Pleistocene-Holocene Climate Fluctuations and Fluvial Response in the Tectonically Active Yamuna Valley, North-Western Himalaya: Timescales and Source-to-Sink Interlinkage

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The present study focus on aggradation and incision history of late Quaternary terrace staircases of Yamuna River and its tributaries in the Sub-Himalaya, between the Main Boundary Thrust (MBT) and the Himalayan Frontal Thrust (HFT) (Fig. 1) to understand the control of tectonics and climate in their genesis. We documented five levels of terraces (T-1 to T-5), cutting across numerous tectonic plains (MBT and its imbricate thrusts), maintaining similar elevations ranging from 65-80, 40-44, 26-28, 8-12 and 3-4 m from the present-day river bed, deposited by both high mountain-fed perennial and piedmont-fed ephemeral streams.

Geomorphological and sedimentological attributes coupled with absolute ages based on optically stimulated luminescence (OSL) chronology of terrace deposits sugggest that fluvial accretion in the area took place in five phases between Marine Isotope Stage-3 (MIS-3) and MIS-1, separated by incision phases, with two major aggradational phases in late Pleistocene (>37 to 24ka and >15 to 11ka) and three minor phases in Mid- to late Holocene (7- 4ka; 3 -2ka; and younger than 2ka). During phase-I (>37 to 24ka), the aggradation was dominantly controlled by ephemeral streams, and occurs as alluvial fill in a pre-existing valley, whereas younger accretion sequences are deposited by both perennial and ephemeral streams after lateral erosion and are deposited on remnants of Phase-1 deposits. The late Pleistocene incision occurred after 24ka under relatively wet to drier climatic conditions prior to the global Last Glacial Maximum (LGM) and weakened ISM whereas after 11ka, incision is in response to increased ISM strength. The multiple minor aggradation-incision phases since mid-Holocene are coeval with ISM dynamics that resulted in the development of three levels of terraces (T-3 to T-5).

The present data is correlated with previous reported aggradation and incision events in the Ganga River system from its upper reaches (north of MBT; Srivastava and others, 2008; Figure 2), Sub Himalaya (Sinha and others, 2010; Figure 2) and south of HFT (southern Ganga Plain; Sinha and others, 2010; Gibling and others, 2005; Figure 2) and other Sub Himalayan basins (Suresh and others, 2007; Phillip and others, 2009; Figure 2) confirms the close linkage of fluvial accretion and incision with Pleistocene-Holocene Indian Summer Monsoon (ISM) oscillations, and in turn, profound climatic control on the terrace genesis in the tectonically active Himalaya on the scale of 10^3 - 10^4 years guided by source to sink sediment dispersal system through Enhanced hillslope erosion in the catchment via glacial fluctuations and precipitation gradient (dry and wet transitions).

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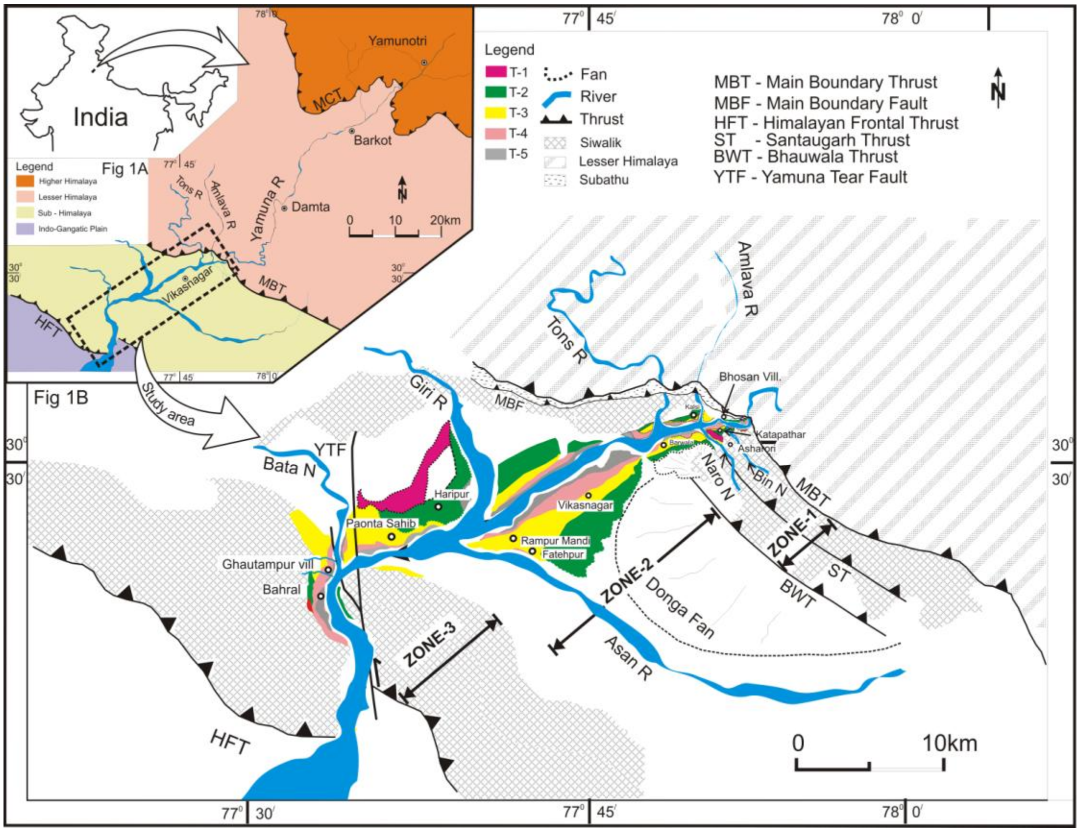

