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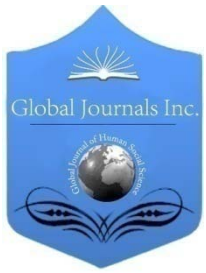

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Analysis of Environmental and Economic Effects of Kiri Dam, Adamawa State, Nigeria

A. A. Zemba [α], A. A. Adebayo [σ] & A. M. Ba [ρ]

Abstract- This research was an attempt to study the consequences of dam construction in Nigeria. This was expedient because such projects are known to be characterised by array of disasters that ensued their construction. Satellite images captured before and after the dam in 1976 and 2014 respectively were subjected to image processing techniques so as to assess the likely changes in environmental variables of the area. This was supplemented by 250 questionnaires administered in settlements along the riverbank to elicit information on the socioeconomic characteristics of the people. Additionally, field observations and informal interviews were conducted to probe further into details of information required. Results show that natural vegetation has decreased by 63%. This has led to chains of environmental problems including soil erosion, loss of biodiversity and pollution. The other land use/cover types experienced increase, with water body accounting for the highest value of 54.7% owing to dam in the reservoir. The hitherto common crops of the area such as maize, guinea corn have been replaced with cash crops like cotton and potato etc., some of which are foreign to the area. This coupled with inundation of farmlands by dam water, has constituted undesirable impacts on the livelihood of the local farmers. Unfortunately, the dam water meant for irrigation farming and fishing, has not been utilized maximally. Instead, the presence of the water has led to emergence of life-threatening animals and birds. It was recommended that the local farmers be provided with appropriate fishing and irrigation facilities to enable them take advantage of the dam. Vast hectares of lands lying fallowed should be utilized to ensure food security.

Keywords: kiri dam, environment, irrigation, fishing, quellabirds.

I. Introduction

Demands of the growing population for food, electricity power supply and economic growth have led to the initiation of large-scale river basin development in Nigeria. These river basins encompasses construction of man-made lakes and dams aimed at providing water for hydroelectric power, irrigation of floodplains, fishing, industrial and domestic needs. Some of the dams are multipurpose in nature, providing series of benefits like reservoir fisheries, transportation, domestic and industrial water supply, and recreational facilities needed by man.

It is in connection to some of the purposes stated above that River Gongola was dammed at Kiri under the auspices of the Upper Benue River Development Authority (UBRBDA). Kiri dam was originally initiated by Savannah Sugar Company but was completed by and it is now under the control of Upper Benue River Development Authority. Savannah Sugar Company is however, still the greatest user of the dam, where the dam water is used for irrigating its sugar plantations. The dam was constructed in 1982, at Kiri, some 25km upstream of its confluence with River Benue at Numan. The dam covers a land area of about 134km^2. Salau (1986) has reported earlier that the construction of Kiri dam displaced over 20,000 people, who were resettled in new areas.

It is also on records that very often ecological and socio-economic problems follow new dam construction. For instance, Adeniyi (1971) reported a decrease of about 70% in the acreage of cultivated farmlands; 75% decrease in income of fishermen; and an adverse effect on transport; and substantial decrease in the availability of fishes in the river after the construction of Kainji dam in Nigeria. This considerably reduced the quality and quantity of fish caught by fishermen and consequently caused them many untold hardships as they gradually and surely lost their means of livelihood after the creation of the dam.

Scudder (1980) cited in Salau (1986), pointed out that most dams and in fact other projects in Nigeria are embarked upon without an adequate knowledge of the location of the areas, hence, such consequences like indiscriminate levelling of land (with all trees uprooted, thus increasing the risk of erosion); diversion of natural water courses as well as alteration of ground slopes, which directly affect the existing ecosystem, ensued. Moreover, studies on environmental and economic impact of dams in different places have been carried out (e.g. Adeniyi 1970, Scudor 1980 in Salau 1986). Findings of these studies also revealed a lot of undesirable impacts, including reduction in water volume in the downstream, flood menaces, disappearance of aquatic lives etc. In extreme cases, floodplain fishing and floodplain pastures as well as recession culture and water availability become a problem and in the long term, soil fertility declines due to reduction of silt deposits. Reduced silt loads downstream deprive the floodplain from natural fertilization and sedimentation. These endanger the sustainability of traditional recession culture. Other impacts may include stream intrusions and surface run-

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off from the field, which cause much damage to agricultural lands; loss of aquatic lives; river bank erosion etc.

Observations of certain happenings around Kiri dam seems to suggest manifestations of dams related impacts. It is against this background that this research work was formulated to investigate whether the presence of the dam has any influence on the environment and economic well-being of the immediate communities.

