Minireview Article

GEOGRAPHICAL DESCRIPTION OF KUMADUGU-YOBE RIVER BASIN OF WEST AFRICA

Abstract

Kumadugu-Yobe river basin is located in African sub-region within the boundary of Nigeria and Niger republic. The basin is drained by two major river systems river Yobe and kumadugu gana. The Two major rivers empty their waters in to Lake Chad. The basin fall within three major climatic belts namely: the guinea savannah at the water head; Sudan at mid-stream and Sahel at downstream. The rainfall pattern varies from over 1200mm at the Jos plateau water head to less 400mm at downstream. The basin constitutes 35% of the Lake Chad basin but accommodating more than 55% of the basin's population and also providing livelihood means to over 15 million people, particularly farmers, pastoralists and fishermen. However series of impediments has been altering with hydrology of basin following the sahelian drought of 1970s and 1980s. The basin ecosystem is vital to not only the local population but to global community at large. The hadejia-Nguru wetlands of basin is the key host to wintering migratory birds from Europe and also one of the Ramsar wetland site of international important.

Keywords: Kumadugu-Yobe basin, Geography, Description and Ecology

Introduction

1. Location and Size

Kumadugu-Yobe river basin is the area drained by river Yobe. The basin is one of Lake Chad basin sub-basin. Geographically, Kumadugu-Yobe basin is located approximately between latitude 10^{o}N to 14^{o}20'N and 7^{o}25E to 13^{o}E. The basin has a total area of 145 833Km^2. The Hydrological boundaries of the Basin traverse the States of Kano, Jigawa, Bauchi, and Yobe and to a lesser extent, Plateau, Kaduna, Katsina and Borno in Nigeria and Diffa region in Niger Republic (Tanko 2014). With a combined catchment area of 148,000 km2 shared between Nigeria (north-east) and Niger (south-east). Fifty seven percent (57%) of basin area is in Nigerian territory covering 84,138 km2 (International Union for Conservation of Nature, nd). The basin is bordered by Agadez region of Niger Republic to the North, Damagaram region of Niger Republic; Katsina and Kaduna states of Nigeria to the west, Bauchi and Plateau states to the south and Gombe state; southern Yobe state and Borno state to the east. The map of the basin is show in fig 1.

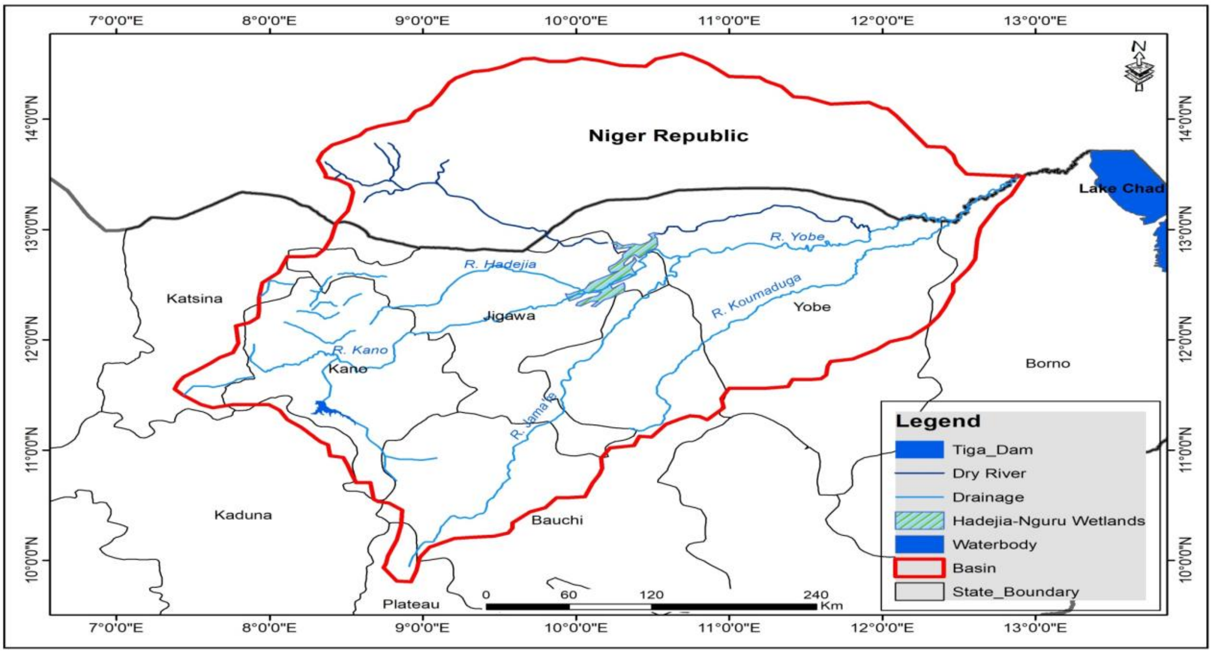

Figure 1: Kumadugu-Yobe River Basin
Source: Google high resolution image *(2018)*.

