nature of the catchment touches international political boundaries and involves many decision makers. This coupled with climate variability, spatial and temporal distribution of water resources and the complex political, economical and social status creates challenges to sustainable development. The creation of the Nile basin initiative in 1999 with the initiative of provision of basin wide framework for incorporation the riparian countries which perused shared vision development through equitable utilization of the benefits from the common Nile resources. Most of the Basin countries are burdened by weak human and institutional capacity to manage water resources in an integrated manner. This situation applies not only to the management of international waters but also to the management of national and local waters. Water management within each country is still fragmented between sectors, and there is little integration among various sectors of water use, between water quantity and quality, and between surface and groundwater. Most issues associated with water management in the Nile basin are of a trans boundary nature, and need a regional perspective for the identification of solutions. As the population and water use per capita increases, the water stress in the basin is likely to intensify. Water stress leads to water competition which might result in conflicts and even war. This is complicated by the Trans boundary nature of the conflict, the water agreements made during the colonial era and the perceived disparities in economic and infrastructural development, political and religious orientation. The challenge lies in managing the water resources in

ways that reduce the water stress and in creating cooperation and economic development mechanisms that effectively manage the emerging conflicts (Newater, 2005).

According to Lannerstad et al (2009) in its study of adaptive water resource management in the southern Indian Bhavani Project which is located in the southern Indian state of Tamil Nadu which has much of its parts in the rain shadow while other unlike other parts of India who relatively benefit from the reliable southwest monsoon from October to December which is characterized by cyclone and short heavy downpour. It is the largest basin in southern India and most important source of water in Tamil. Weirs, some tanks and large number of wells were constructed as methods of adopting to natural water limit during the historic time and another weir was also constructed in in the thirteen century and which was named after a local ruler Kalingarayan. It was the first local attempt to adapt to water scarcity in the basin. It also created a direct link between two irrigated systems in the basin and was the first step towards today's complex situation where the basin river flows are controlled by people.

3. ABOUT THE LAKE CHAD BASIN

Lake Chad is the fourth largest lake in Africa sustaining over 20 million people and forming the boundary of four countries of Nigeria, Niger, Chad and Cameroon. Over the past four decades the Lake has lost about 90% of its size and is under threat of extinction if nothing is done to stop the pace of degradation. This drying lake poses a water and food scarcity problem to its dependent population and a challenge to Tran's boundary water management. It is located between latitude $12^{\circ} 20'$ and $14^{\circ} 20'$ North and Longitude 13° to $15^{\circ} 20'$ East, covering about 8% of Africa and extending to eight different states. The main Lake however, is a terminal depression less than 1% of the geographical basin and forming the boundary of Chad, Cameroon, Niger and Nigeria. The basin is constituted by three climatic zones; Sahel and Sahara to the north and humid tropical zone in the south. The main sources of water are two rivers, Chari-Logone from the south which supplies about 95% and Komadugu-Yobe from the North-West contributing less than 3%.

The Lake supports 150 fish species, 60 amphibious and 272 birds' species. This resource potential of the basin has annual population growth of 2.5-3%. The population, about 20 million, are mainly from the four riparian states and few from neighbouring countries. The major economic activities of the region are fishing, farming and livestock rearing. A study by Jauro (2007) has indicated considerable reduction in the depth of lake with the maximum depth averaged 1.5m and its surface area reduced to less than 200km² from about 25000km² in the last thirty years. This is indeed a huge reduction considering that in the 1960s the lake was at full capacity after it rebounded from a completely dried up basin in the late 1990s. Like any other natural water body, the study attributed the balance of the Lake on interactions between rainfall, groundwater recharge and surface evaporation; this balance has however been significantly affected by the persistent decline in rainfall over the whole of the basin in the last 30 years, with the mean rainfall isohyets shifting by more than 185 km southwards. Close to 20 million people rely on lake-based economic activities; this is expected to increase to 35 million by the year 2020 (LCBC, 2000). The problem of changing or declining sizes of the Lake Chad has, so far, been attributed to two key things: climate change and anthropogenesis as a result of High reliance of various irrigations projects on the lake (Ayuba and Dami, 2011). While climate change is blamed for the dwindling rainfalls hence recharge of the Lake, anthropogenesis is related to land use change from mainly farming activities and overgrazing leading to creation of arid-like conditions. Humans have been adapting to changing climatic conditions and to the impact of extreme climate events in the Lake Chad Basin for several centuries. Much of this adaptation occurred gradually and spontaneously and the economies of many local communities in the basin to this day still depend on sophisticated production and social systems adapted to manage climate risk and variability. Unfortunately, with increasing population, poverty, illiteracy, globalization, coupled with the rapid preponderance of climate related risks in recent decades

