Detection of Tropical Landslides using Airborne Lidar Data and Multispectral Image: A Case Study in Genting Highland, Pahang

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Abstract: Landslide geomorphology system in a tropical region remained complex, and its understanding often depends on the completeness and correctness of landslide inventorization. In mountainous regions, landslides pose a significant impact and known as an important geomorphic process in shaping major landscape in the tropics. Modern remote sensing based approach has revolutionized the landslide investigation in a forested terrain. Optical satellite imagery, aerial photographs and synthetic aperture radar images are less effective to create reliable tropical DTMs for landslide recognition, and even so in the forested equatorial regions. Airborne laser scanning (ALS) data have been used to construct the digital terrain model (DTM) under dense vegetation, but its reliability for landslide recognition in the tropics remains surprisingly unknown. The present study aims at providing better insight into the use of airborne laser scanning (ALS) data: i) to investigate qualitatively the performance of different LiDAR filtering approaches in removing non-ground point clouds ii) to generate different parameters layers suitable for landslide recognition in tropical region, iii) to evaluate the capability of object-oriented approach to detect different types of landslides in a lowland evergreen rainforest region. The methodology was developed over the forested landslides characterized by tropical regime in Genting Highlands, Pahang and supported by field evidences. By using the Optech ALTM 3100 sensor flying on 3rd of August 2007, 728 412 million points with a mean point density of 0.66 points per meter squared is obtained. For the bare-earth extraction, the qualitative evaluation of several prominent filtering algorithms and surface interpolation methods are used; (i) progressive TIN densification, (ii) morphological, and (iii) command prompt from Lastool with aims in removing non-ground points while preserving important landslide features. For automatically identification of landslides, a series of topographic-, hydro-topographic-, geological structures-, and antropogenic factor maps were used which is purely derived from ALS data as input dataset for object-oriented landslide detection. Qualitative assessment is illustratively presented and critically discussed. As a result, progressive TIN densification filter algorithms able to extract ground points and Kriging surface interpolation method had a better strategy of producing reliable terrain models for tropical landslides. Derivative of DTM production; flow accumulation and hill shading are the best layer to classify the landslide in tropical region. By using OOA, three out of five landslides are correctly classified; debris flow, debris slide, and rotational landslides, however small landslide remains unrecognized. The results are promising given the complexity of the terrain and difficulty of generating precise terrain information in the tropics. This paper also addresses the limitation of the methods and highlights the research challenges in making reliable landslide inventory maps and subsequently used for assessing landslide hazard and risks in such environment. The method

of the present study is recommended for all forested mountainous terrain affected by landslides in the tropics.

Keyword: Landslide, airborne LiDAR, tropical, object oriented classification.