Research Report

Alteration in Hydro-geomorphic Landscape and Its effects on Wildlife Population around Dadinkowa, Gombe State-Nigeria

Biyenta E. Daniel [1*], and Helen H. Ray [2]

[1] College of Education, Billiri, Gombe State, Nigeria; biyentadaniel@gmail.com
[2] Modibbo Adama University, Yola, Adamawa State, Nigeria; hhray@gmail.com
* Correspondence: biyentadaniel@gmail.com +2347033811769

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Abstract: The study assess the effects of alterations in hydro-geomorphic landscape on population of wildlife biodiversity around Dadinkowa communities of Gombe State, Nigeria. The study sought to identify wildlife species affected by changes in landscape brought about by the development of Dadinkowa dam comparing pre and post modification periods as well as identify pattern of changes in specie population over time. The study made use of 41 respondents from 13 settlements adjourning Dadinkowa dam. Respondents were selected purposely and resident of the selected community for at least 40 years. A semi-structured questionnaire was the instrument administered to derive information on observed changes in wildlife population over period of residence in the region. Responses collated were analyzed descriptively using tables. Major findings of the study reveal that, 20 species of wild birds have declined in population, 16 species of wild mammals were noted to have also declined in their population with 1 specie increasing in population across all settlements. In addition, 4 reptiles species population is altered by the development of Dadinkowa dam. The study therefore suggest the need to protect the remaining wildlife in the region through enactment of laws that ensure the conservation of fauna in the region for overall eco-tourism development of the state and nation at large.

Keywords: 1. Landscape; 2.Wildlife; 3.Biodiversity; 4. Dam; 5.Species

1. Introduction

Humans over a long time have altered the natural hydro-geormophic landscape of many places through damming [1]. Although developers of dams consider it as an environmentally friendly activity, several studies finds unforeseen environmental impacts [2]. The impacts of damming activities specifically on wildlife biodiversity are enormous and widely studied. A study reveal that diversity of wildlife species of 289 vertebrates were greatly impacted by dams in British Columbia Basin [3]. According to a study, species faced a substantial habitat loss with specific reference to Amphibians, water birds, fishes, song birds, bats and aerial insectivores as the species with highest habitat impacts [4]. During dam construction, wildlife are chased away by noise generated from various processes resulting in forced and mass migration of wildlife to areas they may not easily adopt leading to their total extinction [4]. In other instances, species die due to clearing of site for dams and due to changes in quality of water such as pollution and increasing turbidity [4].

Wildlife diversity and its associated ecosystems services such as cultural, provisioning, regulating and protecting services are alternatives for nation building. Habitat modification or alteration is among the greatest threat to biodiversity globally and among factors for low contribution of the wildlife sector to national economic growth especially among developing nations [5]. Large volume of data to help informed decision that will efficiently recognize these services as viable socioeconomic alternative is on the build-up.

Starting from 1979, the Dadinkowa region has seen dramatic landscape change due the award of contract for the construction of dam on the passing river Gongola by the federal government of Nigeria [6]. Studies shows that a region with just a channel for a river has experience modification in areal coverage, volume and flow regime of the river for a totally new terrain when compared. The Figure 1 and 2 as follows is a graphical representation of the water coverage on the terrain comparing 1979 ,

1986, 2001, 2015 and 2019 derived using a remotely sensed techniques, it shows the changes in relative areal composition of water around the region over time;

