Multi-Jurisdictional Issues In International Water Quality Monitoring: The Case of Lake Chad Basin of West Africa

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Dr Edmund is an assistant professor with the Department of Urban and Regional Planning at Jackson State University. He has nearly 10 years of experience in the areas of Global environmental planning, national and regional environmental accounting for oil and gas and agricultural land use change, Hydro-politics of the Middle East and Africa. Edmund is an experienced researcher, scholar, writer, analyst, and teacher on a variety of domains such as natural resources management, rural planning and development, sustainability, plan implementation and international development. He has been quite active in environmental ethics; corporate social responsibility, ecological economics, growth management, environmental analysis and assessment, as well as community based environmental initiatives. He is very fluent in a number of European and African languages.

Abstract

In the last decades of the twentieth century when countries of Sub-Saharan Africa were busy forming their respective economic blocks under the aegis of globalization, trans-boundary water quality monitoring emerged as a key regional issue. Accordingly, the degradation of water quality continues to erode the integrity of valuable ecosystems and the well being of local communities in Sub-Saharan Africa along the Lake Chad Basin. With the Chad Basin agreement entering its fourth decade, signatories to the accord who pledged to meet the water needs of their local population are today faced with unprecedented water quality related problems.

Considering that several attempts have been made to remedy these concerns over the years, coordinated monitoring of water quality across the various political boundaries remains elusive. The current state of affairs remain compounded due to a wide range of multi-jurisdictional/international factors that are predicated upon politics, environment, technology, demography, social-cultural setting and economy. To address these issues, the paper suggests the adoption of strategies based upon ecosystem approach for water protection, coherent policy objectives, effective monitoring program, consultation among stakeholders, financial consideration in water management and capacity building. This paper examines the multi-jurisdictional and international issues embedded in trans-boundary water quality monitoring with a synthesis of the situation in the Lake Chad Basin of West Africa. Several strategies for dealing with the problem are also provided.

SECTION 1

INTRODUCTION

Background Information and the Issues

In the last decades of the twentieth century when countries of Sub-Saharan Africa were busy forming their respective economic blocks under the aegis of globalization, trans-boundary water quality monitoring emerged as a key regional issue. While these nations formed economic and political blocks such as Economic Community of West African States (ECOWAS) and the African Economic Union to enhance development, declining water quality and ineffective management of the resource across diverse political jurisdictions continues to be a major problem. Notwithstanding these constraints, some of the nations in Sub-Saharan Africa have for several decades, undertaken joint management of rivers and lakes in different regions of the continent. Accordingly, Africa is the continent where most of the river systems are international, on the premise that the river basins are shared by several countries. Of the nine international water bodies shared by six or more countries, five are in Africa. The Niger flows through 10 countries: the Nile and Zaire, through nine countries: the Zambezi through eight countries; and Lake Chad is shared by five nations. Close to 60 percent of the surface area of the continent is accounted for by shared river and lake basins, and about 50 rivers in Africa are shared by two or more countries. This makes Africa particularly liable to the problems of co-operation encountered when shared water resources monitoring have to be partitioned among the countries within the joint water divide (Johns Hopkins 1998).

In the midst of these challenges currently facing Africa, perhaps none is more significant, nor more often overlooked, than the threat to the continent's supply of clean, fresh water and the multi-jurisdictional aspects of monitoring the quality of the resource. The nations in African sub-regions experience water scarcity, in places where the supply itself is adequate in quantitative terms, the quality of the water is in serious decline. Although water is an essential life support resource, what is critically missing is the knowledge of how to tend to and monitor the quality of this resource properly to ensure its availability for future generations across diverse jurisdictions in the continent (Schoneboom 1998; WHO/UNICEF 2000; UNEP 2003).

The threats to Africa's lakes, rivers, and wetlands appear in different forms, among them are eutrophication, salinization, and pollution from industrial effluents and chemical run-off as well as habitat destruction, and loss of biodiversity. The main threats to water quality extend to broader ecosystem concerns, including exotic weed infestation such as water hyacinth. The issue of water hyacinth has seriously affected most water bodies in the region. As no efficient way of controlling this weed has yet to be discovered, the water hyacinth will continue to disrupt the supplies of water to urban areas, the fishing industry, and the livelihoods of many local communities. Some of all these effects, however, can be traced to anthropocentric activity. The introduction of alien fish species, devegetation of catchment areas, use of pesticides, and disposal of wastes as few examples, fueled by competing human needs, have severely impacted these sensitive ecosystems. In the continent where freshwater fisheries stand as the major source of income and protein, the damming of the lakes and the disposal of untreated sewage and industrial effluents has reduced the fish catch in many regions, including the Lake Chad (Johns Hopkins 1998).