2 Climate

Owing to latitudinal and altitudinal variation within the Kumadugu-Yobe basin, there is wide climatic variability within the catchment. There are three distinct climatic zones from South western to Northeastern part of the basin: Sundan-savanna climate, with 900 - 1200 mm of mean annual rainfall at river water head, the Sudano-sahelian climate, with an average of 600 to 900 mm of rainfall and Sahelo-sudanian climate, with an average annual rainfall of between 300 to 600 mm. The rainfall pattern within the catchment follows the ITCZ (inter-tropical convergent zone) movement pattern, as rainfall decrease in amount and durations north east ward.

The basin records three (3) distinct temperature seasons namely; cold dry, hot-dry and warm moist season. The seasonal temperature pattern varies significantly between the mountainous humid climate of south and Sahelian dry climate of the west. The cold dry season (CDS) which starts begins November to Febuary is characterise by cold dry and dusty wind that blow south ward from North east from sahara desert. The basin CDS temperature increase south ward, the season records maximum temperature below 35^0 C and minimum temperature 18^0C (Areola, 1978). The hot dry season temperature decrease south ward within the basin, the parts of the basin records HDS temperature above 40^0C. The worm moist temperature is generally a function of seasonal rainfall the season lasted about 1-2 month at northern part and 5-6 months in southern part of the basin. Genarally temperature of the basin from March to October and increase South ward from November to February. Danual temperature generally increase north ward. Annual potential evaporation tends to vary between 1,800 mm and 2,400 mm across the basin, though lower rates are recorded at Jos on the raised Plateau (NEAZDP 1990).

The Sahelian climatic zone is the zone of climatic instability, as one of the most vulnerably climatic zones of the world with very high temporal rainfall irregularities. Meteorological history of Sahel reveals that 20 years of severe drought was recorded within period of only 23 years (1970 to 1993). Similarly, rainfall decline of almost 20% was recorded in 1970s and 80s, with a resultant ecological degradation of over 80% of regional land (FAO, 2007). The temperature of Sahel is rising above the global average which is projected to rise by 3^0C to 5^0C by 2050 (Malcolm, Eliya, Michael, Federico and Courtney, 2013). Therefore, the combined effects of irregular rainfall, rising temperature, land use and land cover changes is posing serious environmental crises in Sahel ecological zone resulting into the deterioration of soil and water resources (International

Atomic Energy Agency, 2015; 2016, United Nations Environment Programme, 2006). The basin rainfall pattern is presented in Table 1.

Table 1: Descriptive summaries of KYRB Rainfall Variability (1981-2017)

		Downstream			Upstream	
		Nguru	Potiskum	Kano	Bauchi	Jos
Mean (mm)		408	641	1022	1127	1317
Max (mm)		616	966	1789	1871	1612
Min (mm)		237	375	473.7	726	1018
Variability rate per year (mm)		3.1	1.1	18.2	17	-0.2
Variability (%)		20	1	30	44	0.03
Drought years	**Number**	7	5	7	4	5
	%	20	14	20	10	14
Wet years	**Number**	5	7	6	6	5
	%	14	20	16	16	14

Source: Jajere 2020.

3 Relief and Drainage

The basin relief varies significantly from 1600m at water head of Jos plateaus to less than 300m toward Lake Chad at the eastern part of the basin. The relief of the basin is dominated by low land plains. Kumadugu-Yobe Basin is a sub-catchment of the larger Lake Chad Basin, representing approximately 35% of the Lake Chad Basin. Ninety five percent (95%) of the basin's water is from Nigerian Land. Within Nigeria, Kumadugu-Yobe basin is drained in a north-easterly direction from the Jos Plateau and about 10 percent of the inflow discharges into the Lake Chad (Carter, 1992). The basin is drained by two main river sub-systems: the Komadugu Yobe and the Komadugu Gana, with the Yobe River flowing into Lake Chad. According to North East Arid Zone Development Programme (1990), River Hadejia, the River Jama'are and the Kumadugu Gana are main tributaries of river Yobe. The active watersheds supplying surface water to the basin and subsequently to Lake Chad are located in basement complex rocks in Plateau, Kano and Bauchi States, outside the limit of the conventional basin (IUCN 2005).

