

Assessment of the Impact of Human Activities along the River Ngadda Channel, Maiduguri, Borno State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author JA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author JOO managed the literature searches, analyses of the study performed the spectroscopy analysis and author BBW managed the experimental process and author JA identified the geomorphic processes and the gradients. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JGEESI/2015/14161

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Complete Peer review History: <http://www.sciencedomain.org/review-history.php?iid=1105&id=42&aid=9726>

Original Research Article

Received 22nd September 2014

Accepted 13th April 2015

Published 12th June 2015

ABSTRACT

The paper examines the impact of human's activities along the River Ngadda channel, Maiduguri, Borno State, Nigeria. Primary and secondary data were used for the study. The primary data include field observation and measurement of various activities along the river's channel where their coordinates, slope angles and distances from the channel were taken using GPS and measuring tape. Secondary data were generated from topographic and soil maps. The data were analyzed through the use of ArcGIS 9.3 and Surfer 7.0. Descriptive statistics was also used. The

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result shows that the slopes along the River Ngadda channel range from 0° to 30° with distances of 8 m to 77 m. The findings also revealed that settlement, farming, quarrying, mining, excavation, grazing, dumping of refuse, construction, fishing and open defecation are among the various activities observed along the River Ngadda channel. Geomorphic processes such as splash, sheet, rill and gully erosions were observed. These geomorphic processes are occurring at an accelerated rate due to the human activities along the River which expose the soil to both wind and water erosion. Some significant environmental consequences of these activities are gullying, landslides, floods, water and land pollution. The paper recommends that there is need for enforcing existing laws prohibiting settlement in close proximity to the River channel and designation of specific areas for excavation, quarrying and mining as against the present random practice. Planting of trees along the River Channel should be encouraged to check unnatural rates of geomorphic processes. Awareness campaign on environmental hazards associated with settling along floods prompt areas should be carried out at the grassroots level.

Keywords: Impact; human's activities; river Ngadda; channel.

1. INTRODUCTION

From time immemorial the river channel or course has been a pulling factor in determining human settlement and the associated socio-economic activities. [Rivers have always attracted and exerted a strong pull for humans since the dawn of history (i.e. since human occupation of Planet Earth]. Often, people choose to settle in areas close to rivers without taking into cognizance the risks involved. As true of other rivers, the Ngadda has attracted humans and human interests to it such that there is burgeoning riparian socioeconomic activities along its channel. Notable among such activities in the riparian area of the Ngadda are rain fed and dry season farming, animal husbandry mining, excavation and quarrying of sands along the river channel. There are also human settlements in and around the river channel. In-channel activities include dumping of liquid and solid refuse into the river channel and fishing. Bush burning and indiscriminate felling of trees and other conspicuous activities around the river channel.

These activities in and around the Ngadda river channel have caused serious environmental problems such as accelerated splash, rill, sheet and gully erosions, diminishing soil fertility (due to loss of top soil) and pollution of land and water. Other issues affecting the present use of the Ngadda riparian environment or resources are mass wasting, silting of the river channel which reduces its capacity and causes inundation of adjacent areas, increasing both the frequency and magnitude of floods, and environmental degradation.

1.1 Statement of Research Problem

Human presence around the Ngadda channel dates back to about 7,000 to 2,000 years BC [1]. This long history of human link to the River Ngadda could be attributed to fact that it has continued to serve as a source of livelihoods for people in its part of the Lake Chad Basin.

Several research works [2-5] have been carried out on the Ngadda channel as well as the Bama Beach Ridge. These studies focused on various aspects of the Ngadda channel. For instance, Shehu [3] looked at the impact of quarrying activities within the river Ngadda valley was studied; Ibrahim [4] examined the landforms and land use pattern on the Konduga Marsh and Pond system. Boso [5] assessed the relationship between toposequence land use patterns within the Ngadda valley and Nyanganji (1994), examined the morphology and hydrography of the Ngadda catchment and the Bama Beach Ridge (BBR). Kagu [6] examined excavation on the Bama Beach Ridge (BBR).

However, these studies primarily focused on the land use practices associated with the nature of the topography without taking into cognizance the viability and effects of these activities on the landscape. Therefore, this research intends to fill this gap in knowledge by assessing the human activities and their effect of these along the Ngadda River channel.