In that light, the rising demand for increasingly scarce water resources is leading to growing concerns about future access to quality water, particularly where two or more countries share water resources. The 8.3 million inhabitants living along the Lake Chad basin who depend on the lake for drinking water, fishing, trade and agriculture, would need to adapt in order to survive. Already, the communities residing around Lake Chad’s shores are lacking access to safe drinking water and proper sanitation. Thus, with the Chad Basin agreement entering its fourth decade, signatories to the accord who pledged to meet the water needs of their local population are today faced with unprecedented water quality related problems Unsustainable water management, including dyke-building and pollution intensive activities, worsen this problem. The absence of high quality water has also resulted in farmers and cattle herders moving southward towards greener areas, where they end up competing for land resources with host communities. This has led to conflicts between herders and farming communities in recent years in northeastern Nigeria. Accordingly, the degradation of water quality continues to erode the integrity

of valuable ecosystems and the well being of local communities in Sub-Saharan Africa along the Lake Chad Basin (Jolley 2001; Falkenmark 1989).

In response to these problems, intergovernmental commissions or planning agencies have been formed for coordinating and integrating the development of several basins. Progress in most cases has been rather slow, and it is likely that the problems will become more complex and severe. Considering that several attempts have been made to remedy these concerns over the years along the Chad Basin area, coordinated monitoring of water quality across the various political boundaries remains elusive. Research on the multinational problems associated with the joint monitoring and assessment of the health of these rivers can help us understand the challenges faced by the countries and the ways of addressing the issues in the context of Sub-Saharan African (Wolf 1998).

Another twisting to the water problem confronting Africa is the issue of management within nations and the joint task of overseeing water quality matters across national frontiers. In these nations, it has been typical for a number of different agencies to administer the several freshwater ecosystem resources in a given country. A Case in point is the separate management of Fisheries agriculture, industrial waste, and drinking water without coordination. Governmental policy frameworks have chiefly stressed natural resource exploitation for development at the expense of conservation and sustainability. In some of the nations, there is no single agency responsible for wetlands management, as there tends to be for agriculture and forestry. To compound matters as mentioned before, the major freshwater ecosystems in Africa are shared by several countries; in case of poor coordination within a country, the task becomes more challenging across political boundaries. In light of these challenges, the multi-jurisdictional monitoring of the quality of these waters is gradually emerging as a regular component of contemporary research endeavors in international water management (Schoneboom 1998; Wolf 1998).

THE PURPOSE AND ORGANIZATION OF THE PAPER

This paper examines the multi-jurisdictional and international issues embedded in trans-boundary water quality monitoring with a synthesis of the situation in the Lake Chad Basin of West Africa. This paper also examines the efforts of the agencies charged with planning and management of the Chad Basin along with several strategies for dealing with the problem. To analyze the trend, the project adopts a qualitative approach based upon the analysis of available secondary information. The prime objective of the paper is to present a simple approach for analyzing multi-jurisdictional trends associated with water quality resource management at the international level. The second objective is to update the literature on Trans-boundary issues in international water quality management with a special focus on the Lake Chad Basin of Sub Saharan Africa. The paper contains five sections. Section two offers a description of the methodology and study area. Section three provides a review of the efforts made by the regional institutions regarding water quality. Section four analyzes the factors militating against access to safe drinking water. Section five provides some major findings of the paper with recommendations and concluding statements.

SECTION 2

METHODOLOGY AND THE STUDY AREA

The research methodology stresses a mix scale approach involving the descriptive analysis of the trans-boundary nature of water quality trends, brief descriptive statistics, and spatial mapping of images showing the present and previous conditions of the study area. Some of the relevant steps guiding the research consist of a preliminary stage that outlines the identification of variables, data gathering and design as well as analysis. The research methodology stresses the use of a mix scale approach involving the presentation of socio-economic and environmental trends based upon secondary data sources and a review of the issues.

