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Theory of Hydraulic Geometry

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The term “hydraulic geometry” represents the relationships between the mean stream channel form and discharge both at-a-station and downstream along a stream network in a hydrologically homogeneous basin. The channel form includes the mean cross-section geometry (width, depth, etc.), and the hydraulic variables include the mean slope, mean friction, and mean velocity for a given influx of water and sediment to the channel and the specified channel boundary conditions.

In this paper, it is hypothesized that (1) the spatial variation of the stream power of a channel for a given discharge is accomplished by the spatial variation in channel form (flow depth and channel width) and hydraulic variables, including energy slope, flow velocity and friction; and (2) that the change in stream power is distributed among the changes in flow depth, channel width, flow velocity, slope, and friction, depending on the constraints (boundary conditions) the channel has to satisfy. The second hypothesis is a result of the principles of maximum entropy (POME) and minimum energy dissipation or its simplified minimum stream power. These two hypotheses lead to families of downstream hydraulic geometry relations. The conditions are discussed under which these families of relations can occur in field. Also discussed is the relation between these conditions and scaling of exponents and energy expenditure.