The Uncertainties of DoD Under Forest Cover with Multi-temporal Airborne LiDAR DEMs

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Abstract: All measurements of physical quantities are subject to uncertainties in the measurements. Uncertainty is the degree of a measure deviating from trueness and accuracy. An airborne LiDAR system is a complex integrated sensing system which may introduce substantial uncertainties when acquiring data due to both natural environment and human factors. The new capability to develop spatially distributed models of topographic change by multi-temporal DEMs acquired by airborne LiDAR becomes increasingly important in Taiwan, due to that most of the sovereign territory of Taiwan has been surveyed with LiDAR under National LiDAR Mapping Program.

Methods of geomorphic change detection (GCD), based on gridded models, may be applied to a wide range of time periods to measure erosion, deposition, and volumetric change. It is straight-forward to construct DEMs of difference (DoD) by subtracting one elevation model from another. The period of DoD analysis can be extended to several decades if accurate historical DEMs can be obtained. The challenge is to recognize and minimize uncertainties in multi-temporal DEMs which are subjecting to uncertainties such as flight plan parameters, landscape conditions, land surface conditions and the overall environment during data acquisition, especially that under tropical forest in southern Taiwan where laser penetration rate is relatively low.

This paper reviews potential sources of error in DoD for sedimentation assessment of a water reservoir. A comparison is made to find the difference of volumes between simple DoD and masked DoD over which only landslide areas are used and forested area are masked. The result shows that 55% of the total volume is due to the uncertainties of forest cover. To minimize the effect of uncertainties under forest cover when applying simple DoD, a data-set aggregation method is proposed for further experiment in addition to the masked DoD method. It is concluded that though airborne LiDAR DEM is claimed to be accurate cares must be taken to treat the uncertainties when it is applied to measure erosion, deposition, and volumetric change.

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Keyword : NSDI, ground penetration, land-cover type, landscape evolution, point clouds