The methodological framework guiding this research also drew largely from a keyword literature search for the relevant documents on multi-jurisdictional issues in international water management as well as a descriptive approach. As a result, much of the analysis in this paper has a descriptive focus. The literature search also relied

on information from databases and abstracts that are presently available. Based upon keywords related to the term trans-boundary water issues, multi-jurisdictional issues and efforts, several articles were located. In addition, the information search relied on the exchange of ideas with the library staff of Jackson State University and resident experts at Jackson State from the University of Yaounde in the Republic of Cameroon and access to Federal archives of the Federal Republic of Nigeria. From discussions with the library staff and these individuals as well as the author's field knowledge of West Africa, the writer then became aware of more articles with relevance to the topic.

Stage 1: Identification of Variables, Data Gathering and Design

The initial step guiding the research began with an identification of the variables needed in the research at the national level. The variables consist of socio-economic and environmental information in the form of total land areas of a country, area of the country within the basin, percentage of the basin, percentage of total area, budget, and population distribution and the percentage of population, (See Tables 1 to 4). As mentioned before, the various categories of data needed for the research were derived from secondary sources such as government documents, newsletters and previous work found in the libraries. Accordingly, the data gathering process was facilitated by the information provided by The United Nations Development Program (UNDP), World Conservation Union (IUCN), The Lake Chad Basin Commission and a host of other governmental agencies. This process was followed by the design of data matrices on socio-economic and environmental variables of the study area.

Stage 2 Identification of Spatial Data Needed For The Paper

The design of spatial data needed for the project encompasses the identification of boundary lines of Lake Chad Basin countries. The spatial boundary files for the area units in the 1960s, 1970s and 1980s existed in hardcopy paper maps at that time. As the years went by, they became available in digital forms. Given that the spatial trends as shown in these maps mirror some of the environmental issues associated with trans-boundary water problems in the region, there were then chosen in order to quicken analytical coherency in the paper.

THE STUDY AREA: THE LAKE CHAD BASIN

Lake Chad was originally an ancient sea, extending to as far as the Nile basin (Environment News 2000), but currently the study area runs through five West African nations located around the Sub-Saharan region. In the area, only about 51 per cent of the inhabitants have access to safe water. Accordingly, people living around the lake continue to lack safe drinking water and proper sanitation (UNDP 1997). Industrial wastes are still being discharged without treatment into rivers and lakes in most of these countries, causing persistent health problem. The current states that make up the Lake Chad Basin consist of Cameroon, Chad, Niger and Nigeria. In 1994, the Central African Republic (CAR) was admitted as the fifth member state. Selecting the aforementioned study area as shown in Figure 1 depended largely on its location and the extent of declining water quality being experienced along the Basin as well as numerous problems associated with trans-boundary water quality monitoring.

As the continent's fourth largest body of water, the affairs of the lake is administered by the Lake Chad Basin Commission (LCBC) which was created by the Fort Lamy convention signed in 1964, by the leaders of the four original founding members. Although the LCBC was established for regulating the uses of the water and other natural resources of the conventional basin, most of the activities undertaken in its early days were in response to drought that devastated the region mainly between 1973 and 84. The Lake Chad Basin extends over 967,000 km2 and is home to about 20 million people. These include 11.7 million in Nigeria, 5.0 million in Chad, 2.5 million in Cameroon, 634,000 in CAR and 193,000 in Niger (Table 1.2). The population of the basin is expected to grow from the current estimate of 20 million to 33 million by the year 2025 (Coe and Foley 2001; UNDP 1997).

