Estimation of Composite Hydrodynamic Roughness Overland in Tropical Environment using Airborne LiDAR; A Case Study in Hutan Rekreasi Ayer Keroh Melaka

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Abstract: Parameterization of flood modeling overland has benefited from Airborne LiDAR technologies in many ways and one of the prominent examples is the estimation of hydrodynamic roughness. Low density airborne LiDAR with relatively low penetration over vegetation canopy under leaf-on condition further complicate the estimation of hydrodynamic roughness in tropical zone. This paper will present a detail investigation on the capability of airborne LiDAR data for hydrodynamic roughness estimation over tropical region in Air Keroh, Melaka, Malaysia. The study area is divided into four landcover classes i.e. building, forest, grassland and paved road. The airborne LiDAR data was obtained using the Optech ALTM 3100 in 2009 with a posting density of about 0.69 point per meter squared. The estimation of composite hydrodynamic roughness consists of four processing stages namely 1) landcover classification, 2) estimation of parameters as required by the hydrodynamic roughness, 3) estimation of hydrodynamic roughness of individual landcover class and 4) estimation of composite hydrodynamic roughness with different spatial resolutions. In the first stage, the landcover classification is performed by using Support Vector Machine (SVM) on the aerial photo of the study area obtained simultaneously with the airborne LiDAR. Estimation of hydrodynamic value for each landcover class requires different hydrodynamic models expressed by Manning's (n), Chezy (c), and Darcy (f) coefficients. The calculation of hydrodynamic roughness for each landcover class should be done separately, in which finally will be merged at specific spatial resolution to produce composite hydrodynamic roughness map represented by the Manning's n coefficient. In the stage of hydrodynamic roughness estimation building, forest, grassland and paved road require estimation of momentum absorption area, tree density, height of grass and area classified as road respectively. These parameters will be estimated by using airborne LiDAR data and aerial photograph. Estimation of tree density requires delineation of individual trees in forest area. Tree density and diameter at breast height (DBH) of individual tree is then estimated for each tree based on allometric equation. The overall accuracy for landcover classification is 96% with user and producer accuracies more than 80%. The results show that based on the airborne LiDAR data, the height of grass and tree DBH can be estimated with about 0.33m and 0.22m RMSE respectively. Finally, the composite hydrodynamic roughness is calculated based on the conventional averaging concept, which integrates different landcover types in a specific piece of land (spatial resolution).

Keyword: Composite hydrodynamic roughness, airborne LiDAR, allometric, tropical environment.