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Impact of anthropogenic activities on channel characteristics: A case study of Muhuri River, Tripura, North-East India

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ABSTRACT

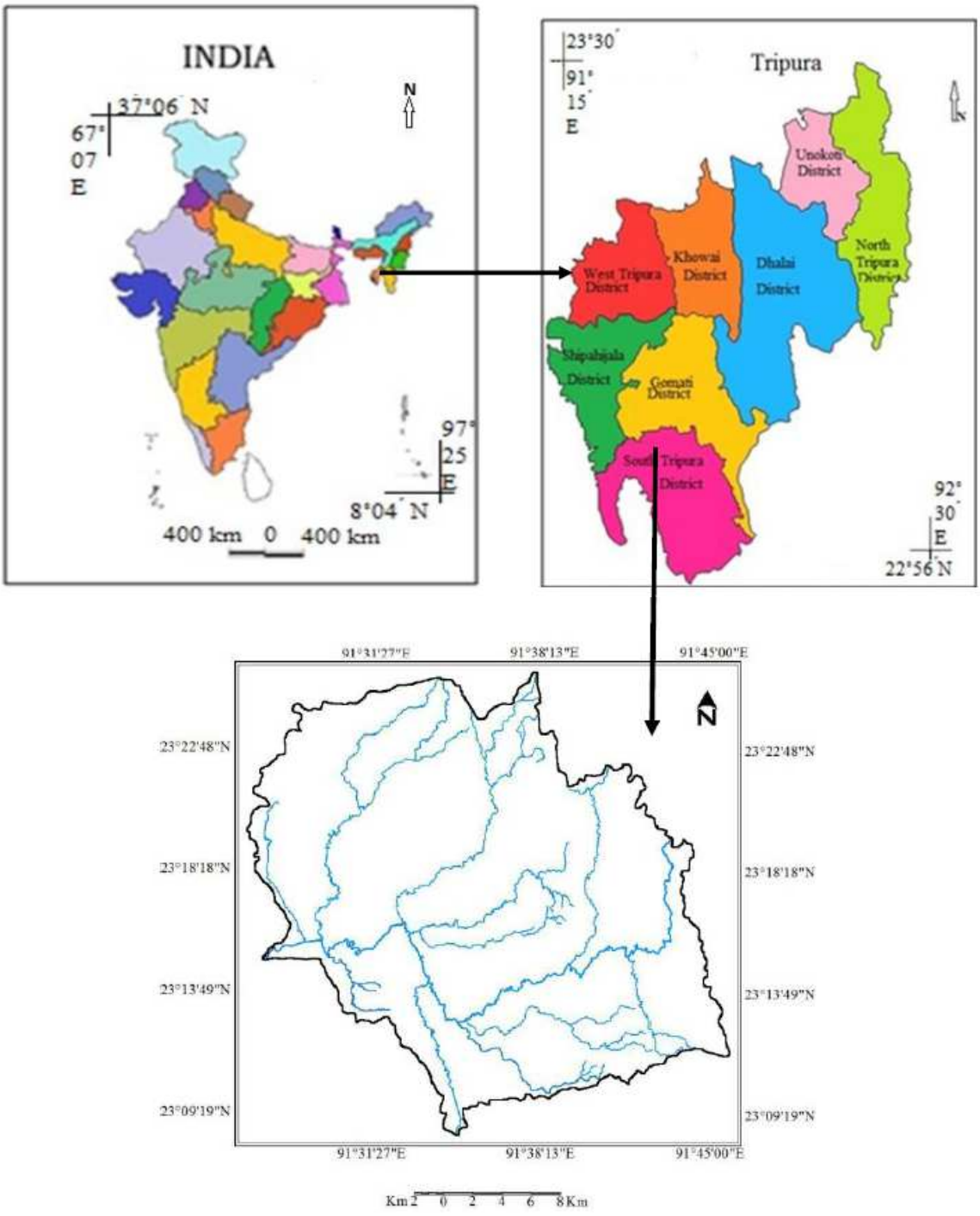
Natural Rivers are sensitive to human interference which causes change in channel characteristics. The impact of human activities on rivers is large-scale process that leads to diverse negative consequences. Muhuri River is one of the most important rivers of Tripura flowing through the southern part of the state. The river is affected by several human interventions which deteriorate its characteristics. Thus the present study aims to analyze the effect of anthropogenic activities such as construction of barrages and bridges, lifting of water for drinking purpose and sand mining from the channel bed. For this purpose several cross sections have been taken just immediate upstream and downstream of the affected spots to detect the changes in channel characteristics of the Muhuri River. The result indicates that the natural characteristics of the Muhuri River are modified by several human activities in the name of development.