Figure 1: The Study Area of Lake Chad

Although the hydrographic Lake Chad basin extends over an area of about 2,355,000 km^2, the area of jurisdiction of LCBC, known as the conventional Basin covered 443,300 km^2 at the inception, it extended to about 967,000 km^2 from 1994 to cover the active hydrographic basin (Jauro 2000). The lake is less than seven meters deep. Its size has always fluctuated between seasons and between years, but over the past four decades it has become progressively smaller. A dryer climate and a higher demand for water for agriculture are the reasons for the decrease in its surface area, (Coe and Foley 2001). Rainfall patterns in the basin have changed over the past three decades, resulting in a significant drop in water level, a decline in vegetation and an increase in vulnerability to erosion. Large numbers of people and their livestock have migrated due to the deteriorating conditions and have increased pressure on resources upstream. There are also problems of desertification and deforestation along the basin. Industrial wastes are still discharged without treatment in the lakes causing a major and persistent health problem (Gordon 1998). The widespread cases of unsustainable development decisions such as the construction of large dams and mining operations without sufficient planning are eroding the carrying capacity of the Lake's ecosystem. In addition to direct support for livelihoods, the lake also plays an important ecological and socio-economic role in regulating annual water supply, recharging groundwater, and helping to control flooding. While the lake supports a growing human population, it provides habitats to different species of floras and faunas. The local economy in the upper part of the basin is based upon fishing and agriculture. However, due to the environmental changes since the 1970s, there have been considerable changes in the fish fauna (Jauro 1998).

Table 1 The Lake Chad Area Nations

Country	Total area of the country (km^2)	Area of the country within the basin (km^2)	As % of total area of basin (%)	As % of total area of country (%)
Cameroon	475440	50775	2.1	10.7
Chad	1284000	1046196	43.9	81.5
Central African Republic	622980	219410	9.2	35.2
Niger	1267000	691473	29.0	54.6
Nigeria	923770	179282	7.5	19.4
Total	4,573190	2,187,136	91.7	201.4

Source: FAO 1997

Table 2 The Population Composition of The Basin

Population Distribution In the Area	
Nations	Population
Cameroon	2,550,000
Chad	5,048,530
Central African Republic	634,283
Niger	193,000
Nigeria	11,376,000
Total	20,000,000

Source: Coe and Foley 2001

SECTION 3

EXISTING REGIONAL EFFORTS IN DEALING WITH THE PROBLEMS

Notwithstanding the nature of trans-boundary water problems, in the last several years the member nations of the Lake Chad Basin Commission have undertake various water related projects with a view to enhancing effective monitoring of fresh water ecosystem and unhindered access to water in the region. This section of the paper deals with the efforts made by member nations of the Lake Chad Basin Commission in dealing with the growing threats to water quality in the basin. Some of the efforts range from monitoring initiatives, reversal of land degradation trends as well as joint water programs (LCBC 2000).

Monitoring Initiatives

There has been a growing tendency among the countries along the basin to intensify monitoring and assessments for their respective water resources sector. To actualize these efforts, the basin's Strategic Action Plan supports shared water resources monitoring with intra and inter country cooperation as well as preventive programs aimed at controlling the spread of contaminants in the basin's fresh water ecosystem. More so, new measures are being introduced for water conservation and the development of infrastructure, in order to improve management. While these efforts were made possible during the past three decades with the help of numerous intergovernmental organizations in charge of shared rivers in the region, their actual performance remains far below their potential (LCBC 2000 a and b).

Reversal of Land Degradation Trends

One of the initiatives upon which the LCBC has been concentrating seeks to reverse land and water degradation trends. To get the program operational, the Lake Chad Commission earmarked about US $10.6 million in 2003 to regenerate the lake's declining ecosystem. This initiative falls within the LCBC and Global Environment Facility (GEF) Project on Integrated Management with funding provided by the World Bank (IRIN 2003). This initiative also stresses a Program Coordination Unit (PCU), involving lead agencies in member states to oversee sustainable management of the trans-boundary waters and natural resources of the basin (LCBC 2000a).

Joint Water Programs

The rising levels of pollution of surface and groundwater resources in the sub-region hinder adequate access to freshwater for the inhabitants. This trend also creates problems for domestic, industrial and agricultural users. In response to these constraints, the Africa 2000 initiative of the World Health Organization (WHO) Africa Regional Office has seen considerable gains in water supply and sanitation in some areas of the basin. For example, in some areas, drinking water quality guidelines are the same as WHO guidelines, and disinfection of drinking water has 100 per cent coverage. A number of Western African countries under the LCBC are members of the African Union of Water Distributors. This organization has been instrumental in improving water exploitation, distribution and pricing among member states including those in the LCBC (UNEP 2003). Additionally, the proposed master plan 2025 by the LCBC envisions a scenario whereby member states will have equitable access to safe and adequate water resources in order to meet their water needs (LCBC 2000 a and b). It is the expectation that the proposed program will help member states in maintaining their freshwater, ecosystem and biodiversity in the years ahead. These efforts are laudable to some extent, however, the early stages of the programs and the current state of monitoring in the region shows that more work will still be needed in order to reverse trends. Before articulating strategies for dealing with these problems, it is pertinent to examine some of the factors fuelling the problems in the next section.

