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Understanding surface processes 3D imaging from micro-scale to regional scale

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The production of topography using remote sensing techniques has considerably been improved during the last fifteen years due to the advances in electronics and to the increase of computing power. The earth surface is monitored at all the scales using Space Shuttle Missions (SRTM) digital elevation model (DEM), or using laser scanner (LS), both terrestrial (TLS) and airborne (ALS), with accuracies that can reach up to less than 50 microns for observations of objects at meter scale. Recently, photogrammetry has been pushed by the progress of LiDAR and thanks to the advance in image recognition. It led to the development of new techniques such as structure-from-motion (SFM), which allows obtaining 3D point cloud based on several pictures of the same object taken from several point of views. Both LiDAR and Photogrammetry produce 3D point clouds.

One of the current 3D applications is the surface changes, which is often based simply on the subtraction of DEM at different time intervals, leading to a simple superficial description of the natural processes without information on the mass transport. However, a point cloud has much more information than a simple surface. For instance, shape recognition can be used to track objects or deformations such as a rock mass toppling, either using the shape of the point cloud or a specific moving element. Such method permits, for instance, to study in detail pre-failure accelerations, and are now routinely used in mining industry. Other methods are coupling images and DEMs and are used, for example, to capture the surface vectors of displacements in order to deduce the surface deformations of landslides.

These types of surveys have now broad applications to all kinds of erosional processes. The coastal retreat can be monitored, and it displays in some places several centimetres per year of retreat on average. The sediment transports in torrent are now better constraint showing clearly pulses. The seasonal cycles can as well be detected either for debris-flows prone catchments or at the level of the soil erosion such as in black marls context. In addition, the application of these methods to micro-scale erosional processes such as raindrop erosion permits to open new perspective in the understanding of the soil erosion that is a major threat.

Last but not least, these fine topographies can be used to map geology not only by the morphometric attribute but also by the intensity of the laser or by images from other sources, providing useful tools for lithological mapping. Therefore, the erosion processes are even better tackled, as it has been demonstrated for instance on granite cliffs. Furthermore, the use of surface information such as slope aspect etc. can give information on the ground structure. Large domains of research are now being opened, providing great perspectives in earth surface dynamics.