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PERCEPTIONS ON THE IMPACTS OF MORPHOLOGICAL CHANGES ON THE LOWER COURSE OF RIVER MAYO-INNE, YOLA SOUTH, ADAMAWA STATE, NIGERIA

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ABSTRACT

Rivers are important natural resources that support the existence of humans and other living organisms right from time immemorial. Despite their significance to human livelihood; changes in their morphology can impact on the socio-economic, cultural and environmental values of the riparian environment. Therefore, this study focused on the perception of the impacts of morphological changes on the lower course of River Mayo-Inne, Yola South, Adamawa State, Nigeria. This was done with the view to examine the perceived impacts of morphological changes on riparian land uses; factors influencing morphological changes and estimate the land area affected by changes in river channel morphology of the study area. An integrated approach of remote sensing, GIS, questionnaire survey and interview, were employed in this study. Descriptive statistics such as percentage and sum were used to analyse the data sets. The results revealed that fishing activities, agricultural land, damage on crops, plantation and residential land use have high impacts in the study area. While grazing land and commercial land uses have medium and low impacts respectively. The perceived factors influencing morphological changes in the study area were: discharge 50.75%, sand mining 17.10%, channel bed siltation 13.15% and urbanization 6.80%; all of which provide 81% of the total response of people living in the riparian environments. The temporal analysis of satellite imageries from 1990 to 2015 revealed that the river channel area increased from 486.34ha to 594.90ha respectively; impacting riparian land uses through bank under cutting, chute cutoffs and meander migration. The result of key informant interview revealed that the average productive capacity of the floodplain is 6000kg of rice per hectare and 4250kg of maize per hectare in dry season farming. The mitigation strategies put in place to curtail the impacts of morphological changes on land uses in few reaches of the river channel includes: building of retention walls along Ngurore market and biological methods of planting of kafi kansila (Ipomoea carnea). It is recommended that there should be a re-establishment of riparian vegetation so as to increase bank stability; sediment trapping and provide habitat for riparian dependent species and in-stream species in the study area.

Keywords: Impacts, Morphology, Land use, Floodplain, River Channel

INTRODUCTION

The extensiveness of rivers all around the globe have made them a major component of livelihood; as they provide environmental, cultural, and economic benefits of navigation, fishing, irrigation, hydropower, recreation and water supply among others (Jeje and Adesina, 1997; Ijafiya, 2023). Alteration in river ecosystem either by natural or anthropogenic forces can generate instability which may cause the river to shift to a new state of dynamic equilibrium; by changing its morphology through the processes of erosion, transportation and deposition (Faniran *et al.*, 2006; Ibisate *et al.*, 2011). Such changes affects the riparian land uses/ land cover such as farmlands, settlement, forest, fisheries, infrastructure and hydraulic structures among others (Alan *et al.*, 2007; Bashir, 2013; Arohunsoro and Adebayo, 2015; Brooshkeh and Sokuti 2017; Valenza *et al.*, 2020).

Studies on changes in river channel morphology have increased over the last few decades (Buffington, 2012; Granfell *et al.*, 2014; Djekovic *et al.*, 2016), owing to growing interdisciplinary and collaborative interests among various environmental scientists and engineers over river system management and sustainable exploitation of the potentials resources provided by the river. This is based on the notions that changes in the river channel morphology could pose serious impacts on riverine ecosystems, water ways, river based engineering structures such as bridges and dams and settlement and other riparian land uses.

The lower course of River Mayo-Inne have attracted several riparian settlements due to the vast nature of its floodplain that support the establishment of settlements, farming activities, fishing and rearing of animals. Previous research have shown that this area is vulnerable to the vagaries of fluvial activities which have resulted to increase in channel width dimension and the development of chute cutoff; all of which were attributed to changes in land use/ land cover, discharge and non-cohesiveness of bank materials (Ijafiya and Yonnana 2018).

Analysis of the impact of morphological changes on riparian landscape are mostly significant from the perspectives of people inhabiting the floodplains areas (Alan *et al.*, 2007; Eziekiel, 2007; Bashir, 2013). Thus, this study seek to: analyse the perceived impacts of morphological changes on adjacent land uses; factors influencing morphological changes and estimated land area affected by morphological changes.