SECTION 4

FACTORS RESPONSIBLE FOR THE PROBLEMS

The international water problems facing the Lake Chad Basin do not operate in a vacuum. The current state of affairs remain compounded due to a wide range of multi-jurisdictional/international factors that are predicated upon politics, environment, technology, demography, social-cultural setting and economy. This portion of the paper analyzes some of the factors militating against the effective monitoring of trans-boundary waters in a multi-jurisdictional setting. Emphasis is on a whole range of factors from local politics to economy.

Politics

There is a political dimension embedded in the ongoing problems associated with water resources in the Lake Chad Basin (Jolley et al 2001). This is a reaffirmation of the inseparability of water and politics as conceptualized in the intellectual discourse of hydro-politics (Wolf 1998). The nations of the Lake Chad Basin Commission operate under different political and administrative settings that sometimes work against multi-jurisdictional coordination and management of trans-boundary waters. Of the five member nations, only Nigeria inherited a British system of public service while the rest nations operate under a French bureaucratic tradition. The differences in the political structure and regulatory framework of the bureaucracies dictate their operational capability and readiness in confronting the larger issues facing multinational agencies charged with management of water resources. Poor coordination between water regimes hinders joint monitoring when they are unable to arbitrate among competing uses and demands within and beyond their areas of operation. For example, the Nigerian Ministry of water resources has several departments with the appropriate policy infrastructure in the areas of monitoring that are capable of meeting the needs of the LCBC (Government of Nigeria 2000). Yet, the LCBC has for decades faced a growing deficiency in those areas and it has not been able to fulfill some of its original mandate. The problem is compounded further by political conflicts, and the incessant adjustment of international boundaries along the basin with former colonial powers as the adjudicators. Negotiating international water cooperation in such political environment undermines continuity in policy coordination and the enforcement of regulations among member states in areas under their jurisdiction. (Jolley et al 2001).

Environment

Water is not only becoming scarce because of increased demand, but also because of higher pollution levels and habitat degradation in the Lake Chad Basin. The ecological tragedy facing the basin can be attributed to natural causes (Coe and Foley 2001). The gravity of these environmental changes that accumulated over the years along the Lake Chad Basin is clearly manifested in Figure 2. Part of the problem is the growing impacts of human activities and the nature of the lake as a common resource stretching across several nations (Johns Hopkins 1998). The rising incidence of degradation denies millions of people access to clean water supplies in the area. The extent and nature of current level of pollution has not only diminished the carry capacity of the basin, but the lake has become an endangered ecosystem (Coe and Foley 2001).

Technology

Unhindered access to modern scientific and technological infrastructure are highly indispensable in the preservation and international monitoring of fresh water ecosystems. In the case of the LCBC, some of the countries lack adequate access to latest technological innovations that are essential in the prediction of ecosystem decline being caused by human activities in the basin. The absence of appropriate technology in confronting these problems renders trans-boundary monitoring of water quality in the basin quite ineffective (Jolley et al 2001; Gordon 1998).

Demography

The rapid population growth in the basin continues to trigger competing demands between urban residents and other sectors in terms of access to water (Table 2). Some of the states adjacent to the Nigerian side of the basin that are dependent on the waters of Lake Chad have very high population. This is becoming a major problem especially in drier regions. More so, the current population growth in many areas has been associated with rising

demand for water and the environmental degradation limiting the quality of water (WHO/UNESCO 2000). With the high rates of population growth in Sub-Saharan countries of Lake Chad Basin leading to rapid urbanization of cities, millions of people in these areas will require access to water which is rapidly deteriorating in quality. Given the rising prospects of water resource degradation and the inherent dangers of population explosion in the area, the LCBC faces the enormous task of making water available to a teeming population in a region where citizens lack access to high quality drinking water. Therefore, the freshwater available today for more than 22 million people in the basin is no greater, when the population was at a minimal level during the 1960s and 1970s. Thus, the projected population growth of 33 million in the area by 2025 will require unhindered access to enormous supply of high quality fresh water for domestic, industrial and agriculture uses. International monitoring of the basin in the face of these population problems will drain the meager resources of the LCBC as it strives to make water available to the citizens.