Keywords: Muhuri River, anthropogenic activities, sand mining, channel characteristics.

INTRODUCTION

The man-environment interaction explains how people adapt to the prevailing environment and also the modifications in the environment to suit their demands. It is being realized that the morphological study of river needs to be properly documented and analyzed. The unique characteristics of each river should be understood so that the responses of the river due to any encroachment in the flood plain and more in the case of future man-made structures may be anticipated and preventive measures as considered necessary may be planned before hand [7]. People change the river environment by making artificial levees, bridges and barrages. Although, these activities are important for the development but they have adverse effect on natural characteristic of river [6]. The constructional work, in associated with continued soil materials extraction from the river bed, which cause adverse changed in the geomorphologic characteristics and water resource of the river. Since the early civilization, human activities intervened in the natural flow and characteristics of river, to manage the water resources and to protect against flooding or to make passage along or across river easier. From the late 20^{th} Century, rivers play vital role in this modern civilization and due to construction of dam and barrages, there has been raised some environmental concern [8]. In addition to variations of climate, alluvial rivers counteractively respond to human activities such as construction of dams, levees and bridges, diversion of bed material and/ or flow, sediment withdrawal, water withdrawal for urban, industrial and agricultural needs, and change of land use [1]. Strong human activities have changed perennial rivers of North China into seasonal rivers and these rivers can be regarded as new category river name, anthropogenic seasonal river [9]. Extensive sand mining which are uncontrolled, have changed river hydrological and natural characteristics adversely. Human activities are creating the interferences between nature

and human beings. The anthropogenic activities have direct consequences, where human activity affects river channel characteristics through engineering works including channelization, dam construction, diversion and culverting been long recognized.



THE MUHURI BASIN

Fig.1: Location of the study area

Study area: Muhuri River is one of the most important rivers of Tripura located in the southern part of the tate. It originates from the Deotamura hill range, crosses the undulating plains of South District of Tripura and then enters into Bangladesh. It is located within an extension of 23°4´24´´N to 23°26´15´´N Latitude and 91°20´44´´E to 91°42´44´´E longitude. The length of the river within Indian Territory is 59 km with a basin area of 652 km^2. In order to identify the impact of anthropogenic activities on the Muhuri River a stretch of 37 km in downstream section of the river has been selected where density of population is high. Several cross sections have been taken both in the upstream and downstream of the points of human intervention.

Objective: Main objective of the present study is to analyze the changes in channel characteristics of the Muhuri River due to anthropogenic activities.

MATERIALS AND METHODS

For the purpose of identification of the effects of anthropogenic activities on the Muhuri River the basic information about the study area have been collected through questionnaire survey and extensive field work, in part of the Muhuri River from Kalashi Barrage up to Belonia Town, has been carried out. Cross sections have been taken immediate upstream and downstream of the points of interference to identify the changes in channel characteristics. For taking cross sections survey instruments like Dumpy Level, Clinometer etc have been used. GPS was used for recording coordinates of the spots and tracking. Maps regarding channel characteristics have been prepared from the Google Earth imagery (2014) using Global Mapper Software.

RESULTS AND DISCUSSION

Various anthropogenic activities, mainly building of bridges and barrages, sand mining, obstruction of natural flow, lifting of water from the river etc are the main causes of modification of channel characteristics which includes channel depth, discharge, wetted perimeter, river environment etc.

Effect of Barrage

Barrages are constructed across the river to provide irrigational facilities in the agricultural fields, especially in the dry seasons. Besides, it also plays vital role to control flood during high discharge. But barrage also has negative impact on character of the river. This impact is quiet significant in upstream and downstream segment of the barrage located in the Muhuri River.