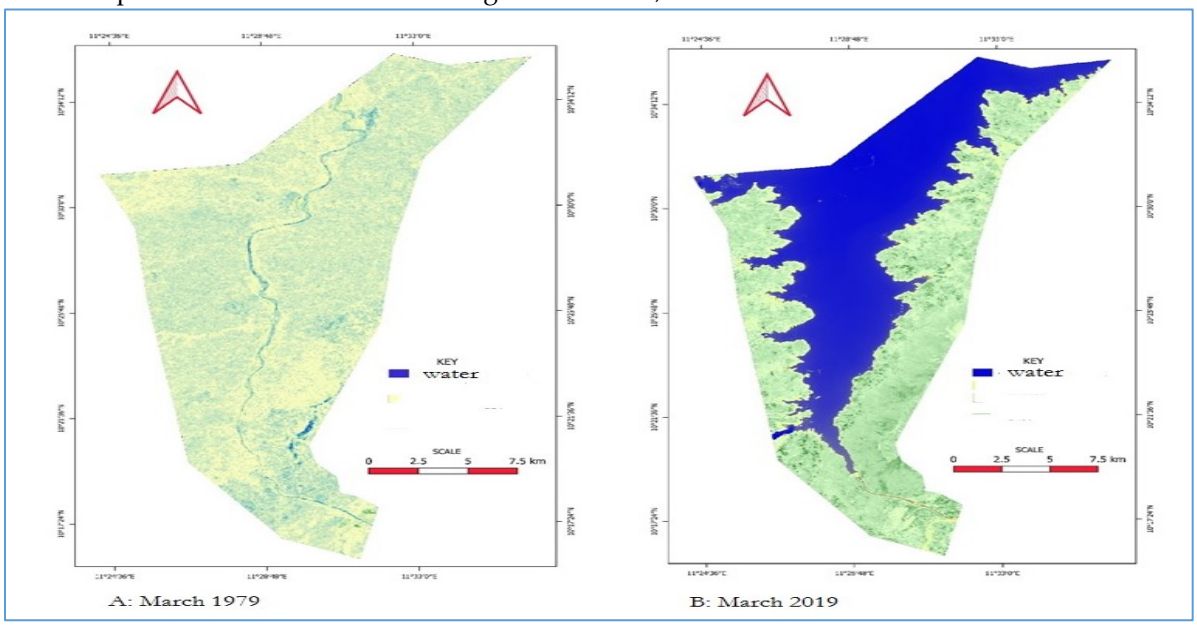


Figure 1:Water areal coverage in Dadinkowa region 1979 and 2019 (Source: Daniel, B.E (2023)