River Yobe which is major river in basin has its source from Plateau high land, specifically Delimi in Jos. Thus the basin is drained by two main river sub-systems but discharge in to Lake Chad through single valley (channel). The first sub-system, the Yobe River, is formed by the Hadejia and Jama'are tributaries, which create the Hadejia-Nguru floodplain at their junction. Hadejia and Jama'are rivers meet at Karage a village in Yobe Sate, the confluence is shown in plateI. Komadugu Gana (or Missau) river is the second sub-system, which historically has been seen as a tributary of the Yobe River. River Kumadugu-Gana joins river Yobe to form a natural boundary line between Nigeria and Niger republic around Gaidam town in Nigeria and Maine-Sorowa in Niger Republic. Hadejia Nguru Wetland is one of the major hydrological land marks in the basin covering a total area of about 6000 km^2 and a water surface area of about 2000 km^2.

River Yobe and its tributaries cover a distance of about 400 kilometers. The natural flow regime of the Yobe is highly seasonal with high flows after rainy season (May-September) and low or zero flows during dry season and almost 80% of the runoff from the upper parts of the basin on the Basement Complex occurs during August and September (Adams and Hollis, 1987). All rivers within basins lose flow on crossing the geological divide between basement complex and sedimentary formation as a result of evaporation and evapotranspiration and infiltration to recharge the groundwater. The inflow varies between 1 and 1.8 km /year, the outflow between 0.6 and 0.7 km /year. When the inflow is more than $2km^3$/year, the outflow gradually increases to $1.2km^3$/year. Upstream the peak flow is at the end of August and rises and falls rapidly reflecting the sporadic nature of heavy rainfall and the largely impermeable strata. Downstream the peak flow is in January (FAO, 2012).

Kumadugu- Yobe river Basin is an area of recent drama in water resource issues as a result of combined effects of natural factors and poor water resource management, leading to environmental degradation, loss of livelihoods; resources use competition and conflicts (Chiroma, Kazaure, Karaye and Gashua, 2005). Reduced Stream flow, shrinking of wetland and increasing human pressure couple with high climatic variability within Kumadugu-Yobe basin is increasing the gap between water demand and availability in the basin. According to (IUCN, 2003b), the potential water requirements in the Hadejia river system are 260% higher than available water supplies. Ikusemoran and Ezekiel (2011) reports shrinking of Hadejia-Nguru wetland from 3191.2465km2 in 1972 to 1781.9361km2 in 2005.

Lake Chad Basin Commission (LCBC, 1992). Reported a significant reduction in both the Hadejia and Jama'are river systems after crossing the geological divide between the basement complex and the chad formation. What is clearly not understood is why these changes only pccured in a recent time with a lot of hypothesis that are yet to be scientifically test. The confluence of rivers kano and Jamaare at Karege village and river alaraba one of tributaries of river Kumaduga Gana are present in plates 1 and 2 respectively.

Plate 1: The Confluence of River Kano and Jamaare at Karege Village Yobe State Nigeria December 2018.
Source: Authors Field Measurement and Observations

Plate 2: River Alaraba a tributary of River Kumadugu-Gana. The river has it source from Fika Hills. July 2019.
Source: Authors Field Measurement and Observations

3.1 Wetlands spatial distribution

Wetlands of KYB are largely concentrated within the sedementray formation of the chad basin. The wetlands are predominatly spread along river Yobe, Kumadugu-Gana, small tributaries, famous Hadejia-Nguru wetlands, Oases at the northern parts of the river Yobe and isolated pockets of ponds, as it can bee seen in fig 2. The wetlands fall within the political boundries of Borno, Yobe, Bauchi, Jigawa and Kano States within Nigeria. Some of Oases of Northern part river Yobe largely falls within the Deffa region of Niger republic. The concentration of the wetlands is largely within the sedementry formation of the basin, where the relief is below 400m above sea level.