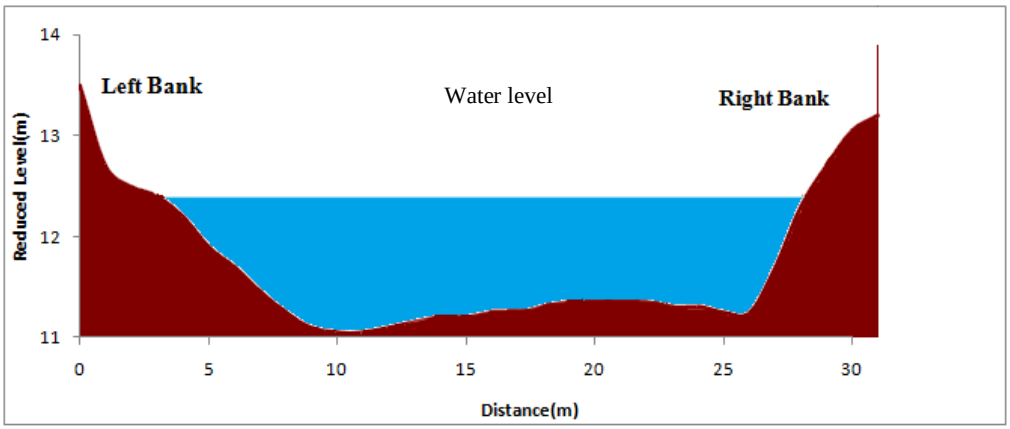


Fig.2: Cross section across the Muhuri River upstream of the barrage located at Kalashi

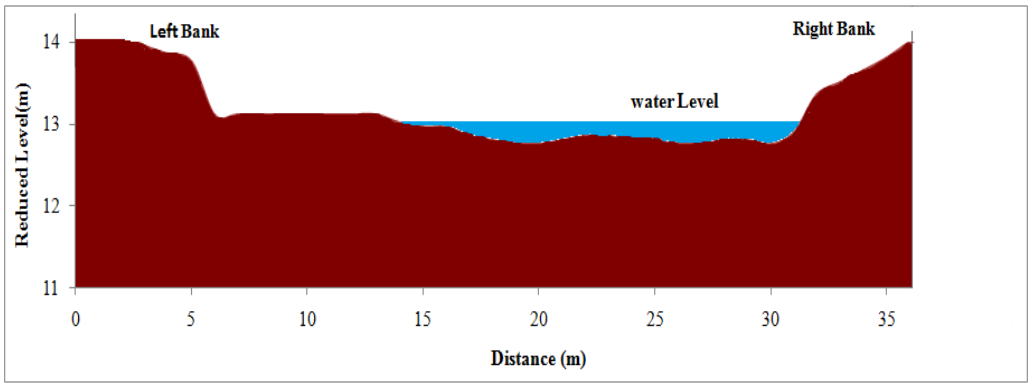


Fig.3: Cross section across the Muhuri River downstream of the barrage located at Kalashi