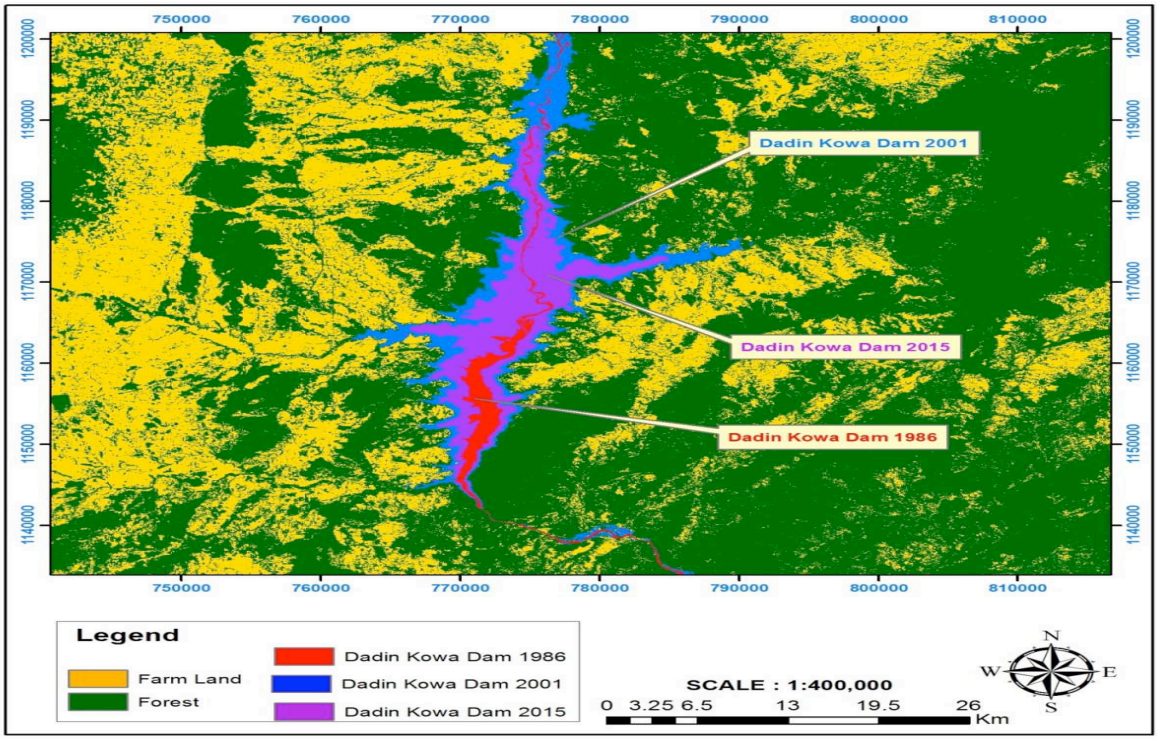


Figure 2: Areal coverage of water in Dadinkowa 1986, 2001 and 2015 (source: Jesse, et'al (2019)

A further detail of extent of alteration of the landscape shows that water body (river Gongola) and related channels only covers 5.8 Km^2 before the development of dadinkowa dam, over time, water areal coverage rose to 38.85 Km^2 in 1986, then 287.37 Km^2 in 2001, 159.37 Km^2 in 2015 and slightly down to 155.4 Km^2 in 2019 [9;11]. This entails that between 1979 and 2019, the dadinkowa region has undergo significant landscape modification with great expectation of similar effect on the components of the ecosystem such as wildlife.

Data on the relationship between hydro-geomorphic landscape change and related issues are crucial for conservation planning and general environmental management. Although the quality of data is paramount, these data are either inadequate, not available or are made obsolete by

contemporary forces of nature such as climate change. Detailed investigation becomes necessary to understand the consequence of changes in volume, areal coverage and flow regime of the River Gongola on wildlife population around Dadinkowa dam site in Gombe state, Nigeria.

Until less than a decade ago, there is little or no effort by the government to conserve forest resources and associated biodiversity around Dadinkowa since the complete construction of a dam in the area in 1984. Out of the 30 forest reserves (active, encroached and de-reserved) in Gombe State, none was sited around the dam environ [13]. There is rise in Public interest on a need for conservation measures around Dadinkowa over time [14]. It became imperative to understand the pattern of wildlife population changes and distribution around Dadinkowa region since there is little or no protection offered to wildlife after dam construction in the region.

This study aims to assess the effects of alterations in hydro-geomorphic landscape on wildlife biodiversity populations around Dadinkowa communities of Gombe State, Nigeria. The study strives to achieve the following specific objectives;

1. Identify specific wildlife species whose population where affected by alteration in hydro-geomorphic landscape due to dam development in Dadinkowa region.
2. Highlight patterns of population change in individual terrestrial wildlife species whose population where affected by alteration in hydro-geomorphic landscape due to dam development in Dadinkowa.

The study found answers to the following research questions;

1. What are the specific wildlife species whose population where affected by changes in hydro-geomorphic landscape due to dam development in Dadinkowa?
2. What is the pattern of population change in identified wildlife species affected by the landscape change from pre-dam and post-dam period?

2. Methods

2.1 The Study Area

Dadinkowa region lies relatively 35 km east of Gombe metropolis (state capital) and absolutely between 10^0 18′ 00′′N to 10^0 36′ 00′′ N and 11^0 24′ 00′E′ to 11^0 37′ 00′′ E. It is located in Yamaltu/Deba Local Government of Gombe State, Nigeria. The region falls on a savannah vegetation belt of woodland nature comprising scattered shrubs and trees [10]. It is situated on a highly undulating terrain with several rock outcrops and steep slopes in the immediate western part of the Dadinkowa dam [10]. Dadinkowa environs lies along Gongola River Basin with an elevation range of 184-351m height above sea level [10]. It is fed by several tributaries within and outside the Gombe state such as Bauchi, Yobe and Borno. Popular among supplying tributaries to River Gongola are River Difa, River Dinya and River GajiBauchi [10].