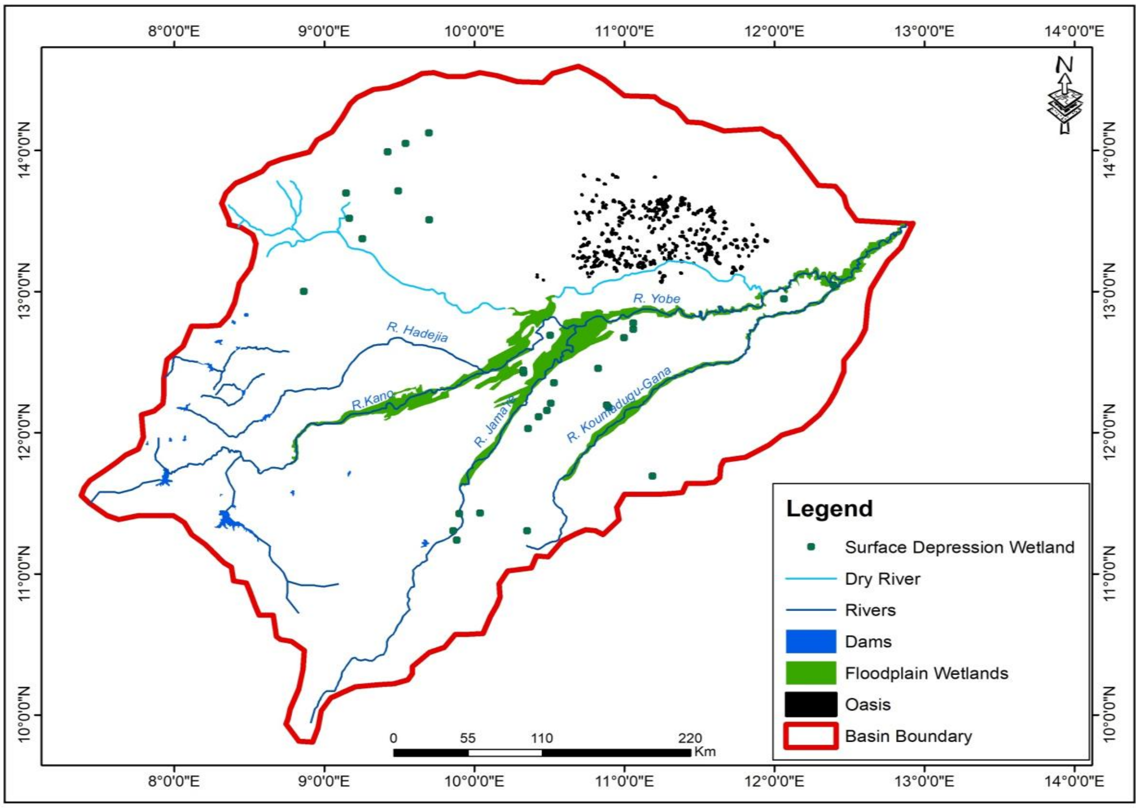

Figure 2: Kumadugu-Yobe River Basin Wetlands Spatial Distribution Pattern
Source: Jajere 2020.

4 Geology

The Lake Chad Basin was formed by extensional tectonic forces during the Cretaceous Period around 65 million years (Worldatlas 2016) with the geological and geomorphological development of the Basin being conditioned by the slow and ‘cool’ rifting of the West and Central African Rift System(Chartchly 1984). Kumadugu-Yobe Basin covers two main geological formations, the basement complex at south-western part of basin with provide greater parts the waters in to the basin and sedimentary formation known as Chad formation. The hydro-geology of Chad Formation can be unconfined or confined; the deeper sandstone layers are often confined and can be artesian. The water Table depth is often between 10 and 15 m (Offodile 2002). The relief and drainage of the study area is presented in Figure 3