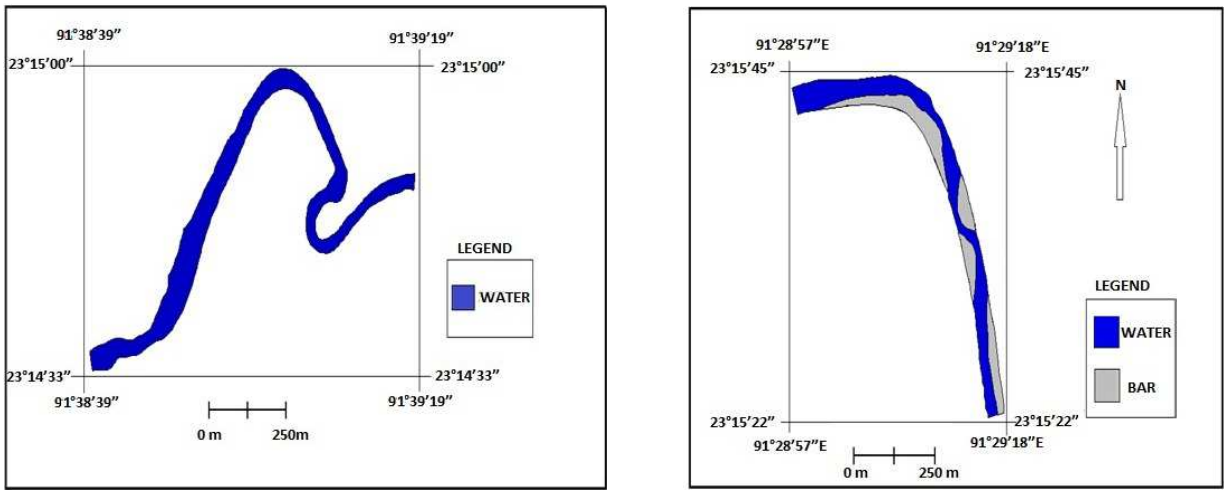


Fig.4: Natural condition of the river in upstream of the barrage at Kalashi

Table1: Upstream and Downstream Variation of Variables at Kalashi

Variables	Upstream of the Barrage	Downstream of the Barrage	Percent change
Average depth (m)	1.47	0.17	-88.44
Water discharge (m^3/s)	2.88	0.49	-82.99
Wetted perimeter (m)	29.47	16.34	-44.55

Source: Measured and calculated by the researcher.

Huge volume of water has been trapped behind the barrage to provide water for irrigation. The study shows that the variables like average depth, discharge and wetted perimeter of the Muhuri River are higher in upstream of the barrage (Fig.2) whereas markedly decreased in the downstream portion (Fig.3) by 88.44%, 82.99% and 44.55% respectively (Table1). The bridge and barrage play a significantly important role in the river environment and river morphological features [6]. Due to decrease in discharge (82.99%), the competency and capacity of the Muhuri River to transport load has also decreased remarkably in downstream of the barrage. These results in the formation of various stable and unstable bars, creates downstream water scarcity, char lands etc (Fig.5).

Effect of sand extraction from the Muhuri River:

Alluvial rivers have historically been an attractive source of sediment for a variety of industrial uses. Commercial sediment extraction from alluvial rivers is a global phenomenon, particularly intense in countries subject to rapid urban and industrial growth over recent decades and lacking alternative sediment sources [2 and 3]

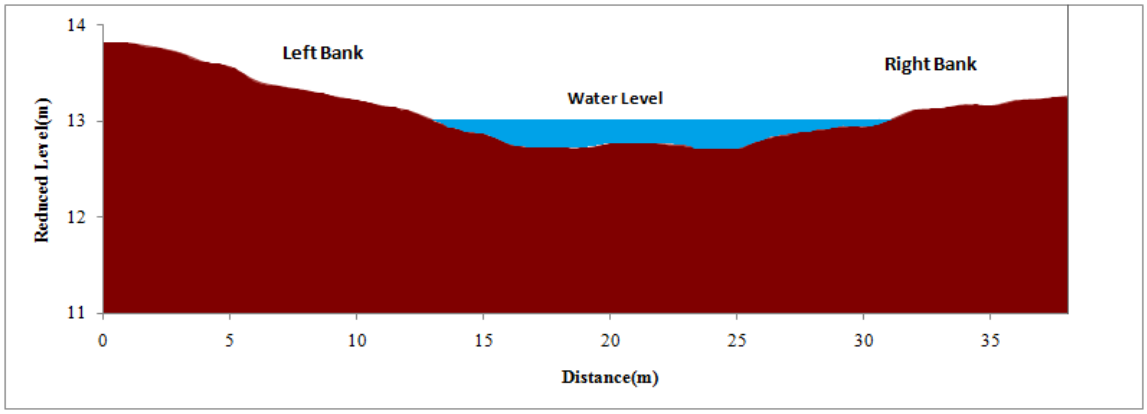


Fig.6: Cross section across the Muhuri River immediate upstream of the sand collection site near Jolaibari

