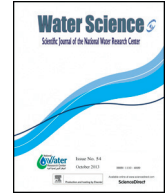




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Research Article

Sedimentation under variable shear stress at lower reach of the Rupnarayan River, West Bengal, India

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Abstract

The lower reach of the Rupnarayan River has been deteriorated and incapacitated due to continuous sedimentation (26.57 million m³ shoaling in last 25 years). Attempts have been made to explain the causes and mechanisms of sedimentation in connection to the seasonal fluctuation of shear stress. River depth and water velocity was measured by echo-sounder and current meter respectively. Textural analysis of grains was done by sieving technique. Available and critical shear stress (N/m²) have been calculated following Du Boys (1879), Shield (1936) and Van Ledden (2003) formula. The lack of available energy to transport a particular grain size during low tide (in dry season) is the main reason behind the rapid sedimentation in this area. Most of the places (>75%) having negative deviation of shear stress (available shear stress lesser than critical shear stress), during low tide are characterized by deposition of sediments. The presence of mud (silt and clay) above the critical limit (15%) in some of the sediment samples generates the cohesive property, restricts sediments entrainment and invites sedimentation.

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Keywords: Shoaling and scouring; Sedimentation; Grain texture; Available and critical shear stress

1. Introduction

An ongoing problem in the management of freshwater ecosystems is sedimentation. When flow velocity increases gradually over a sedimentary bed, the motion of sediments occur if the bed shear stress (available shear stress) induced by the flow exceeds a certain critical value of shear stress (Ahmad et al., 2011). If the incoming sediment supply is similar to the sediment which is being entrained, then the sediment coming in to a particular reach may replace the entrained sediment (Charlton, 2007; Clayton and Pitlick, 2008; Lane, 1955). But if a huge amount of sediment is discharged from upstream area, the river response by aggrading in order to steep the gradient and increase its velocity to become more competent (Mackin, 1948; Smith, 1974). The rate of sediment transport and accumulation in estuarine environments are affected by tidal currents and river discharges (Hall et al., 1987). The transportation and deposition processes of sediment particles are affected by the parameters like roundness, sphericity, surface texture, detrital heavy mineral ratio and biogenic components (Folk and Ward, 1957; Friedman, 1979; Martins, 1965). Sedimentation on

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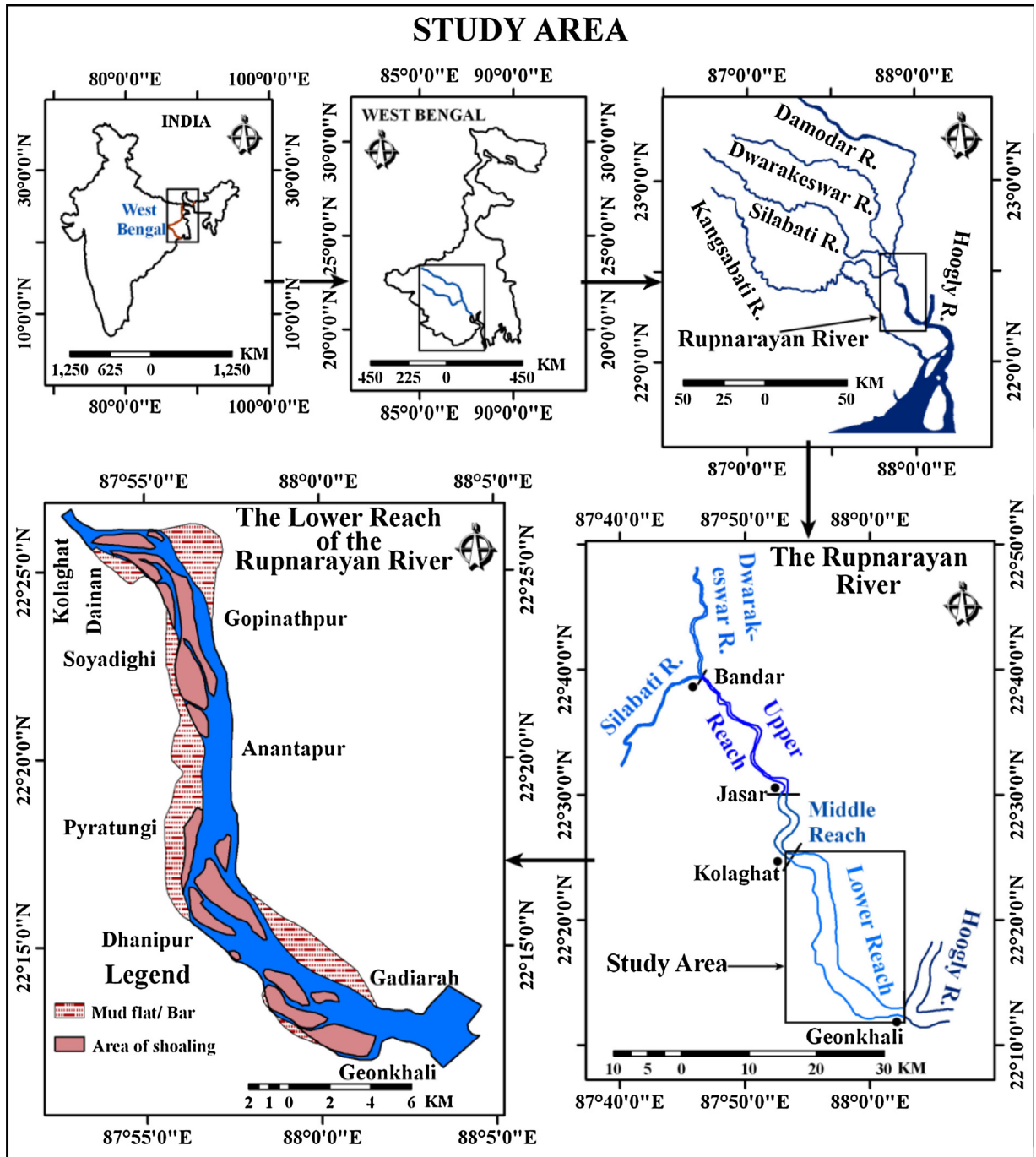


Fig. 1. The study area.

river bed and catchments system is important and significant as sedimentation rate is an imperative parameter that determines the water system dynamics (Salas and Shin, 1999).

The lower reach of the Rupnarayan River, from Kolaghat to Geonkhali (40 km) (Fig. 1) has been deteriorated and incapacitated due to continuous sedimentation and development of shoal area. During the last 25 years the area has experienced a net sediment deposition of 26.57 million m³ (estimated by Kolkata Port Trust, 1990–2015). Rapid sedimentation and development of shoal area creates a variety of detrimental problems and impacts on society, economies

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