Socio-Cultural Setting

On the socio-cultural side of things, the inhabitants of the areas adjacent to Lake Chad are predominantly nomadic peasants with adequate knowledge of the local ecosystem dating back to several centuries. They share diverse beliefs and culture on the ecological sanctity of water. This is deeply rooted in indigenous water resources management strategies that are often overlooked by the orthodox approaches. The experiences from Cameroon and Nigeria have shown a linkage between dismal results in water management and the negation of socio-cultural experiences in the decision making process (IUCN 2000; UNEP 2003). Under these circumstances, the top-down approach inherent in the administrative structure of member nations of the LCBC has done little to enshrine a decision making process cognizant of the infinite potentials located within the socio-cultural setting. This approach hampers the ability of the authorities to foster effective trans-boundary water monitoring programs especially in situations where local peasants are closer to the problems (Jaspers 2003).

Economy

Another major factor is the economic constraints hampering the upgrade of water infrastructure in member nations of the LCBC (Gordon 1998). Monetary stagnations compel these countries to forgo the upgrade of their water resource infrastructures at the expense of environmental safety. These nations have huge foreign debts requiring a sizeable proportion of their GDP for debt servicing instead of water management (World Bank 1996;UNDP 1997). There is also the issue of uneven contribution towards the budgetary up keep of the LCBC among the member nations. Table 4 shows that 52 percent of the annual budgetary contribution of the agency comes from Nigeria alone while Cameron provides 23 percent. Among the other nations, Chad is responsible for 11 percent while Niger and Central African Republic are two countries with miniscule contributions (LCBC 2000; Jauro 2000). Nigeria as the regional political and economic power has more wealth and resources than the other members of the LCBC. This gross disparity in financial contribution among the countries mirrors their economic viability and their preparedness in assuming an active role in confronting transboundary water problems facing the region. To some extent, it determines the level of influence a member nation wields on trans-boundary negotiations pertaining to water quality and the degree of attention it is willing to pay to water problems. Economic constraints of this dimension diminish the extent to which the agency can collectively confront some of the much broader water issues facing the areas under its jurisdiction. The foregoing analysis is a clear indication of the factors hindering the international monitoring of water quality in the area. The ability of the agency to resolve the problems will demand more efforts and the adoption of appropriate strategies.