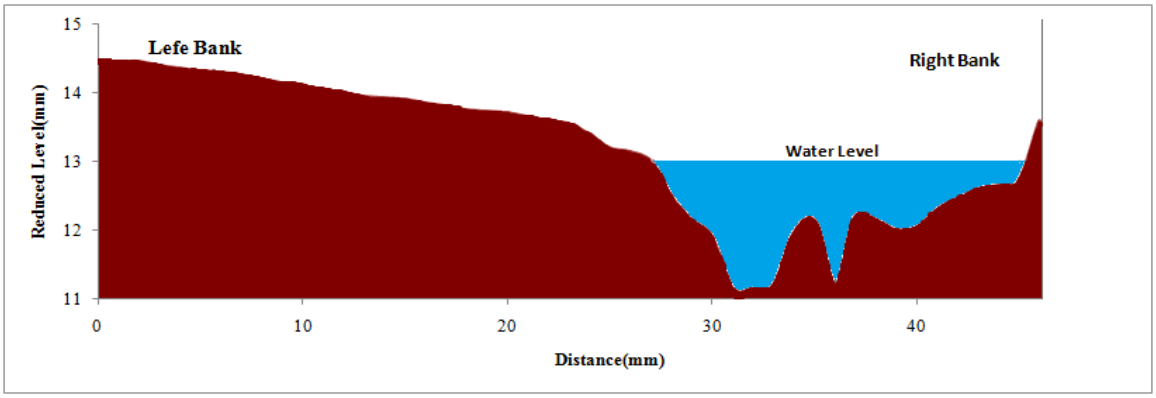


Fig.7: Cross section across the Muhuri River at the sand collection points near Jolaibari

Extraction of sand from the Muhuri River bed near Jolaibari is going on for a long period of time to use for constructional purposes. It has negative impact on channel characteristics which can easily be analyzed by comparing the channel at the sand collection site and immediate upstream of that site. Depth of the river is very high at that part of the bed from which sand has been extracted (Fig.7). As a result the rate of scouring at that part becomes very high due to the formation of eddies, especially during high discharge. This creates instability in the bed and bank. Extraction of bed material from an active riverbed may trigger changes in many factors governing fluvial processes, disturb the sediment balance and alter the erosion and sedimentation patterns [4].

Table 2: Upstream and Downstream Variation of Variables at Jolaibari

Variables	Upstream of the sand extraction site	At the sand extraction site	Percent change
Average depth (m)	0.2	0.92	+360
Water discharge (m^3/s)	0.87	0.82	-5.75
Wetted perimeter (m)	19.4	19.82	+2.16

Source: Measured and calculated by the researcher.

Table 2 indicates the increasing instability of the river bed and bank in the sand collection site at Jolaibari where 360% increase in channel depth near the left bank has been identified. Mining and its associated activities can also be responsible for considerable damage of river morphology. Physical impacts of sand mining include deterioration of water quality and destabilization of the stream bed and banks. Mining can also disrupt sediment supply and channel form, which can result in a deepening of the channel (incision) as well as sedimentation of habitats downstream [5]. Now a day an unscientific way of sand collection is practiced using pipe and motor from side of the river bed, which pose threat to river bank stability.

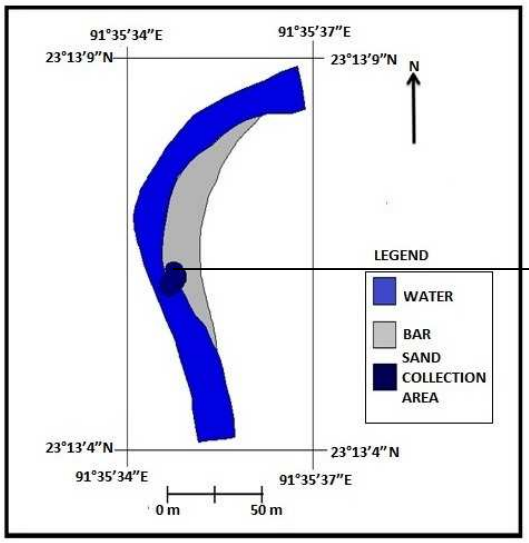


Fig. 8: Sand collection Point near Jolaibari

Plate 1: Changed thalweg line of the Muhuri River at sand collection point near Jolaibari

Obstruction of natural flow:

River water is one of the major sources of drinking water. With decrease in rainfall and fall in ground water level, the dependency on river for drinking water is increasing. Several treatment plants are operating along the bank of the Muhuri River to purify the river water for drinking purpose. For this purpose the natural flow of the river has been obstructed by placing heaps of cement bags to store water near the treatment plants (Plate 2) which affect the downstream characteristics of the river.

