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A conceptual model for gravel bed mean bed slope and bed load fluctuations

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Sediment transport prediction in ungauged basins is still a challenge for the scientific community. One surprising feature characterizing bed load of natural non uniform gravels is the existence of large, time and space, periodic fluctuations affecting the bed load and bed morphology. This phenomenon, that can largely influence a field sampling strategy, was investigated experimentally.

Flume experiments were performed over graded sediment, for long durations, and a wide range of flow conditions. No equilibrium slope was obtained whatever the run and the experiment duration (up to more than 60 hours). Instead a periodic pattern fluctuation was observed, affecting the bed slope, the bed state (varying from armor to fined bed) and the bedload discharge. Two kinds of fluctuations were observed: short (length and time) fluctuations associated with the passage of bedload sheets (local bed slope changes) and large fluctuations associated with overall changes in bed morphology.

The most striking finding is that when a constant feeding is maintained over a sufficiently long time, the bed states also evolves continuously, in a periodic manner, and cover almost all the states described in the literature (embedding of fine material, partial transport, paved or fined bed, patchiness, sand ribbons, downstream fining or coarsening, sorting in bedforms, bedload sheet, aggrading and degrading). Thus, the duration may be an important component of a flume experiment or field measurements analysis.

Bedload sheet appeared to be the keystone for explaining the short fluctuation periods, but also the long -term periodic changes in bed morphology. We hypothesized, from steep slope observations, that bedload sheet would be produced by a local and efficient

upstream grain sorting mechanism operating over a finite length L_s and producing sediment pulses which propagate downstream.

A conceptual compartment model, based on this concept, was proposed to simulate slope fluctuations observed in long-term flume experiments. It provides an illustration of a possible endogenous factor responsible for time scales affecting bedload. It also provides an interpretation for the flume length control on these periodicities.