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Geoinformatics in Change Detection & It's Impact of Ganges River: A Case Study on Raghunathganj I & II and Lalgola Block in Murshidabad District, West Bengal, India

KARTIC BERA[1] AND DR. JATISANKAR BANDYOPADHYAY[2]
[1]Research Scholar, [2]Assistant Professor
Department of Remote Sensing & GIS, Vidyasagar University

ABSTRACT

The river Ganges is primarily responsible for land sculpture in its basin area. The Ganges is characterized by high altitude and tectonic prone drainage areas with heavy sediment load and irregular high rate of downstream deposition. The present case study reflects the geomorphological changes which affects the socio-economic status and adaptation at the heart of Bengal (both West and East), due to erosion & deposition (Adel, MM-2001). The study area is Raghunathganj Block I &II and Lalgola Block in Murshidabad district. The extent of study area is between 24°50′ N-24°35′ N &88°04′E-88°21′E. The Ganges originates at the Gangotri glaciers at an elevation of 7010 m and crisscrosses the Greater and Lesser Himalayas over a distance of 250 km, descending into the plains at Rishikesh. The Ganges River and its tributaries drain more than one million Sq Km of Nepal, Bangladesh and India. In India total area of the Ganges is 862769 Sq Km. The river bifurcates at Malda-Murshidabad district border into Padma passing through Bangladesh and Bhagirathi through West Bengal. It is crisscrossed by the Eastern Railways and some national Highways. In the study area, the river flows through the alluvium tract and has very low gradient, forcing the flow slowly in a meandering and sinuous path. Nature and intensity of the alluvial channel with variation of discharge and sediment load influenced by different season change its course. The study area of Raghunathganj Block I&II and Lalgola Block is formed within this Ganges-Bhagirathi-Padma region. Erosion and bank line shifting are more pronounced in Raghunathganj-II and less in Raghunathganj-I & Lalgola Block. The Geomorphology of the alluvial channel is dominated by natural levee, confluences of river, abundance of back swamps, abandoned courses of stream and many other morphological and ecological features. The constructions of embankments and dams have modified the natural

river course and channel banks as well as the centre of flood plains. Such study has been carried out along the Ganges-Bhagirathi-Padma region through R.S &G.I.S studies with ground truth verifications. According to the study of a 1971 Toposheet the study area was 7.19232 Sq Km and length of the Bhagirathi river was 11.28066 Km; along with this, tunnels, ponds and other water bodies area include 25.09066 Sq Km which belong to the same drainage system. In Raghunathganj-I Block the flooded water of the Bhagirathi has formed separate body of stagnant water. But nowadays the river valley is advancing to the west. Its traces are found in geomorphological features (Ox-bow Lakes, Meanders belt) in Raghunathganj-II and Lalgola Blocks. The river has changed its course step by step for last 30 years (1971-2002) comparatively. Its meandering course has increased gradually. For this reason there grows deposition which helped to increase river widths. As a consequence different new landforms have generated. All these factors generate new socio-economic status and adaptation due to shift in agricultural lands, homestead lands, the rail and road network and drainage problem at rural and suburban areas.

KEY WORDS

LISS-III, River Shifting, Meandering, Deposition, Flood plain, Socio-economic, Ox-bow Lake, Biodiversity

INTRODUCTION

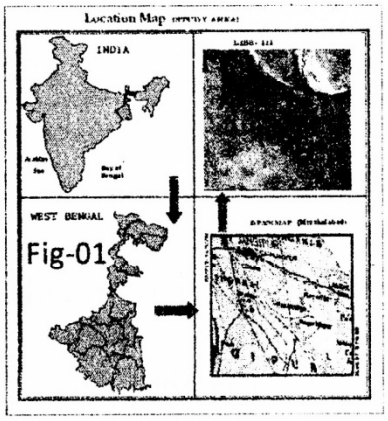

Fig-01

The river Ganges is primarily responsible for land sculpture in its basin area. The Ganges is characterized by high altitude and tectonic prone drainage areas with heavy sediment load and irregular high rate of downstream deposition. The present case study reflects the geomorphological changes which affects the socio-economic status and adaptation at the heart of Bengal (both West and East), due to erosion & deposition.

