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Dynamics of Sand Bars in Braided River: A Case Study of Brahmaputra-Jamuna River

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Numerous bars are essential large scale topographic feature of the braided river morphology. Through this study we tried to investigate some individual bar scale property as well as their interaction with the braided plain of a highly sediment laden reach of Brahmaputra-Jamuna River using numerical analysis tool. Our study indicates the development process of bar is quite different from the bars of straight and meandering channels. The spatial growth of the bar seems to be dependent to the width-depth ratio up to a certain limit and finally the migration rate of the bar recedes with the growth of the bar.

1. Introduction

Networks of channels separated by transient bars exemplify the uniqueness of braided type of river˙ In case of highly sediment laden braided river different types of bars are found like unit bar or compound bar (based on formation type) and free bars or force bars (according to forcing). The linear bar theory clarifies the relationship between bar dimensions and channel geometry which is confirmed by many laboratory experiments, field observations, and mathematical analyses but in case of highly sediment driven braided river which contains so many compound bar; applicability of such theory may not be fully successful every time (Schuurman et al., 2013). Hence, the main objective of this research is to understand the interaction of braided bar with the braided plain during the peak flow, especially the relationship of geometrical properties of bar and channel during the peak flow. Attention has been given to the migration process of the sand bars. As the study area, 225 km reach of Brahmaputra- Jamuna River (downstream continuation of the Brahmaputra River in Bangladesh, see Fig 1) was selected.

2. Methodology

In this study, a 2D morphodynamic model was developed using the real river bathymetry and boundary condition for the year 2011(Fig 2) using Delft3D software. The model was simulated for one wet period from 1st of June, 2011 to 15th of October, 2011 assuming the major morphological changes for that particular year occurred within the peak discharge. The hydrodynamics are modeled by applying Navier Stokes equations assuming incompressible fluid, applying the shallow water and the Boussinesq assumptions. For non-cohesive sediment transport prediction the equations of Van Rijn (1993) was used. Exner equation for mass conservation of sediment was used for updating the bed level.The roughness was assumed to be constant (Manningsȏs roughness co-efficient was 0.027 $s/m^{1/3}$) and equilibrium sand concentration profile was considered at inflow boundary. The median sediment diameter was considered as 277 μm.

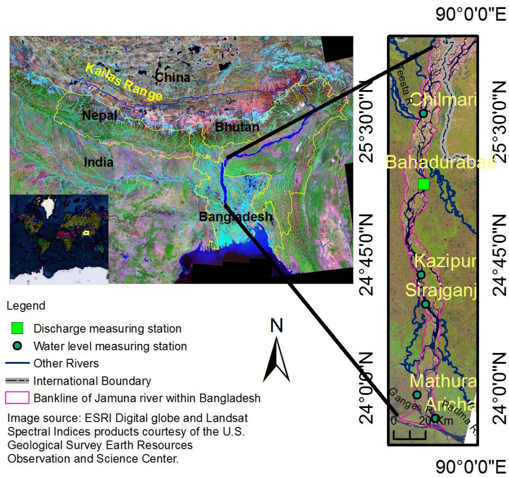

Figure 1: Map showing the study area

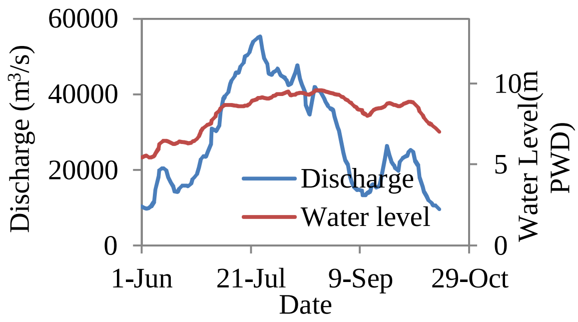

Figure 2: Boundary condition of the Model

The model was well calibrated and validated for the year 2012 in the water level and discharge measuring location (Fig 1).

Dry season satellite imagery was of IRS-LISS images of 2011 and 2012 were used to estimate the actual bar migration rate and validation of planform generated by numerical simulation.

3. Results

The Planform from the satellite image and simulated one is shown in Fig 3a and it can be said that the model can predicts the main anabranch but in case of bar scale there are some discrepancies like it could not predict well the alignment of chute channels. As the model was simulated only for one wet season, no huge bed level change is observed, the average change of bed level change was only 0.49 m (Fig 3b). But in some confluence, huge scour (23.66 m near Sirajganj) was observed.

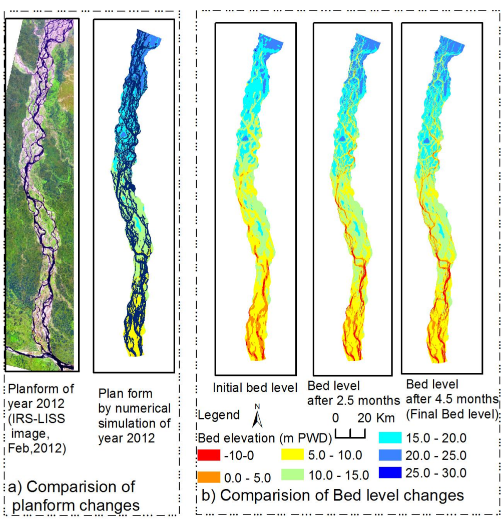

Figure 3: Planform and bed level changes by numerical simulation

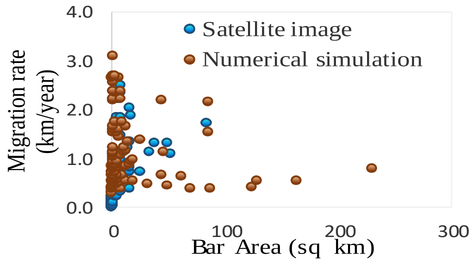

Figure 4: Actual and simulated bar migration rate

The simulation result showed the dimensionless Bar height (Bar amplitude/ maximum scour depth), and width/depth ratio of river were strongly correlated (r=0.85) with an increasing trend. But the dimensional less Bar length (bar length/reach width) showed a nonlinear relationship with width/depth ratio and it seems there exist a critical value of dimensional less Bar length beyond this the bars did not develop spatially. Both the simulation results and satellite imagery analysis showed logarithmic relation as the migration rate of bar which recedes with the growth of bar (Fig 4). The average migration rate of bar is 1.05 km/year but satellite image analysis showed the average 0.04km/year.

4. Discussions and Conclusions

The prediction of planform using numerical model for highly dynamic river is still need some modification especially for local scale prediction. This dimensionless analysis of bar property indicates there may also be exist suppression point for braided bar. The migration rate of bar tends to recedes with its growth. Therefore, this phenomenon can also be used to maintain the river.

5. References

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