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Small is beautiful: upscaling from microscale laminar to natural turbulent rivers

L. Malverti, **E. Lajeunesse** and F. Métivier (LDFG, IPGP)

Laboratoire de Dynamique des Fluides Geologiques, Institut de Physique du Globe de Paris, Paris, France

The use of microscale experimental rivers (typically having a length of several tens of centimeters and width of a few centimeters) to investigate natural processes such as alluvial fans dynamics, knickpoint migration, meandering or braiding has become increasingly popular in recent years. This raises the need to address the question of how to extrapolate from the experimental microscale at which flow is laminar to the scale of natural turbulent rivers. We address this question by performing measurements of the sediment transport law in an experimental laminar river. We show that laminar sediment transport is consistent with the law of \citet{MeyerPeter-1948} commonly used to describe sediment transport in natural turbulent rivers. We then demonstrate that the evolution of longitudinal bed profiles of turbulent or laminar rivers are governed by similar equations. Differences of time and length scales at work in experimental or natural rivers are encoded in the expression of only two parameters, a diffusion coefficient and a threshold slope. These parameters provide the key to extrapolating experimental results to the field scale as well setting the limits of doing so. We show that the elevation profiles of laminar and turbulent rivers follow the same dynamics provided the flow rate is kept constant. This study validates the use of experimental microscale rivers as a tool for investigating many fluvial processes.