The Figure 3 as follows shows the situational location of the study area;

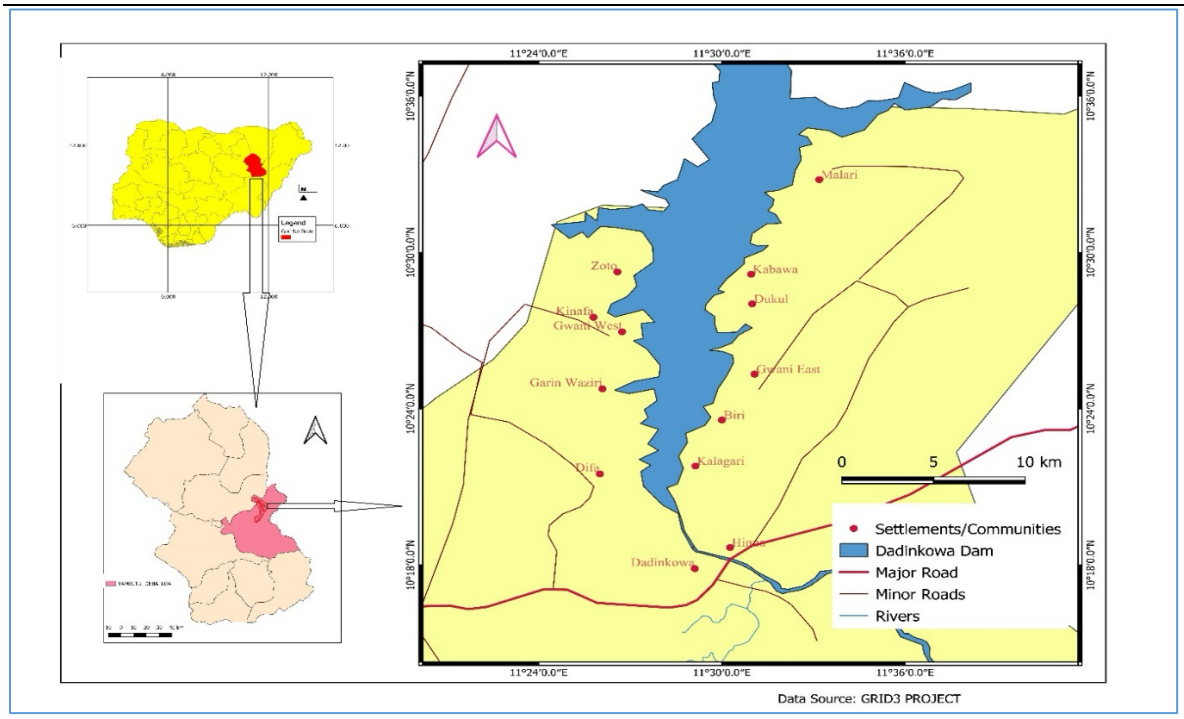


Figure 3: The Study Area *(source: Authors Design, 2020)*

2.2 Sampling Techniques

The target population of the study are matured adults of all gender with perceived relative long-term knowledge of the study area and associated changes. A Criterion based Snowball sampling technique was used to sample persons from the target populations for the study. The basic criteria for selection as sample were persons who have attained the age of age 55 years and have a minimum of 40 years' residency in the identified 13 settlements within 5 Km distance to the bank of the Dadinkowa dam reservoir. The basis for these criteria is to select individuals with knowledge and experience of the pre-dam and post dam environmental conditions especially as it relates to interaction with the environment including wildlife.

2.3 Data Collection and Analysis

A snowball technique was used to identify sampled individuals for questionnaire administration. In all, 41 persons were administered a semi-structured questionnaire in their respective communities after a verbal confirmation of meeting criteria for serving as respondent for the study over a period of two weeks. In most instances, respondents were assisted by the researchers and sometimes with the aid of an interpreter from the locality to fill the questionnaire due to low literacy and language barrier between researchers and the respondents.