Plate 2: Obstruction in natural flow of the Muhuri River to store water for the purpose of drinking water supply near Muhuripur

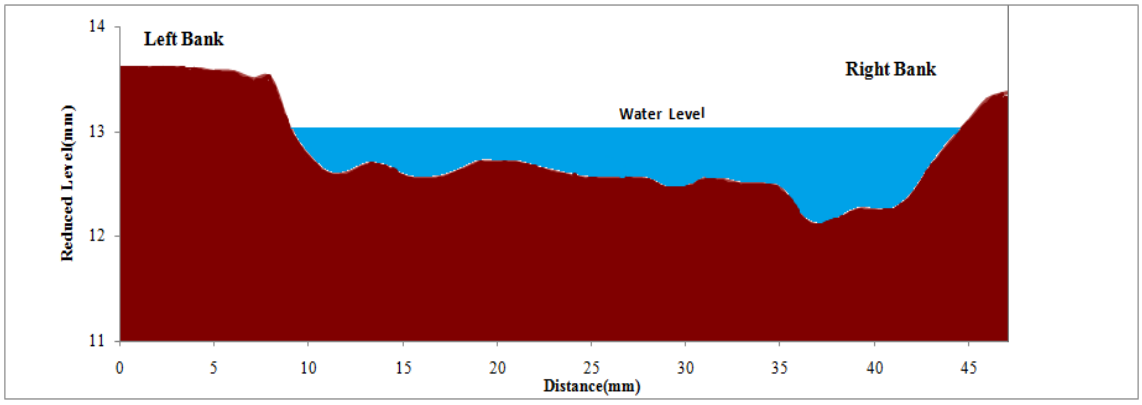


Fig.9: Cross section across the Muhuri River in upstream of the obstruction site near Muhuripur

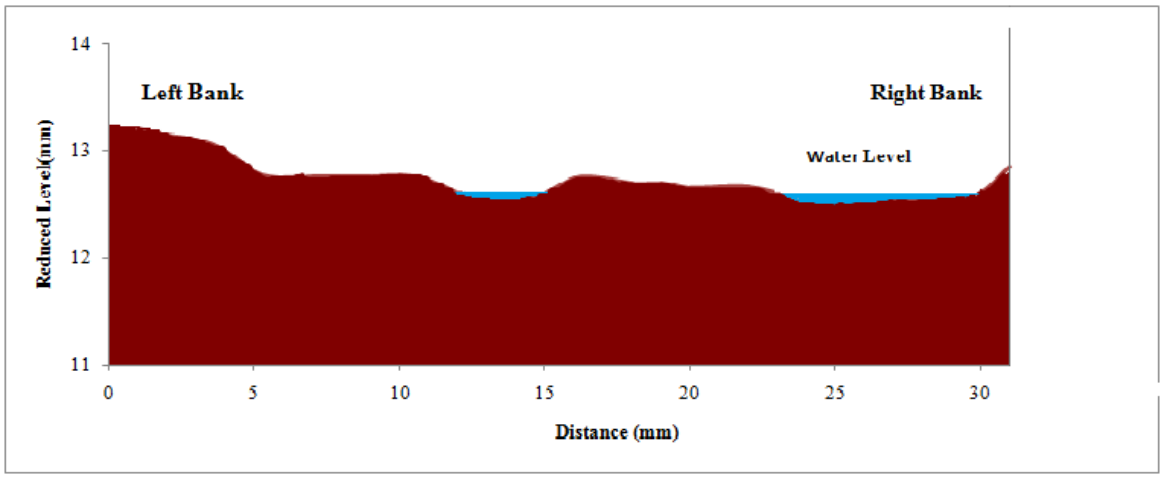


Fig.10: Cross section across the Muhuri River in downstream of the obstruction site near Muhuripur.

