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Towards an extension of the hydraulic geometry concept to include tidal networks

Maximiliano Sassi (1) and Ton Hoitink (1,2)

(1) Hydrology and Quantitative Water Management Group, Wageningen UR, The Netherlands (maximiliano.sassi@wur.nl), (2) Institute for Marine and Atmospheric Research Utrecht/IMAU, Department of Physical Geography, Utrecht University, The Netherlands

Relations between water discharge and the geometric properties of channels are known as Hydraulic Geometry (HG) relations. HG relations are of fundamental importance to water management in channel networks, and they are scientifically interesting for their relation with geomorphological evolution. River delta channels typically scale according to HG relations such as $A=Q^p$, where A is channel cross-sectional area, Q is water discharge, and the exponent p is typically in between 0.8 and 1.2. Our aim is to improve the HG concept to make the equations dimensionally homogeneous and to include the effects of tides, which are generally ignored in HG theory. Tidal rivers are intrinsically more complex than rivers free of tidal influences, as tidal propagation is influenced by river discharge and vice-versa. Systematic variation of the tidal range may lead to a cyclic variation in water discharge distribution at bifurcations, affecting HG relations. We present preliminary results from research in the Mahakam delta channel network in Indonesia, which represents a tide-river dominated delta that has prograded 60 km over the last 5000 years. Bathymetric surveys were conducted in the network of nearly rectilinear distributaries connected to sinuous tidal channels. Based on a geomorphic analysis of the present distributary network, we show that channel geometry of the fluvial distributary network scales with bifurcation order. Opposed to the case of river deltas, bifurcation order does not fully explain bifurcate branch length or bifurcate width ratio. Tidal channels attached to the fluvial network show convergent widths with intrinsic wavelengths decreasing landward, and possible signatures of ebb/flood transition in sediment transport. Our results may help to understand the morphological evolution of delta channel networks affected by tides, improving idealized models of delta evolution.