Filled questionnaires were retrieved, and responses from the questionnaire were collated for each item, they were tallied by settlements and tabulated. Local names used by respondents were translated with the aid of a 'Preliminary Hausa Bird Lexicon' [12]. Bargery's dictionary (online version) was also resourceful in the translation process. Descriptive tools such frequency tables and percentages were used for analysis.

3. Results

3.1 Demography of Respondents for the Study

Respondents for the study were drawn from settlements on the east and west bank of the Dadinkowa dam. Settlements on the western bank include; Gwani west, Zoto, Difa, Kinafa, and Dadinkowa town, on the eastern bank on the other hand are, Gwani East, Kalagari, Biri, Hinna, Malari East, Kabawa and Dukkul. Table 1 as follows presents the demographic data of respondents used for the study;

Table 1: Demographics of Respondents

Variable	Frequency	Percentage

Gender		
Male	36	87.8
Female	5	12.2
Age Range (Yrs)		
55 -60	13	31.7
Over 60	28	68.3
Residency Period (Yrs)		
40-50	29	70.7
51 -60	10	24.4
Over 60	2	4.9
Educational Attainment		
Non_Formal only	19	46.3
Primary	15	36.6
Secondary	5	12.2
Tertiary	2	4.9
Major Occupation		
Farming	28	68.3
Fishing	4	9.8
Hunting	3	7.3
Others	6	14.6

Source: Field survey 2020

Table 1 shows that majority (87.8%) of the respondents are males while smaller portion (12.2%) are females. By age distribution, majority (68.3%) of the respondents are over 60 years of age while 31.7% are between 55-60 years of age. The dominance of the male respondents may be attributed to culture where mostly men are the heads of most households and feel free to interact with strangers, this implies that gender based socioeconomic activities that may have ecological consequence such as agriculture and hunting are prevaling. The table on the other hand implies that respondents were at-least 13 years old as at the time noticeable modification began on the landscape and could clearly recall observed changes in landscape over time.

In addition, Table 1 shows that all respondents have lived for over 40 years around the dam project, indicating that majority of the respondents have lived in the area even before the construction of the dam which actually began in 1979. By implication, respondents for the study were long term resident of the region, indicating long-term human interaction with the environment and good knowledge of changes in landscape over time.

3.2 Hydro-Geomorphic Landscape change and Wildlife Population around Dadinkowa

The Table 2 as follows show the responses of respondents in this study in regards to identification of birds species affected by the development of dadinkowa dam and the pattern of alteration in their population;

Table 2: Wild Birds affected by landscape alteration (comparing pre-dam and post-dam periods) as reported by Respondents

	Names of Wild Birds	Nature of Population Alteration	Responses by Settlements													Total Responses
			Biri	Dadinkowa	Difa	Dukkul	Garin Waziri	Gwani East	Gwani West	Hinna	Kabawa	Kalagari	Kinafa	Malari East	Zoto	
1	Cattle Egret	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	2	0	0	0	3	1	1	0	0	0	1	0	9
2	Abdim's Stork	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	0	1	0	2	1	2	0	0	0	0	0	7
3	Black-faced dioch	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	0	0	0	0	1	0	0	0	0	0	0	2
4	Black Hawk	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	2	1	0	0	0	1	2	0	0	2	1	0	10
5	Senegal Coucal	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	2	0	0	0	0	0	1	0	0	1	0	1	5
6	Marabout Stork	Increase	0	0	0	0	0	0	0	0	0	1	0	0	0	1
		Decrease	0	0	1	0	0	0	0	0	0	0	0	1	0	2
7	Guinea Fowl	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	1	0	0	0	0	1	0	1	0	0	0	4
8	Goose	Increase	0	0	0	0	0	0	0	0	0	1	0	0	0	1
		Decrease	0	0	0	0	0	0	0	0	0	0	2	0	0	2
9	Black-headed Heron	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	3	0	1	0	0	0	1	0	0	0	0	0	5
10	Hooded Vulture	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	1	1	1	2	3	4	1	2	0	1	1	2	20
11	Dove	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	2	1	0	2	2	1	0	0	0	1	0	0	9
12	Speckled Pigeon	Increase	0	0	0	0	0	1	0	0	0	0	0	1	0	2
		Decrease	1	3	0	1	1	1	2	1	0	0	0	0	2	12
13	White-faced Tree Duck	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	0	0	0	0	0	1	0	0	0	0	0	2

