Climate Variability and Basin Management: A Threat to and from Wetlands of Komadugu Yobe Basin, North Eastern Nigeria

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ABSTRACT--- ***The paper describes the effects of climate variability and non-adequate management of wetlands of Komadugu Yobe Basin (KYB) and the strategic significance of the sustainability of the KYB. Basically about 50% of the 84,000Km^2, which make up the basin, is comprised of wetlands. These wetlands, the most notable of which is the Hadejia- Nguru Wetlands, support a wide range of ecological, economic and hydrological processes, which not only directly support the livelihoods of over seven million people, but also host biodiversity of global significance that has qualified one of them to serve as Nigeria's premier Ramsar site. The paper goes to describe threats to the integrity of the wetlands resulting from climatic variability, dam operations, population pressure, bad management practices, break down of traditional control mechanism, obsolete and ambiguous legislation, institutional failures, and conflicting resources use policies. The most outstanding impact of the threats on the wetlands is the creation of a favourable condition for invasion by Typha grasses, accentuated by variations in rainfall which now occupies over 200 Km^2 of prime farm lands, and fishing ground. Typha has also contributed to the blockage of several channels. The paper further describes the impact of the present induced condition of the wetlands on the economic, ecological, and hydrological integrity of the KBY. The most outstanding of these impacts include a ten-fold increase in poverty levels in the areas of the Hadejia- Nguru Wetlands, zero contribution of the Hadejia tributary to the Yobe River, and heightened levels of conflict over resources. Data on climatic and the socio-cultural and economic background of respondents were collected from six randomly selected villages located near the wetlands in the six States covered by the basin. The climatic data were collected from the archives of KBY and upper Benue River Basin Development Headquarters, Yola and interview schedule where. 20 respondents randomly selected in each of the sampled villages were interviewed, making a sampled population of 120 people in all. The data collected were analyzed using mean and simple percentages. The result revealed that majority of the respondents have farming as major occupation and they need wetland resources for their farming activities. This is followed by fishing, both of which are attributes of the wetlands. The last part of the paper proposes a pilot intervention measure, which will proportion a flow in to the wetlands; this will enable water to flow into the blocked channels and reduces the excess water inundation in to the other channels. The pilot intervention will also pilot institutional reforms geared towards empowering stakeholders to play leading roles in the management of water resources of the basin. The paper concludes with recommendations for some institutional reforms in the management of the KYB to avert the recurrence of the threats, as well as to facilitate sustainable management of the land and water resources of the basin.***

Keywords---- Climate, Variability, Threats, Wetlands, Kumadugu, Basin, Management and hydrological processes

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1. INTRODUCTION

Climate and water systems are closely linked. Both are components of the common global system powered by the energy of the sun. Climates are also categorized on the basis of water availability as humid or dry. Furthermore, to a large extent, climate controls the quantity and variability of the water resources available in any region (Ankidawa et al., 2015). Information on past and present climate is therefore essential in planning the development of any water resources and the resulting decisions are strongly dependent on the reliability and accuracy of the climate data at hand.

One variable of particular importance to water management is river flow, its past magnitude and variability and its current and forecast future states. Where flow data are not available at the location of interest-as is often the case, particularly in developing countries- it may be necessary to estimate past flows from climate records (instrumental or proxy).

There are variety of purposes to be served by basin water management projects, such as water supply, flood protection, irrigation, power generation, navigation, sediment control and ground water recharge. Recently, a number of environment-oriented purposes are being afforded increasing importance in the management of wetlands, such as the improvement of water quality, including salinity control, fish and wild life conservation and the protection of biodiversity. Moreover, account has to be taken of recreational and aesthetic needs of water basins, as well as of various cultural and religious requirements. Consequently, the majority of water projects now serve multiple purposes.

The basic climatic information needed for wetlands and water management projects relates to precipitation and evaporation, and their spatial and temporal distribution. In order to determine evaporation, which is often a data product, information on temperature and other meteorological variables is required. Information on precipitation and evaporation is also necessary for feasibility studies, the planning and design of projects related to hydropower, pollution abatement (including low flow augmentation), salinity control and ground water recharge. In planning irrigation schemes particularly from wetland waters, climate data are used to determine crop water requirements and the demand for irrigation water. Climate information is also indispensable in studies of domestic water demands, residential needs (gardens, lawns, and swimming pools), livestock water use, and industrial use such as cooling systems in factories and power stations.

The basic component of most wetlands management schemes is a water storage reservoir, typically serving multiple purposes such as flood protection, water supply and power production, climate information is therefore indispensable in general water management studies particularly wetlands basin management.

Wetlands are shallow ecosystems in which the land surface is saturated or submerged at least part of the year. Wetland support rich biodiversity such as endangered species and migrating birds spend part of their lives in wetlands. It also retains some water and reduces flooding by slowing the rate at which rainfall riches river systems. As water stands in wetlands, it also seeps into the ground, replenishing ground water supplies. Wetlands filter and even purify, urban and farm runoff as bacteria and plants take up nutrients and contaminants in water. And in addition, wetlands are also in great demand for socio-economic activities.

