MEANDER MIGRATION IN THE GANGA-PADMA SYSTEM IN INDIA AND BANGLADESH: ANALYSIS, ESTIMATION OF MIGRATION AND CONTROL

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Abstract
This study focusses on the issue of the migration of the meandering Ganga –Padma river system in India and Bangladesh. The problem is particularly severe at Jalangii in India where the Padma river forms an international boundary. Appropriate remedial measures are suggested to arrest bank erosion on the Indian side at Jalangi.

Introduction

The Ganga-Padma system in India and Bangladesh has a meandering nature composed of bends, several of which tend to migrate. While some migrate relatively slowly, others migrate faster, causing extensive damage to property. The present study studies the causes of meandering, examines method of prediction, evaluates rate of meander migration at certain locations in India and Bangladesh and suggest methods for prevention of meander migration.
Rivers are dynamic system. The action of the flowing water can change the elevation and the lateral location of the river and riverbanks. Meanders are particularly prone to change in lateral location because of the centrifugal force that increases the shear stress at the interface between the water and soil and migrate over time.

Causes of Meander

Predicting the movement of meander is both difficult and necessary. As in the case of any erosion problem, predicting such movements requires the knowledge of the input parameters: the geometry, the water and the soil. The geometry of the meander and of the river cross section has an impact on the hydraulic shear stress generated at the interfaces between the water and the soil. The velocity of water influences the hydraulic shear stress on the soil. The soil controls the erosion rate on the resistance side. These simple concepts are fundamental but one must also acknowledge the complexity of some factors. For example, the interface may not be soil, it could be rock vegetation or a men-made material used as a countermeasure. Also the shear stress developing at the interface may lead to a slope failure of the bank; the slumped mass of soil is then eroded by the flowing water.

Very mild meanders tend to straighten out as the thread of maximum tangential velocity lies close to the inner bank. On the other hand very strong meanders may develop cut-off. In between these two extremes lies a range where meanders remain as such with or without migration.

The Ganga- Padma System

Meander migration rates have been calculated for the Ganga at Manikchak upstream of the Farakka Barrage and for the Padma downstream of the Farakka barrage upto its confluence with the river Brahmaputra at Goalunda in Bangladesh. The **Table 1** below gives salient meander parameters and meander migration and meander migration rate for different locations on the Ganga and Padma. The definition of strong and mild meander (Bhattacharya, 1995) is that a meander is strong if b/r_c is more than 4.0 and is mild otherwise.

In strong meander, the maximum tangential velocity is near the outer side a bend and in weak meanders, it is near the inner side of a bend. In both cases the radial velocity is directed outwards in the upper part of a bend. In strong meanders, naturally erosion on the outer side is more.

Table 1

Serial No.	River	Position	r_c (km)	b (km)	r_c/b	M_c (m/yr.)	Type of Meander
1	Ganga	Manikchak	9.9	2.75	3.6	267	Mild
2	Padma	Between Debipur and Rajsahi	8.8	2.2	4	192	Mild
3	Padma	Jalangi	12.1	6.6	1.83	550	Strong
4	Padma	Raita	9.9	5.5	1.8	440	Strong
5	Padma	Between Raita and Pabna	7.7	2.2	3.5	220	Mild
6	Padma	Pabna	20.9	2.2	9.5	81	Mild
7	Padma	Between Pabna and Goalunda	4.4	2.2	2	220	Strong

Prevention of Migration

The problem at Jalangi is very complicated because the river Padma forms the international boundary at the location. According to Fig. 5.5, It is suggested that spurs be placed on the Indian side of the bend at Jalangi (concave side) at 135^0 to the upstream (Basu, 2002) and at a spacing of 140 m. The spurs may be 8 m long (Basu, 2002). Other measures designed to repel the main current away from the concave (outer) side of riverbank are listed below.

1. Wooden piles may be driven along rectangular grids covering the channel portion occupied by the curved portion of the riverbank. These piles may be driven up to the bedrock or sufficiently deep into the riverbed material to be stable at least up to the bankfull flow condition. Over time, the resistance of flow provided by these gridded piles causes silt deposition in the area.
2. Rock may be dumped on the channel bed in the curved portion to raise the channel bed, reduce channel velocities and minimise scour in that portion.

3.

Biotechnical and Other Methods of Bank Protection

These methods include the use of vegetation or synthetic materials in place of rock riprap or gabions. The following alternative erosion protection materials may be used for bank erosion protection.

1. **Fabriforms or Articulated Blocks*:*** As defined previously, fabriforms are bags made of synthetic materials filled with concrete, cement or soil cement and placed on bank slopes and toes. Green synthetic bags may be used to maintain a park-like visual setting. The bags may be placed adjacent to the one another or with spaces left between them for plant growth or seeding. Articulated blocks are prefabricated concrete blocks with voids left in them for seeding and plant growth. These are placed on the bank slope and their voids are filled with soil and seeded with suitable plant species.
2. **Rolled Erosion Controlled Products (RECPs):** These are mats made of synthetic materials able to resist microbial and environmental degradation and they contain open spaces for plant penetration. They are constructed from multiple layers of synthetic threads, which minimise migration of soil from areas covered by them. These mats may be reinforced by turf or wires and may have an organic component made of coir, excelsior or wood chip fibres. Seeds are introduced into the soil prior to covering with RECP protection.
3. **Vegetation Cover:** This includes both the selection of vegetation type that will survive and grow under prevailing climatic conditions at the site and the seeding, sodding or planting of such vegetation.

Conclusion

Remedial measures are suggested for the erosion at Jalangi which will go a long way in preventing from scouring its right bank at the alarming rate at which it is doing that at present. Remedial measures can be adopted at other locations also.

References

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