Assessment of forest degradation by selective logging in the Brazilian Amazon using a multi-temporal dataset

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The forests in the Brazilian Amazon have undergone heavy pressures in recent decades not only due to deforestation but also from degradation processes (e.g. unsustainable logging, forest fires, etc.), which are still poorly monitored. The Brazilian National Institute of Spatial Research (INPE) has mapped forest degradation in the Brazilian Amazon (DEGRAD project, INPE 2008) since 2007 but a preliminary assessment showed that many selectively logged forest areas are not being included.

Mapping selective logging is still challenging because (1) logging evidence (e.g. roads, logging decks, skids) can be detected by remote sensing imagery only for a limited amount of time because the forest canopy closes rapidly after the logging event (Asner et al., 2009); (2) logging result in a complex environmental landscape including vegetation, dead trees, bare soil, etc. (Souza, 2009) and (3) selective logging and forest fires happen in a synergistic and recurrent way, showing highly dynamic and complex temporal and spatial patterns (Souza, 2013). Landsat imagery has been extensively used for mapping selective logging in the Brazilian Amazon (Asner et al., 2005; Souza et al. al, 2005, Matricardi et al. 2007, 2012). However, Landsat datasets have limitations especially due to the spatial resolution.

The objective of our study is to compare Landsat 8 and Sentinel-2 imagery for mapping selective logging in the Brazilian Amazon focusing on the assessment of the benefits of combining the two types of imagery for such purpose. Moreover depending upon Sentinel-2 image availability, we expect to perform an assessment of intra-annual changes in order to better understand selective logging spatial-temporal patterns.

Our test area (Figure 1) is located in northern part of Mato Grosso, within the Amazon biome. Mato Grosso is a key state of the Brazilian Amazon in relation to its high rates of deforestation and high occurrence of selective logging. All available cloud-free sentinel 2 and Landsat 8 images will be assessed for year 2015. In addition, one Landsat image per year will be used for the long term assessment over the period 2005 – 2015. Our approach combines object-based (to build a forest mask) and pixel-based (fraction images) classification strategies and encompasses the following steps: (1) data selection and pre-processing, (2) creation of fraction images from linear spectral mixing model (Shimabukuro and Smith, 1991), (3) production of a forest mask through an object-based classification approach and (4) development of an interactive and sequential classification approach initially identifying cleared areas and then assessing
selectively logged areas from the soil fraction image. Building a forest mask is an essential step to avoid mapping logging affected areas directly as deforestation. The fraction images help to deal with land cover heterogeneities within a pixel, especially for Landsat, and to highlight areas with high reflectance such as bare soil and clear cuts (Shimabukuro et al., 2014). This approach has already been tested for Landsat and will be assessed and adapted to Sentinel-2 data. A detailed comparison of the results will be performed in order to assess the differences on the estimated areas (incl. logging roads, logging decks, canopy damage, etc.) using datasets at 30m and 10m spatial resolution (Figure 2).

Lessons will be derived for the use Sentinel-2 data for mapping forest degradation in the Brazilian Amazon in the context of REDD+ activities.

Figure 1: Study area (red) in Mato Grosso State (grey) and the Brazilian Amazon biome (green)
Figure 2: Selective logging in (a) Landsat 8 (08/10/2015) and (b) Sentinel 2 data (28/09/2015).

References