In spite of these numerous advantages of wetlands, climatic variability, inappropriate water management, and increased demand for land due to increased urbanization are some of the factors posing threats to wetlands in the area with climatic variability being the most determinant factor. It is against this background this study investigate climate variability and bad basin management as threats to wetlands in the study area.

2. MATERIAL AND METHODS

The Study Area

The Komadugu-Yobe Basin (KYB) drains catchment of approximately 84,138 Km^2 in northeast Nigeria (Figure 1) (Tanko, 2003). Located between Latitude 9’48’ to 13’30’north and longitude 7’30 to 14’30’ East covering six States namely Borno, Yobe, Jigawa, Bauchi, Kano and Plateau. Over 15 million people are supported by the basin through agriculture, fishing, livestock keeping and water supply. They are fourteen major wetlands identified in Nigeria including the KYB (Jibrin, 2007; KYB, 2008; Dauda, 2014).

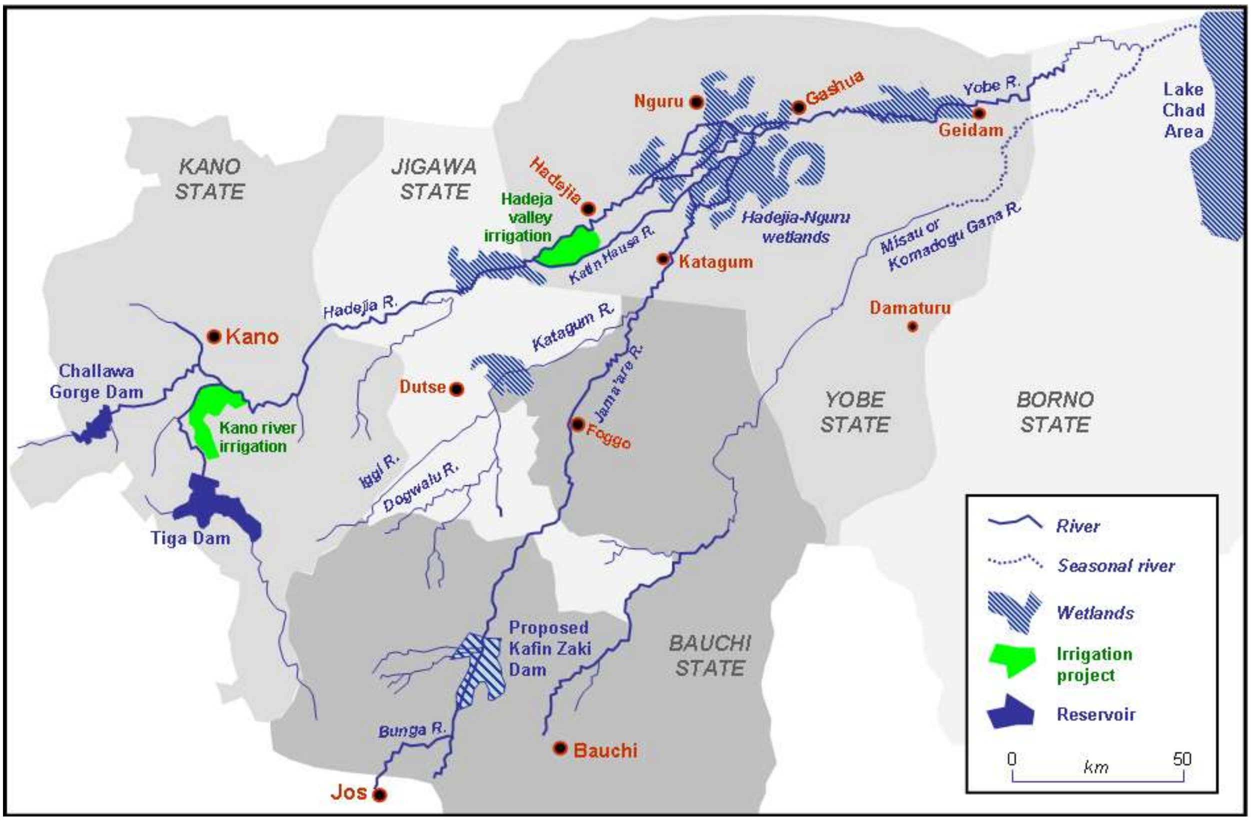

Figure 1: The Komadugu-Yobe Basin and Locations of some important Wetlands (from ADB, 2014)

Contextual Climatology of the study area

Due to its location, the KBY has a semi-arid climate that is dominated by the cyclical migration of the inter-tropical Convergence Zone (ITCZ) and is very torrential convective storms. In most parts of the basin, rainfall occurs between the months of May and October, with the wettest month being August, although in some years, little rainfall may be experienced in November and April. Rainfall in the KYB also vary spatially, the southern parts of the basin are under the influence of the ITCZ, the longest and consequently receive the greatest annual rainfall. For example, the mean annual rainfall for Jos is 1332mm, while Nguru receives on the average only 512 mm (Hollins et al., 2003).

