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Estimating bed material transport in Himalayan streams using the virtual velocity approach

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This study investigates sediment mobility and transport dynamics in two Himalayan rivers, the Aglar and Paligad Rivers, during both monsoon and non-monsoon flows. Employing the virtual velocity approach, key parameters such as bed proportional mobility (Y), active layer depth (d_s), and displacement length were measured to estimate the virtual velocity of mobilized grains. Local parameters (0.5 m sub-sections) and wetted cross-sectional averages were utilized. Using local parameters, the total annual bed material transport was determined as 67,100 t (±20,400 t) and 18,400 t (±6,000 t) for the Aglar and Paligad Rivers, respectively, with nearly 60% occurring during the monsoon. The significant contribution of non-monsoonal flows (~ 40 %) could be ascertained to higher enough flows in specific sub-sections inducing partial or full mobility. Still, the contribution of partial transport *(PT)* remained lower (< *6%*). In contrast, based on cross-section average parameters, total transport was estimated at 42,300 t (±15,800 t) and 12,200 t (±4,700 t) for the Aglar and Paligad Rivers, respectively, with approximately 79% and 68% occurring during the monsoon. The contribution of *PT* increased to nearly 18% and 29% for the Aglar and Paligad Rivers, respectively, attributed to the averaging effects of shallower sections. Furthermore, the interdependence of partial transport on Y and full transport on d_s leads to discontinuities in transport curves, prompting the proposal of a unified function to represent transport extent for both partial and full transport conditions. The unified function ensured the generation of continuous transport curves, yielding similar transport patterns concerning the contribution of PT, FT, monsoonal, and non-monsoonal flows. The findings are particularly relevant for efficient river management as the region houses several hydropower plants and is highly susceptible to climate change.

Keywords:

Painted tracers, partial transport, full transport, active layer, monsoonal flows