The Need to Develop Compression and Decompression Data for Geomorphologists to Improve Sediment Volume Estimates from High-Resolution Topographic Data

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The present contribution is centred on (1) a need of paradigm and methodological shift for transported sediment volumes, due to the advent of point-cloud technologies and (2) an attempt of solution for debris-flow and heterogeneous material.

Point-cloud technologies such as terrestrial and aerial LiDAR and photogrammetrically-based data have broken the inverse correlation between resolution and space-scale. Indeed, defining landforms at a centimeter vertical and horizontal scale, along several tens of kilometers was until very recently a pandora box, which both acquisition technologies and the democratization of computing capacity have allowed scientists to open. Unexpectedly, new challenges and the need to shift some of the traditional paradigms have emerged. In the present contribution, the author asks the question of whether the faithful tandem "topographic change and erosion/deposition" needs a revisit or not. The hypothesis of this question is imported from soil engineering, where questions of compaction and decompaction are essentials (and well understood). In other words, when sediments and soils are being eroded and redeposited, does the relation between erosion and deposition holds when using high-resolution topography? To this first question, the author then proposes one solution (already explored with TLS) using SfM-MVS photogrammetry to measure in-situ the density of heterogeneous

Using simple laboratory experiments on different sediments to simulate (a) the effects of compression/decompression, and (b) the effects of self-comminution during transport, the author demonstrates that material fragmentation, and abrasion modifies the shape of the particles and their size resulting in variable bulk-volumes (as defined by the topography) for similar level of deposition energy, and that this volume change even further when the relay of processes are differentiated, resulting in further variation in the topographically measured volumes. In other words, the result show that high-resolution topography and topographical change does not signify high-resolution volumetric change, both in term of bulk and solid-phase volumes. It therefore appears that Geomorphology and Earth-Surface Processes Research need to integrate the use of soil density estimates from field-survey and also in the relay of processes model (i.e. should we expect compaction or decompaction from one type of deposit to another, and is the sediment transport modality expected to modify the shape and size of sediments significantly?).
Finally, the author presents one of the tools he has been working on for environments where compaction and decompaction are important: the transition between rockfalls/debris-flows/pyroclastic-flows and debris-flows, fluvial flow in heterogeneous media. The author shows how SfM-MVS photogrammetry can be used to replace the sand-cone density estimation method with a higher-fidelity and an estimate of calculated error. Using “reverse-engineering”, this density calculation method combined with high-resolution topography could be used to then estimate and define the transport modalities of sediments from one location to another.