Climate, particularly precipitation, temperature and evaporation appears to be the major factors causing threats to wetlands ecology. It is therefore, necessary to describe in details the nature of the rainfall climatology of the study area because of the wide variability it exhibits. The spatio- temporal pattern of rainfall in northern Nigeria reflects the rainfall climatology of West Africa in general and that of Nigeria as a whole (Adejokun, 1996). The geographical location of the region, its topographic variations and latitudinal extent dictates the behavior of the air masses and disposition of rainfall over it at any given period of the year (Olaniran and Sumner, 1989).

During the rainy season, low pressure belt occurs over the Sahara located between 18° and 21° N. At the same time, the sub-tropical high pressure belt over the Southern Atlantic Ocean intensifies and shift equator wards. The consequent pressure gradient between the two pressure systems induces the northward low-level flow of the rain-bearing moist tropical south-westerly maritime air mass (Mt) of southern hemispheric origin reaching up to the southern fringes of the Sahara Desert in August. Above this Southwest monsoon is a hotter and drier Northeasterly tropical continental air stream (Ct) emanating from the Sahara desert. These two principal air masses influence the Nigerian weather and climate to great extent.

The surface transitional zones between these two contrasting air masses are known as Inter- tropical discontinuity (ITD), or inter-tropical convergence zone (ITCZ). Normally, the dry tropical continental air mass to the north of the surface ITD overrides the moist tropical maritime air mass of the southern origin, while the latter form a wedge pointing north under the former.

The ITD fluctuates from north to south; it assumes its north most position around latitude 20'N in August and attains its southernmost position between latitude 5° and 7° N in January (Bdliya et al., 2006). The movement of the ITD is very irregular, varying according to the season from 2° to 6° of latitudes per month (Walter, 1985), and in general, its southward retreat is faster than its northward advance (Oladipo and Salahu, 1993). This migration of the ITD is fundamental to the understanding of the rainfall regime of northern Nigeria.

Table 1: Mean annual climatic elements (1979-2012) in the study area

Month	Rainfall (mm)	Temp. (°C)	R. Humidity	Evaporation	Wind
Jan	0	35	28	310.5	189.5
Feb	0	36	29	395.1	231.3
Mar	14.6	39	82	453.9	279.6
Apr	24.8	40	78	459	343.5
May	77.8	35	90	365.7	325.6
Jun	96.3	34	93	306.4	366.8
Jul	158.3	31	95	177.1	244
Aug	174.5	31	91	174.6	158
Sep	159.7	32	87	170	137.1
Oct	66	30	91	181.9	106.5
Nov	0.01	21	84	200.1	111.1
Dec	0	18	38	165.9	187.8

Source: UBRBDA, 2012

Drainage system and Geology of the area

The two major rivers of the basin are the Hadejia and the Jama're which meet in the Hadejia- Nguru wetlands (HNG) in Yobe. The Hadejia River raises from the Kano highlands, while the head waters of the Jama'are in the Jos Plateau. These uplands are underlained by the impermeable basement complex, which comprises of Precambrian granites and high-grade metamorphic strata (Thompson, 1995).

Geologically, the middle of the KBY is different from the upper part of the basin. Here the basement complex dips eastward below the rocks of the Chad formation (Adams and Hobbs, 1998; Adams et al., 2005). This formation is a lacustrine argillaceous sequence containing thin discontinuous inter-bed of sands and gravels. Within the Hadejia river system, the natural pattern of runoff has been modified by the construction of large scale irrigation schemes and the associated dams, most notably the Kano irrigation scheme (KRIP), Tiga and Challawa dams and the Hadejia valley irrigation project (HVP). The Jama'are River is uncontrolled as plans to construct a dam at Kafin Zaki have been put on halt.

During the wet season, particularly, in the middle and lower part of the basin, (where slopes are very gentle) as discharged within the river rise, adjacent areas (within the floodplains) begin to be inundated, thereby forming floodplain wetlands. Average slopes of the Hadejia and the Jama'are within this part of the basin are only 0.13 and 0.27 Km^2 respectively (IWACO, 1985). Therefore, relatively small increase in water level can be responsible for large increases in the area that is seasonally flooded. Using Turner's (1985) classification, these seasonally inundated areas are either streamside *fadamas,* which are found adjacent to river channels in either continuous or intermittent strips, or floodplain *fadamas* characterized by levees, back-swamps, point bars, meander scrolls and ox-bow lakes. Bodies of open water are also found where local rainfall concentrates in depressions. Most human activities within the basin are dependent on these river systems and the resultant floodplain wetlands.

In recent years, studies (IUCN-HNWCP, 1999, Diyam, 1998) indicate that estimated demand for surface water in the basin exceeds available supply by 2.6 times. Climatic down turn, inappropriate water management, and increased demand due to the population increase and urbanization, etc have been implicated for this short fall. Contribution of surface flow by the Yobe in to Lake Chad has been reduced drastically. Siltation and other invasive weeds have further compounded the problem. Already, competition for water by various users has degenerated to conflicts.

