



Geomorphic characterization and diversity of the fluvial systems of the Gangetic Plains

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Abstract

The extensive Gangetic alluvial plains are drained by rivers which differ strongly in terms of hydrological and sediment transport characteristics. These differences are manifested in the geomorphic diversity of the plains. The Western Gangetic Plains (WGP) are marked by a degradational topography with incised channels and extensive badland development in some parts, while the Eastern Gangetic Plains (EGP) are characterized by shallow, aggrading channels with frequent avulsions and extensive flooding. We interpret such geomorphic diversity in terms of differences in stream power and sediment supply from the catchment areas. The rivers draining the western plains are marked by higher stream power and lower sediment yield that result in degradation. In comparison, the rivers draining the eastern Gangetic Plains have lower stream power and higher sediment yield that result in aggradation. The variation of stream power, a function of channel slope and high sediment yield, is attributed to differences in rainfall and rate of uplift in the hinterland. It is suggested that such differences have resulted in a marked geomorphic diversity across the plains. It is also suggested that such diversity has existed for a fairly long time because of climatic and tectonic variance.

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1. Introduction

The physical study of large tropical rivers has gained enormous importance during the last two decades and a variety of topics have been covered that include fluvial geomorphology and hydrology

(Kale et al., 1994; Sinha and Friend, 1994; Sinha and Jain, 1998; Kale, 1999, 2002; Dettinger and Diaz, 2000; Gupta, 2002; Thorne, 2002), sediment budget and catchment processes (Curtis and Douglas, 1993; Oguchi, 1997; Galy et al., 1999; Metivier, 1999; West et al., 2002; Goodbred and Kuehl, 1999, 2000; Galy and Lanord, 2001; Goodbred, 2003), geochemistry and biogeochemistry (Han and Liu, 2001; Sarin, 2001), climate change (Srivastava et al., 1994; Mulder

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and Syvitski, 1996; Cluis and Laberge, 2001), and river management (Gore and Shields, 1995; Sparks, 1995). The geological perspective of such studies has been to develop understanding of the process-form relationships and to use them for interpreting ancient fluvial sequences. Geomorphology has increasingly played an important role in multi-disciplinary research of river systems and a growing realization of a close coordination has developed between geomorphologists, river engineers, and policy makers to understand the process-form relationships and to account for the fluvial dynamics.

The Gangetic rivers, such as the Ganga, Yamuna and their tributaries, drain one of the largest alluvial plains in tropical region and a substantial attention has been paid by the national as well as international workers during the past few decades (Geddes, 1960; Wells and Dorr, 1987; Gupta, 1993; Gohain and Parkash, 1990; Gole and Chitale, 1966; Goswami, 1985; Richards et al., 1993; Friend and Sinha, 1993; Sinha and Friend, 1994; Sinha, 1996; Jain and Sinha, 2003a). Given the enormity of the plains, the information available is still very fragmentary and somewhat flawed. Despite distinct differences in the

climatic setting over an east–west transect and in morphological and hydrological characteristics of the rivers draining these plains, a spatial homogeneity across the monotonous, flat alluvial plains has been emphasized by most earlier workers (Singh, 1987, 1996; Singh and Bajpai, 1989; Singh et al., 1999). Surprisingly, little emphasis has been placed in the existing literature on recognizing and explaining the geomorphic diversity across the plains, a diversity that may have important implications for understanding the sedimentary architecture of this rapidly filling and subsiding basin.

In this paper we select two regions of the Gangetic Plains (Fig. 1) to compare the morphology, hydrology, and fluvial processes: the Ganga–Yamuna interfluvium in the Western Gangetic Plains (WGP) of Uttar Pradesh and the Gandak–Kosi interfluvium in the Eastern Gangetic Plains (EGP) of north Bihar. The Ghaghra–Gandak interfluvium region in between the WGP and EGP is named as Transitional Gangetic Plains (TGP; Fig. 1). The objective of this paper is to investigate the spatial inhomogeneity across the plains and to explain any diversity in terms of geomorphic and geologic controls.

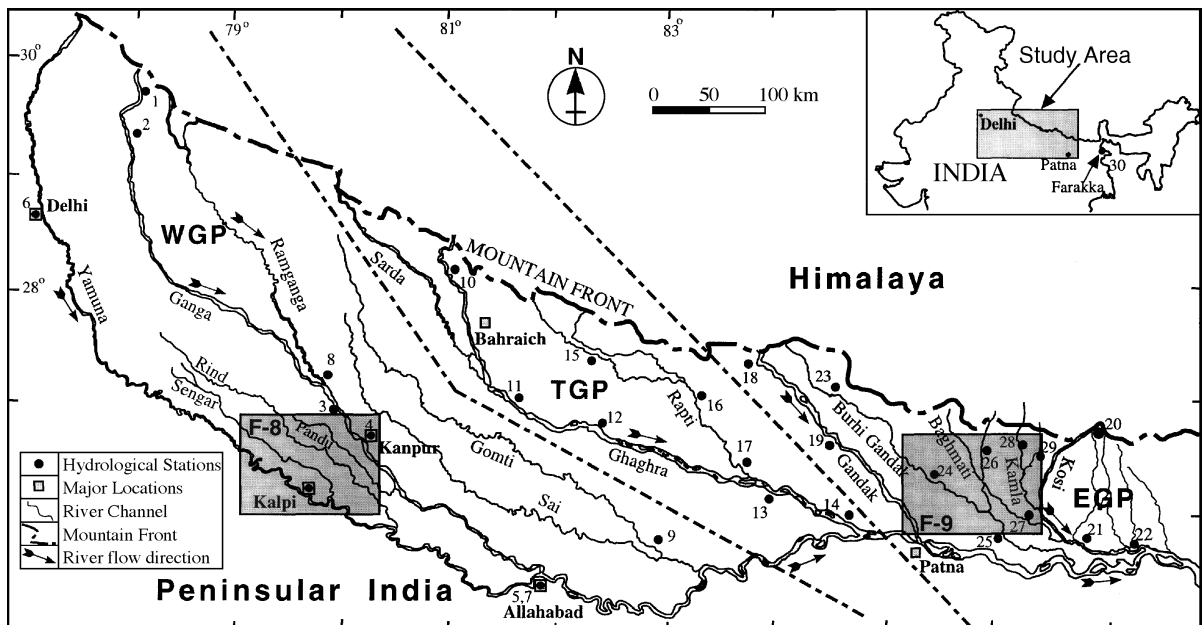


Fig. 1. Location map of the study area; the Gangetic Plains is drained by the number of N–S flowing rivers; WGP—Western Gangetic Plains, EGP—Eastern Gangetic Plains.

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