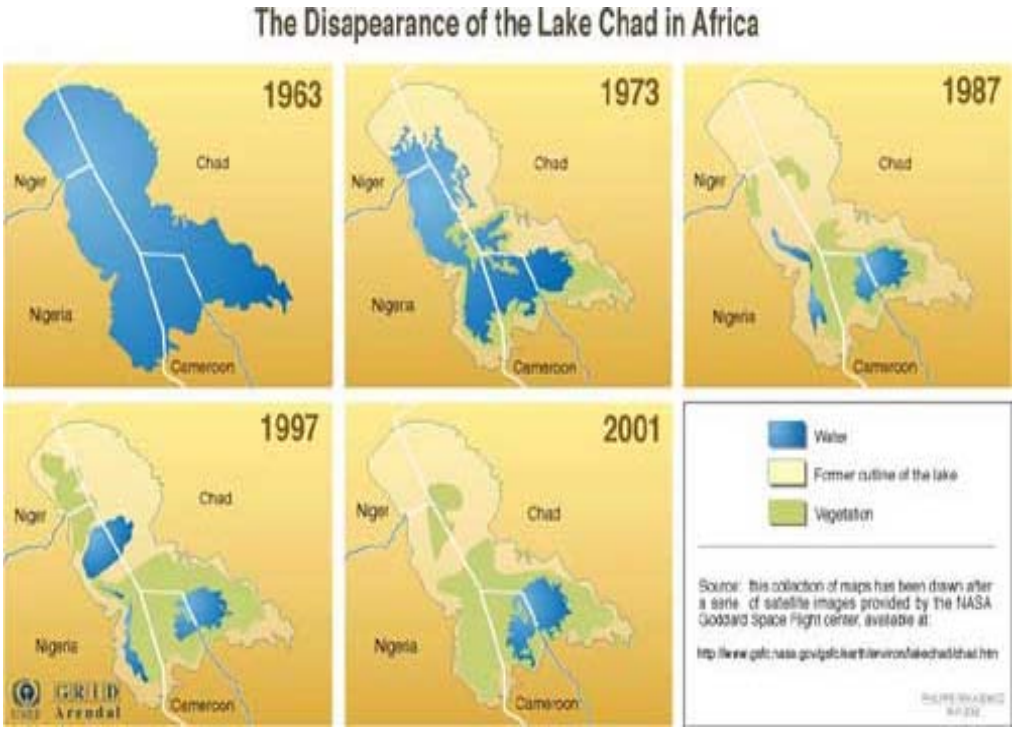

Figure 2 Evidence of Environmental Change Over the Years From 1963-2001

Table 3 Population Distribution

The Percentage Distribution of Population In the Area	
Nations	Population
Cameroon	12.9
Chad	25.4
Central African Republic	3.2
Niger	1.0
Nigeria	57.4
Total	100

Source: Coe and Folley 2001

Table 4 Budget Contribution

Budget Contributions of Member Nations	
Nations	Percentage Contributions
Cameroon	26
Chad	11
Central African Republic	4
Niger	7
Nigeria	52

Source: Jauro 2000; The Lake Chad Basin Commission 2000

SECTION 5

FINDINGS, INTERPRETATIONS AND CLOSURE

From the results of the analysis provided so far in the project, it is evident that the multiplicity of shared waters makes Africa essentially liable to the problems of cooperation encountered when shared water resource monitoring have to be partitioned among the countries within the joint water divide. Additionally, the analysis of international issues embedded in trans-boundary monitoring of water quality shows that in spite of the efforts in the Lake Chad Basin of West Africa to address the water problems. The region still faces a daunting task in reversing the growing incidence of water degradation as a result of several factors.

Of all the factors none is quite revealing than the insidious role of politics in fuelling some of the issues. The signatories of the Lake Chad Basin commission operate under different political and administrative settings rooted in British and French bureaucratic traditions. A case in point is how the differences in the political structure and regulatory framework of the bureaucracies dictate the operational capability of member states in confronting the larger issues facing multinational agencies charged with management of water resources. In fact, improper coordination between regional water regimes hinders joint monitoring. The Nigerian Ministry of water resources operates several departments with the appropriate policy infrastructure capable of meeting the needs of the LCBC, however the inability to share information renders the basin ineffective in dealing water problems and in fulfilling its original mandate. This institutional defect is compounded further by the lack of adequate technological infrastructure to aid water quality monitoring and the prevalence of top-down approach that excludes the involvement of local people in the management of water resources in the region.

The ecological tragedy being experienced in the region in the form of pollution and droughts as a result of human and natural causes has stretched the basin's ecosystem beyond its carrying capacity. Thus the basin's current conditions imply that it is an ecosystem under stress. Additionally, the current population growth in many areas of the basin has also been associated with rising demand for water and environmental degradation. This constraint hinders access to high quality water and proper sanitation for the citizens. Notwithstanding the policy constraints and enormous pressure being put on the available water resources by the current population, the projected growth of 33 million in 2025 will live the region worse off in terms of future access and management of the waters of Lake Chad. Such demographic changes reveal that population growth stands as a major challenge to the international efforts aimed at preserving water quality along the Lake Chad Basin.

The increase in population coincides with declining economic conditions and huge foreign debts of member nations of the Lake Chad Basin Commission as part of the limiting factors. The study reveals that the LCBC operates a defective budgetary system that depends on over 50 percent of its annual budgetary contribution solely from a member nation of the commission. Such uneven funding system not only reflects the gross economic disparity among members of the commission, but it shows that intervention mechanisms for dealing water problems are often dictated to a large extent by the prevailing economic conditions of member nations. In case of inaction due to monetary constraints, the upgrade of trans-boundary water infrastructure is overlooked. In light of these findings, it is evident that the analysis of multi-jurisdictional issues in international water quality monitoring stands as a valuable tool for resource managers in gauging the problems posed by shared waters in Sub-Saharan Africa and ways of ameliorating them through effective coordination.