3. DATA COLLECTION

Data on climatic elements for the periods of thirty-three years (1979-2012) were obtained from the data pool of the KYB and UBRBDA, Yola while the socio-cultural and economic background of respondents were collected from 6 randomly selected villages located near the wetlands in six States curved by the Basin using a questionnaire schedule, with some additional relevant information obtained from reports and other government documents. The interview schedule was administered by field assistants who could speak Hausa, Fulani, Kanuri and Birom languages (major languages of the study areas) fluently. This made it easier for the respondents to talk more freely. In each of the villages, twenty (20) respondents were interviewed making a sample population of 120 in all. The data was collected in 2012.

4. RESULTS AND DISCUSSIONS

Climate determines what crops a farmer can grow; weather influences the annual yield and hence the farmer's profit and more importantly how much food there is to eat. It is the mean values of climate coupled with the soil environment, that mainly determine what crop a farmer can grow, accepting the risk that there will be years when harvest are reduced or even destroyed by extremes in the form of droughts, floods, typhoons or epidemics of pests and diseases linked to weather in complex ways.

A major part of the study area falls under the dry Savanna or Semi-arid region. In this region, agriculture is still predominantly rain-fed and as a result of erratic rainfall conditions, it is characterized by low and variable crop production. Since agricultural operations are only possible under optimum soil moisture conditions, wetlands and reliable predictions of rainfall characteristics are indispensable. Daily rainfall data for the periods of 33 years (1979-2012) were collected and analyzed. Annual, seasonal and monthly rainfall analyses were conducted to give a description of rainfall characteristics in the area. Rainfall statistics in the area are given on Table 1 which is presented in three different periods of 11 years each mean averages. As expected, rainfall decreased from the first period through the third period under review in the area.

Table 2: Summary statistics of annual Rainfall (mm) for the first periods (1979-2012)

Period	Mean	Std Dev	Cv	Min	Max	Range
1979-1989	1051.2	181.6	17.4	608.2	1478.9	870.7
1990-2000	816.3	186.1	22.8	416	1298.8	882.8
2001-2012	519.5	114.3	22.1	206.2	678	471.8

Source: Field Survey, 2012.

The availability of water in form of rainfall is the most important factor which influences the productivity of wetlands and patterns of socio-economic activities in wetland areas. The amount, incidence, variations and reliability of rainfall have far reaching effect on the socio-economic livelihoods of the inhabitants of the basin area. The rainfall pattern in the basin has never been static. Long-term trends in the rainfall distribution over the basin have been well documented by UBRBDA, Yola. A north-south gradation is observed in rainfall amounts over the basin, with sharp decline in rainfall amounts in the north than the southern parts of the basin.

About half of the 84,000 Km^2 of the Komadugu-Yobe Basin (KBY) is made up of wetlands, many of which are earlier stated- floodplain wetlands. Some of the most important of which include: Gumugur, Gantsa, Miga, Geidam, Dumus, Harbo, Hantsu and the Hadejia-Nguru wetlands (HNW), (Figure 1).

These wetlands support a wide range of ecological processes and economic activities which sustain (directly or indirectly) the livelihoods of over 7 million people. These activities include agriculture, pastoralism, fishing, wild resources collection and tourism potential. The wetlands also host biodiversity of global significance. Over 370 species of birds have been inventorised in the basin, with 33% of them being migratory. There are also about 100 species of fish, but five of which are endemic (Okali and Bdliya, 1997). Recharge to the region ground water is also believed to be through these wetlands. Studies of the groundwater recharge function of the HNWs (Carter, 1995; Thompson, 1995; Thompson and Goes, 1997) confirm that the wetlands play an important role by maintaining groundwater recharge in the basin. Irrigated agriculture using water from the shallow ground aquifer has a value of 36,308 Naira per hectare in the wetlands (Acharaya et al., 1997). It is based on this vast significance which the wetlands present, that some p[art of the HNW, precisely, Nguru Lake and Marma Channel Complex has been designed as Nigeria's first Ramsar Site of International importance.

Further to this, economic benefits of wetlands resources have been valued into millions of Naira. Fish, cattle trade and variety of forest products such as doum palm fronds, gum Arabic, fuel wood, etc have generated significant income to the local economy of the wetlands. In the HNW for example, 250,000 herds of cattle are found in the wetlands during the year and livestock markets in the area provide an income of N146 million. Agriculture has been valued at over N600 million per year. 6,000 metric tons of forest resources are obtained from the marketing of just one forest product, doum palm fronds (Bdliya et al., 1997). In the early 1990s, ecosystem valuation of wetlands benefits (Berbier, 2004) indicate that the wetlands provides US dollars of 167 per hectares in benefit to a wide range of local people engaged in farming, fishing, grazing livestock or gathering fuel wood and other wild products. In comparison, benefits from other areas (outside the wetlands) are much lower. For instance, benefits from formal irrigation schemes in the upstream have been calculated as only US 27 dollars per hectare.

