Monitoring forest disturbance using medium spatial resolution satellite imagery – a case study in Cambodia

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Abstract

Even though forest degradation is responsible for a large share of carbon emissions due to land use, land use change and forestry activities (LULUCF) (Pearson et al, 2014) the monitoring of degradation activities is technically more challenging than detecting deforestation events. In the context of REDD+ (Reduction of Emissions from Deforestation and Forest Degradation) the long-term reduction of biomass due to anthropogenic activities in forests remaining forests is the most prominent aspect of forest degradation (GOFCGOLD, 2014). Depending on location and forest type various degradation drivers occur in Southeast Asia with different effects on the forest ecosystems (Miettinen et al, 2014; Stibig et al, 2014). In our study we analyze forest disturbance mainly caused by selective logging in a tropical evergreen forest in Cambodia (Kampong Thom province) by monitoring changes in canopy cover over time. For this purpose, two cloud- and haze-free Landsat 8 scenes from January 2014 and April 2015 are selected, the former serving as base and the latter as secondary scene. A comparison of the top of atmosphere (TOA) reflectance values of the two scenes is used to derive information about disturbances in canopy cover, involving the following steps of image processing: Firstly, we generate an evergreen forest mask using a fully automated pixel-based classification algorithm from a series of Landsat imagery from October 2013 and to April 2014. Forest disturbance events occurring from 2014 to 2015 are then detected and analyzed within that mask. Secondly, in order to compensate for non-anthropogenic differences in the spectral values of the vegetation most probably caused by varying soil water content or other seasonal effects, a relative normalization of the secondary scene to the base scene is applied. This is achieved by adding a local correction matrix to the secondary scene, which is derived by calculating the difference of both median-filtered scenes. Finally, changes in the canopy cover are derived by calculating the difference between the normalized burnt ratios (NBR) of both scenes. The NBR is calculated similar to the NDVI but replacing the red band by the short-wave infrared band (SWIR 2 at 2.11 - 2.29 μm). While values around 0 indicate areas of no forest disturbance, any deviations can be interpreted as openings (positive values) or closings (negative values) of the crown cover. In our study only crown cover openings are analyzed (Figure 1). Visual comparisons with spatially high-resolution RapidEye scenes
from February 2014 and March 2015 (Figure 2) confirm the capability of the approach to identify small-scale or even sub-pixel changes in crown cover closure. The result shows that by applying the difference between two normalized scenes an almost complete reduction of topographic effects can be achieved, which enables in contrast to single-scene approaches the monitoring of forests in mountainous areas. Furthermore, the relative normalization derives consistent and comparable results, thus allowing a time series analysis over longer periods (GFOI, 2013). Using Sentinel-2 imagery from the coming dry season 2015/16 we expect to derive an even more detailed detection of small-scale disturbance events (Miettinen et al, 2015).

Figure 1: Landsat-based disturbance monitoring showing the openings of the crown cover (violet) that occurred between January 2014 and April 2015 (white areas reflect masked pixels)

Figure 2: High spatial resolution RapidEye reference scene from March 2015 clearly showing the openings of the crown cover due to selective logging activities

References