and the resulting patterns of loss, there seems to a breakdown in the effectiveness of spontaneous adaptation and coping strategies.

4. CHALLENGES OF APPLICATION OF ADAPTIVE WATER MANAGEMENT IN LAKE CHAD

It has been observed that Climate change and variability has negative impact on the Lake Chad basin. Studies have confirmed that particularly the arid and semi-arid regions of Africa are the most vulnerable areas to climate variability and change because of multiple stresses and low adaptive capacity (Osman-Elasha, 2007; IPCC 2007). This vulnerability is due to several factors such as: over-exploitation of natural resources, widespread poverty, poor infrastructure, high illiteracy rates, conflicts, and dependence of a large share of its economies on climate-sensitive sectors mainly rain fed agriculture. These factors, coupled with limited institutional and technological capabilities, have contributed to the region's low adaptive capacity. The high physical sensitivity of the region to climate change has resulted in increased average temperatures and rainfall variability, both of which have severely affected food production, water resources, biodiversity, and human and livestock populations.

The open water surface of Lake Chad has reduced from approximately 25 000 km² in 1963, to less than 2 000 km² in the 1990s heavily impacting the Basin's economic activities and food security. The shrinkage of the lake has been driven by both global and local causes, climate change and vastly increased competing demands on the lake and its surrounding land have accelerated its shrinkage over the past years. Led by the belief that there cannot be much water saving from efficient management only, due to the high evaporation, there is the need for the adoption of measures beyond what is available in the management of water resources in the Basin. The supply management has, however, been dominating while less attention has been given to demand management. The challenges of adaptive water management in the Lake Chad region can be categorised into climate Change and Variability, Population Pressure and weak institutional frame work the Lake Chad basin commission (LCBC).

The combination of both as well as the introduction of emergent measures that respond to the global cause of the problem is needed within an adaptive framework to save the Lake. Adaptation is important to the Lake Chad current situation as mentioned in the Lake Chad basin commission (LCBC) Vision 2025, based on an analysis of the current situation and challenges to integrated management of the basin's natural resources, current causes of the environmental degradation in the basin are identified to be mainly global climate change, unsustainable decisions, lack of good policy and political will by the member states of LCBC, poor coordination mechanisms, poverty and fragile economic situation of the region.

The effect of climate change, coupled with several anthropogenic effects, is one of the main causes of the severe depletion of the Lake. Inadequate observation of climatic data limits the regional diagnostic analysis and the dearth of information on climatic change forecasting hinders the capability to detect the negative effects of climate change on non-adapted human communities. Ayuba (2009) stressed that it is urgent to enhance the traditional climate change adaptation strategies already put in place in the Lake Chad Basin through the development of effective climate predictability systems and broad integrated programmes to observe, predict and model changes brought by climate. Despite all analysis, it is, nonetheless, apparent that the causes of the shrinking of the Lake are multiple and still debatable. There is still a need to better investigate the source of inflow into the lake and identify the causes of the shrinking of the basin which is of great importance. The common history of the countries sharing Lake Chad can be considered as a precious asset to foster the sustainable management of the basin. Successful experiences from other regions sharing similar challenges should be collected and used as examples and benchmarks. A common information system at basin level is crucially needed as well as a

stocktaking of the consolidated knowledge. The information already available is massive but a great effort is to be carried out to help the uptake of the available knowledge.