MATERIALS AND METHOD

Study Area

River Mayo-Inne, is a tributary of River Benue, which takes it source from an undifferentiated basement complex (Jangali Hills) in Toungo Local Government Area of Adamawa State. It is located between latitude 9^0 16` and $9^0$ 26` north of the Equator and between longitude 12^0 12` and 12^0 20I east of the Greenwich Meridian (Fig.1). The climate is a savanna type with rainy season that usually start from May to October while

the dry season is observed between the months of November and April. The annual rainfall ranges between 800 and 1100mm. The vegetation of the study area can be classified as Sudan Savannah type that covers most parts of the Northern States (Ileoje, 2001; Zemba, *et al.*, 2010).

The channel section selected for this study, consist of four geological formation which are Pindiga formation at the north-west, Bima sandstone at the west and south-west, Yolde foration at the south-east and alluvium deposits along the river banks. Soil types found in the study area include: luvisols, combisols, and alluvial soil (Adebayo and Tukur, 2022). The relief falls within the plains of the Benue trough that range in height between 311.1 and 140m above sea level. Drainage pattern is said to be dendritic at the upper course; however, flowing down current to the middle course at Tullabenbi, where the river cut across a different geological formation, the drainage pattern changed to parallel. At the lower course, the river flow, meander and joined the River Benue which serve as its local base level.

