

2022_43_ESE_Whittaker: Landscape sensitivity to past and future climate: Solving the intermittency puzzle

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Understanding how changing climate affects erosional processes that shape the planet's surface is a key goal for geoscientists. Constraints on the intermittency of water flux and sediment transport in catchments are rare, but are of critical importance in reaching this goal. The data that exist indicate that bankful sediment transport rates, if sustained, would imply millennial sediment fluxes orders of magnitude greater than that observed in depositional archives or from erosional estimates. Consequently, small changes in the intermittency of fluvial transport, caused by enhanced storminess in a warming world, could significantly enhance erosion rates and sediment export. This project aims to solve the 'intermittency puzzle' by using a combination of field data from modern rivers; geological stratigraphy; and numerical modelling to provide new constraints on landscape and sediment routing system sensitivity to environmental change:

- 1) Using well constrained modern catchments in Greece, the student will calculate bankfull sediment transport capacities and water discharges, using published and new measurements of catchment geometry and sediment grain size. This locality is selected because its semi-arid climate is well-studied and because IODP data in the Corinth area have uniquely constrained Holocene sedimentation rates with exceptional fidelity. Flux estimates will be compared with Holocene depositional volumes and catchment average erosion rate estimates to calculate the ratio of actual sediment fluxes to potential bankful fluxes, were they to be sustained over the same time period – the sediment transport intermittency ratio. These sediment transport intermittencies will be directly compared with the present-day distribution of rainfall and historical data on the frequency of storm events.
- 2) These modern data sets will be compared critically to geological examples of arid systems. We will focus on Eocene fluvial deposits – the warmest Epoch of the Cenozoic. Well-studied exemplars in the Spanish Pyrenees will be selected as comparators. These systems have known depositional volumes, and well preserved channel architectures which enable bankful flow conditions to be reconstructed. Sediment transport intermittency will be compared to climate reconstructions for the mid and late Eocene and to modern examples.
- 3) Finally, the student will use a coupled model of a catchment-basin system, developed at Imperial with external collaborator Brooke, which includes rainfall intermittency and an infiltration threshold, to model sediment routing system response to rainfall variability. Predictions of how rainfall/storminess may evolve in the future for a range of scenarios will be used to forward model synthetic landscape evolution and erosional fluxes, using the geological data above to calibrate key inputs. The results will be used to solve the intermittency puzzle and identify catchment vulnerability to enhanced storminess.

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