1.2 Aim and Objectives of the Study

The aim of the study is to assess the impact of human activities along the Ngadda River channel, Maiduguri, Borno State, Nigeria. The specific objectives of the study are:

1. To examine the nature of slope gradient along the Ngadda river Channel.
2. Examine the human activities in relation to the gradients.
3. To identify the types of geomorphic processes in relation to the gradients and human activities.
4. To elicit people's perception and awareness of hazards in terms of the encroachment into the channel.
5. Examine the immediate and future environmental problems associated with these activities.

1.3 Research Questions

1. What is the nature of the slope gradients around the Ngadda River Channel?
2. What are the human activities in relation to the gradients?
3. What are the types of geomorphic processes operating in relation to these gradients?
4. What is the level of people's perception and awareness about environmental hazards associated with these activities?

2. METHODOLOGY

2.1 Field Instruments, Methods and Procedure for Data Collection

The river Ngadda flows through Maiduguri, which is also located between latitude 11° 40' N and 12° 05' N and longitude 13° 05' E and 13° 20' E (Fig. 1). It is located in the Sudano-Sahelian belt of Borno State and is part of the Chad Formation. The Ngadda which means either "flood" or "river" in Kanuri language is a well-known river located in the Chad Formation. Maiduguri and other settlements are strategically located along the river channel and derive some socio-economic benefits from the river. The length of the river Ngadda channel is 82.2 km. The river takes its source from Sambisa swamp sources by the flood spill of Gombole and river Yedzaram, Nyanganji, [2].

The relief of the area forms part of the Chad Formation. The vast and almost plain landscape stretches for several kilometers. The extensive plain contains no prominent hills except some sand dunes and the Bama Beach Ridge which has been modified by the combined effect of human and denudational processes. The relative relief lies between 350 m asl and 282 m above sea level (asl) on the Lake Chad is about 68 m asl in the northern part of the BBR with a height

little above 336 m above mean sea level at the highest part, descending from the BBR towards Jere Bowl is a plain where loamy and clayey soils of the Chad Formation alternate with low lying sand dunes ridge [7]. Due to the nature of the relief, the drainage system is generally very poor, hence inundation occurs frequently during rainy season, forming extensive temporal bodies of stagnant water on the plain and in the depressions. The nature of the relief, landforms, rainfall, soil and human activities are factors compounding the drainage problems, especially flooding in the Ngadda channel.

The climate is characterized by two distinctive kind of wet and dry seasons, which tend to be controlled by the inter-tropical discontinuity (ITD). The rainy season lasts for about five months (May-October). Available rainfall data reveal that annual rainfall average ranges between 500 mm and 750 mm while the intensity of rainfall ranges from 0.002 mm/hr – 112 mm/hr. The mean temperature both seasonally and diurnally varies from 25°C – 36°C, the hottest months being March and April with values between 39.80°C and 40.70°C. The corresponding minimum temperatures of 20.60°C and 32°C are in December and January.

The area is located within the Sudan Savannah grassland which is characterized by a wide range of vegetation species that have been modified by anthropogenic and other factors. The western bank of the Ngadda River is characterized by denser vegetation cover compared to the eastern bank which could be attributed to types of soil and slope gradient of the two banks.

2.2 Field Instrumentation

Abney level, ranging poles and measuring tape were used in measuring the slope gradient in the area. Digital Camera were used in taking photographs of features of interest while the GPS was used in taking the coordinates of objects of interest.

2.2.1 Sources of data

Both primary and secondary sources of data were used for this study. The primary source includes the use of field observation and measurement of features of interest such as settlements, quarrying, mining and excavation sites, farmlands, grazing land, refuse dump site, and geomorphic processes along the river channel. Interviews were also conducted to elicit people's perception and awareness of the environmental hazards associated with these

activities. The secondary sources include topographical and soil maps.

2.2.2 Procedure for data collection

Data on slope gradient in some selected plots of farm lands were obtained through the use of the Abney level and Ranging Poles. Various human activities were identified along the Ngadda channel and their GPS coordinates were

recorded. Types of geomorphic processes were observed and recorded along various gradients. Fifty respondents were randomly selected and interviewed, 25 from each side of the channel to generate data on people’s perception and awareness on the environmental dangers associated with their activities along Ngadda river.