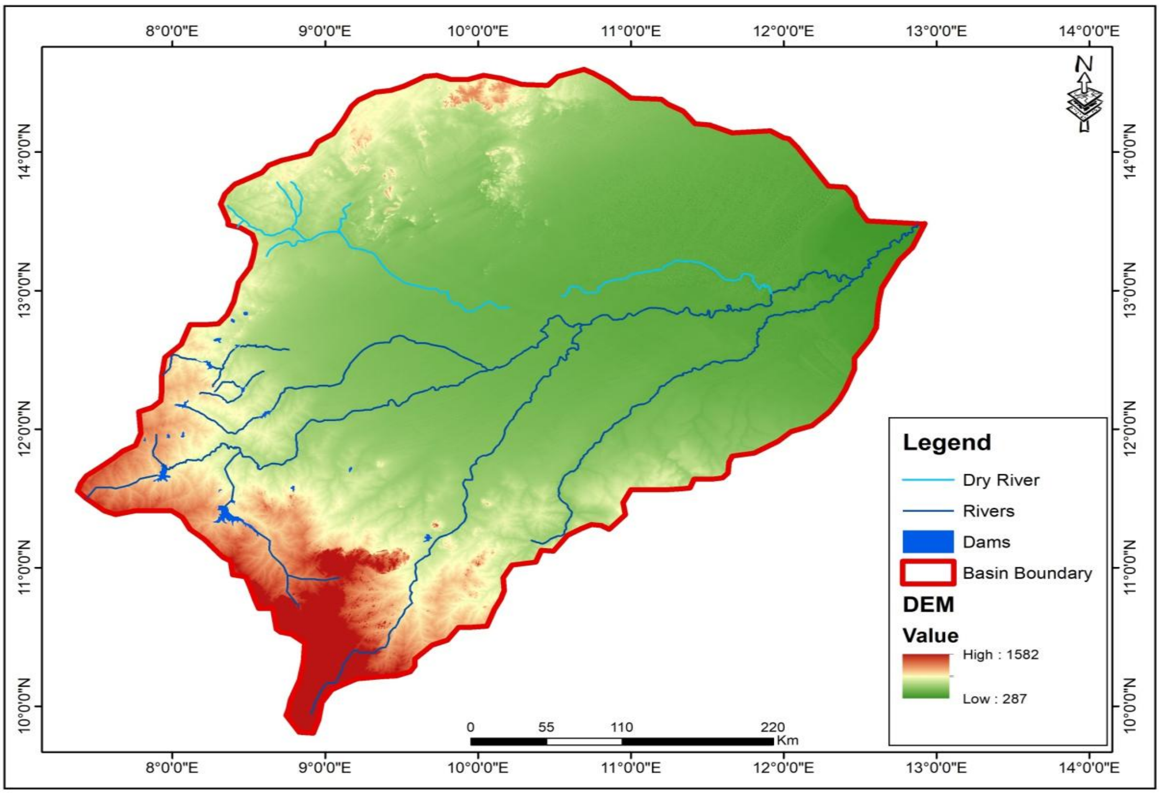

Figure 3: Relief and Drainage Map of Kumadugu-Yobe River Basin

Source: Jajere 2021.

5 Soil and Vegetation

There are basically two different types of soils in the study area. They are pedosals and pedalfers. The pedalfer consists of minerals and iron while the pedosals are made up of calcium. The limiting factor to crop production in this region is insufficient rainfall. Soil is sandy in most places and sandy clay in the some areas. However, the soil along the river valleys and fadamas have high water retention capacity as it poses some clay, silt and some organic matters, hence suiTable for growing rice cultivation.

Kumadugu-Yobe basin area largely falls within Sudano Sahelian vegetation ecological zone to the Northern part, the basin has tropical vegetation and is characteristed by scattered shrubs, thorns such as *Acacia Albida* (Gawo), *Acacia Nilotica* (Gabaruwa), *Tamarindus indica* (Tsamiya), Baobab (Kuka) and *cummiphora spp*. Most of the trees found are xerophytic in nature while the grasses are seasonal grasses which dry up during dry season. It is a region of short grasses (such as *Aristida spp* and *Chlons spp*.) and small, often thorny trees with small leaves (*Acacia Senegal and Greia spp*) (Omotoye, 2002).

According to Lake Chad basin commission (2016), inventory Wooded Savanna species found in the basin includes:

> *Acacia senegal, Acacia seyal, Borassus aethiopum Prosopis sp., Acacia nilotica, A. tortillis, Balanites aegyptiaca, Ziziphus spinachristi, Acacia raddiana, Tamarindus indica, Disopiros mespiliformis, Hypheane thebaica, Adansonia digitata.*
>
> Shrubby steppe include: *Acacia spp. Balanites aegyptiaca, Ziziphus spp, Calotropsis procera, Aritida spp, Ipomea, spp, Schoenefeldia gracilis,*

Cordia sinensis, Cadaba farinosa, Pennisetum purpureum, Anogeissus léocarpus, *Piliostigma reticulatum, Hypheeane thebaica, Phoenix dactylifora, Hyperthelia dissoltua, Pentzia monodia, Artemisia thiloana, Ephedra thiloana*.

Grasslands species includes *Echinochloa pyramidis*, *Hyparrhenia rufa, Oryza longistaminata, Vetvera nigrita, Cenchrus biflorus, Aristida mutabulis, Pergularia tomentosa, Tribulus terrestris, Pennisetum sp.* Desert (strips of dune) species includes *Acacia radiana*, *Ziziphus mauritiana, Leptadenia pyrotechnica, Acacia senegal, Malcolmia aegytiaca.* Oasis species includes *Daniella oliverie, Vitex doniana, Burkea Africana, Cassia senegalensis, Hyphaena thebaica, Acacia spp, Maerua sp., Caparis sp. Calotropis procera, Citrullus colocynthis, Phoenix dactilifera*.