II. Study Area

Kiri dam is located on floodplain of lower Gongola River basin, about 25km upstream of its confluence with River Benue at Numan. It was reported to have formed as a rift phase due to lithospheric peak thinning which caused long narrow depression that developed in some places filled with variety of sedimentary environment (Whiteman 1982, reported in Mubi 2001). Specifically, Kiri dam is located in Shelleng Local Government Area of Adamawa State and situated on latitude 9^0 42' North and longitude 12^0 01' East (Figure 1). The area has a sedimentary rock, which made up of shale and thin bands of limestone and lignite. It contains wide range of alluvial deposits, along wide channels of River Benue and Gongola which overlies the cretaceous deposit. It is generally a lowland area, between 500 – 700 meters above sea level. The landforms of the area are characterized by extensive floodplains and alluvial swamps. Most of the locations are liable to flooding, water logging or swamps along river catchments. The subsoil and shale formation allow underground flow of water, which raises water table during raining season and drops very low during dry season.

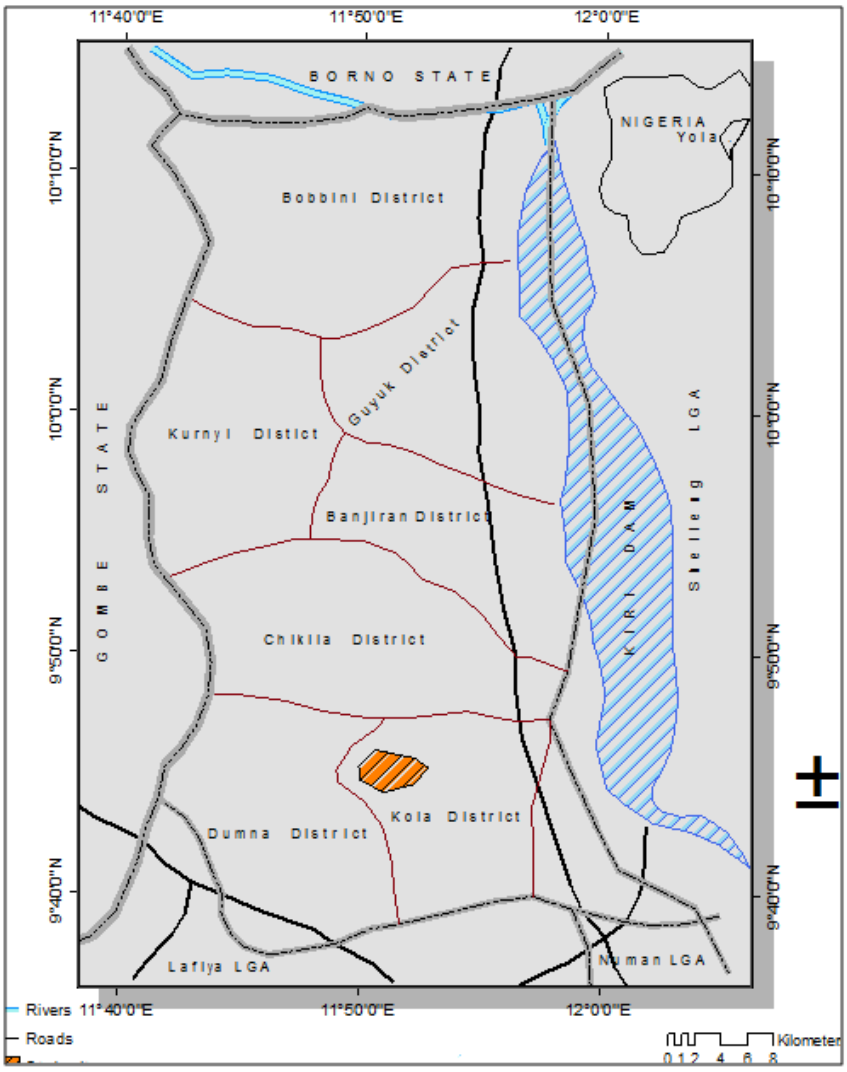

Fig. 1 : Map of the Study Area

The rainfall regime in the area is a tropical continental type of single peak toll usually in the month of August or September. The wet season ranges from April to October, with annual rainfall values of between

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510 – 1040mm and dry season lasts for about 7 months. Kiri area of the Gongola valley has warm temperature with a mean annual minimum value of 18^{0}C in December and a mean annual maximum of 38^{0}C in March. The evapotranspiration is very high throughout the year. Relative humidity varies greatly during the year. It is high from May to October, which ranges from 60 – 78% but has lowest values during dry season that ranges from 27 – 35%. Table 1 shows mean monthly values of some climatic elements of the area.