Another Challenge to adaptive water management is incorporation of the indigenous people in to the management and planning water management in the basin, The Indigenous people has to be taken into consideration in other to have adaptive water management, they have adequate knowledge about various ways in which water is being manage through local indigenous knowledge, the knowledge been used for thousands of years by the indigenous people and passed from one generation to another. Indigenous people live close to the resources, observe activities and are the first to identify any change and adapt to them. They are more linked to the environment; their source of live and livelihood entirely depend on the environment. In all their observations using various traditional methods in understanding very well change in time and season through indicators, such as appearance of certain Birds, Mating of certain animals or the flowering of certain plants which are all important signals in identifying change in the climate.

One of the greatest challenges of adaptive water management in the lake Chad region is the problem weak institutional framework of the institution that protect water resources in the basin which is the lake Chad basin Commission, LCBC as the only intergovernmental river basin organization in the Lake Chad basin was created on 22 May 1964 and is headquartered in Fort Loamy, now N'Djamena. It was founded by Cameroon, Niger, Nigeria and Chad. The LCBC now has six country members: Chad, Central African Republic, Cameroon, Nigeria, Niger, and since April 2007, Libya. Sudan has an observer status. Its creation is an important step in the direction of establishing the institutional support needed for protecting the water resources. The riparian states agreed on the recognition of the international status of the Lake Chad basin. The LCBC has very wide objectives which include regulation and control of the utilization of the water resources and other natural resources as well as the initiation, promotion and co-ordination of projects and settlement of disputes. While LCBC have good intentions to monitor, better understand, promote awareness of and conserve natural resources, there has been very little coordination of such efforts which has resulted in bringing setbacks in the existing water management in the basin, this lack of coordination stems from often simple gaps in communication, lack of information-sharing, lack of a shared vision, lack of public participation, limited integrated planning systems, low degree of local stakeholders involvement, and lack of adequate knowledge of national policy, activities and orientation of water resources project at national level. In other to adopt adaptive water management in the Lake Chad basin and to reduce the harmful effect of climate change the possibility of inter basin water transfer has to be seriously taken into consideration.

Inter-basin water transfer is defined as: "the artificial withdrawal of water by ditch, canal or pipeline from its source in one basin (or catchment) for use in another". Micklin (1985). This could be achieved by diverting the course of a river, or by constructing a large canal which could carry a significant portion of available water. Both these alternatives have important economic, social and environmental impacts which need to be carefully analysed and evaluated. According to Michael (2009), the Lake Chad water transfer project, which aims at constructing a navigable channel using some inflows from the Ubangi to supply Lake Chad with water, will have multiple goals: to ensure river transportation in order to transfer goods from east to west across Africa; to produce electricity; and to develop irrigation and agro-industry in the region. Socio-economic and environmental benefits are also clearly demonstrated: extending and creating water supply; promotion of trade; and irrigation and agro-industry development. The water transfer project will be an example of integration project in Africa which will connect regions and even tribes beyond borders and frontiers

Another challenge to adaptive water management in the Lake Chad basin is Dam construction. Which is the artificial modification of river, Most of the dams in the upstream of lake chad basin have been dammed for irrigation and other activities, such as the Logone in Cameroon and the Komadugu-Yobe in Nigeria, further altered the hydrological pattern in the Lake Chad basin. According to Adenle (2002), the indiscriminate construction of Tiga and Challawa dams in the upper reaches of the Komadugu-Yobe has had untold impact on the reduction in the area of the Nguru wetlands, while the virtual disappearance of Lake Chad and poor land use has caused environmental degradation that further accelerates the rate of desertification in the area. This led to the loss of an estimated 200 000 ha of floodplains along the lakeshore and rivers, which were critical fish breeding and nursery areas (Batello et al., 2004). The Maga Dam in Cameroon has reduced the flow of the Logone River and seasonal inundation of the Yaéré floodplain. In the Maiduguri urban area, there is a serious problem of lowering of the groundwater level because of the indiscriminate withdrawal for water supply and the construction of Alau Dam, which has resulted in the reduction of flooding over the Sambissa Wetland (JICA, 1995).