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14	Crowned Crane	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	1	0	0	0	1	0	0	0	0	0	0	2
15	Pied Crow	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	2	0	0	1	2	0	0	0	0	1	0	6
16	Pallid Harrier	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	2	0	2	0	1	1	0	0	0	0	0	1	7
17	Eagle	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	1	0	0	1	0	0	0	1	0	1	0	0	5
18	Bat	Increase	0	1	0	0	0	0	0	0	0	0	0	0	0	1
		Decrease	0	0	1	0	0	1	0	1	0	0	0	0	0	3
19	Owl	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	1	0	0	0	0	0	0	2	0	0	0	0	4
20	Ostrich	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Total Responses		6	24	9	6	6	15	15	12	6	3	9	6	6	123

Source: Field studies 2020

As can be seen from Table 2, respondents were able to identify 20 species of wild bird whose population were altered since the creation of Dadinkowa dam. The table 2 also shows that all identified bird species have declined in population when compared to pre-dam periods around settlements of the region. Top bird species identified in most communities includes Hooded Vultures (locally called Angulu), Speckled Pigeon (locally called Hazbiya), Dove (locally called Kurciya) and Black Hawk (locally called Shaho). Bird species around Dadinkowa with least mention among respondents are Goose and Ostrich.

The Table 3 as follows show the names of wild mammals that respondents can identify at pre-dam periods and how the development of Dadinkowa dam affected their population over time;

Table 3: Respondents identification of wild mammals affected by change in landscape (comparing pre-dam and post dam periods)

	Names of Wild Mammals	Nature of Population Alteration	Settlements (Responses)													Total Response
			Biri	Dadinkowa	Difa	Dukkul	Garin Waziri	Gwani East	Gwani West	Hinna	Kabawa	Kalagari	Kinafa	Malari East	Zoto	
1	Buffalo	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	0	1	2	2	1	0	0	0	0	0	6
2	Hedgehog	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	0	1	1	0	0	1	0	0	2	0	0	6
3	Monkey	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	5	1	1	0	2	2	2	1	0	2	1	1	19
4	Leopard	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	1	0	1	1	0	0	0	0	0	1	4
5	Grasscutter	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	1	1	0	2	0	1	0	0	0	0	0	0	6
6	Lion	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	2	0	1	2	1	0	0	0	0	1	7
7	Rhinoceros	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	0	0	1	0	1	0	0	0	1	1	4
8	Elephant	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	1	0	0	0	0	0	2	0	1	0	0	0	4
9	Antelope	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	2	3	1	0	1	1	2	0	1	0	2	1	0	14
10	Wild Pig	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	0	0	0	0	1	0	1	0	1	0	0	0	3
11	Deer	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	3	1	0	0	1	2	0	1	1	1	0	0	10
12	Jackal	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	1	0	0	0	1	0	0	1	0	1	1	0	6

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13	Squirrel	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	2	0	0	0	2	1	0	1	0	0	0	6
14	Rabbits	Increase	0	0	0	0	0	1	0	0	0	0	0	0	1
		Decrease	0	1	0	0	1	0	0	1	0	0	0	1	4
15	Rats	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	0	3	1	0	0	0	0	2	0	0	0	1	7
16	Hyena	Increase	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decrease	1	3	1	1	0	1	2	0	1	0	1	0	2
17	Hippopotamus	Increase	2	4	2	2	1	3	2	2	2	0	3	1	2
		Decrease	0	1	0	0	1	0	2	0	0	0	0	1	0
Total Responses			8	29	8	8	8	18	19	14	8	3	11	8	8	151

Source: Field Studies 2020

Table 3 shows that 17 species of wild mammals were identified by the respondents to have been altered in their population due to Dadinkowa dam. Table 3 also shows that all identified mammalian species have declined in population across all communities. Further query during field work with some respondents revealed that most of these animals have locally gone extinct around the environ. By spatial coverage as shown in table 3, mammals identified in most settlements include monkeys, Antelope, Hyenas, Deer, and Hippopotamus as revealed the respondents in the study.