As described earlier, based on the interactions between wetlands and other ecosystems in the basin (through their linkages with river flows, ground water recharge, maintenance of soil fertility, stores of natural products and drought- fall-back mechanisms), as well as their contribution to the total economy of the basin, wetlands have been visualized as the nerve centers of the KYB.

Table 3: Cultural background of the respondents in selected villages of the States

State	Hausa	Fulani	Kanuri	Birom	Total
Bauchi	48	51	5	16	120
Borno	33	30	57	-	120
Yobe	62	29	29	-	120
Jigawa	58	32	21	9	120
Kano	71	35	10	4	120
Plateau	37	10	-	73	120
Total	309	187	122	102	720
Percentage	43	26	17	14	100

Source: Field survey, 2011.

Culturally, the ethnic groups sampled in the study area are the Hausa, Fulani, Kanuri, and Birom (Table 2). The Hausa has the highest percentage (43%) of ethnic groups in the area. This is followed by Fulani with 26%, while the least ethnic groups are Birom and Kanuri with 14% and 17% respectively.

Table 4: Educational background of the respondents

State	Illiterate	Primary	Quranic	Pri./ Quranic	Total
Bauchi	22	48	39	11	120
Borno	52	18	43	7	120
Yobe	49	36	22	13	120
Jigawa	37	41	30	12	120
Kano	28	27	40	25	120
Plateau	16	82	12	10	120
Total	204	252	186	78	720
Percentage	28	35	26	11	100

Source: Field survey, 2012

Just as in most rural areas in Nigeria, the level of illiteracy is at its highest point in the study area. Table 4 shows the educational background of the respondents in the study area. The Table shows that 28% of the respondents never had formal education of any kind, with respondents interviewed in Borno and Plateau States score the highest and lowest with 52 and 16 of the respondents respectively, while 35% of the total respondents had primary education, with Plateau State having the highest score of 82.This could be attributed to the earlier introduction of western education in the State than any other State in the study area. Quran and Primary/Quran have 26% and 11% respectively.

Table 5: Occupational Structure of Respondents

State	Farming	Fishing	Arts/Craft	Trading	Total
Bauchi	40	28	17	35	120
Borno	24	38	26	32	120
Yobe	29	43	18	30	120
Jigawa	46	22	17	35	120
Kano	48	36	25	11	120
Plateau	56	22	18	24	120
Total	243	189	121	167	720
Percentage	35	26	18	21	100

Source: Field Survey, 2012.

Table 5 depicts the occupational structure of respondents. The table shows that 35% of the respondents practiced farming as their major occupation using both rain-fed and irrigation farming systems. This is followed by 26% of the respondents who engages in fishing from the wetlands. Art/craft and trading have 18 and 21% of the respondents as their major occupation respectively. The implication of the above situation is that over 60% of the respondents in the study area engage in agricultural practices. Declining in rainfall regime due to climatic variability therefore, affects their local economy and also, at high risk of becoming permanently jobless after drying up of the wetlands, eventually they may end up migrating or relocated to other sites than their former and are uncertain of finding work. The sudden drop in harvest and possible loss of food production due to climate variability in the area are predictable; also, rebuilding the food reproduction capacity at the new site may take years. This will lead to chronic food insecurity, defined as calorie-protein intake levels below the minimum necessary for normal growth. Prolonged malnutrition directly increases morbidity and mortality risks, particularly among the most vulnerable groups; infants and elderly.

Threats to the integrity of the wetlands

Wetlands, floodplains and shallow lakes temporarily and permanently play a major ecological, economic and social role. They are vital for water, energy, food and transportation.

Unfortunately, in the past few years, climatic downturn, eutrophication, toxicity, siltation, and pollution which are quickly increasing in the basin due to rapid urbanization, accumulation of untreated sewage and agricultural waste as well as bad basin water management (such as the effect of poor management of water flow in the KYB, poor dam operations in the upstream, fragmented water regulatory systems and uncoordinated development interventions) population pressure and resources use conflicts are some of the factors threatening the integrity of the wetlands. Such problems affect human health, the quality of life and sustainable development.

Changes in water availability and levels of wetlands due to climate change are of paramount importance for food security of thousands of rural people leaving around the wetlands. Many recent extremes of water shortage in the wetland followed by devastating floods reflect some of the climate change predictions, which are gradually becoming more certain and alarming. Appropriate measures in agricultural water management can greatly reduce poor people's vulnerability to climate change by reducing water related risks and creating buffers against often unforeseen changes in precipitation and water availability. An appropriate water research agenda is essential to improve our knowledge of the linkages between water, food and climate change and guide the right investment aimed at improving resilience of farming communities and food security living around the wetland basin. This agenda includes understanding the adaptation and mitigation roles of agricultural practices and water resources management options, characterization of climate change impacts at different scales, and evaluation of water implications of direct climate change mitigation interventions.