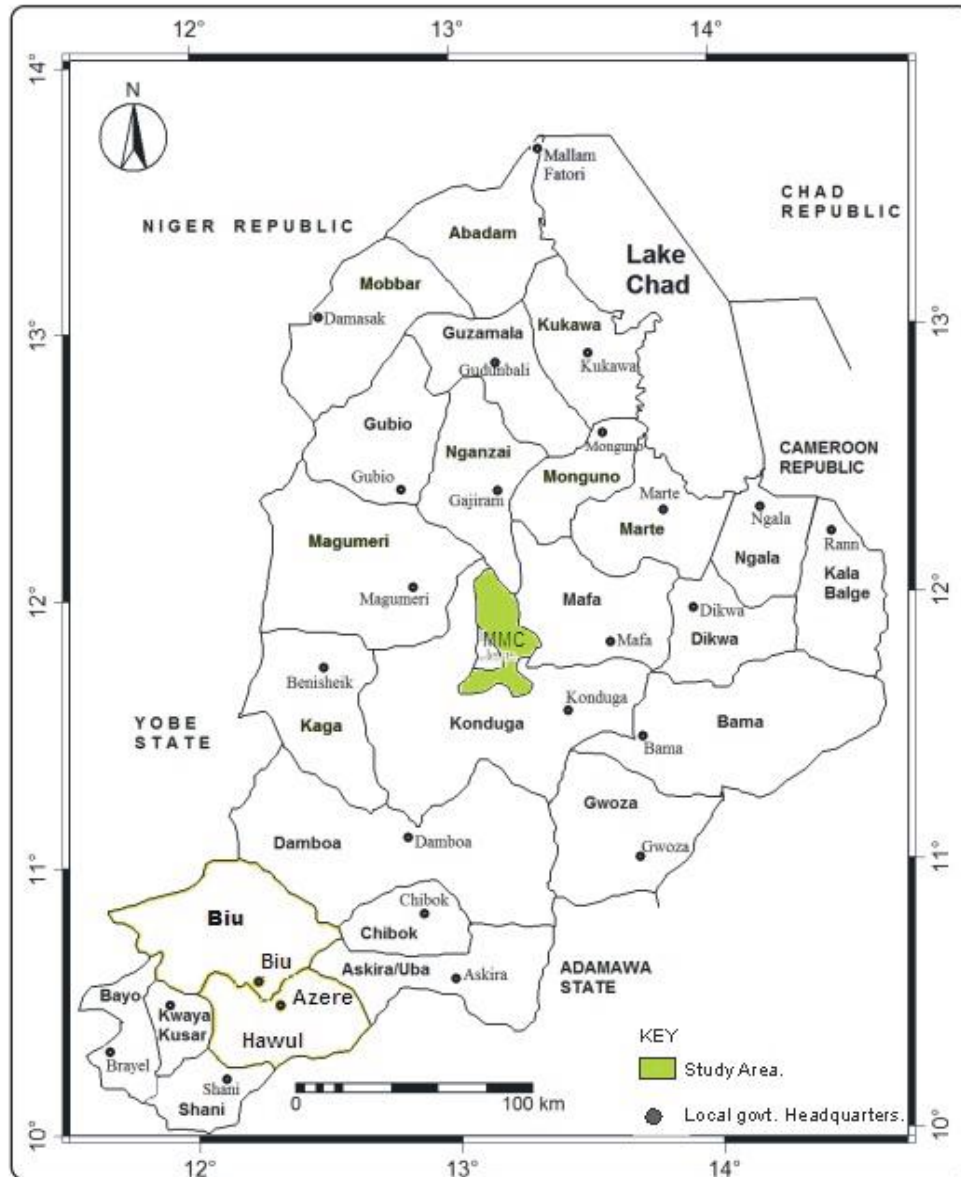


Fig. 1. Borno state showing the study area
 Source: GEONETCAST Spatial Database CAZS Unimaid 2014

2.2.3 Data analysis

The data generated were analyzed through the use of ILWIS GIS software and Surfer 7.0. The topographic map of the area was scanned from Corel Draw environment and exported as tagged image file. The geo-referencing processes were performed using the ILWIS environment so that the pixel of the maps conform to the precise coordinates of the points they represent on the ground. Descriptive statistics such as percentages was used for analyzing the data on people's perception and awareness on environmental hazards.

