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A geomorphic approach to define e-flow in a disconnected Himalayan river system near a megacity

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Anthropogenic exploitation of large river systems specially near megacities is a major challenge in maintaining health of a river system. There is a need to develop new process-based approaches for better management of river health. It is essential to estimate required flow for maintaining suitable channel morphological condition, which finally represents physical habitat for riverine ecosystem. Hence, channel morphological attributes and sediment transport process were used to define e-flow. This work was carried out on [U+F0BB] 8 km long urbanized stretch of the Yamuna River flowing through the National Capital Region (NCR) Delhi, India. The river originates from the north-west Himalaya and carries large amount of sediments before reaching to Delhi, NCR. The present work provides a methodology to incorporate geomorphic data in E-Flow assessment.

Morphological condition of the Yamuna River was mapped using satellite data and its downstream variation was analysed after generating downstream distribution pattern of stream power along long profile. Presence of dam and barrages have significantly restricted river discharge, and there is almost no sediment transportation at midstream reaches, near Delhi, NCR. This river reach is geomorphologically disconnected from upstream reaches. E-flow was defined for the reach as flow requirement to initiate sediment transport process and to establish longitudinal and lateral connectivity. Channel slope and cross sections were surveyed using Kinematic GPS and Total Station. The field data was used to derive stage-discharge and flow duration curves. Flow requirement was estimated for both monsoon and non-monsoon season.

The shear stress at channel cross-section in non-monsoon period is very low in comparison to the critical shear stress, which was defined on the basis of median grain size of bed-material load. Hence, required flow for lean period was estimated to establish effective sediment transport in river channel. While for the monsoon period, the key consideration for flow requirement was to establish lateral connectivity with different geomorphic units. The required flow duration curve was proposed to suggest flow requirement in different seasons. This approach on the basis of sediment transport, channel connectivity and downstream flow variability provides a holistic hydro-geomorphic methodology for e-flow estimation.