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Baseline data on forest loss and associated uncertainty: advances in national forest monitoring

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Abstract

Countries participating in climate change mitigation via the United Nations Framework Convention on Climate Change reducing emissions from deforestation and forest degradation mechanism are required to establish national forest monitoring systems. The design of national forest monitoring system includes provision of transparent, consistent and accurate estimates of emissions and removals from forests, while also taking into account national circumstances and capabilities. One key component of these systems lies in satellite remote sensing approaches and techniques to determine baseline data on forest loss against which future rates of change can be evaluated. Advances in approaches meeting these criteria for measuring, reporting and verification purposes are therefore of tremendous interest. A robust example advancing such approaches, focused on Peru, is provided in the recent paper of Potapov *et al* (2014 *Environ. Res. Lett.* **9** 124012).

Many developing countries are engaged in preparation for reducing emissions from deforestation and forest degradation (REDD+) under the United Nations Framework Convention on Climate Change (UNFCCC). An indication of the level of engagement is the fact that some 47 countries have now joined the readiness fund of the World Bank's forest carbon partnership facility (FCPF), a fund directed to preparing tropical and sub-tropical countries for REDD+. Readiness for REDD+ requires participating countries develop a robust national forest monitoring systems (NFMs) that allow for transparent, consistent over time and accurate estimation of greenhouse gas (GHG) emissions and removals from forests (UNFCCC 2009, 2013). NFMs require a combination of remote sensing and ground-based forest carbon inventory approaches (UNFCCC 2009, Goetz *et al* 2014) and following the guidance and guidelines provided by Intergovernmental Panel on Climate Change for estimating carbon fluxes from forests (UNFCCC 2013). The UNFCCC REDD+ decisions also specify a step-wise approach to monitoring improvements towards performance-based payments (UNFCCC 2010). Thus, the preparation of countries for measuring and reporting GHG emissions based on forest cover change (activity data) and carbon density (emission factors) is rapidly advancing. However, as recently as 2010, only 4 of 99 developing countries were approaching a state of effective national forest monitoring, with many countries having large capacity gaps, particularly in tropical Africa (Romijn *et al* 2012).

For measuring activity data, there is general consensus that satellite remote sensing is the most practical way to establish baseline deforestation rates against which future rates of change can be monitored (Achard *et al* 2010, Baker *et al* 2010). Many developing countries lack the resources and expertise to use remote sensing to evaluate forest extent and change, and some do not have national land-cover map available, so widespread technical capacity building efforts are needed. Several countries have 'snapshot' land-cover maps for one or two points in time, typically years apart, but they fail to capture annual deforestation events and associated land-use/cover dynamics (Pelletier *et al* 2013). Moreover, the methodologies used to create such maps often lack technical details necessary for adequately assessing map accuracy. When good practices for estimating uncertainty of changes in forest area are applied, the variability of the estimates have a major impact on associated GHG emissions estimates (Olofsson *et al* 2013). Good practice change assessment should include estimates of the accuracy of change, change area adjusted for the classification error, confidence intervals associated with the

accuracy, and error statistics on the area of change (Olofsson *et al* 2014). These good practices allow identifying and targeting the sources of uncertainty, as well as prioritization of capacity advancement in a continuous manner to advance remote sensing approaches and techniques.

In this sense, the work of Potapov *et al* (2014) is important for advancing operational REDD+ measurement and reporting because it responds to the very criteria that are desirable for accurately estimating emissions from deforestation as part of NFMs. Potapov *et al* establish a statistically robust baseline on the rates and extent of forest loss for the humid tropical biome of Peru. In doing so they provide a well-documented, repeatable change detection approach that is consistent over time, and can be extended forward and backward in time for forest change monitoring. They provide an example of operational national REDD+ forest monitoring that is well-documented and transparent, thereby establishing a reproducible approach that other countries might well emulate. Their methodology for assessing accuracy, based on samples of high spatial resolution imagery for estimating total forest and change area statistics, also provides a source of validation for their 'wall to wall' full coverage maps. Their work is a national-scale refinement and implementation of the global approach recently advanced by Hansen *et al* (2013).

The approach of Potapov *et al* (2014) also advances the attribution of forest cover change by separating natural from anthropogenic disturbances, an important criteria for addressing the drivers of change and establishing payment for performance under REDD+ (Goetz *et al* 2014). In the case of Peru, they find anthropogenic disturbance accounts for over 92% of gross forest loss. Their approach further attributes forest cover loss by year of change and forest type, which establishes a basis for potentially assessing carbon removals of GHG from the atmosphere via vegetation recovery and regrowth. The application of this multi-step approach establishes a firm basis for assessing activity data for REDD+, as well as potentially providing a means to maintain consistency with national GHG inventories in the broader land use, land use change and forestry sector. Establishing these baseline data sets for ongoing forest change can also serve as input for establishing forest reference emission levels and forest reference levels.

Broad-scale efforts are underway to advance NFMs in developing countries, with significant technical and financial support dedicated to this in REDD+ participating countries (e.g. UN-REDD[1] and FCPF[2]). The design phase of these efforts includes the selection of appropriate remote sensing approaches and techniques that are also cost-efficient and tailored to national circumstances and capabilities (De Sy *et al* 2012, GFOI 2013). The work of Potapov *et al* (2014) provides an advance in this regard as well since they established meaningful collaboration and real partnership between Peru's Ministry of Environment (MINAM) and the University of Maryland, thereby ensuring sustainable development of capabilities for national scale forest monitoring and response to the drivers of deforestation. The suitability of their approach is further aligns with several important criteria for REDD+ measuring, reporting and verification, including data continuity, cost and access, as well as data processing repeatability across space and time. This collaborative effort demonstrates a clear advance in the implementation of technological capabilities and the development of a robust national forest monitoring system. The work of Potapov *et al* (2014) clearly shows there is no current technological limit to robust measurement, monitoring, reporting and verification of deforestation activities. Their work thus paves the way to improved emissions estimates from forest loss and associated efforts to mitigate climate change under REDD+.

[1] The UN-REDD programe supports national readiness in 56 partner countries in Africa, Asia and, Latin America, with a financial contribution of totaling US$195.7 million in June 2014. Available at: http://www.un-redd.org/

[2] The FCPF of the World Bank's support to countries via the readiness fund sums up to US$360 million. Available at: https://www.forestcarbonpartnership.org/

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