Quantification of erosional processes using inertial sensors across environments

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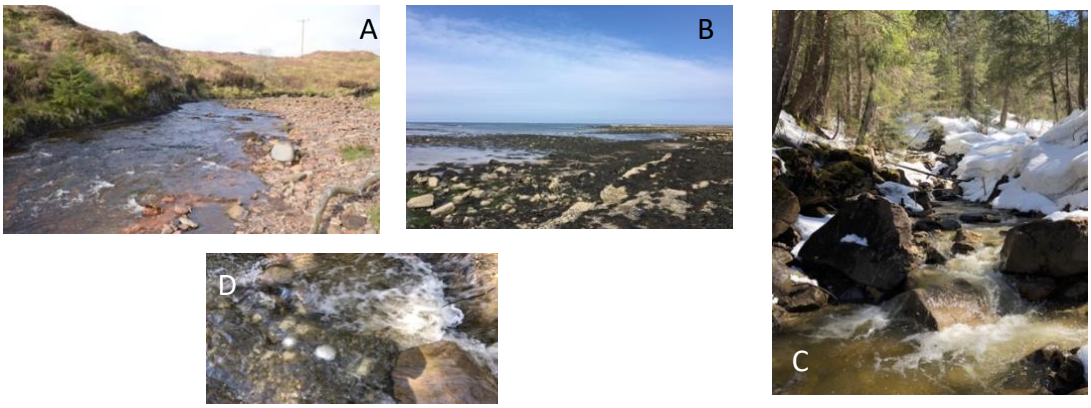
Project background and aims:

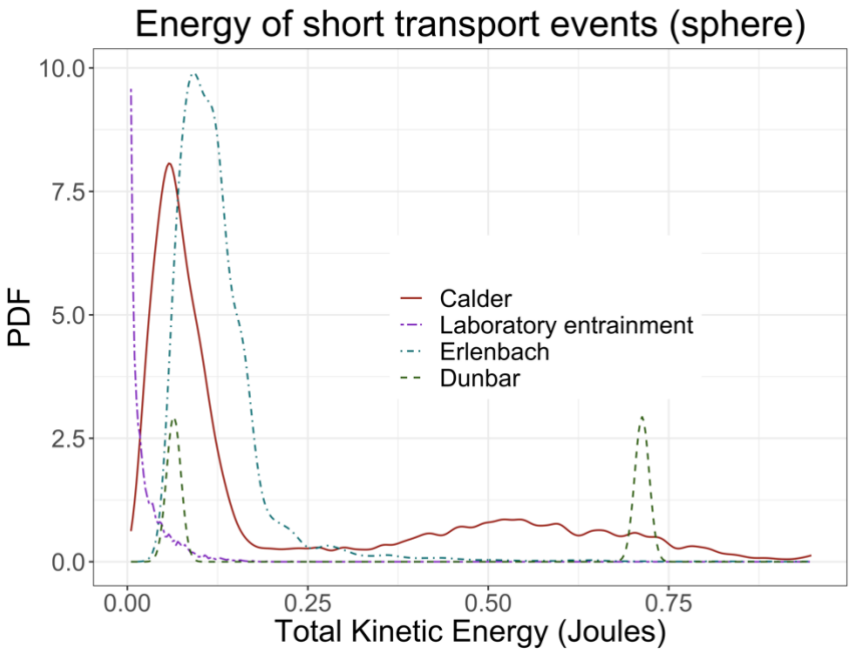
Grain scale dynamics exert significant control across the spatial and temporal scales of sediment transport. To date, there has been a lack of measurements that capture the scheme of forces exerted on individual grains, both in terms of force magnitude and frequency. Recent results [Maniatis et. 2013, 2016] demonstrate how low-cost Inertial Measurement Units (assemblies that comprise 3D acceleration and 3D orientation sensors), often called "smart pebbles" give new theoretical and empirical insights into coarse sediment motion, if detailed operational considerations are undertaken and the data are formally analysed. The aim of this project was to derive and cross compare IMU measurements in different sediment dominated environments and support the development of a new sensing system capable of long-term unattended monitoring. Currently, only measurements derived from two bedrock-alluvial streams (Calder in Scotland and Erlenbach in Switzerland) and a rocky coast (Dunbar Beach, Scotland) have been preliminary analysed.



(A) River Calder, Scotland site selected for measuring point grain vibrations (B) Dunbar Coast, sensors tested under oscillatory motions (C, D) River Erlenbach, sensors tested during vibrations and short-term transport events.

Project methodology

Two sensor assemblies where deployed for the three surveys: one spherical and one designed to simulate an ellipsoid. In the two river environments, the experiments focused on measuring long series of background vibrations and short-term grain transport events. The two rivers are of comparable geomorphic background, and the transport events where always initiated from submerged, high-flow, exposed bedrock areas. In the coastal experiment the sensors where placed on a low cover platform and subjected to oscillatory motions during retreating tide.



Continuation of work.

The results will inform the design of a second generation of smart pebbles. Building on an ongoing collaboration with Kinneir Duffort (RnD, Bristol) and Dr Andrew Markham (University of Oxford), we scheduled a detailed development plan which will extend the deployability, precision and capability of the existing system. The data collected in Erlenbach are included in a manuscript under the title "Coherent implementation of inertial sensors, in laboratory and field experiments", currently in preparation for the Water Resources Research AGU journal.

Funding extension.

The data will support an EPRSRC New Investigator Award Application (April 2019). The award also funded an exploratory study in Wales (supervision Larissa Naylor) and a research visit at GFZ Potsdam (Dr Jens Turowski), which initiated discussions towards collaborative funding applications for the development and evaluation of the sensor system.