Developmental interventions such as the establishment of the River Basin Development Authorities (RBDAs) to manage and to regulate water resources use in the country have been popular in the 1980s and 1990s. Unfortunately, the jurisdictions of the RBDAs were based on political rather than natural boundaries, and worse still, their activities are largely uncoordinated. The KYB falls under the jurisdiction of two RBDAs; the Hadejia- Jama'are River Basin Development Authority (HJRBDA) and the Chad Basin Development Authority (CBDA). And based on this disposition of the KYB, being under the jurisdiction of 2 RBDAs, and the restricted mandate of the RBDAs, it becomes difficult for the RBDAs to effectively manage the water resources of the whole basin.

Furthermore, the RBDAs also exhibit what I referred to as 'keep poacher syndrome' in their operations. This means that, while the RBDAs are supposed to regulate the use of water in the basin, they are themselves beneficiaries of the resource. In such case, it becomes practically difficult for them to be objective in allocation of water resources among the various users (Bdliya et al., 2003).

Another loophole of the RBDAs is that they lack mechanism for monitoring and auditing of the outcomes of their initiatives, the combined effects of these loopholes together with poor funding of the RBDAs leads to poor management of water resources in the KYB.

Increased water use by upstream irrigation schemes and for Kano City Water Supply (KCWS) has also affected water flow to downstream wetlands. In the Kano River Irrigation Project (KRIP), changes in crop intensity from lower to higher intensity as a result of majority in high water consuming crops, mainly rice as against wheat, coupled with the planting of three instead of two crops has led to increase in water use in this irrigation scheme. This will mean more water released in the dry season into the Hadejia River.

Siltation at the two intake works on the Challawa and Kano Rivers for the KCWS means that more water have to be released in order to fill the sumps at these intakes. The implication of this is that more water is released in these rivers from the two dams, Tiga dam on the Kano River and Challawa Gorge dam on the Challawa River. This is inimical to regular water flow into the Hadejia River and hence into the wetlands. More often than not, water that is needed to fill the sumps is not available from the rains due to climatic downturn.

Irregular flow of water in the Hadejia River, a consequence of the above situation, has resulted into silting up of many of the distributaries of the rivers as well as other channels. This made the Marma channels to receive and contain more water than the Burum Gana and the old Hadejia Rivers. For instance, the Hadejia- Nguru wetlands (Figure 2), the Burum Gana River is almost completely silted up (by silt and Typha weeds) right from its bifurcation with the Marma channel near Likori up to Wachakal village (a distance of about sixty kilometers alone the river channel). The old Hadejia River too has been blocked by silt for about 15 km downstream from the Magunji Idi bifurcation. Most of the water from the Hadejia River is therefore flowing into the Marma channel, thereby creating excessive flooding. Also, the artificial dry season releases by upstream dams have further exacerbated the above hydrological problems in the basin (Bdliya et al., 2003).

With increase in flooding in some channels, such channels became permanently flooded thus making them perennial instead of seasonal. This condition became conducive for the proliferation of Typha grasses as well as the intrusion of potash.

Impacts of the Threats

Water resources development has been viewed as one of the priority areas in regional development, particularly in the developing countries. This is primarily because water is the single most important factor determining the performance of productive activities as well as the quality of life. In addition, the range of water-based requirements is quite wide, including agricultural, industrial and domestic needs, energy production, fisheries, transportation, flood control, and outdoor recreation. Hence, an integrated approach has increasingly been adopted and elaborated with the aim of achieving interrelated development goals.