However, the natural vegetation of this region has been seriously tempered mainly due to anthropogenic factors. Floodplains provide important dry season pastures, exploited in particular by partly nomadic pastoralists (Adams and Hollis, 1987). Wetland Plant biodiversity along River Yobe is presented in plate 3

Plate 3: The KYRB Wetland Plant biodiversity along River Yobe
Source: Field Measurement & Observation 2018

6 People and Livelihood Activities

The predominant tribes in the study area are the Hausa and Sedentary Fulanis knowns as Hausa Fulani; Bade; Manga; Fulani; Ngizim and the Sokotawa, popularly known as Takari. Agriculture has a unique position in the economy of the region.

Kumadugu- Yobe River Basin constitutes 35% of the Lake Chad basin but accommodating more than 55% of the basin's population and also providing livelihood means to over 15 million people, particularly farmers, pastoralists and fishermen (African Development Bank Group 2014).The economy of the basin is highly dependent on freshwater resources, particularly on the livelihoods derived from the wetland ecosystems (African Development Bank Group, 2014). Natural ecosystem of Hadejia-Jama'are-Komadugu-Yobe Basin provides livelihoods means through flood recessional agriculture, grazing, and fishing, and rain fed agriculture which is dependent on a strong seasonal rainfall regime (IUCN, Water Audit Inception Report 2005).

The Kumadugu Yobe Basin is one of Nigeria’s most important agricultural basins producing varieties of food and cash crops including sorghum, rice, millet, groundnuts, wheat, cowpeas and vegetables under both upland and irrigated farming. This involves the production of more food on land already under cultivation (Tanko, 1999). In addition to these, there are also the productions of livestock, trees which yield fruits, edible leaves and fruits, cotton and firewood. Fishing is also an important activity of the people in the basin. Part of the basin is the Hadejia-Nguru Wetlands which for many years were the pride and joy of the north-eastern part of Nigeria (Tanko 2014). This has been critically affected by water release patterns from Tiga and Chalawa dams at upper stream, as the two dams control over 80% of the flows into the Hadejia-Nguru wetlands (Shakirudeen, Ifeyinwa Ademola and 2011).This results into losses in environmental productivity such as fish stock, livestock production and general water shortage in the downstream parts of the basin including inflow into the Lake Chad (African Water Facility 20014).

6.1 KYRB Wetlands livelihood Activities

Crop production through rainfed farming and irrigation, pastoralism/livestock breeding and fishing are the major livelihood activities at KYRB wetlands sites.

6.1.1 Crop Production

The rural population and significant urban population of the wetlands site derive their livelihoods means either directly or indirectly from the wetlands. The income of any agrarian population depends on agricultural output, the greater the output the higher the income. Agricultural production at mid and downstream parts of the largely depends on wetlands. Kaugama and Ahmed, (2014) and Birdlife international, (2015), reported that the financial benefits of major agricultural outputs in the Hadejia-Nguru wetlands has been estimated at US$ 75 million, while cattle trade annually contributes about US$ 5 million (Eaton and Sarch, 1997). Therefore an average rice producing household in the study area earned $2000.00 from rice only (Jajere, 2020)

6.1.2 Pastoralism

Livestock rearing is one of the major livelihood activities of the area Jajere (2020) reported that 55%, 47%, 45% and 20% of the respondents households keep Cattle, Goats, Sheep's and Camels respectively, as presented in Table 5.50. Cattle are the major livestock husbandry by predominant household. This may not be unconnected with fact that apart from nomadic households, agrarian households also keep bulls for farm work and other services' as can be seen in Plate 5.9. Wetlands provides both fodder and serves as a sources of water supply for livestock production in study area. Jajere (2012), reported that wetlands remains the most important water points to pastoralist in the study area, access to water point in fadama areas 'fulka' is restricted by increasing fadama cultivation. This is one of trigger of conflict in the study area.

