A new method to measure in situ soil density using SfM-MVS photogrammetry

*Christopher A Gomez[1]

1. Kobe University Faculty of Maritime Sciences Volcanic Risk at Sea Research Group

The measure of soil density in the field has been relying traditionally on the sand-cone method, the balloon method or the radioactive method. All those methods require heavy equipment, are not appropriate for non-horizontal surfaces, and do not provide control over the methodological error in the field, that is very site-dependent.
To solve this issue, the author has developed a new (or adapted other methods from different fields) method to measure the soil density using photogrammetry based on SfM-MVS, so that the method can be used in irregular soils that are coarse grains, and with limited equipment transported in the field. Furthermore, the method the author proposes can be used along outcrops vertically and on horizontal surfaces, whereas a perfectly horizontal surface was necessary up to present.
Results show good agreement between the water-measured hole volume and the SfM-MVS data, with the best linear fit correlation line of y=1.022*x+3.167, where x is the SfM-MVS calculation and y represents the water measurement. The water-measures are thus slightly higher than the volumes calculated using SfM-MVS. The RMSE of the upper 50% of the data is ~5 and the lower 50% displays an RMSE of 2.6 (about half of the top 50%). The author interpreted this result as being a function of the small crannies that are filled with water and that can’ t be calculated from SfM-MVS, which had a millimeter-scale infra-millimeter (after software calculation). Therefore the discrepancy between the two datasets can be potentially linked to the size of the surface of the hole walls and the roughness of the grains.
The photogrammetric-based method to measure field density proves to be a reliable method with a control on the potential error (error control from the photogrammetric method), providing a more reliable method of field density measure and calculation. At present, the author is preparing further result presentation with full-scale field data, showing the usability and reducing the weight of the equipment carried in the field.

Keywords: SFM-MVS photogrammetry, soil density, field measurement, unconsolidated soils