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Mapping Tree-based Systems in Tropical Landscapes: Fostering Sustainability at Agricultural Frontiers (Zambia, Ecuador, Philippines)

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Abstract

Global forest maps, such as Hansen's Global Forest Change (GFC) dataset, are inestimable tools to monitor land cover and land use effectively at large-scale. This is a precondition to support international environmental objectives such as defined by the SDGs or Forest Landscape Restoration (FLR) and to design policies that support the future life on Earth. However, the applicability of large-scale remote sensing products at local levels still faces operational challenges. This is particularly critical in tropical landscapes, due to the lack of reference data or the permanent cloud cover presence. Finding consistent and valid forest definitions, which target the vast diversity of tropical vegetation can also be challenging. For instance, defining adequate tree cover thresholds of the GFC product that match specific forest characteristics is strongly dependent on the region of application. Additionally, other tree-based systems such as agroforestry and fast-growing vegetation cause further classification uncertainty. The accurate differentiation of forests, agroforestry and other tree-based systems can help to support natural resource management in tropical landscape mosaics, especially those located at the agricultural frontiers. We collected 16,000 ground control points/photographs and digitised 18,000 ha (with details on land use and disturbance history) across thirty-six landscapes, located in nine regions of Zambia, Ecuador and Philippines, which constitute a gradient of pantropical deforestation contexts. We generated forest masks covering our landscapes (0.36 Mha) and regions (15 Mha), by combining remote sensing data from different satellites (Landsat-8, Sentinel^{-1}, SRTM). Furthermore, we validated the quality of our maps across our deforestation gradient and compared them to seven national and global forest datasets (including GFC), which are commonly used in international reporting such as FAO or UNFCCC. We observed recurrent difficulties in distinguishing forest from other vegetation, especially from mixed tree-based systems (e.g. perennial crops, palms and other agroforestry arrangements). Our results highlight that the importance of ground truthing as accompanying method to establish efficient land cover and land use monitoring systems. This is especially relevant in tropical regions of advanced stages of deforestation and early stages of reforestation; precisely, where current FLR initiatives (Agenda 2030, Bonn Challenge), are likely to occur.

Keywords: Ecuador, forest mapping, forest monitoring, land cover, land use, Philippines, remote sensing, tropical deforestation, Zambia

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