5. Conclusion

It has been that Water Management is facing major challenges due to increasing uncertainties caused by climate and global change and by fast changing socio-economic boundary conditions. Adaptive management is advocated as a timely extension of IWRM to cope with these challenges. Adaptive management aims at increasing the adaptive capacity of river basins based on a profound understanding of key factors that determine a basin's vulnerability. Climate change is expected especially changes in rainfall patterns with resulting changes in agriculture, food and nutrition security, hydrological regimes of rivers and the Lake Chad leading to physical and economic water scarcity, and increased variability of droughts in the Lake Chad Basin. There are numerous challenges of adaptive water management in basin which needs to be addressed by the member state countries with the assistance of development agencies and partners, because of the importance attached to the water basin. The Proposed Inter basin water transfer if constructed would likely revive the lost glory of the Lake Chad Basin

REFERENCES

- Adenle, D., 2002, The significance of climate change to the viability of Nigeria-Niger joint commission and Lake Chad Basin Commission. IHP-VI, Technical Documents in Hydrology.
- Appel, A. 2006. Global warming may dry up Africa's rivers, study suggests. National Geographic News, 3 March 2006.
- Ayuba ,H. K. and Dami, A. 2011, Environmental Science, An Introductory Text. Apani Publications, Kaduna, Nigeria.
- Ayuba H.K., U. M. Maryah and D. M. Gwary 2004, Climate Change impact on plant species composition in six semi-arid range lands of North east Nigeria. Workshop paper. AIACC Stakeholders workshop on climate change, crop yield and food security in the 21st century Nigeria.
- Batello, C., Marzot, M., Touré, A. H., 2004, Traditional knowledge, biodiversity and genetic resources for food and agriculture in Lake Chad Basin ecosystems. FAO.
- Falkenmark, M. 2007, Global warming: water the main mediator. Summary of third volume of the report entitled: Impacts, Adaptation and Vulnerability.

http://en.wikipedia.org/wiki/File:Lakechad_map.png

IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.

Japan International Co-operation Agency (JICA), 1995, The study on the national water resources master plan (NWRMP): summary and main text, vol. 1, (Federal Ministry of Water Resources and Rural Development, Federal Republic of Nigeria).

Jauro, A.B. 2007, Socio-economic Issues and Conflict Resolution in water Resource use. A paper delivered at the Regional Roundtable on Sustainable Development in the Lake Chad Basin held at the University of Maiduguri, Maiduguri. 20th – 22nd February 2007.

Lannerstad, M.; Molden, D. 2009, Adaptive water resource management in the South Indian Lower Bhavani Project Command Area. Colombo, Sri Lanka: International Water Management Institute. 38p. (IWMI Research Report 129)

LCBC, 2000, The Lake Chad Basin Vision for 2025. Second World Water Forum.

Michel, D. K. 2009, The Project for water transfer from Ubangi Basin To lake Chad. World Water Week, Stockholm

Micklin, P. P. 1985, Environmental factors in soviet Inter basin water transfer Policy. Environmental Management.

Osman-Elasha, B. (2007), Africa's vulnerability: environmental stress and climate change. Tiempo.

Pahl-Wostl, C., P. Kabat, and J. Möltgen, 2007, Adaptive and integrated water management. Coping with complexity and uncertainty. Springer Verlag, Berlin, Germany.

UNEP 2008, Lake Chad: Almost Gone, Vital water Graphics. [Online] Available at <http://smbhome.uscs.susx.ac.uk/mn261/Desktop/Lake Chad almost gone - Vital Water Graphics.htm>.