Livestock are assets and source of income to the herders. The households derived their food and income for other uses from milk. They only sale the livestock for special purposes like wedding, naming ceremony, health care, payment of fine and the likes. The respondents confirmed that excessive flooding affects cattle during the rainy season, as flooded wetlands breed insects that affect the livestock. The excess flooding is however, conducive for dry season grazing as green grasses linger all year around. The shrinking of the wetlands enables rainy season grazing at the wetland sites but it seriously affects the dry season grazing as grasses disappear few month after the rainy season. This reduces the milk output, and reproductivity of the livestock. Extreme drought scenarios resulted into death of animals, southward migration in search for fodder and incurred extra cost of feeding the animal with animals according the respondents. The wetland site herders observed that the milk output and reproductivity of livestock is a function of wetlands productivity. Therefore, wetlands degradation affects the livelihood asset and income of pastoralist households.

6.1.3 Fishing

Wetlands are known as a major sources of fish for human. IWMI (2014), teported that around 300,000 people earn a living from fishing in the inner Niger delta wetlands, although yields vary from 40,000 to 80,000 tonnes a year. According to Birdlife international (2015), Fishermen and farmers in the Hadejia-Nguru wetlands constitute about 75% of the indigenous community population and the wetlands represents their entire source of livelihoods through farming and fishing activities. It's an evedent from the study of jajere (2020),that fishing is one of the important livelihood means of the rural population along the wetlands site. He reported that thus, only 27% of respondents engaged in fishing for commercial purposes,. The mean household annual income decrease from 565,000 Naira to 130,000 Naira which implies changes in wetlands productivity decreased household income from fishing by 77%. The fish productivity of the wetlands depends on amount of water that enters into the wetlands, which is the more the water flow the large the fish harvest. The peak fish productivity of the wetlands was recorded in the year 2000 and 2018, since 1960s (Jajere, 2020).

6.1.4 Conflict over access to Wetlands resources

It's an established fact, that income distribution affects social security. Access to land resource is one of the major sources of conflicts in the Sudano-Sahelion ecological zone of West Africa (Jajere 2012). Wetlands ecosystems are the resource base of the African Sahel, thus the availability or scarcity of wetlands resources influence the occurrence of conflicts. Drying of wetlands water resources trigger conflict among wetlands users especially farmers/herders, fishing families, irrigators, and the likes. Fishing, farming and herding livelihoods along river Kumadugu Yobe have been adversely affected and the scarcity of water has led to conflict over the available resources (IUCN, 2009). The respondents' reported a significant reduction in conflicts over wetlands resources especially famers and pastoralist conflicts. Oral interview with key informants revealed that since year 2000, the area didn't witness any conflict, which they attributed to rapid recovery of the wetlands. Ninety seven percent (97%) of the respondents reports conflicts as one of social effects of wetlands degradation.

Therefore the degradedation of wetland's resources coused by climate variability in 1980s and 90s were the major reason of the frequent farmer's harders conflict wittenesed in wetlands sites in 1980s and 90s. Competition over resources trigger conflict among resource users. The relationship between wetlands components degradation and history of farmers and harders conflict in the study area is an evidence from study of Jajere (2012). In his study he reported that the violent conflicts between farmers and herders in the North east arid zone of Nigeria dates back to 1985 in Sugum village at Bade local government area between a Fulani clan Udawa and Bade farmers. Others are that of Gayo in 1986, Dachia in 1994, the last violent conflicts uptill date at wetland site was in 2000 at Malaika.

7 Water Resource Abstraction

The increasing water abstraction from Kumadugu-Yobe basin especially upstream dams construction since 1970s and intensive irrigation activities contribute to the fact that large areas of the floodplains are becoming increasingly drier (FAO 2011). Muslim (2008) reported shrinking of Hadejia-Nguru wetlands by as much as two-thirds in last 30-40 years, largely as a result of diversions from dams, irrigation developments and drought. This coupled with increase in domestic water demand as a result rapid increase in population and urbanization, land cover changes and ground water extraction technology are exerting a heavy stress on fresh water resources within the basin. In response to Sahelian drought of 1970s Kano state government construct two large dams (Chalawa and Tiga) at the upstream of Kumadugu Yobe, with several small earth dams and irrigation projects along Kumadugu-yobe and its tributaries (Barbier, 2003).

Tiga dam is the largest water project in this basin, which was completed in 1974. It was designed to support large scale irrigation project and Kano city domestic water supply. Tiga and challawa dams have 2,000,000m^3 and 904,000,000m^3 full storage capacity respectively, which affects river flow downstream at Gashua in Yobe State by about 100,000,000 cubic metres (3.5×10^9 cu ft) per year due to upstream irrigation and by more than 50,000,000 cubic metres (1.8×10^9 cu ft) due to evaporation from the reservoir (Goes, 2005; Shakirudeen, Ifeyinwa, Ademola and Lekan 2011).