3. RESULTS AND DISCUSSION

3.1 Landforms along the Channel of the River Ngadda

Fieldwork results revealed that River Ngadda is generally characterized by a relatively flat terrain as shown on Fig. 2. On the eastern bank it is 324 m asl by the edge of the bank and increases to about 336 m asl away from the bank. Results of some slope measurements carried out in 20 locations are as shown in Table 1. It can be seen from Table 2 that five of the plots have very steep slopes which made the areas liable to splash, sheet, rill and gully erosions.

On the western bank the relief height is 321 m asl at the edge of the bank and increases to about 336 m asl away from the bank as shown on Fig. 2. This finding disagree with similar work carried out by [9] on the assessment of gully erosion in Gombe Town.

The nature of the Landforms as revealed by the Vector map in Fig. 3 shows how the relief determines the direction of flow of water in the River Ngadda Channel. This result disagree with similar work done by [10] on Terrain analysis of Biu plateau, for road transport development, Borno State.

Results of some slope measurements carried out in 20 locations are as shown in Table 2. It can be seen from Table 2 that five of the plots have very steep slopes which made the areas liable to splash, sheet, rill and gully erosions. This finding differs from similar study carried out by [8] remote sensing and GIS as decision support tools for residential site suitability determination.

3.2 Human Activities along the River Ngadda Channel

It was observed during the fieldwork that various socio-economic activities take place along the River channel. These activities include settlement, farming, mining, quarrying, excavation, dumping of refuse, overgrazing and deforestation.

3.3 Settlements

Field observation revealed that settlements are one of the socio-economic activities carried out along the Ngadda channel. The settlements are linear in pattern as they reflect the morphology of the channel as shown in Plate 1. The nature of the topography provides easy accessibility for both man and animals in and out of the settlement. It was observed that the foot paths, roads, animal tracks originating from the settlements provide the points from which gullies develop. The continuous trampling of the soil by both man and animals initiate rill erosion that subsequently developed into gullying.

3.4 Farming

Farming activities were observed on the flow and along the channel on the following plots of lands 1, 4, 8, 15 and 18 which are located 23 m, 26, 11 m, 21 and 31 m from the bank of the channel respectively as shown in Table 2. These locations could be described as steep slopes which change the geological erosions in these locations into accelerated erosion. These finding agrees with similar work by Nyanganji [2]. During group interview with the 50 selected respondents it was revealed that their reasons for these activities along the river channel include proximity to channel (20%), soil fertility (40%), land scarcity (10%) and lack of other alternative (30%) as shown in Table 3.

The respondents pointed out that soil in the Ngadda floodplain and riparian environment is very fertile and crop can do well and yields can be substantially high (see Plate 2) where soil creep and landslides do not destroy their farmlands.

3.5 Quarrying, Mining and Excavation

Quarrying, mining and excavation of sharp sand, fine sand and gravels in and around the river channel were observed.