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According to the study of a 1971 Toposheet the study area was 7.19232 Sq Km and length of the Bhagirathi river was 11.28066 Km; along with this, tunnels, ponds and other water bodies area include 25.09066 Sq Km (Rudra Kaylan-2008) which belong to the same drainage system.

In Raghunathganj-I Block the flooded water of the Bhagirathi has formed separate body of stagnant water. But nowadays the river valley is advancing to the west. Its traces are found in geomorphological features (Ox-bow Lakes, Meanders belt) in Raghunathganj-II and Lalgola Blocks.

The river has changed its course step by step for last 30 years (1971-2002) comparatively. Its meandering course has increased gradually. For this reason there grows deposition which helped to increase river widths. As a consequence different new landforms have generated. All these factors generate new socio-economic status and adaptation due to shift in agricultural lands, homestead lands, the rail and road network and drainage problem at rural and suburban areas.

STUDY AREA

Raghunathganj Block I&II and Lalgola Block in Murshidabad district. The extent of study area is between 24°50′ N-24°35′ N &88°04′E-88°21′E.????

METHODOLOGY

Satellite imagery & Toposheet are useful in monitoring the changes in river bank and also been found useful in delineation reconstruction of old courses of river (Ganges & Bhagirathi).

BLOCK NAME (Hectare)	TOTAL LAND
RAGHUNATHGANJ-2	11936.3
RAGHUNATHGANG-I	14216.72
LALGOLA	19000.38

The techniques / methods used for this work are as follows:

Major steps performed in this work:

1. Pre-Field study
2. Pre-Field laboratory work
3. Post-field Laboratory work.

1. PRE-FIELD STUDY

a. Study of the collateral data before filed work.

b. Study of the physical & socio-economical environment of the area.

c. Study of Toposheet and images of the concerned area.

d. Study about the Land use/Landover and human activities.

2. LABORATORY WORK

In laboratory, different techniques are performed with the help of image Processing Software, like ERDAS Imagine 9.0 and Arc-Info (9.3).

CLASSIFICATION

The enhanced satellite images of 1971and 2002 are classified. Supervised classifications have been adopted for the preparation of Land use/Land cover map of the study area (1971, 2002).

BLOCK	TOTAL LAND	UNINHABITED AREA
RAGHUNATHGANJ-2	11936.3	3613.35
RAGHUNATHGANJ-I	14216.72	218.48
LALGOLA	19000.38	1268.46

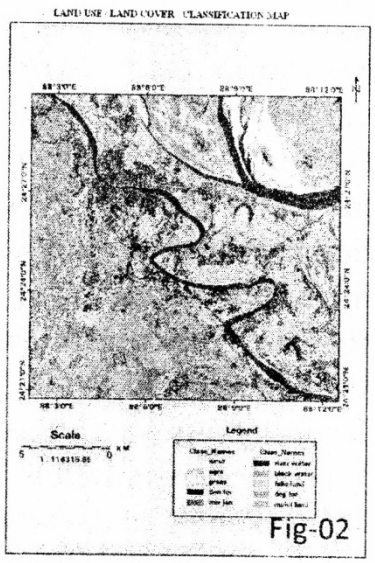


Fig-02

MAPS	YEAR OF PUBLICATION	SOURCE
Block Maps	1991	Census Handbook
Toposheet 78D/3	1972	SOI
Remote Sensing data(LISS-III)	4.2.2002	V.U-RS&GIS Department
Census data	2001	Census India

RESULTS AND DISCUSSION

The study area is the eastern Part of West Bengal, near the Ganges river of West Bengal. An attempt has been taken in this work to detect the changes or development of river flow. Change detection during 1971 to 2002, has been done using toposheet and satellite images (IRS-LISS-III 2002,). The shifting zone is identified with river's morphological changes and landform types (Ganges and Bhagirathi) in Raghunathganj-I&II and Lalgola blocks.

Here satellite imagery has been used for a quick study of river morphology. Drainage Network measurement and classification of location and associated features have been assessed satisfactorily using satellite imagery.

In the study area, the river flows through the alluvium tract and has very low gradient, forcing the flow slowly in a meandering and sinuous path. Nature and intensity of the alluvial channel with variation of discharge and sediment load influenced by different season, changes its course.