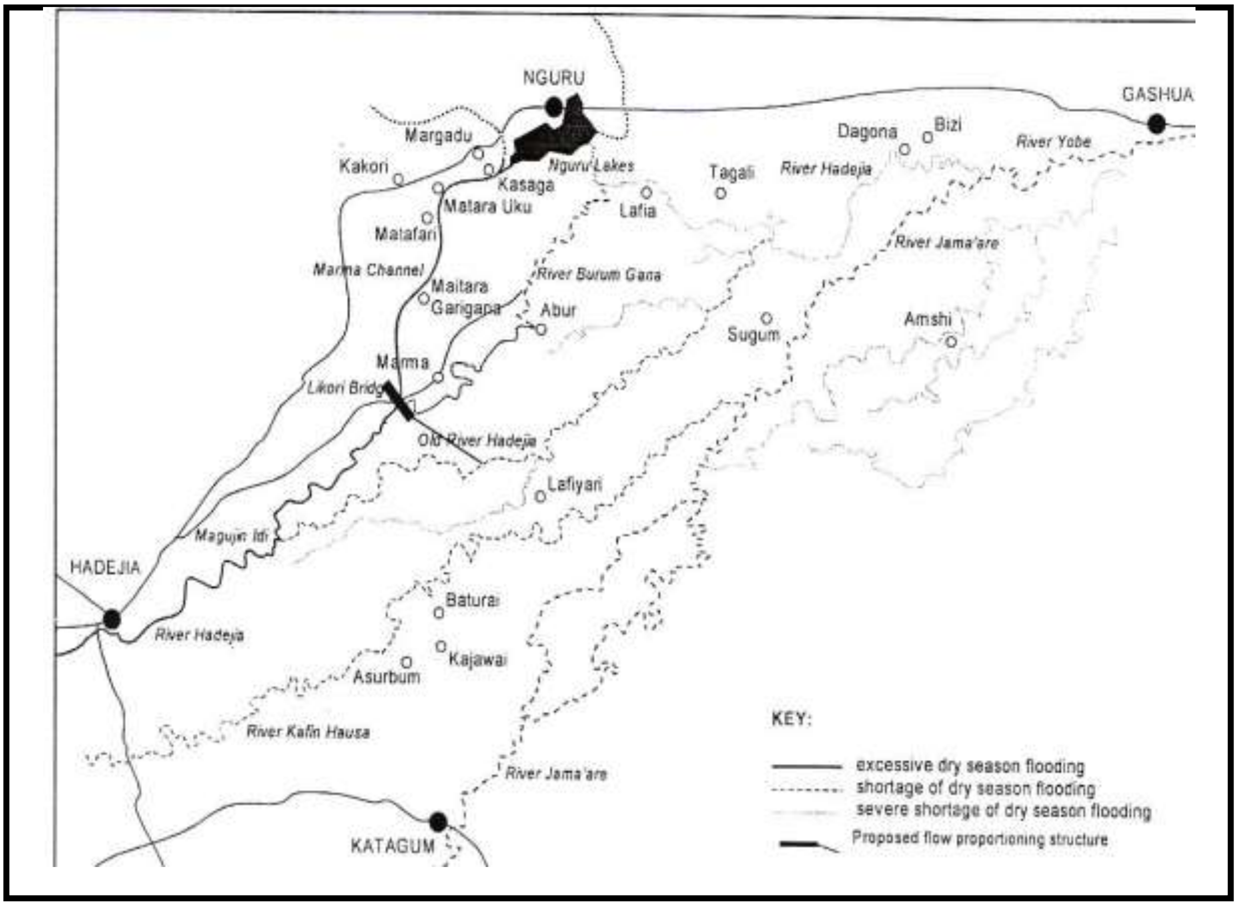

Figure 2: The Hadejia-Nguru wetlands showing hydrology and the proposed flow Proposed Proportioning structure of the Basin (from Goes and Zabudum, 1999)

As the pace of social and economic change accelerates in the developing countries, however, many wetland basins have become increasingly susceptible to various pressures and forces which tend to give rise to several complex water resources management problems issues that cannot be dealt with solely in the context of specific water-related programmes and projects, but should be addressed in a broader socioeconomic context on a basin wide scale. There are number of such problems and issues, but the issues of environmental and social problems arising from water and land use interactions and that of conflicts among various water users seem to deserve special attention from the view point of wetland basin planning and management.

Over the years, increased areas of flooding, potash intrusion and Typha grasses (over 200 km^2 along the Marma channel and Nguru Lake alone) has led to loss of farms and farm lands, grazing lands, loss of fish and fisheries as well as growing conflict over the use of resources (Jimin et al., 2014). The unprecedented floods of 2001 and 2003 have led to displacement of villages and loss of property worth millions of Naira along the Marma channel. Fish catch has reduced to less than half in the in the last 5 years. Farmers' income in some parts of the wetlands was reduced to only about 20% of what it used to be 7 years ago (Acharya et al., 1997; Bdliya et al., 2003).

Increase in conflict over the use of common pool resources (cprs) has been a major concern in the recent years. Resources use conflicts in the wetlands have varied in space, type, time and recurrent. A time line of recent history (1976-1996) of conflicts in Madachi, Kadera, Marma and Guri (Millingan, 2007) indicate that conflicts/clashes between farmers and pastoralists began in 1992. Between 1993and 1995, seven villages have been set ablaze resulting to about 70 deaths, 99 injuries and loss of property worth millions of naira. However, more recent studies (JEWEL, 2003) indicate a slight reduction in the frequency and severity of these farmers-pastoralists conflict but also an increase in the range of other types of conflict over wetlands common pool resources- e.g. farmer-farmer conflicts over water for irrigation, fisher-fisher conflicts over illegal fishing techniques, farmer-fisher conflicts over water diversion, and fisher-herder over net disturbance all of which are accentuated by highly variable nature of rainfall of the area in the past recent years.

On the other hand, channels which receive less water have remained dry for most of the year. Livelihood systems (such as fishing, livestock keeping and irrigation agriculture) which are dependent on these rivers on one hand and on rainfall distribution pattern on the other hand have also been commensurately affected. For example, in Dagona and Lafia villages (alone the Burum Gana River), a farmer who could produce enough to feed ten families 10 years ago can hardly feed his family today.

Combined consequence of rivers having too little water and others having too much had increased poverty levels in the wetland regions, where poverty level has increased by about 10 folds in recent years (JEWEL, 2003).

Other impacts of threats to the wetlands include increase in the level of crime, emigration, apathy among communities and reneging on international responsibility. The later, implying the inability of Nigeria to contribute water flow into Lake Chad.

