

Mapping Deforestation and Forest Degradation Using Landsat Time Series: a Case of Sumatra—Indonesia

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Abstract

Indonesia experiences the second highest rate of deforestation among tropical countries (FAO 2005, 2010). Consequently, timely and accurate forest data are required to combat deforestation and forest degradation in support of climate change mitigation and biodiversity conservation policy initiatives. Remote sensing is considered as a significant data source for forest monitoring purposes, and has been widely used for monitoring deforestation and forest degradation. However, varying definitions have been an obstacle for optimizing the use of remote sensing for a reliable monitoring system, in addition to the problem of cloud cover in Indonesia. In this work, we demonstrate an applicable definition and methods that enable using remote sensing data sets for forest monitoring. We examined Sumatra as a case study, as Sumatra Island stands out due to intensive forest clearing that has resulted in the conversion of 70% of the island's forested area through 2010. We present here a hybrid approach to quantifying the extent and change of primary forest in terms of primary intact and primary degraded classes using per-pixel supervised classification mapping followed by a GIS-based fragmentation analysis. Loss of Sumatra's primary intact and primary degraded forests was estimated to provide suitable information for the objectives of the United Nations Framework on Climate Change (UNFCCC) and the Reducing Emissions from Deforestation and Forest Degradation (REDD and REDD+) program. Results quantified 7.54Mha of primary forest loss in Sumatra during the last two decades (1990-2010). An additional 2.31Mha of primary forest was degraded. Of the 7.54Mha cleared, 7.25Mha was in a degraded state when cleared, and 0.28Mha was in a primary state. The Geoscience Laser Altimeter System (GLAS) data set was employed to evaluate results. GLAS-derived tree canopy height indicated a significant structural difference between primary intact and primary degraded forests (mean height $28\text{m} \pm 8.7\text{m}$ and $19\text{m} \pm 8.2\text{m}$, respectively). Results demonstrate a method for quantifying primary forest cover stand-replacement disturbance and degradation that can be replicated across the tropics in support of REDD+ initiatives. Furthermore, we can incorporate the results with the biomass assessment derived from GLAS data to illustrate the biomass by type in Sumatra.

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