Modeling bedload flux at sediment monitoring stations on supply-limited, sand-bed rivers

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Obtaining high-resolution measurements of suspended sediment load over multi-year timescales has become feasible thanks to recent advances in acoustic monitoring methods and technology. However, bedload can be an important component of total sediment load and remains difficult to measure directly. For practical purposes, bedload is typically treated as a constant fraction of suspended load, a power-law function of water discharge, or ignored. However, bedload flux may vary independently from water discharge or suspended sediment flux in supply limited rivers due to systematic grain size and reach-geometric effects.

We develop and apply a new method for estimating bedload flux from variables that are routinely measured at monitoring stations on the Colorado River in Grand Canyon National Park. Previous workers have used coupled changes in suspended sand concentration and grain size to track changes bed grain size and shear velocity, which are important predictors of bedload transport. We extend this reasoning to derive a power-law scaling expression that reflects changes in bedload flux driven by the complex interaction between flow, bed roughness, and evolving bed grain size in a simplified form. This expression is used to simulate bedload flux over the existing gage record at one monitoring site on the Colorado River. In order to manage uncertainty from multiple sources of information, simulation is conducted in a hierarchical Bayesian framework. This framework incorporates physical reasoning to augment limited bedload data obtained in March and July of 2015, and provides a straightforward means to conduct further analyses using Bayesian predictive distributions.

A low-cost technique to quantify river suspended sediment transport towards the assessment of coastal sediment budget

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Direct measurements of river sediment transport are required for several different activities, which span from the mere scientific curiosity to the application of the collected data for management aspects. While the former drives the effort of the scientific community to expand the knowledge about river dynamics, the benefits resulting from a successful quantification of river sediment load would be mostly felt in terms of improving and optimizing the management of both river and coastal systems. Many techniques involving various disciplines and different levels of technological solutions have been developed ultimately, sometimes using cumbersome equipments that do not allow extended data collection or rather expensive devices anyone cannot afford to employ. A low-cost instrument able to collect and transmit in real time the measurements of river suspended sediment load is here presented.

The proposed device is essentially a densimeter based on the Archimedes' Principle (Figure 1). The mechanical structure is composed by two separate structures linked together: a device composed by four floats, whose immersion level varies according to the density of water, and a floating structure storing the microprocessor and transmission unit, together with the sensor in charge of measuring the immersion level of the other device. The immersion level is measured through an ultrasound sensor that is able to calculate its exact distance from the upper surface of the four floats device. The

microprocessor unit is composed by an Arduino Mini board in charge of acquiring and processing the collected data, translating an immersion level information into a water density data, while the transmission unit is composed by an XBee Series 2 radio module, in charge of transmitting the density information to a data collection gateway provided with GSM connection positioned ashore. This gateway will transmit the locally collected data to a remote data collection centre that will store them in a database making them available through the Internet.

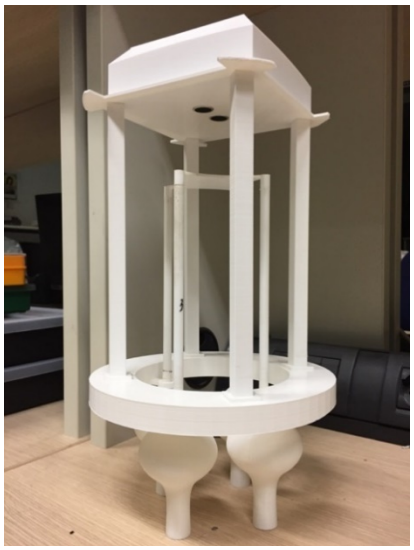

Figure 1. Picture of the device that quantifies the suspended sediment load and automatically transmits the collected data to a storage centre through a wireless network.

The future applications of the technique underlined by the development of the above mentioned device involve the investigation of the bedload transport, which is crucial for the complete definition of river contribution for sediment budget evaluation purposes. Based on the source-to-sink concept, river sediment transport as a whole is among the primary factors controlling the natural feeding of beaches: the lack of reliable measurements hinders the chance to adequately assess the sediment budget of specific sectors of coast, which in turn prevents the coastal managers to take conscious, and possibly right, decisions when the future of a coastal system (intended as catchment – beach – offshore) is on the line.

Improving geochronology in ancient terrestrial strata with detrital Zircon U-Pb maximum depositional ages: Examples from the Mesozoic Western Cordilleran Foreland Basin

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Resolving time in ancient fluvial deposits remains a challenge, and it is difficult to calculate rates of various processes without dates, or test correlation models without independent geochronological control for different geographic locations. This paper reports on efforts to improve geochronological frameworks for Mesozoic and Cenozoic clastic successions of the US and Canadian Western Cordilleran, and the Paleogene of the Gulf of Mexico, using detrital zircon U-Pb maximum depositional ages from fluvial deposits.

Maximum depositional ages (MDAs) are so named because host sediments can be no older than the youngest population of included detrital zircon U-Pb ages. MDAs are calculated from the mean of at least the three youngest U-Pb ages in a population that have overlapping error terms. MDAs can approximate true depositional ages if, and only if, there is significant syndepositional volcanism, such that volcanogenic zircons accumulate on the erosional landscape within a drainage basin, and are transported to the site of deposition in a sufficient concentration to be recorded in the deposit. They are therefore useful and possible in some settings, and not useful in others.

Jurassic and Cretaceous strata of the US and Canadian Western Cordillera illustrate this relationship. Jurassic Morrison zircon populations of the Colorado Front Range include large numbers of grains with ages of 147-149 Ma, which closely approximates geochron data from volcanic ashes, and corresponds to a well-known period of high flux in the Cordilleran magmatic arc. By contrast, Aptian fluvial deposits of the Lower Mannville Group in Alberta, or equivalent deposits in the Colorado Front Range, contain few MDAs that approach true depositional age, which reflects deposition during an early Cretaceous magmatic lull. Further upsection, the Albian Upper Mannville fluvial deposits of Alberta, and Albian-Cenomanian Dakota fluvial deposits of the Colorado Front Range, produce numerous U-Pb ages that again corresponds to a period of significant arc magmatism: U-Pb ages from the Upper Mannville and Dakota are consistent with, and improve on, bracketing geochronological data. Campanian Blackhawk and Castlegate fluvial deposits of the Book Cliffs in Utah represent an intermediate case, where they contain useful MDAs in some parts of the outcrop belt, but not in others, which reflects