Possible intervention measures

Over the years, many intervention measures have been attempted or proposed in trying to solve the problem of water scarcity and distribution in the KBY. Integrated basin level water management plan, basin level sensitive dam operation procedure, National coordination council and technical advisory committee on the KYB are some attempts by the Federal Ministry of Water Resources. Other attempts proposed and/ or supported by IUCN, HNWCP, GEF/LCBC, North East Arid Zone Development Programme (NEAZDP), Diyam consultants and DFID-JWL projects include KYB consultative forum on water issues, water management options, water audit, integrated management of wetlands in the KYB and the construction of a flow proportioning structure near Likori, at the bifurcation of Burum Gana and Marma channel (Figure 3).

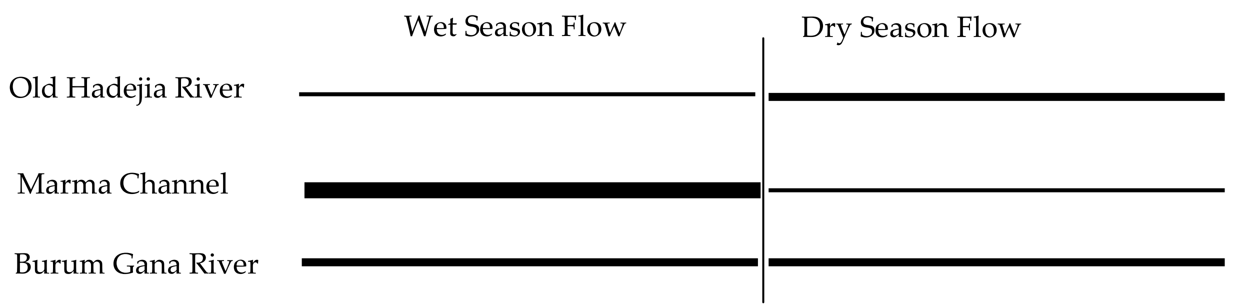

Figure 3: An Illustration of water distribution into the 3 outlets to be proportioned by the flow structure

The flow proportion structure (which this paper elaborates further) is a proposed pilot measure which attempts to proportion water flow of the Hadejia River to be distributed among the Burum Gana and Marma channel which (as mentioned earlier currently receive too little and too much water respectively. The structure consists of three outlets, two of leading the Marma and Burum Gana channels while the third outlet joins the old Hadejia River via a 5.1 km canal. Proportioning of water in the 3 outlets will vary from season to season and will be based on water use practices of communities living along these rivers. A rough illustration of what is visualized as the proposed water distribution from the structure is presented in Figure 3.

On the Marma channel more water is required during the wet season to maintain flood rice cultivation while less water is required in the dry season to allow water to recede so as to give way for grazing, recession agriculture and to maintain ecology. On the Burum Gana channel, water is required all-year round for fishing and dry season irrigation activities. Water is required in the old Hadejia River for fishing, dry season irrigation farming and to maintain contribution of the Hadejia River to the Yobe.

Similarly, attempts are being made to pilot institutional reforms geared towards empowering stakeholders to play leading roles in the management of the water resources of the basin. The DFID-JWL project has recently reactivated the stakeholder consultative forum (SCF) of the KYB and currently engaging other smaller stakeholder bodies in most of its activities.

5. CONCLUSION

It has been discussed (in the paper) that despite its importance to ecosystem, the maintenance of soil fertility, regional ground water recharge function, drought-fall back mechanism and their immense contributions to the national economy, the integrity of wetlands in the KYB is being undermined by increasing threats. Poor water management accentuated by uncoordinated development interventions, fragmented regulatory responsibilities, growing water demands, inequitable access to water resources and many more have been implicated.

The impacts of these threats have resulted into irregular flow of water in the wetlands. Irregular flow in wetland rivers (too much and too little) have led to siltation of channels and increased proliferation of Typha grasses leading to loss of farm lands, grazing lands, fish and fisheries and increased resources use conflicts and poverty among communities.

The proposed flow proportioning structure discussed in this paper and for which DFID-JWL project is catalyzing the process through stakeholder dialogue and a feasibility study will apportion water between the Marma, Burum Gana and the old Hadejia River helping to regulate flow between these rivers. This will subsequently make provisions for the control of Typha grass, liberate farm lands, grazing lands and improve fish catches. This will help to improve local economy, reduce resources use conflicts and hence reduce poverty.

The process to be followed to arriving at the construction of the flow proportioning structure will also demonstrate how to construct similar structures in the basin and in fact, in other basins across the country and elsewhere. The process will also demonstrate how get various agencies (across tiers and sectors of government) to coordinate their activities. Lack of coordination of government agencies has often been a major impediment to the development progress in Nigeria today.

Similarly, the incorporation and integration of the biogeophysical, social and economic components at sub-basins and basin level and the need for the introduction permanent evaluation of ecosystem function, social structures, impacts, has to be stressed.

Community participation, first at local level and at regional level (sub-basin) is also a key factor for the improvement of management systems and for their implementation at basin level also, has to be stressed.

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