RECCOMENDATIONS

To address some of the concerns that were identified in the current research, four recommendations ranging from ecosystem approach to capacity building are hereby made as part of the remedies.

1) **Ecosystem Approach**

The Lake Chad basin as a fresh water ecosystem has deteriorated over the years due to human and natural causes, and as a result, it is recommended that the LCBC adopt an ecosystem approach in its planning process. Restoring the basin requires the initiation of freshwater ecosystem health recovery program. The concept of ecosystem

approach built on a holistic premise recognizes the inter-linkages between the well being of citizens, the environment and economic factors in the management of international waters such as Lake Chad. Such an approach will help decision makers in putting the current monitoring mechanisms of the LCBC in sync with the carrying capacity of the surrounding ecosystem.

2) **Effective Monitoring and Stakeholder Consultation**
The level of ecological decline rattling the lake Chad Basin area and management structure of the LCBC are indications of poor monitoring and lack of stakeholder consultation in the area. In that light the paper suggests more emphasis on effective monitoring and community involvement. The authorities in charge of the LCBC should encourage the involvement of indigenous people in the implementation of future water projects. Inputs from indigenous groups with adequate knowledge of the local environment will enrich the LCBC with multiplicity of views that are indispensable in confronting the challenges of trans-boundary monitoring of water quality. This will enhance the arbitration of conflicting water demands among stakeholders (IUCN 2000).

3) **Coherent Policy Objectives**
The existing policy framework among member states of the LCBC is fragmented along political and bureaucratic traditions of their respective water regimes. In light of this, the lack of information sharing and coordination between water regimes hinder joint monitoring and policy coordination. This has severely weakened the ability of the commission in articulating a consistent policy for addressing the region's trans-boundary water problems. To deal with such anomalies in the policy framework, the LCBC should outline a set of common policy guidelines with objectives anchored in information sharing among member nations. This will help in redesigning the current policy structure of water regimes in the region in accordance with the mandate of the LCBC.

4) **Financial Consideration and Capacity Building**
Judging from the current research, the member nations of the LCBC face severe economic constraints due to high foreign debts and a defective budgetary system built on dependency (World Bank 1996 a). This creates a situation whereby nations facing financial stagnation overlook the upgrading of trans-boundary water infrastructure. This problem can be addressed by levying user fees and pollution taxes on industries and the other sectors of the economy (Jaspers 2003). Lastly, regular training programs in foreign countries should be organized for the employees of water ministries serving the member states of the LCBC. This will enable the member nations come to grips with the appropriate technological infrastructure that is essential for sustainable management of the basin (Gordon 1998; Jolley 2001).

In summary, this paper has examined the multi-jurisdictional and international issues embedded in trans-boundary water quality monitoring with a synthesis of the situation in the Lake Chad Basin of West Africa. Several strategies for dealing with the problem are also provided. To analyze these issues the paper used a mix-scale approach involving the descriptive analysis of the trans-boundary nature of water quality trends, brief descriptive statistics, and spatial mapping of images from governmental sources in showing the present and previous conditions of the study area. The results of the analysis provided so far in the project shows that Sub-Saharan nations of Africa using shared waters are particularly liable to the problems of cooperation encountered when shared water resources monitoring have to be partitioned among the countries within the joint water divide. More so, in spite of the current and previous efforts in the Lake Chad Basin of West Africa to address the trans-boundary water problems confronting the area. The region still faces a daunting task in reversing the growing incidence of water degradation as a result of several factors. Perhaps no variable is more revealing than the insidious role of politics in compounding some of the issues. Not only has the ecosystem of the basin been stretched beyond its carrying capacity due to pollution and droughts triggered by human and natural causes, but also the population projections in the area will pose numerous challenges in the foreseeable future for managers. As part of the remedies, the paper suggests the adoption of strategies ranging from ecosystem approach to capacity building. Having gone this far, it is evident that the analysis of trans-boundary issues embedded in multi-jurisdictional monitoring of international waters of Lake Chad stands as a valuable tool for decision makers and resource managers in gauging the problems posed by shared waters in Sub-Saharan Africa and ways of ameliorating them.

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