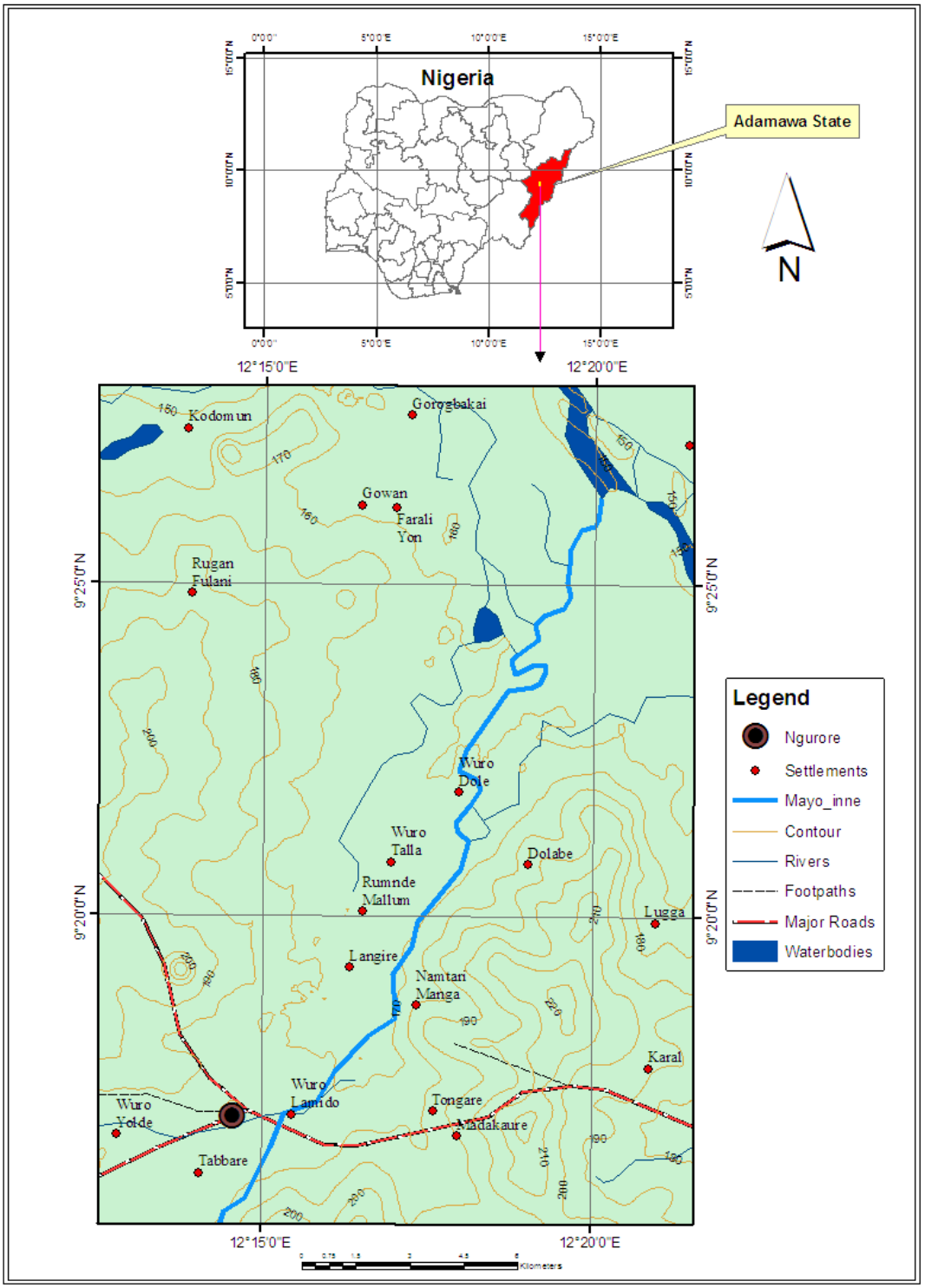

Figure 1: The Study Area
Source: Adapted from Federal Ministry of Land and Survey (1970)

Primary and secondary sources of data were used in this study. Primary data were sourced from questionnaire and interviews while secondary data was sourced from satellite images of 1990 TM and 2015 ETM + from United State Geological Survey achieve.

To determine the sample size of the study area; a reconnaissance survey was conducted to estimate the sizes of farmlands for both irrigation and rain fed agriculture located at the riparian zones. The estimated sizes of the farmlands were as follows: 25×25, 30×30, 50×50, 75×75, 100×100, 200×200 and 300 and above. The sampled farm size was selected by balloting method where each of this farm size were written on a small piece of paper, folded and placed into a plastic cup; this was shaken and the 30m×30m size was picked with eyes averted. This form the basis for estimating farmland population in the study area.

The section of the river selected for this study span a length of 30km; when converted to metres will give 30000m; dividing 30000m by 30m which is the dimension of a single farmland gave a total of 1000 plots of land. Thus the population in this study is 1000 plots. Using Krejcie and Morgan, (1970), table of sample size determination, a population of 1000 plots have a sample size of 278. Thus, 278 questionnaires were administered purposively to the riparian inhabitants in their farms and various communities of the study area. Interview were also conducted to assess the productive capacity of the floodplain in terms of rice and maize farming. The satellite images of 1990 to 2015 was classified using isocluster unsupervised classification from spatial analyst tool in ArcGIS 10.1. These images were later re-classified into two classes and was converted from raster to polygon. The edit tool was activated and the river portion of the satellite images were selected and copied. The area occupied by the river channel was calculated from the attribute table of GIS analysis.

RESULTS AND DISCUSSION

The respondent perception on the impact of morphological changes on the various land uses such as agricultural, residential, commercial, plantation, fishing and grazing land were presented in Table 1.

Table 1: Impact of Morphological Changes on Riparian Land Uses in the Study Area

S/N	Land use Type	High Impact (%)	Medium Impact (%)	Low Impact (%)	Insignificant Impact (%)	No Impact (%)	Total Percentage
1	Agricultural Land	83.45	8.99	5.04	1.80	0.72	100
2	Residential Land use	71.22	5.40	4.32	6.47	12.59	100
3	Commercial Land use	34.12	7.96	6.12	15.11	36.69	100
4	Plantation	75.54	15.11	4.67	2.88	1.80	100
5	Damage on Crops	77.34	11.51	7.19	2.52	1.44	100
6	Fishing Activities	84.89	9.35	3.24	1.08	1.44	100
7	Grazing Land	32.01	33.09	12.59	5.76	16.55	100

Source: Author's Field Survey (2016).

Fishing activities, agricultural land, damage on crops, plantation and residential land use revealed high impacts in the study area. Most of the riparian communities such as Namtari, Wuro Dole, Wuro Tella, Rumde Mallum and Ngurore among others specialized in fishing as one of their means of livelihood. They reported that over the years; the fishing industry have experienced significant decline due to loss of habitat by clearing of riparian vegetation, channel bed siltation and over exploitation from the neighboring urban settlements.

