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Identification and Seasonal Analysis of Degraded Tropical Peatland by Using ALOS AVNIR-2 Data

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Abstract

Tropical peatlands are being subjected to the consequences of rapid economic development without any consideration of the importance of sustainable management practices. Sustainable management of tropical peatlands is an important element in controlling carbon emission. However, the available information of tropical peatlands lacks of accuracy and is outdated, especially in terms of medium to high resolution. Thus, development of reliable monitoring techniques is a significant step towards the sustainable management of tropical peatlands. The remote sensing (RS) application is suitable as a tool to monitor tropical peatlands, whereas direct measurements are generally labor-intensive, time-consuming and limited to accessibility. In this study, methodology to identify degraded tropical peatland was developed by using the McFeeters Normalized Difference Water Index (McFeeters-NDWI), which was derived by Advanced Land Observing Satellite (ALOS) Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) data. Additionally, a seasonal analysis was carried out to examine the characteristics of degraded tropical peatland during the rainy and dry seasons from the viewpoint of the medium to high resolution of optical RS. Overall, a relationship was discovered such that the wet shrub class was considered as the degraded tropical peatland area, and was identified as being in between -0.43 to -0.11 of the McFeeters-NDWI value. The wet-shrub class yielded a producer's accuracy of 80.6% and a user's accuracy of 91.8%. Afterwards, the seasonal change was discovered to slightly shift the threshold values (TrVs) in the identification of degraded tropical peatland by as much as -0.05. However, the interval of the TrVs for the wet shrub class was stable and remained unchanged.

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Keywords: tropical peatlands; McFeeters-NDWI; ALOS AVNIR-2; remote sensing

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1. Introduction

Tropical peatlands play an important role in the global carbon balance, while being recognized as one of the largest terrestrial carbon stores (Jauhiainen et al., 2005). Therefore, tropical peatlands have a direct relationship with the process of global climate change (Jaenicke et al., 2008). Unfortunately, tropical peatlands are being subjected to the consequences of rapid economic development without any consideration of the importance of sustainable management practices (Rieley et al., 2008). Excessive land conversions to commercial plantations, drainage and illegal logging have led to fires, as well as large increases in carbon emissions to the atmosphere (Rydin and Jeglum, 2006). Sustainable management of tropical peatlands is an important element in controlling carbon emission. However, the available information on tropical peatlands lacks accuracy and is outdated (Page et al., 2007), especially in terms of medium to high resolution. Thus, the development of reliable monitoring techniques is a significant step towards the sustainable management of tropical peatlands. The remote sensing (RS) application is suitable as a tool to monitor tropical peatlands, whereas direct measurements are generally labor-intensive, time-consuming and limited to accessibility. The use of the RS application to the monitoring of tropical peatlands has been increasing expeditiously in recent years, along with the availability of RS data sets (e.g., Page et al., 2002; Wijaya et al., 2010; Wahyunto et al., 2012). The data from the Advanced Land Observing Satellite (ALOS) Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) are a particular concern, as they provide a medium to high spatial resolution of 10 meters for optical RS data (JAXA, 2008). The present study was carried out to develop methodology for identifying degraded tropical peatland using ALOS AVNIR-2 data. The McFeeters Normalized Difference Water Index (McFeeters-NDWI) was evaluated to measure the amount of wetness in shrub areas, as well as examine the characteristics of degraded tropical peatland from the perspective of the medium to high resolution of optical RS. In addition, a seasonal analysis was carried out to examine the characteristics of degraded tropical peatland during the rainy and dry seasons from the perspective of the medium to high resolution of optical RS.

2. Materials and Methods

2.1 Description of the study area and dataset

The study area was taken from the catchment area of the Kahayan River in Central Kalimantan, Indonesia (Fig. 1). In general, the condition of tropical peatland in this area is mostly in a severely degraded condition (Jaenicke, 2010). A sparse to medium vegetation layer in the form of shrubs covers the degraded tropical peatland in this area. This condition was considered as a key parameter in order to identify the degraded tropical peatland. In this study, ALOS AVNIR-2 data, acquired on 11 January 2009 (rainy season) and 17 October 2010 (dry season), were used as the primary data. An existing land use/cover map, published by the Indonesian Geospatial Information Agency, which was updated by using visual interpretation, was used as a reference map. In addition, data collected from a ground truth survey conducted between 23 and 28 August 2013 was used to provide basic information about the study area.

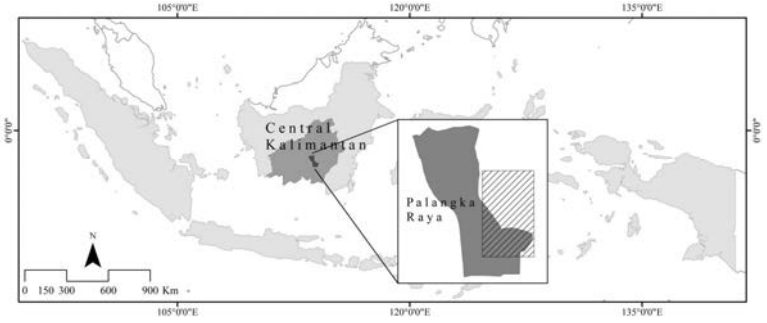

Fig. 1. Map of Indonesia showing the location of the study area (hatched rectangle).