Erosion and bank line shifting are more pronounced in Raghunathganj-II and less in Raghunathganj-I & Lalgola Block. The Geomorphology of the alluvial channel is dominated by natural levee', confluences of river, abundance of back swamps, abandoned courses of stream and many other morphological and ecological features. The constructions of embankments and dams have modified the natural river course and channel banks as well as the centre of flood plains.

A continuous water flow over land generated from vast stretches of slopping land is primarily responsible for river bank erosion flow and meets with lake, sea, and other channel. In the mountainous region as the slope is high the lower erosion takes place profoundly. But in the lower stream as the water flow is low the side erosion

is much more pronounced. This reason is not enough; there are some other reasons which contribute in the consideration. These are:

1) Soil
2) Curvature of the river
3) Floodplain morphology of the river bank

Soil

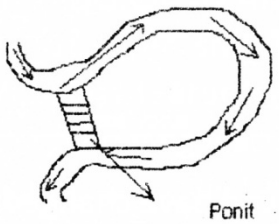
Characters of the soil also have an important bearing on the extent of erosion. The banks of river Ganges and Bhagirathi have been formed by alternate layers of silt and sand. Incoming high velocity, of water colliding with the sand particles often disrupts the land support thereby inducing bank erosion. Virgin bank of stiff clay or other stable materials may generally be absent except at a few places of the river Ganges and the Bhagirathi.

The soil along the banks has pore spaces, which get filled up with water of the river during monsoon months. When this water gets inside these pore spaces an equilibrium is maintained among the soil particles (i.e. liquefaction) along the banks but when this water from these pore spaces recedes and returns back to the river during winter months the soil particles loses its equilibrium. The soil particles thus become loose and it cannot be supported by flowing water and causes bank erosion.

Curvature of the river

Curvature of the river is important factor for river bank erosion (Basu, Subhash Ranjan-2005). If the curvature is high the river bank energy is concentrated at the narrow bank margin, that's why bank is highly eroded. If the curvature is low then the energy is dissipated on the bank margin.

Bank erosion also occurs where the river initiates a bend. The most rapid parts of the whither are driven by the vertical circular motion towards the concave bank which comes up from the bottom and has thus a low velocity due to friction with the ground. Hence the erosion is recession of the same bank.



Probability to cutting of river course

3) Floodplain Morphology of the River Banks The area of the floodplain is captured in IRS ID LISS-III geocoded FCC image, February 4, 2002, covering a part of Raghunathganj & Lalgola block of district Mursidabad. It depicts the channel/ river fill deposits, a major fluvial geomorphic unit of the Bhagirathi-Ganges basin. Hydrogeologically, these are considered as permeable deposits, having top silt or clay with possible coarser material at a depth. The channel and related features can be easily identified by their uniform surface patterns, resembling present day channels in dark to medium tone and color contrast.

The satellite picture clearly shows that the area is full of channel fill and allied fluvial units, representing the ancient fluvial courses. The Ganges & Bhagirathi in Murshidabad undergo flooding, bank erosion and river migration during the monsoon season. Flood can pose serious problems in the form of loss of human life, cattle and agricultural land. Because of unique recognition characteristics of water features in near infrared spectral bands, drainage networks and extent of area inundated by flood can be obtained easily form Remote Sensing data.

IMPACT OF SHIFTING ON LAND

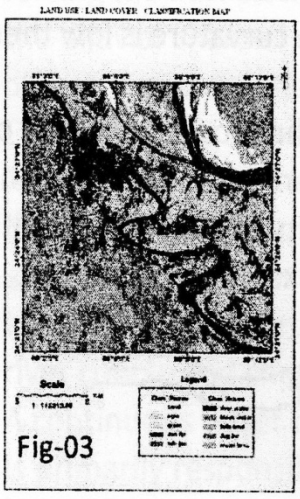


Fig-03

The river erosion has taken place for various reasons for last 30years (1971-2002). Its shifting impact can easily be understood if we discuss from different aspects (Hunter, W.W-1875).

