4th World Congress on Agroforestry

20-22 May 2019
Montpellier, France

Book of Abstracts

L16_O.06

Fine-scale mapping and dynamics of cyclic agroforestry agriculture using UAV remote sensing in Borneo

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The swidden agriculture practice, a cyclic agroforestry system that presents high ecological heterogeneity, still represents the most used farmers' practice in the SE Asian region, experiencing rapid land-use transitions driven by the conversion of biodiversity-rich ecosystems to monoculture plantations. Increased fragmentation creates mosaic of land cover types difficult to map. Challenges persist for evaluating such matrix configuration using satellite remote sensing. The present study explores feasibility, advantage and inconvenience of UAV technology for the acquisition of geospatial data to better understand, fine-scale agroforestry landscape fragmentation, connectivity and the dynamics of the burning and cropping phase.
The study site is a swidden agriculture forest landscape, north of Kapuas Hulu regency in West Kalimantan, Indonesia. The drone system consisted of a customized SkyWalker fixed-wing plane equipped with RGB camera (resolution 7-12 cm). Each flight at 400 m elevation covered around 3000 ha, replicated over 3 years, in the month of October after the burning phase season. Orthophoto mosaics were created using AgiSoft software. Object based image classification (OBIA) was tested with open source software to create a reproducible and automated assessment of landscape, together with an appraisal of the landscape metrics. Ground check and vegetation sampling were performed for each mapped classes.
The results showed that: (1) Up to 25 vegetation classes can be easily interpreted visually, but the low spectral resolution of RGB bands restricted the number of classes used for OBIA; (2) The area of swidden agriculture on forest increased only by 2%; (3) Over 80% of swidden fields were transformed from fern savannahs, the rest mainly taken on young fallows; (4) From 2016 to 2019, the frequency of swidden fields in the district remained constant; (5) The proportion of very short burning cycle (1 to 3 years) was around 50%, revealing that swidden cycles in this particular area were shortened; (6) Overall, connectivity of old fallows and forest patches was maintained.
This particular study represents promising preliminary steps in fully mapping the agroforestry landscape for future monitoring. Local people involvement was critical in mapping their landscape. Integrating ground-based surveys with UAV remote sensing appeared as promising tool essential for achieving cost-efficient wide-scale surveys of agroforestry resources and to monitor changes and long-term sustainability of the system. The ecosystem recovery time following initial slash-and-burn practices may be longer in our study area. Soil impoverishment related to reduction in rotation length may become a serious threat likely to jeopardize the production of goods and services in the long-term. In our study site, the long-term persistence of the swidden agriculture system maybe at stake, if enhanced management of fallows and agroforestry plots (enrichment planting) is not performed.

Keywords: swidden agroforestry, UAV, land use land cover change, communities, Borneo.