Table 4 as follows show the distribution of reptiles and amphibians that respondents can identify before the development of Dadinkowa dam and how their population were altered when compared to post-dam periods by settlements;

Table 4: Respondent's identification of Reptiles and Amphibians affected by change in landscape

	Names of Specie	Nature of Population Alteration	Settlements (Responses)													Total Responses
			Biri	Dadinkowa	Difa	Dukkul	Garin Waziri	Gwani East	Gwani West	Hinna	Kabawa	Kalagari	Kinafa	Malari East	Zoto	
1	Snakes	Increase	0	2	1	0	0	2	0	2	0	0	0	1	0	8
		Decrease	2	5	2	2	2	3	5	3	2	1	3	1	2	33
2	Monitor Lizard	Increase	0	3	0	0	0	1	0	0	0	0	0	0	0	4
		Decrease	2	6	3	2	2	4	4	2	2	0	3	1	2	33
3	Alligators	Increase	0	0	0	0	0	1	0	0	0	0	0	0	0	1
		Decrease	2	6	1	2	1	3	5	4	2	1	3	1	1	32
4	Lizards	Increase	0	1	0	0	0	0	1	0	0	1	0	0	0	3
		Decrease	0	1	2	0	0	0	0	1	0	0	0	2	1	7
5	Crocodiles	Increase	0	1	0	1	1	3	1	2	0	0	0	0	0	9
		Decrease	1	3	2	0	1	0	3	0	2	1	1	2	0	16
6	Toads/frogs	Increase	0	1	0	0	0	1	0	0	0	0	1	0	0	3
		Decrease	0	2	2	1	0	0	0	0	0	1	2	0	0	8
7	Snails	Increase	0	1	0	0	0	0	1	1	0	0	0	0	2	5
		Decrease	1	0	1	0	0	0	0	0	1	0	0	0	0	3
8	Tortoise	Increase	0	1	1	0	0	0	0	0	0	0	0	0	0	2
		Decrease	0	2	0	0	0	0	0	1	0	0	0	0	0	3
Total Responses			8	35	15	8	7	18	20	16	9	5	13	8	8	170

Source: Field Studies, 2020

Table 4 shows that respondents identified 8 reptiles species and amphibians whose population have been altered by the development of Dadinkowa dam. Results of the study shown in Table 4 indicates that all identified specie have decline in population across all communities. Reptiles shown in Table 4 with highest mention per settlement include snakes, monitor lizard and Alligators while Lizards have the least mention among respondents in the study area.

4. Discussion

The Dadinkowa Dam environ is considered an ecologically rich site, which provides a critical habitat to a wide variety wildlife species, human population increase around the dam due to agricultural potentials as shown by this study is threatening the growth of these species [7]. Declining mammalian wildlife around Dadinkowa dam might be due to deaths from clearing of site for dams as well as mass migration of wildlife to areas they may not easily adapt leading to their total extinction as also indicated by a study in another location [4].

In general. The study agrees with the assertions that 'The hydrological systems of most northern Nigeria have been profoundly changed by human actions in many areas with implications for the size and diversity of the wetland species components in local avifauna'[12]..

5. Conclusions

The Dadinkowa dam project have contributed to profound changes on wildlife population around the region, although not neglecting other factors that may be responsible for the effects on wildlife, ecological offsets in forms of situ-protection should be offered to wildlife around greatly altered environs such as the study area to minimize such negative effects.