Bank line migration due to chute cutoff, undercutting and collapse by fluvial erosion have been said to be responsible for not only loss of fertile agricultural land but also on residential land uses, damage on crops, plantations and grazing land. This finding is in agreement with the work Ijafiya and Yonnana (2018) who observed that chute cutoff occurred at bend II of the study area. In an interview with some of the local inhabitants especially elderly, who have reside in the study area for over 35 years revealed that in 1996 some houses close to the river channel were affected by fluvial activities. Changes in channel morphology especially width, has also led to the relocation of Wuro Yanka primary school, Ngurore, from the river bank to its present location. At Wuro Talla, and Wuro Dole, houses located at the river banks were destroyed due to continuous channel migration. The greatest of all impacts, is that, all the residents of Tabbare village, have been forced to relocate from the river banks due to the dangers of fluvial activities. Slumping of bank materials alongside with crops, plantations and grasses used for gazing are obvious in some of the degraded reaches of the study area. The finding of this research is agreement with the work of Arohunsoro and Adebayo (2015) who observed that destruction of habitat for aquatic organisms, wasting of cultivated land and subsidence of residential area, are the main impacts of morphological changes in River Ajilosun drainage basin, Ado-Ekiti, Ekiti State, Nigeria. The finding of this research is also in agreement with the work of Guite and Bora (2016) who observed that the effect of morphological changes on land uses were more pronounced on agricultural land use, forested land use and human inhabitant located in the riparian zones of the lower Subansiri River floodplain.

The impact on commercial land uses was obvious in two significant sections of the Ngurore market; one of such places is the cattle market and the other is the grains market. During an interview session with some of the local marketers, it was disclosed that almost all of the cattle market and some parts of the grains market are usually submerged when the river over flow its banks. This lead to loss of animals, destruction of animal feeds, and other infrastructure in the market place. Personal observation by the researcher also revealed that about four shops in the grain market are silted to half of their original height and are thus rendered useless. The outcome of

this research is in agreement with the work of Yunus (2020) who observed that low lying areas close to rivers are highly vulnerable to urban flooding in Kano Metropolis, Nigeria.
The types of measures put in place to curtail the impacts of morphological changes on adjacent land uses in few sections of the river channel are building of retention walls along Ngurore market and biological methods, which involves the use of some plant species in few places along the channel banks; all of which, to no avail.

Respondents Perception on Factors Influencing Morphological Changes in the Study Area
The perception of respondents on factors responsible for morphological changes in the studied river are presented in Table 2.

Table 2: Respondents Perception on Factors Responsible for Morphological Changes

S/N	Factor Influencing Morphological Changes	People Perception of Factors
1	Discharge	50.75%
2	Siltation	13.15%
3	Clearing of Vegetation	4.70%
4	Sand Mining	17.10%
5	Grazing	4.70%
6	Farming	1.90%
7	Bricks making	0.90%
8	Urbanization	6.80%
9	Total percentage of Responses	100%

Source: Field Survey (2016)

The analysis of questionnaire revealed that 99 percent of the respondents were aware of the factors influencing morphological changes in the study area. About 50.75% indicated that discharge is the major cause of the observed morphological changes, 13.15% channel bed siltation, 17.10% sand mining activities and 6.80% urbanization among others. From the foregoing, it can be deduced that discharge, sand mining and siltation accounted for 81% of the perceived factors influencing morphological changes in the study area.
Siltation on river bed is known to reduce the effectiveness of the channel cross-section and carrying capacity, causing the river to erode its outer banks. This might be the reason why some houses and settlements where relocated from the river banks. The observation herein is in consonant with the work of Alan *et al.,* (2007) who observed that changes in channel morphology of River Brahmaputra due to siltation have caused significant impacts on agricultural land, settlement, forest, fisheries, infrastructure and hydraulic structures among others.
Interview with some of the residents of the study area found at the sand mining site, revealed that over 20 trips of sand are being extracted on a daily basis in order to meet up with the high demand of sand from nearby urban centres like Jimeta and Yola (Plates 1). Some of the respondents also identified six local block industries at Ngurore which make use of both bank and bed materials to produce concrete and local bricks (Plate 2); such activities help in accelerating channel bank erosion and degradation. The findings of this research agrees with the work of Iroye (2015) who reported high values of channel width at sand mining site of River Asa, Ilorin, Kwara State, Nigeria. He also noted that in channel sand mining activities has caused serious damage to both private and public properties such as bridge, pipeline, houses and farmlands.

Plate 1: Dry Season In-channel Sand Mining in River Mayo-Inne, Ngurore
Source: Authors Field Work (2016).

Plate 2: Local Brick Production and its Impact on Channel Bank
Source: Authors Field Work (2016).