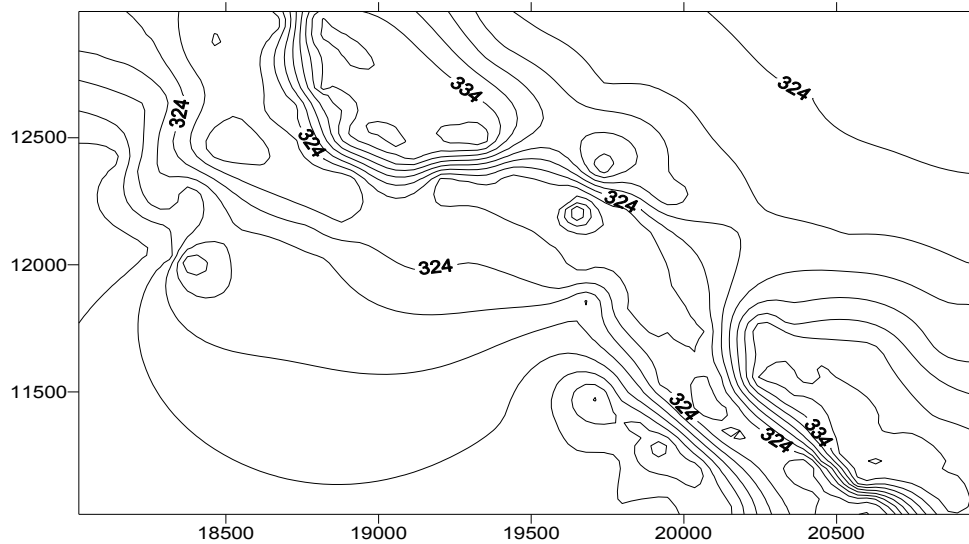


Fig. 2. Landforms of the study area
 Source: Fieldwork; April 2014; Scale: 1:2500

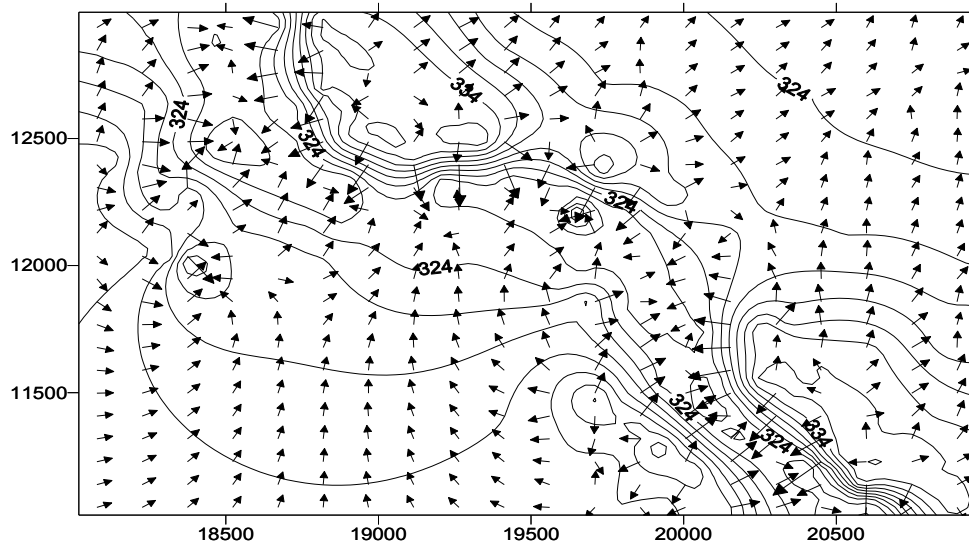


Fig. 3. Vector map showing the terrain and direction of flow of water
 Source: Fieldwork; April 2014; Scale: 1:2500

The study revealed that these activities cause accelerated gully erosion that eventually leads to soil creep and landslide and silting or sedimentation of the river channel. Some measurements of the width of the channel carried out at fifteen different locations are shown in Table 4. The measurements revealed that the channel of the river Ngadda is under serious threats of contraction at some points with width of 65 m at Point 15 and expansion with width of 140 m at Point 1. This could be attributed to the activities in the channel environment as shown in

Plate 3. This finding agrees with that of a similar study by Kagu [6] that human activities in and along the River Ngadda channel had affected both the depth and width of the river.

3.6 Refuse Dumping

It was observed in the area during fieldwork that indiscriminate dumping of refuse in and around the channel of the River Ngadda poses a great threat to the free flow of water as shown in Plate 4.



Plate 1. Settlements along river Ngadda channel

Source: Fieldwork; May 2014



Plate 2. Shows irrigation farming for subsistence consumption

Source: Fieldwork, July 2014; N11° 48' 203"; E13° 10'39.7"; Elevation 1072 ft



Plate 3. Showing quarrying activities around the river channel

Source: Fieldwork; Mach 2014; N11° 47' 43.8", E13° 11' 15.0"; Elevation 317 ft

Table 1. Slope gradient, of twenty locations with their distances

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Slope 0°	4°	3°	1°	28°	4°	1°	2°	30°	5°	3°	0°	7°	2°	0°	23°	4°	3°	24°	15°	4°
Location	23 m	13 m	8 m	26 m	11 m	31 m	8 m	11 m	25 m	77 m	22 m	30 m	13 m	19 m	21 m	30 m	11 m	31 m	23 m	25 m