A number of small dams and associated irrigation schemes have also been constructed or are planned for minor tributaries of the Hadejia River. Jama'are River is relatively uncontrolled in comparison, with only one small dam (Shabaki dam) across one of its tributaries. However, plans for a major dam on the Jama'are at Kafin Zaki have been in existence for many years, which would provide water for an irrigated area totaling 84,000 ha. Kafin Zaki Dam Work has been facing political challenges from downstream communities, environmentalists and concerned bodies. Its future is at present still unclear (Kole 1997). The Socio-economic benefits of the upstream water developments were at the expense of the downstream ecosystem and livelihood, as a result of floodplain losses.

The floodplains benefits includes flood-recession agriculture, fuel wood and fishing, (Barbier, 1993) groundwater recharge that supports dry season irrigated agricultural production and groundwater recharge of domestic water supply for household use

(Acharya and Barbier, 2002). Julian and Gert (2000) reported reduction in Hadejia-Jamaare floodplain from 300,000ha in 1960s and 1970s to 100.000ha in 2000s, largely as result of upstream water development. The location of the dams is presented in figure 4.

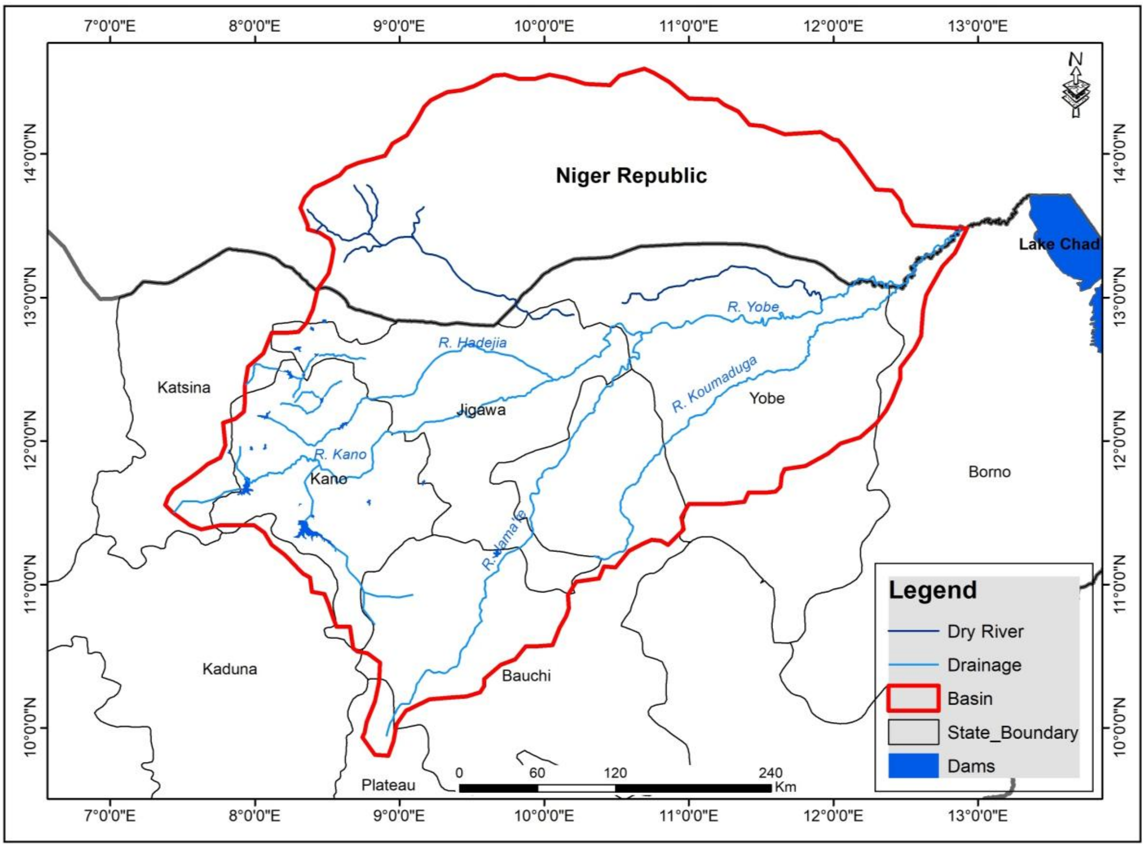

Figure 4: Kumadugu-Yobe River Basin Water Impoundement Map
Source: Google high resolution image (2018).

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