Table 1 : Mean Monthly values of some Climatic Elements of Kiri

Month	Rainfall (mm)	Mean Temp (^{0}C)	Relative Humidity (%)	Evaporation	Wind speed (Km/day)
Jan	0.00	35	28	310.5	189.5
Feb	0.00	36	29	395.1	231.3
Mar	14.6	39	82	453.9	279.6
Apr	24.8	40	78	459.0	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	244.0
Aug	174.5	31	91	174.6	158.0
Sep	159.7	32	87	170.0	137.1
Oct	66.0	34	91	181.9	106.5
Nov	0.01	35	84	200.1	111.1
Dec	0.00	33	38	265.9	187.8

Source: Computed from the data obtained at UBRBDA.

III. Materials and Methods

The types of data required for this study included climatic data, hydrologic data, remote sensing images and information on the socioeconomic characteristics of the people in the study area. The climatic information was necessary so as to assist in assessing the amount of rainfall available in the area. It was also required so as to help in determining the intensity of annual flood, which is important for the development of farmlands along the river valley. Similarly, hydrologic data was important for the assessment of water discharge of the dam. Remote sensing images were required in order to assess the general changes in the water level of the dam over time and the presence of reservoirs along the river valley. It was also needed in order to assist in knowing the extent of the current land terrain as a result of changes in water level of the dam, as well as detecting changes (if any) in the physical characteristics of the dam site.

These data were obtained from two sources. These are through primary and secondary sources. Primary source involved the use of questionnaires, field observations and scheduled interviews. The data collected from secondary source included climatic and hydrologic records as well as remote sensing images. Climatic and hydrologic data were obtained from the archive of agro-meteorological data year book of the UBRBDA. Remote sensing images (landsat MSS and SPOT) of 1976 and 2014 respectively were obtained from National Centre for Remote Sensing (NCRS), Jos.

The study covered five settlements: Kiri, Tallum, Banjiram, Purokayo and Shelleng. These settlements are all located directly at the bank of River Gongola. For equal representations, each of the settlements was taken to form a cluster for the purpose of questionnaire administration. Fifty questionnaires were administered in each of the clusters. The questionnaires were issued out to the respondents in such a way that they took care of all the sub-clusters i.e. farmers, fishermen etc. The number of questionnaires allocated to each group was proportional to their total population.

The information from the questionnaires was analysed using different statistical techniques. These included both descriptive and inferential statistics. Descriptive statistics used included the use of simple percentages and measures of central tendencies in analysing the data. Student t-test was employed to test the difference in farm sizes as well as crop outputs before and after the construction of the dam. Remote sensing images were subjected to classification and change detection techniques using Integrated Land and Water Information System (ILWIS) GIS software. The remote sensing images were of two different dates, 1976 and 2014, and were analysed with the aim of assessing likely changes in the land cover around the river basin as well as floodplain delineation.

IV. Results and Discussion

This study was aimed at assessing the likely environmental and economic impacts of Kiri dam on its hosting communities. The study was deemed expedient considering the fact that such impacts have both short and long term consequences on the lives of the people living around such projects.

Findings of the study indicate that the establishment of the dam has impacted both negatively and positively on the inhabitants of the area. Negative effects seem to outweigh the advantages of the dam. This is because what are required to be put in place to

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enable the local people take full advantage of the dam are lacking. For instance, fishing and irrigation equipment have not been made available and affordable to the local farmers and most of them cannot afford buying them on their own owing to high costs. This makes life difficult for them since these occupations are new to them. Meanwhile, the dam waters have overtaken most of the lands previously used for farming and grazing by the people. The dam has also brought in dangerous animals and birds particularly crocodiles, snakes and quella birds. These animals, which were not common in the area before the dam, are threats to both lives and crops.

Because some of their farmlands have been taken over by dam waters, farmers have been forced to go into cultivation of foreign and cash crops like cotton at the detriment of their former staple crops like guinea corn, maize etc. Moreover, fishes, which are supposed to be the available resources now, are reportedly scarce. Worse still, most of the farmers reported that they are not familiar with irrigation farming and fishing. The t-test result reveals that there are significant differences, at 1% level of probability, between the farm sizes and farm outputs of the peasant farmers before and after the dam in the area.

Considering the above catalogue of problems, it is not out of place to conclude that the social and economic well-being of the farmers has been inadvertently disrupted. At best, the dam can be said to be most advantageous only to Savannah Sugar Company, Numan, which draws its daily water from it for irrigating cane plantations. The commercial fishermen in the area are mostly immigrants from other parts of the country. Observations on remote sensing images also revealed a great difference in the environmental variables of the dam area before and after its establishment. For instance, the width of the Gongola River generally in Kiri area before the dam was about 2km. However, information from the Information Unit of the Dam project and analysis of images indicate that the dam presently has a catchment and dam area of 25, 000km^2 and 134m^2 respectively (Table 2). A 6.5 million cubic meters capacity of the water stored in the reservoir is an indication that large area has been engulfed by the dam structure. This is further confirms by the length (1,400 meters) of the embankment erected to contain the dam water to avoid spilling over to the other side.

