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Estimation of paleo-discharge of the lost Saraswati River, north west India

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The lost Saraswati has been described as a large perennial river which was 'lost' in the desert towards the end of the 'Indus-Saraswati civilisation'. It has been suggested that this paleo river flowed in the Sutlej-Yamuna interfluvium, parallel to the present-day Indus River. Today, in this interfluvium an ephemeral river- the Ghaggar flows along the abandoned course of the 'lost' Saraswati River. We examine the hypothesis given by Yashpal et al. (1980) that two Himalayan-fed rivers Sutlej and Yamuna were the tributaries of the lost Saraswati River, and constituted the bulk of its paleo-discharge. Subsequently, the recognition of the occurrence of thick fluvial sand bodies in the subsurface and the presence of a large number of Harappan sites in the interfluvium region have been used to suggest that the Saraswati River was a large perennial river. Further, the wider course of about 4-7 km recognised from satellite imagery of Ghaggar-Hakra belt in between Suratgarh and Anupgarh in the Thar strengthens this hypothesis.

In this study, we have developed a methodology to estimate the paleo-discharge and paleo-width of the lost Saraswati River. In doing so, we rely on the hypothesis which suggests that the ancient Saraswati River used to carry the combined flow or some part thereof of the Yamuna, Sutlej and Ghaggar River catchments. The paleo-discharge of the river would compare with that of some of the large rivers of the Himalayan Foreland. These alluvial rivers are often called self-formed rivers, as they flow on the loose sediment and are subjected to erosion and deposition of channel bed and banks. The geometry of rivers such as width (W), depth (D) and slope (S) are primarily controlled by water discharge (Q) and catchment area (A). Various functional relationships have been developed to scale the alluvial rivers, which we have used to obtain the first-order estimate of the river discharge of the 'lost' Saraswati. A scaling relationship was established between the catchment area-channel width for 31 rivers and catchment area-discharge at 26 different locations on the rivers presently flowing on the Himalayan Foreland from Indus in the west to the Brahmaputra in the East. We found the width and discharge of all the Himalayan rivers scale in a similar way when they are plotted against their corresponding catchment area. Using these regime curves, we calculate the width and discharge of paleochannels of the Sutlej, Yamuna and Ghaggar rivers by measuring their corresponding catchment area from satellite images. Finally, we add the discharge and width obtained from each of the contributions of individual catchments (Yamuna, Sutlej and Ghaggar River) to estimate the paleo width and paleo discharge respectively of the Saraswati River. Our regime curves provide a

first-order estimate of the paleo-discharge and paleo-width of the lost Saraswati ~2500 cumec and ~1000 m respectively. We also suggest that the 4-7 km channel width observed earlier on the satellite image corresponds to the channel belt width of the lost Saraswati River.