Optimal Energy Expenditure, Discharge Skewness, and Geomorphic Effectiveness in relation to the Area-Slope Relationship

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Abstract An area-slope relationship for rivers is often described as a power function (slope = contributing area^z). The value of the exponent *z* is a widely discussed topic in the literature. Empirically, *z* lies near –0.65, which represents a concave longitudinal profile. Explanations for the degree of concavity include, but are not limited to, downstream fining of sediment, optimal energy expenditure, and tributary effects. Previous theoretical research on channel networks that expend minimum energy predict a static value of *z* equal to –0.5. We include skewness and geomorphic effectiveness of discharge in a simulation approach based on theoretical minimum energy expenditure research and assert that natural channels with $z \neq 0.5$ can potentially be optimal in energy expenditure. We relate model input parameters to grain size distribution and compare model predictions of area-slope relationships with empirical data.

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