Table 2 : Basic Information on Kiri Dam

Variable	Value
Catchment area	25, 000km^2
Area of the dam	134m^2
Height of the dam	20m
Length of the dam	1, 250m
Normal top water	170.5m
Lowest draw level	167.2m
Design flood (up flow)	4, 250m$^{2/s}$
Design flood (out flow)	4, 000m$^{2/s}$
Live storage	290 x 10^{6}m^2
Dead storage below	325 x 106/m^2
Dam type: Embankment	1, 400m long
Reservoir storage capacity	6.5 million cubic meters.

Source: Information Unit of Kiri Dam

Changes in variables around the dam were clearly confirmed by the remote sensing data. The 1976 landsat images, which was captured before the dam, depicts that the area was characterized with abundant vegetal cover, narrow river valley accompanied by intermix of cultivated farmlands. The second image, taken in 2014 (after the dam) shows clearly the increase in the area of dam water. A change detection results show that of the four major land cover types identified in the area, natural vegetation has suffered a decrease of over 63% in its area cover (Table 3). Settlements, farmlands and water bodies experienced some unprecedented increases in their total area due probably to population growth and of course presence of dam waters. This means that most of the land areas occupied by the dam water now used to be dry lands, most of which were farmlands. Incidentally, Salau (1986) has reported that about 20, 000 people had to be resettled as a result of dam construction. Unfortunately, most areas downstream of the dam, which used to be good floodplain areas for agricultural practices, have been disappeared and the upstream have been greatly inundated by water covering wide expanse of lands. Also, most of the trees, soils and other geomorphic features have been tempered with. The dam area has more of man-made features now than physical or natural features.

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Table 3 : Changes in Land Use and Land Cover of Kiri Area (1976 – 2014)

Land Use/Cover 1976	(Hectares)	2014 (Hectares)	Difference (Hec)
Farmland	18, 221 (16.1)	35, 450 (31.3)	+17, 229 (15.2)
Natural vegetation	81, 035 (71.4)	9, 551 (8.4)	-71, 229 (63.0)
Settlement	1, 622 (1.4)	6, 382 (5.6)	+4, 760 (4.2)
Water body	12, 546 (11.1)	62, 041 (54.7)	+49, 495 (43.6)

Note: + means increase and – means decrease. Figures in parenthesis refer to percentages

V. Conclusion

This study focused on investigating the impact of Kiri dam on the immediate environment and economic lives of the inhabitants. It has been established that the dam has impacted mostly negatively on the environment and the economy. This is because farmers' farmlands have been taken over by the dam water. The inhabitants had to be resettled in the first place, thereby subjecting them to a lot of inconveniences and loss of properties. Foreign birds and animals are now common in the area imposing various sorts of threats and intimidation to lives and properties. The dam is mostly advantageous only to Savannah Sugar Company, Numan because it draws virtually all of its water for irrigation from it. Environmental components have also been tempered with in a great way. The aims for which the dam was constructed has not been fully achieved. This aim should be vigorously pursued so as to compensate for the lost environment and threatened human lives.

VI. Recommendations

Based on the findings of this research, the following recommendations have been presented:

- Government should conceive plans for the provision of projects and programmes in the areas of health, housing, rural development as well as other social services that will improve the living standard of the people in the area.
- Immediate communities should be provided with adequate and appropriate facilities and training in dam related vocations like irrigation and fishing to enable them take good advantage of dam reservoir.
- The area should be provided with enough agricultural extension workers so that they can train the farmers on the types of crops to be planted on different lands and how to embark of effective utilization of water for fishing.
- Regulation on minimal mesh size nets is essential of juvenile fish, which would seriously endanger the yields of future years. This is because it was observed that women and children use mosquito nets to catch young fishes that are at the edge of dam waters due to tidal waves.
- Priority must be given to coherent programmes that will deal with rational forest exploitation, energy saving methods and development of alternative energy sources for sustainable development. This is because large scale degradation of natural forest has occurred in the dam area.
- Government should provide enough incentives and encouragement for the farmers to participate in developing the over 400 hectares of land in the dam area and 12 large fish ponds at Tallum.
- There is need for the Department of Pests and Diseases Control to take care of controlling the menace of quella birds and other birds relating problems.
- Communities should be provided with water treatment plants so as to eradicate the problem of water borne diseases.

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