UNIVERSITI TEKNOLOGI MARA

QUANTIFYING FOREST DISTURBANCE USING LiDAR DATA AND TIME SERIES LANDSAT IMAGES

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PhD

July 2021

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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Thesis Title	:	Quantifying Forest Disturbance Using LiDAR Data And Time Series Landsat Images

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ABSTRACT

Tropical rainforest in Malaysia experienced logging activities either legal or illegal since 1960s. Natural regeneration become slower if the permanent production of forest is takes place in inappropriate manner until today. Remote Sensing technology is widely used in forestry application to preserve the natural resources. Airborne LiDAR sensor (ALS) is one of the technologies that can be applied together with satellite imagery available such as Landsat and has been proved as an efficient sensor in managing and analyzing deforestation and forest degradation in tropical rainforest. This research aim is to quantify forest disturbance using multi-sensor Remote Sensing in tropical rainforest. The research objectives are to determine forest and non-forest cover from Landsat time series in 2007 until 2018 and Airborne LiDAR sensor data by using vegetation indices (NDVI) and canopy height model (CHM); to identify the forest disturbance detection from Landsat time series by measuring the history period and structural change using BFAST model, and disturbance index (DI); and to quantify the forest disturbance in tropical rainforest using fusion image of spectral and height data by resampling Landsat (30m) into (1m, 15m) resolutions, object-based segmentation technique and classification method using Nearest Neighbor, Random Forest and Support Vector Machine. Two fusion data are tested; 1) $Spectral_{Landsat}$ and 2) $Spectral_{Landsat}$ + $Height_{ALS}$ by Random Forest and Support Vector Machine classification algorithm. The result shows second fusion data having 1 meter Landsat resolution and Airborne LiDAR performed better classification using object-based segmentation and Random Forest classification, about 96% of the overall accuracy with 0.91 kappa index of aggreement. Using the scale of interpretation for kappa statistic shows the very good agreement. Mcnemar's test (p-value <0.05) for $Spectral_{Landsat}$ + $Height_{ALS}$ using Random Forest classifier is 0.03. All objectives were achieved successfully and the findings shows that; 1) the higher the resolution of the fusion image, the higher the number of the scale parameter will be used in multi-resolution segmentation; 2) the accuracy of classification was improved when combining LiDAR and Landsat image and 3) quantifying the forest disturbance can be performed using NDVI, CHM and DI information.

ACKNOWLEDGEMENT

Firstly, Alhamdulillah. I wish to thank Allah for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully.

This thesis is dedicated to my family for the vision and determination to support and educate me. I feel grateful because my mother Noor Siah binti Zabidin and my father Rozali bin Shamsudin always pray for my best strength, good health, patience and blessings of ALLAH S.W.T. To my brothers (Mohd Uzair, Mohd Hafizudin, Hazim), sisters (Nor Hanisah, Hamizah, Adibah, Nur Syafina, Nurul Hidayah), niece and nephews (Husna, Uwais, Anas, Uwaimir, Affan, Ulwanuddin) that always help me in financial support, useful advice and cheered me up when I felt less motivated and stressed.

My gratitude and thanks goes to my main supervisor Prof. Sr. Dr. Zulkiflee Abd Latif and co-supervisor Pm Dr Nor Aizam Adnan for the support, patience and ideas in assisting me with this thesis. All your knowledge and experienced are very helpful and teach me how to become human with positive attitude and full of respect.

I would like to express my gratitude to Associate Professor Dr. Yousif Hussin, Drs. Evert Hendrik Kloosterman and their Masters students from the International for Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands for providing the facilities of instrument, knowledge and assistance during field work at Berkelah Forest Pahang.

Besides, I would like to express my gratitude to the Ministry of Higher Education Malaysia for MyBrain15 and Fundamental Research Grant Scheme (FRGS) number 600-IRMI/FRGS 5/3 (319/2019) as the financial support for this research and also to Airborne Research and Survey Facility, UK (ARSF UK) for providing the Airborne LiDAR data and the United States Geological Survey (USGS) for providing satellite imagery.

Finally, this is a thesis which is full of my courage and passion. To all my friends especially (Muhammad Syahir, Noorita, Sharifah Zalikha), thanks for the positive vibes and words of encouragement to keep me strong.
Thank you.

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