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Procedia Environmental Sciences 33 (2016) 386 – 392

Procedia Environmental Sciences

The 2nd International Symposium on LAPAN-IPB Satellite for Food Security and Environmental Monitoring 2015, LISAT-FSEM 2015

Land cover change and its impact on flooding frequency of Batanghari Watershed, Jambi Province, Indonesia

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Abstract

Batanghari Watershed experiences rapid land cover change due to the expansion of agriculture plantations such as oil palm and rubber. Based on National Board for Disaster Management (BNPB) report, flooding frequency in Batanghari Watershed increases steadily in the last 15 years. Objective of the research was to analyse land cover change and its impact on flooding frequency of Batanghari Watershed Jambi Province. Land cover change was analysed using Landsat images from year 1990 and 2013 in combination with Planology Agency land use maps and concession data of oil palm plantation obtained from Plantation office (DISBUN) Jambi Province. Landsat images were processed using Carnegie Landsat Analysis System–Lite (CLASlite) module to differentiate undisturbed (primary), disturbed (secondary) forest and also oil palm growing stages. Flooding frequency was analysed using disaster database from BNPB. The study showed that land cover change in Batanghari Watershed contribute to the higher flooding frequency of Batanghari Watershed.

Peer-review under responsibility of the organizing committee of LISAT-FSEM2015

Keywords: forest cover change; intact forest clearing; landsat images; logged forest; oil palm concession

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Peer-review under responsibility of the organizing committee of LISAT-FSEM2015
doi:10.1016/j.proenv.2016.03.089

1. Introduction

In the last ten years, Southeast Asia has experienced dramatic land-use changes. In particular, the area under oil palm plantation has increased, often sacrificing forested areas [1, 2]. Forest cover changes can have great impact on hydrological characteristics of a watershed. Flood discharge can increase as a result of a change in land use. Flood peak flow may increase after trees are cut down [3, 4]. Jambi province is experiencing rapid land use change. The main driver for land use change in Jambi is the expansion of plantation crops such as oil palm and rubber. In line with rapid land use change in Jambi, flooding event increased with an alarming rate. Objective of this study was to analysis forest cover change and expansion of plantation crops (oil palm and rubber plantations) and relate those change into flooding frequency in Batanghari Watershed.

2. Materials and Methods

The study area is located in Batanghari Watershed Jambi Province, Indonesia covering an area of 5.3 millions ha (Fig 1).

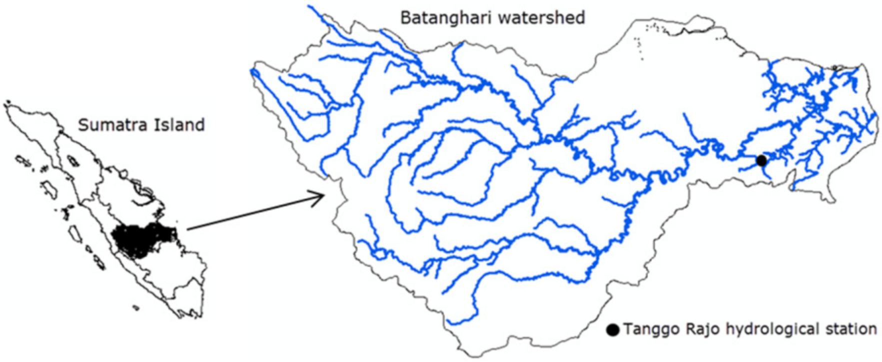

Fig. 1. Location of study in Batanghari Watershed, Jambi Province, Indonesia

2.1. Land cover changes

We differentiated forest cover into the following categories: a) primary forest, and b) secondary forest. Primary forest is undisturbed forest cover. Meanwhile, secondary forest is primary forest having experienced logging activities. We analyzed forest cover change into plantation crops in the period between 1990 and 2013.

To determine proportion of land use types in 1990 we used land use map from Planology Agency Ministry of Forestry as reference and cross-checked with Landsat image of 1990 (Landsat 5) paths 125, 126 and rows 061, 062 especially for forest and plantation covers. Meanwhile, for land use map of 2013 we used land use map 2011 from Planology Agency and updated it using Landsat 8 image of year 2013. During update, we focused particularly on two land use types which we considered as having dynamic change during 2011-2013, namely forest cover and oil palm plantation. Both land use types were relatively easy to identify in Landsat 8 image. During update we found that forest cover in 2011 far greater than that found in Landsat 8 image. Meanwhile, oil palm plantation area in 2013 markedly greater than that in 2011.

The land cover in the Landsat images was processed using Carnegie Landsat Analysis System–Lite (CLASlite) module to differentiate undisturbed (primary), disturbed (secondary) forest and also oil palm growing stages (Fig. 2). The module converts Landsat data to reflectance and applies Automated Monte Carlo Spectral Unmixing model, yielding fractional cover consisting of photosynthetic vegetation, non-photosynthetic vegetation, and bare substrate per pixel [3]. The dead or senescent vegetation fraction is termed non-photosynthetic vegetation (NPV), which is expressed in the spectrum as bright surface material with spectral features associated with dried carbon compounds in dead leaves and exposed wood [5]. Bare substrate is dominated by exposed mineral soil, but can also be rocks and