Fig.1. (A) Regional geological map of Yamuna Valley showing major lithotectonic units of Himalaya. (B) Tectonic and geomorphic map of Yamuna Valley between the Main Boundary Thrust and Himalayan Frontal Thrust showing various landforms and intervening thrusts.

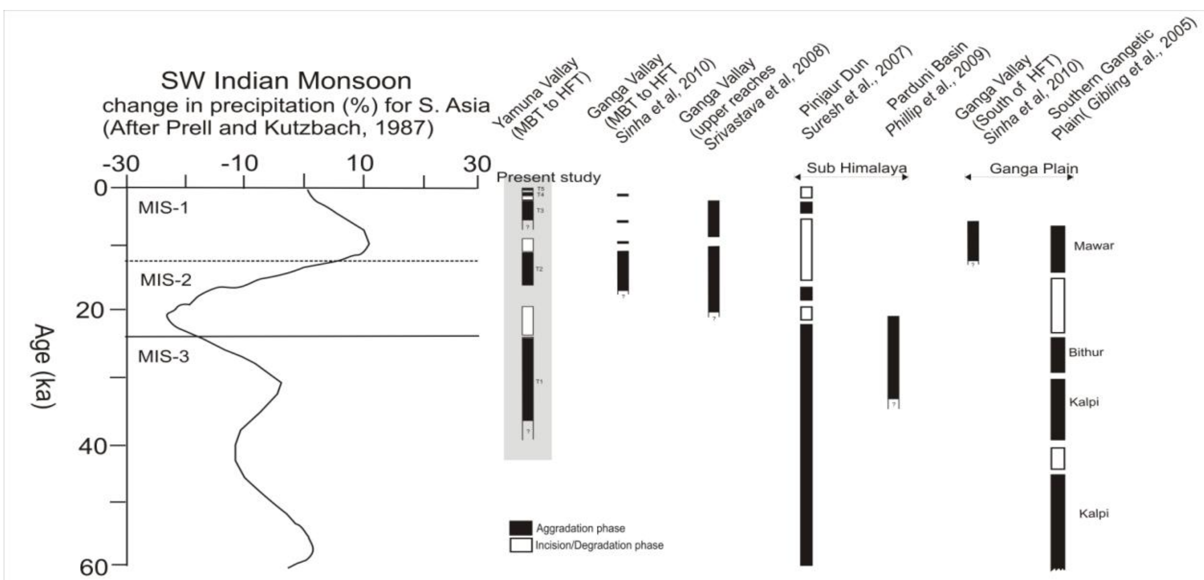

Fig.2. Distribution of late Pleistocene-Holocene aggradation and incision phases in the Yamuna Valley in relation to South-West Indian Monsoon strength and its comparison with various part of Sub-Himalaya and the upper reaches of the Ganga Valley to the Ganga Plain.

Cite as: Dutta, S., Suresh, N. and Kumar, R., 2010, Pleistocene-Holocene Fluctuations and Fluvial Response in the Tectonically Active Yamuna Valley, North-Western Himalaya: Timescales and Source-to-Sink Interlinkage, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey Open-File Report 2010-1099, 2 p. [http://pubs.usgs.gov/of/2010/1099/dutta/].