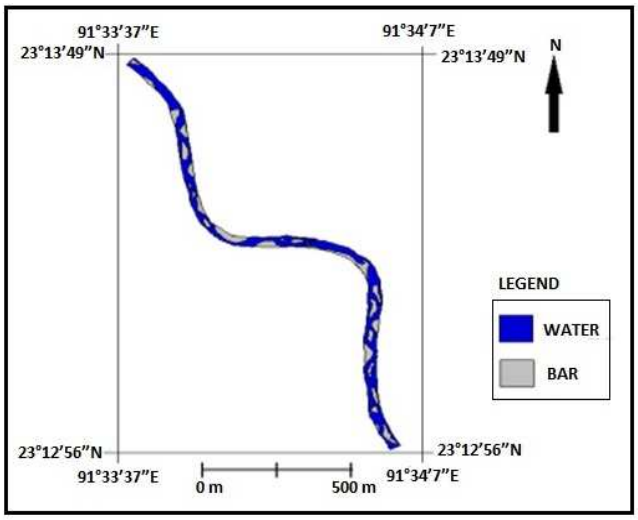


Fig.11: Formation of large number of bars in downstream of the obstruction of natural flow area near Muhuripur

It has been observed near various treatment plants located at different parts of the River Muhuri. In this paper changing characteristics of the Muhuri River near Muhuripur treatment plant has been analyzed. For that purpose two cross sections have been taken across the Muhuri River in immediate upstream and downstream of the Muhuripur treatment plant (Fig. 9 and 10). This shows marked change in characteristics of the river

Table 3: Upstream and Downstream Variation of Variables at Muhuripur

Variables	Upstream of the obstruction site	Downstream of the obstruction site	Percent change
Average depth (m)	0.48	0.35	-27.08
Water discharge (m^3/s)	4.08	3.00	-26.47
Wetted perimeter (m)	34.96	26.07	-25.43

Source: Measured and calculated by the researcher during field survey.

Before the obstruction of natural flow the river water is relatively stagnant. Due to decrease in discharge (26.47%) the ability of the river to carry load has also decreased. As a result lots of point and mid channel bar have been formed in downstream of the obstruction site (Fig.11). This clearly indicates the changing character of the river due to human intervention.

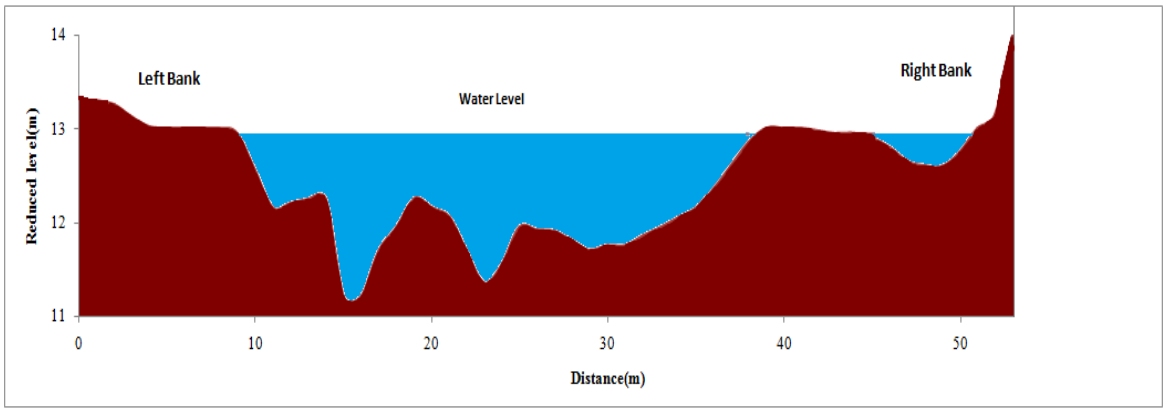


Fig.12: Cross section across the Muhuri River in immediate upstream of the site of constructional work for rail bridge near Belonia

