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Erosion and sedimentation dynamics of fine-grained cohesive sediment in cobble bed alpine rivers

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While mountainous rivers are the main providers of fine particles to the oceans, cohesive sediments dynamics remains poorly understood. Strong and complex interactions exist between the coarse matrix of cobble bed rivers and fine sediments, these latter exhibiting numerous sedimentation and erosion steps during their transfer within the hydrographic network. Given that fine sediment load in alpine environments can be very high (10-100 gl-1) either due to intense natural rainfall or snowmelt events and to man-induced flushing flows from reservoirs, a better understanding of the deposition and sedimentation processes is needed in order to reduce ecohydrological downstream impacts. We tested a field-based approach on the Arc and Isère rivers located in the northern French Alps combining measurements of the erosion and settling properties of river bed deposits before and after a dam flushing. These measurements were performed with the U-GEMS (Gust Erosion Microcosm System) and SCAF (System Characterizing Aggregates and Flocs). A major result of this study was the rather high stability of the natural Alpine river sediments relative to what is measured in lowland or estuarine rivers. The measurements also highlighted that the critical shears, rates of erosion, settling velocities and propensity of particles to flocculate are highly variable in time and space. This is reflective of the heterogeneity of the hydrodynamic conditions during particle settling, the local bed roughness, the nature and size of fine particles. Thus it was not possible to make a conclusive assessment of the extent to which sediment deposited after reservoir flushing were different from those settled after natural events. The absence of any significant relationships between erosion and deposition measured variables makes it impossible to predict one from another. This underlined the need to measure all variables in order to have a full assessment of the fine sediment dynamics and to obtain representative input variables for numerical models. While the SCAF was an effective tool to assess settling properties, alternative methods to the U-GEMS device will be discussed to assess the erodibility of fine sediments stored in cobble bed rivers, in order to make more rapid measurements, possibly at higher shears.