EGU25-20329, updated on 09 Jun 2025
https://doi.org/10.5194/egusphere-egu25-20329
EGU General Assembly 2025

Influence of bed surface roughness on flow in rough-bed rivers

Robert Houseago[1,2], Rebecca Hodge[2], Rob Ferguson[2], Stephen Rice[3], David Whitfield[1,2], Christopher Hackney[4], Richard Hardy[2], Joel Johnson[5], Trevor Hoey[6], Elowyn Yager[7], and Taís Yamasaki[1]

[1]Loughborough University, Department of Geography and Environment, UK (r.houseago@lboro.ac.uk)
[2]Department of Geography, Durham University, Durham, UK
[3]Department of Natural Sciences, Manchester Metropolitan University, Manchester, UK
[4]School of Geography, Politics and Sociology, Newcastle University, Newcastle, United Kingdom
[5]Department of Earth and Planetary Sciences, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, USA
[6]Department of Civil and Environmental Engineering, Brunel University London, Uxbridge, UK
[7]Center for Ecohydraulics Research, Department of Civil & Environmental Engineering, University of Idaho, Boise, ID, USA

Riverbed surface roughness (or topography) modulates channel hydrodynamics, including the velocity and turbulence distributions, which underpin flood risk and sediment transport. Our recent research has presented the diversity of bed surface roughness found in bedrock and boulder-bed channels, prompting an investigation into the subsequent relationships between channel roughness and flow. Here, we investigate the influence of riverbed topography on velocity distributions and bulk flow resistance via physical modelling using 1:10 scaled flume experiments. Three bedrock riverbeds spanning from smooth to rough were reproduced from high-resolution laser scans. For each bed, the addition of boulders was tested for five boulder densities spanning from 5% to 55% coverage. Each combination of bed and boulders was measured at five incoming bulk discharges. Vertical profiles of the streamwise velocity reveal the deviations in velocity distribution over the beds, while depth and discharge measurements enabled the calculation of the Darcy-Weisbach friction factor for each of the five bulk discharges. The results show conditions of wake interference and skimming flow regimes, yet the traditional regime transition thresholds based on boulder coverage are not consistent, indicating the importance of the underlying bed roughness. Topographic data from Structure from Motion (SfM) photogrammetry of the beds was used to calculate surface roughness topographic metrics that correlate to changes in the bulk flow resistance and provide scope for improved predictions.