Source: Fieldwork; April 2014

Table 2. Slope gradient, of twenty locations with their distances

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Slope 0°	4°	3°	1°	28°	4°	1°	2°	30°	5°	3°	0°	7°	2°	0°	23°	4°	3°	24°	15°	4°
Location	23 m	13 m	8 m	26 m	11 m	31 m	8 m	11 m	25 m	77 m	22 m	30 m	13 m	19 m	21 m	30 m	11 m	31 m	23 m	25 m

Source: Fieldwork; May 2014

Table 3. Reasons for human activities along river Ngadda channel

Reasons	No. of respondents	Percentage
Proximity	10	20
Land scarcity	05	10
Soil fertility	20	40
Lack of other alternatives	15	30

Source: Fieldwork; May 2014

Table 4. Measurement of width of the Ngadda channel at some locations

Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Width (m)	140	120	124	83	163	140	130	100	98	97	95	100	89	76	65

Source: Fieldwork; April 2014

The residents in the area revealed during interview that they are aware of the implications of their actions but were left without an alternative. According to them they do not have any other place meant for refuse disposal. However, it was observed that this was only an excuse as there are designated places to dump refuse, which the respondents do not want to use because of distance. They revealed that the river has the ability to transport these refuse downstream during the raining season as such it will not result to floods "as refuse has no power of blocking the water from flowing." However, they further revealed that they are not aware of the implication of the water pollution aspect and that river has a natural way of purifying itself.

3.7 Grazing

Grazing on the floor of the River Ngadda channel was also observed during the fieldwork as shown in Plate 5. According to the people the floor of the river provides the best pasture for their animals especially during the dry season when pasture is scarce. The continuous grazing and trampling of the floor of the river by the cattle expose the soil.

3.8 Deforestation

Indiscriminate felling of trees occurs along the channel of River Ngadda as shown in Plate 6.



Plate 4. Refuse dumping site in the river bank

Source: Fieldwork; Mach 2014; N11° 38' 16.0"; E13° 10' 53.4"; Elevation 323 ft



Plate 5. Cattle grazing on the floor of river Ngadda

Source: Fieldwork; June 2014



Plate 6. Deforestation on the bank of river Ngadda
Source: Fieldwork; March 2014



Plate 7. Embankment at water treatment plant
Source: Fieldwork; March 2014

This and other activities in the riverine environment have significantly enhanced geomorphic processes such as splash, sheet, rill and gully which are operating in the area and are capable of posing a serious threat to the river and its environs if not already so.

3.9 People's Perception and Awareness on Environmental Hazards

The finding revealed that 60% of the respondents are expecting flood once it is rainy session, 30% are contemplating its occurrence while 10% believe that the government has done more than enough to prevent flood from occurring as shown by the embankment at the back of the Maiduguri Mother Cat water treatment plant as shown in Plate 7.

4. SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study revealed that River Ngadda is generally characterized with relatively low flat

terrain. On the eastern bank it is 324 m asl at the edge of the bank and increases to about 336 m asl away from the bank. The western bank has a height of 321 m asl at the edge of the bank and increases to about 336 m asl away from the bank. Human activities along the channel include settlement, farming, fishing, quarrying, mining, excavation, grazing and deforestation. Result of some slope measurement carried out in twenty locations as shown in Table 2, revealed that five of the plots have very steep slopes which made the areas liable to splash, sheet, rill and gully erosions. The study found out that some people are aware of the hazards associated with human activities along river channel but choose to engage in them because they have no other alternative while others are not aware of the implications of their actions.

4.1 Recommendations

This study has the following recommendations. The existing law against settling in close proximity to river channel should be fully

implemented by the Borno State Government. Specific areas should be demarcated by the Borno State Ministry of Land and Survey for quarrying, mining and extraction of sand and gravel as against the present indiscriminate practice. Planting of fast growing trees along the banks of the river to stabilize the soil and check erosion. Enlightenment campaign on the hazards associated with settlement along the river should be carried out.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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