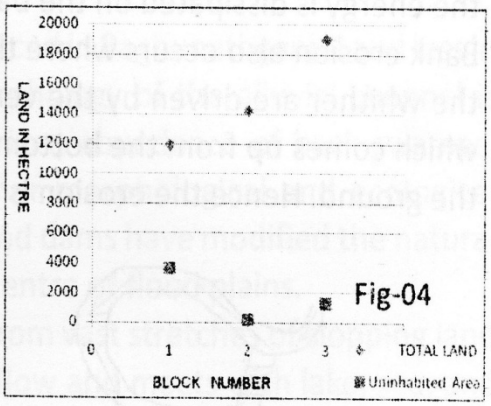


Fig-04

As a result of river shifting agricultural land has reduced in extent as well as its use. For example some land like Agricultural land and Forest land have changed into Fallow land and/or has been altered. It has adverse impact on Bio-diversity as well as on

Settlement area which has changed into uninhabited area. There is also change in crop Pattern.

BLOCK	TOTAL LAND	UNINHABITED AREA
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LALGOLA	19000.38	1268.46

IMPACT OF SHIFTING ON DRAINAGE

The river has changed its course step by step for last 30 years (1971-2002) comparatively. Its meandering course has increased gradually. For this reason there grows deposition which helped to increase river widths. The width of East side Ganges has been incinerated almost 50m to 88.70m is widened 1.30m/per year. As a result the river flows being moved from south to north side by side it's being moved 70m from west to east (Das.at.all-2007). Consequently, different new landforms are coated. As a result of the widening, speed of water has been decreased form earlier stage. As a result of variation of excessive curves, this flows in the curvilinear way.

Fig-06

The change of river, as stated above is reflected profusely in the study area of Raghrnathganj Block -II.

GEOMORPHOLOGICAL-FEATURES

As a result of river shifting there are many geomorphological features found in river basin. These are the following features:

Meanders river

Meanders belt

Ox-bow Lakes

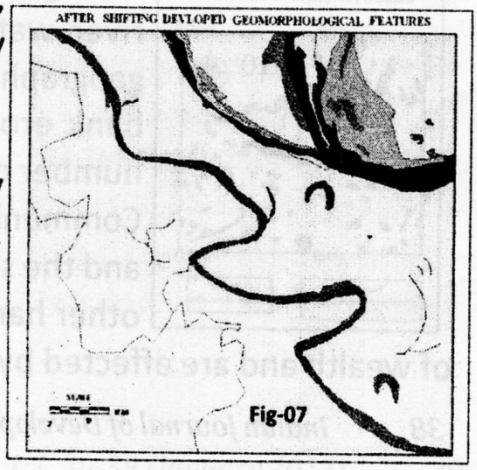

Fig-07

IMPACT OF SHIFTING ON AGRICULTURE

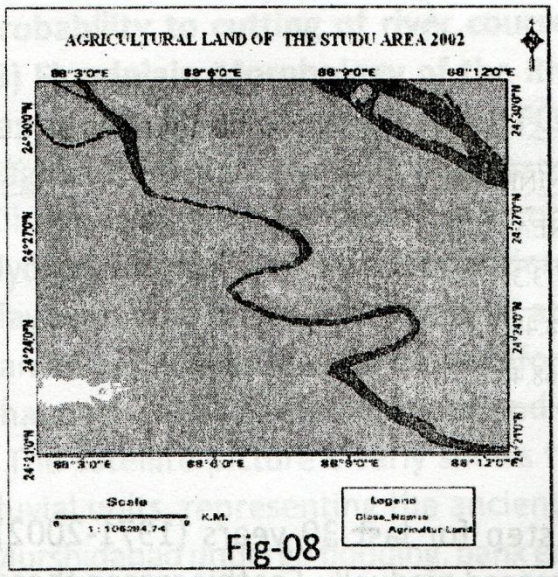

Fig-08

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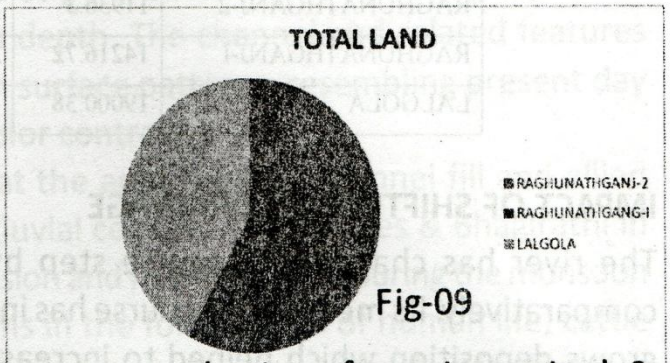
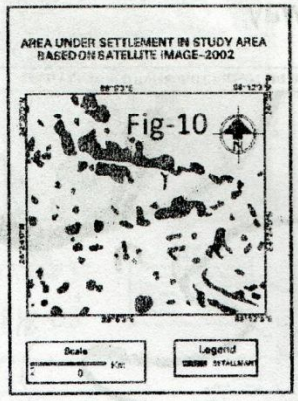


