Geophysical Research Abstracts
Vol. 18, EGU2016-18328, 2016
EGU General Assembly 2016

A cross-disciplinary understanding of incipient motion for effective environmental flow setting

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Environmental flow setting as a tool for maintaining ecological health in rivers has been a focus of debate for many years. Environmental flow setting often involves the establishment of base flow levels below impoundment structures as well as setting flushing flows in order to control excess periphyton accrual and sedimentation. The role of bedload transport and substrate stability is recognised as an integral part of effectively managing benthic communities, but environmental flow regulations often do not focus on managing sediment processes. Environmental flows which fail to scour periphyton have been attributed to increased biomass accumulation through increasing nutrient supply to periphyton mats. It may therefore be more effective to establish environmental flow models based on incipient motion thresholds. The aim of these models would be to establish target near-bed velocities as opposed to discharges.
Establishment of such models requires an accurate understanding of the threshold conditions for incipient motion. Despite decades of incipient motion studies scientists are unable to consistently and accurately predict bedload transport in natural channels. Incipient motion results from a complex set of geomorphic, hydrologic, and ecological interactions operating over a range of spatial and temporal scales. Direct measurement of these processes can be difficult and time consuming, and has been restricted by a lack of suitable high spatio-temporal resolution methods in the past. This paper presents a cross-disciplinary approach to the study of incipient motion to develop effective environmental flow targets. Recent developments in remote sensing and 3D point cloud analysis are used to characterise substrate surfaces. Groundwater head pressures are measured during floods to examine changes in threshold velocities under different seepage conditions. The onset of bedload transport is recorded using impact plate sensors to relate transport initiation to near-bed velocity metrics, seepage conditions, and substrate characteristics.
Setting effective environmental base flows is also a critical part of flow management. Whilst previous studies have shown a link between bed stability and benthic community composition, researchers have lacked a method to rapidly and accurately quantify substrate stability. This paper also presents preliminary findings from the development of a novel bed stability index for the rapid assessment of substrate stability.