Endangered species of Snakes, Crocodiles, Hippopotamus, Monkeys, Antelope, Hooded Vultures, Monitor lizards, and Alligator with wide spread around dadinkowa region are continuously forced to local extinction without measures for their conservation. The physical setting around Dadinkowa is a potential haven for wildlife but human activities such as agriculture and hunting has and is creating harm to these local species.

6. Suggestion for Further Studies

There is need for studies that will involve a detailed inventory of wildlife biodiversity around Dadinkowa with estimated population of species.

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References

1. Xie, Z., Liu, J., Huang, J., Chen, Z., & Lu, X. Linking Land Cover Change with Landscape Pattern dynamics Induced by Damming in a Small Watershed. 2022. Remote Sensing Vol.14. https://doi.org/10.3390/re14153580
2. Salisbury, C. Dams inevitably result in species decline, losses on reservoir islands. Mongabay Series: Amazon Infrastructure. 2016. A download from https://news.mongabay.com/2016/08/dams-inevitably-result-in-species-decline-losses-on-reservoir-islands/amp/?print accessed on 2nd/August/2022
3. Utzig, G. and Schmidt, D. Dam footprint Impacts Summary: BC Hydrodams in the Columbian Basin. 2011. Prepared for fish and wildlife compensation program: Columbia Basin. Nelso. British Columbia

4. Rezaian, S. Jozi, S.A. and Zaredar, N. Environmental Risk Assessment of Dam during Construction Phase. Global Journal of Environmental Science and Management.2016. Vol.2 No. 4. Pp.*345-356.*
5. Doherty, T.S., and Driscoll, D.A. Coupling movement and landscape ecology for animal conservation in production landscapes. Proc. R. Soc. B. 2017. vol 285: 20172272. http://dx.doi.org/10.1098/rspb.2017.2272
6. Upper Benue River Basin Development Authority [UBRBDA]. Semi-detailed Soil Survey in Lower Gongola River Basin (Final Report). 1980. Yola. Nigeria
7. Adang, K.L., Nsor, C.A., & Tela, M. Checklist of Bird species at the Dadinkowa Dam, Gombe State, Nigeria. *Global Advanced Research Journal of Agricultural science.2015.vol.* 4(6). 270-274
8. Bargery, G.P. A Hausa-English Dictionary and English-Hausa Vocabulary. 1934. Oxford University Press. London Online pages from https://maguzawa.dyndns.ws
9. Daniel, B.E. An assessment of the Ecological Risks Associated with Dadinkowa Dam Project on its Environ, Gombe State, Nigeria. 2023. An Unpublished M.Sc. Thesis submitted to the department of Geography, Modibbo Adama University, Yola.
10. Ikusemoran, M. Wanah, B.B. & Mbaya, L. A. Geospatial Techniques for Terrain Analysis of Gombe State, Nigeria, *Journal of Geography, Environment and Earth Science International. 2016. Vol.* 6(1): 1-20
11. Jesse. E.E., Igbokwe, J.I., Essien, E. & Sumi, Y.L. Assessment of Water Level in Dadinkowa Dam Reservoir in Gombe State Nigeria Using Geospatial Techniques. *International Journal of Environment and Geoinformatics (IJEGEO)*, 2019. Vol. 6(1): pp.115-130. DOI: 10.30897/ijegeo.487885
12. Manvell, A. A Preliminary Hausa Bird Lexicon (Version 1.1). 2012. Download from www.adammanvell.info/notes Accessed 12/Oct./2020
13. Mbaya, L.A. & Hashidu, S. Biodiversity Status of Forest Reserves in Gombe State. In Mbaya, L.A., Wanah, B.B., Dan, Y. &Ahmed, B.Y (eds.). Gombe: People, Environment and Development. 2019. Dept. of Geography, Gombe State University.
14. News Agency of Nigeria [NAN] (2021) Gombe to partner U.S. conservationist on hippopotamus colony. A download from https://gazettengr.cotgombetopartneru.s.conservationistonhippopotamuscolonythedadinkowacommunityingombeisfamousforitspopulationofhippopotamuses.newsagencyofnigeria/

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