Fig-09

Due to observed increase in population more production of crop is required. So farmers cultivated various types of crops within the river bank margin; where flat and fertile soils are available. But when river bank retreated due to erosion the agricultural fields are also washed away by the river water (Patel.at.all -2007). These types of cases are visible in Raghunathgang & Lalgola blocks.

IMPACT OF SHIFTING ON SETTLEMENT

Poor people build their habitats towards the bank margin. This is because they can get their living resources from the fertile land of river bank by having cultivation and sometimes from the fish catch of the river water. They do not know the actual lithological or geographical condition in the bank margin area. When the river bank erosion occurs, it leads to the disaster for the large number of people in the Lalgola and Raghunathganj area. Communication network have been affected by shifting of river and the settlement is migrated to the new safer place. On the other hand as a result of flood the inhabitants suffer the loss of wealth and are affected by various water-borne diseases.



IMPACT OF SHIFTING ON BIO-DIVERSITY

A field survey was conducted to study the effect of shifting of river course on vegetation cover and soil and its relationship of spectral indices with vegetation cover. Different series of trees are found along the bank margins. Some of the plants are natural grown and some of plants are planted. Large amount of bio-diversity occurs in the region. Due to the alluvium fertile soil, different species of trees are easily grown (Basu AK-1992). Along the Bhagirathi River bank the soil is also fertile beside the bank margin. When river bank erodes away due to the loss of basal lapper and other causes, loss in Bio-diversity occurs.

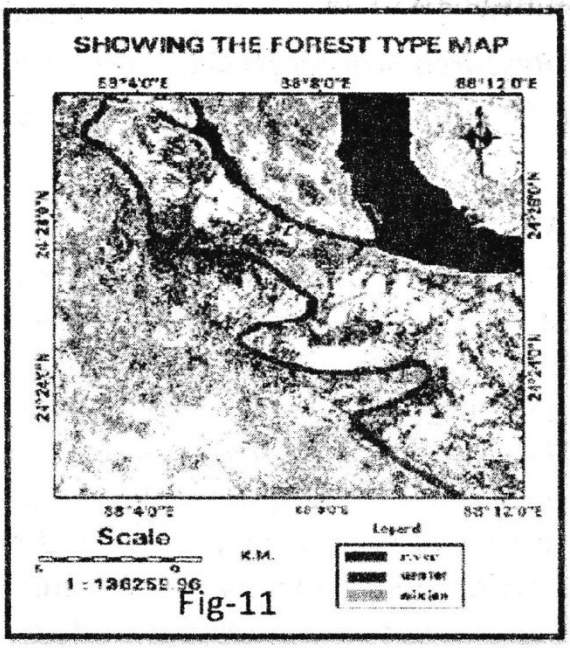


Fig-11

In the study area, there are two types of vegetation: a) Mixed forest, b) Dense forest. Dense forests are found beside the river with settlement area. On the other hand mixed forest is found in the whole study area.

Conclusion:

The river erosion has taken place for various reasons for last 30years (1971-2002) to the present day. Erosion and bank line shifting is more pronounced in Raghunathganj-II and less in Raghunathganj-I & Lalgola Block. The Geomorphology of the alluvial channel is dominated by natural levee', confluences of river, abundance of back swamps, abandoned courses of stream and many other morphological and ecological features. The constructions of embankments and dams have modified the natural river course and channel banks as well as the centre of flood plains.

Its shifting impact is very much pronounced in the study area to a large extent. As a result of river shifting amount of agricultural land as well as its use has been reduced. Agricultural land and Forest land have changed into fallow land and/or have been altered. It has also some impact on bio-diversity as well as on the settlement of the area which has changed into uninhabited area. There is also change in crop pattern.

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