Land Area Affected by Morphological Changes in the Study Area
The land area affected by morphological changes in the study area, have been viewed through a temporal window, from 1990-2015. The over two decades of data analyzed reveals that the channel of the study river have continuously expand in area, changing from 486.34ha in 1990 to 594.90ha in 2015. The total land area lost within 25 years period of study to morphological changes is 108.56ha. This implies that the annual loss of floodplain area is 4.34ha. The productive

capacity of the floodplain in terms of cereals farming were determine through interview with farmers in the study area. Majority of the rural farmers holds that each hectare of land produce an average of 6000kg of rice and 4250kg of maize in either rain fed or dry season farming. This is a significant threat to food security in Adamawa State and the Nation at large.

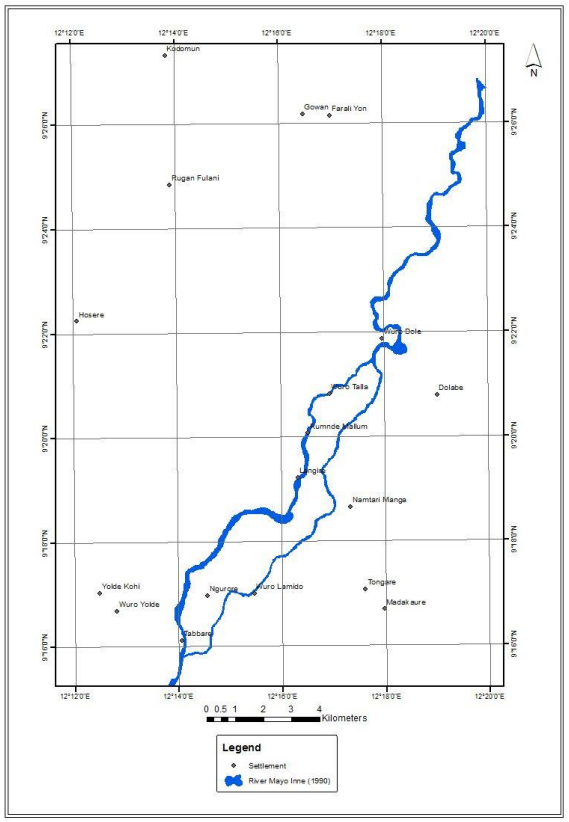

Figure 2: River Channel in 1990
Source: Analysed from 1990 Satellite Image obtained from U.S.G.S.

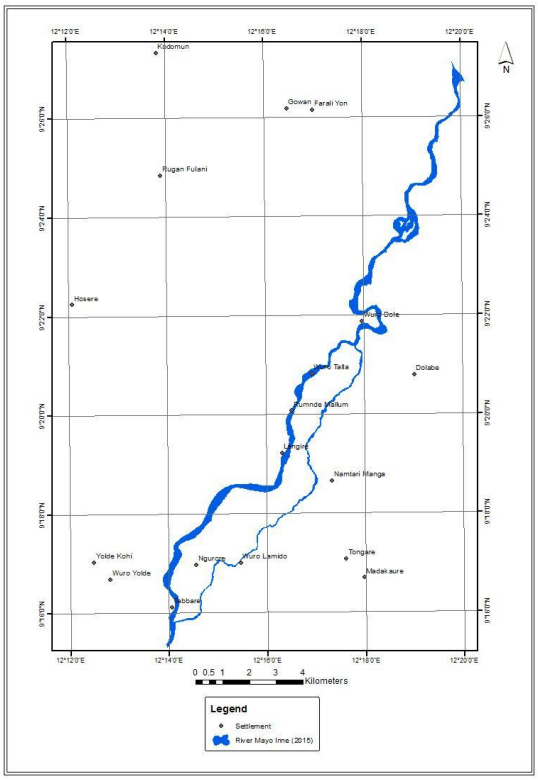

Figure: 3. River Channel in 2015.
Source: Analysed from 2015 Satellite Imagery obtained from U.S.G.S.

CONCLUSION

The study conclude that the morphological changes have more impact on the livelihood and wellbeing of the inhabitance of the area. River discharge is the major factor influencing morphological changes in the area and a total of 108.56ha of land was lost due to morphological changes within the study period with an annual loss of 4.34ha of land year-^{1}.

RECOMMENDATION

Re-establishment of riparian vegetation so as to increase bank stability, sediment trapping and provide habitat for riparian dependent species and in-stream species in the study area.
Healthy agricultural practice within the riparian zone should be encouraged so as to reduce the amount of sediment generated to the river channel from farming activities.
Activities such as in-channel sand miming and production of bricks using bank materials should be checkmated in order for the channel to achieve equilibrium position.

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