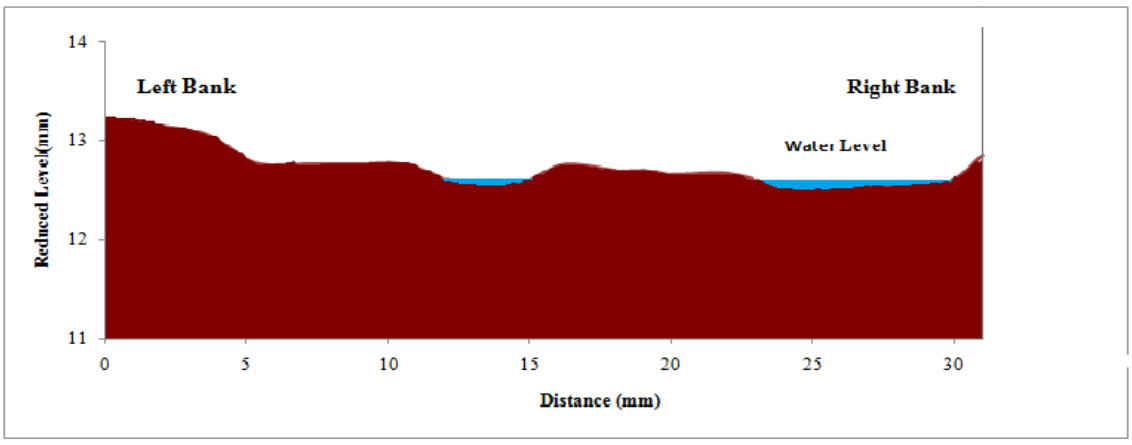


Fig.13: Cross section across the Muhuri River in immediate downstream of the site of constructional work for rail bridge near Belonia

Effect of constructional works within the river and river bank

Human impact on the river morphology is displayed by the building of bridges. Although bridges are built up on the river for connecting two different places, increasing transport facilities and overall socioeconomic development of those local areas, but it has some negative impact which totally disturb river's natural character while the bridges are

under construction. In this paper the negative impact of rail bridge construction on Muhuri River near Belonia has been analyzed.

The bridge and barrage play significantly important role in the river environment and river morphological features. River water flow, sediment distribution and wave regulation largely rely on bridge on the river [6]. The Central Government has taken over various constructional works for establishing railway lines in Tripura. One of the most important constructional works is going on across Muhuri River at Manurmukh, Belonia since last two years. This is one of the biggest constructional works on the Muhuri River. In this site a kachha road has been constructed from left bank to right bank, which disturbs the normal flow of the river (Plate 3). As a result the width of the river at the construction site has reduced to only 9m, whereas earlier it was 36 m, i.e. 75% decrease in channel width.

Table 4: Upstream and Downstream Variation of Variables at Manurmukh, Belonia

Variables	Upstream of the construction site	Downstream of the construction site	Percent change
Average depth (m)	0.77	0.2	-74.03
Water discharge (m^3/s)	2.8	1.54	-45.00
Wetted perimeter (m)	47.14	27.62	-41.41

Source: Measured and calculated by the researcher during field survey.

Plate 4: Sediments are deposited in the downstream section of the constructional site due to the construction of artificial road across the river

Plate 3: Construction site of Rail Bridge where the channel is blocked by an artificial road near Belonia

Due to this narrow passage, huge volume of water remains stagnant immediate upstream of the construction site which results in increase of depth, discharge and wetted perimeter. As a result in the upstream of the site various pot holes have been formed due to scouring of running water in the left bank side. Again, lots of point and mid channel bar have been formed immediate downstream of the construction site by the effect of sedimentation due to decrease in discharge (45%) and channel depth (74.03%).

During field visit it has been observed that the nature of the river at Manurmukh area (in Belonia) is badly affected by the constructional work of Rail Bridge. Here, soil materials are extracted from river bed through boring holes and are dumped across the pillar to construct bridge. Moreover, the waste and cement materials used for construction purpose are dumped across the channel. Consequently, depth of the river is gradually decreasing in the study area.

CONCLUSION

The present study shows significant negative impact of human intervention on channel characteristics of the Muhuri River in downstream segment of each and every intervened site. Such anthropogenic activities lead to the problem in water supply, sedimentation in the river bed, river bank failure, decreased water holding capacity, increased chances of flood, bank line shift etc. It is true that developmental work across the river cannot be totally stopped but it should be meant for sustainable development.

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