

Section Summary

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REDD+ and Forest Degradation

REDD+ implementation requires two key steps: (1) establish a reference emission level or reference level (RL); and (2) monitor performance against the reference level (RL). A monitoring system must be able to monitor the performance of implementing action plans to reduce emissions. Degradation activities are of concern because it is unknown to what degree they are contributing to emissions, with potentially and in some cases likely significant contributions to emissions. For REDD+ the key feature is the need to estimate the net emissions from *anthropogenic-caused* (i.e., human-caused) changes in forests remaining forests.

Forest degradation is brought about by many factors, or drivers, resulting in different carbon impacts. International experts tend to agree that simple classifications are most useful, with two categories of drivers - direct (or proximate) and indirect (or underlying) – being commonly used (Kissinger et al. 2012). Direct forest degradation drivers are activities that cause long-term (persisting from some undefined number of years) loss in forest biomass, and directly contribute to CO₂ emissions. The duration of the impact in a given location can be a function of one or more activities, and a single event (pulse disturbance) or repeated use (chronic disturbance) over one or more decades.

Indirect drivers are the underlying causes that result in the occurrence of direct drivers. Currently there are no international agreements through IPCC or the UNFCCC on how to classify forest degradation drivers. However, relevant to a REDD+ mechanism, there are several ways to classify the activities that contribute to degradation of forests. International experts tend to agree that simple classifications are most easily understood. In this context, we adopted the direct and indirect drivers system recommended by Kissinger et al. 2012. Direct forest degradation drivers are human activities that cause a long-term loss in forest carbon stocks in forests that remain forests.

Characteristics of Degradation Activities

Degradation activities are dynamic across landscapes and over time. Individual activities are a function of the intersection of opportunity and need, and both of these factors are constantly changing in response to environmental and social pressures. Characteristics of individual activities include: occurrence (rare or common), spatial extent (limited or extensive), intensity (low or high impact per occurrence), temporal frequency (singular, recurring, chronic), and temporal persistence (short or extended recovery per occurrence).

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Further, multiple degradation activities are often occurring in the same forested areas. A composite description of the spatial and temporal characteristics of individual degradation activities for a given landscape can provide a model for degradation across a given landscape. The model can then be studied to determine measurement approaches that are most effective and efficient. Similarly, available and proposed survey and monitoring designs can be evaluated relative to which degradation activities are expected to be detected and how reliably their impact may be captured. The characteristics of degradation activities across a given landscape (at any scale) can and will change in response to a variety of influences, including land use, resource use policies, and market forces. Characterizations and subsequent measurement and monitoring approaches need to be robust to changes in degradation activities over time.

Prevalent Direct Drivers

Current inventories of GHG emissions do not effectively account for degradation because associated emissions are difficult to detect. Manley et al. (this volume) conducted an assessment of degradation activities and monitoring options at the sub-national scale within three countries in Southeast Asia: Viet Nam, Lao PDR, and Cambodia. They found that six primary degradation activities were present in all districts, and common in one or more of them: planned selective tree harvest, unplanned selective tree harvest, commercial fuelwood collection, customary fuelwood collection, shifting cultivation, and wildfire. Tree harvest was widespread in all three assessments, whereas the other activities varied in their extent among the districts.

There are many challenges in defining, identifying, detecting, and quantifying losses or changes in carbon resulting from degradation. Some experts would argue that degradation is an inconsequential loss of carbon compared to deforestation and that it is too expensive and difficult to quantify. Others would argue that only those activities that result in substantial reductions in carbon density are worth pursuing, and they should be addressed individually. Yet others would argue that it is the degree of degradation in a given area that is of interest, not individual activities. Most would agree, however, that low levels of degradation – meaning minor losses in carbon density – are not the primary concern or target of degradation monitoring efforts. Workshop participants generally agreed that degradation was a significant source of carbon loss in many landscapes in Southeast Asia and neighboring countries, and that losses were likely to be substantial and needed to be quantified.

Degradation Detection and Estimation

A fundamental objective in any sampling effort is the ability to reliably detect the subject of the sampling effort. It may seem like an overly simplistic objective, but in reality many biological and physical features in natural environments are difficult to detect. Detectability is the ability for an observer to directly or indirectly determine the presence of the feature when it is present. Spatial distribution, extent, and intensity all affect the ability of a given sampling effort to detect carbon loss. For example, rare, small, or cryptic species may be difficult for observers to detect within a sample plot in the forest, even when they are present. In the case of degradation, if the degradation is low

intensity (e.g., few small trees per hectare or small areas that are dispersed over a large landscape) it may be difficult to detect either by remote sensing (minimal reductions in canopy cover) or dispersed small (0.1 ha) sample plots. Landscape-wide data, such as remote sensing, provides a 100% sample, so detectability is a function of resolution of the imagery - high resolution will have greater detectability but is more expensive. Field-sampling methods that use larger plots and/or a high density of plots have a greater likelihood of detecting rare occurrences across a landscape, but variability in occurrence of degraded conditions greatly increases sample size requirements, thereby increasing the cost of field sampling.

Detection of degradation activities is also a function of temporal characteristics. If detectability is based on changes in canopy, it is likely to be highly ephemeral, or have a short half-life in that the effects quickly become difficult to detect while the impact is much longer lasting. For example, when a substantial proportion of the forest canopy is reduced through tree removal, gaps in the canopy are likely to recover quickly, but biomass will take much longer to recover. Multiple activities that occur on a periodic or chronic basis in the overlapping locations and varying over time present the most challenging scenario for detection and characterization of degradation, particularly detection of individual drivers.

Estimating Carbon Loss and Emissions

Fundamentally, there are two approaches to quantifying carbon losses and associated emissions: direct measure and estimation through statistical modeling. The stock-change method of accounting (compares two measurements of standing biomass taken at two or more points in time) relies more heavily on direct measure (although statistical modeling is still used to derive final estimates of emissions). The gain-loss method of accounting (comparison of gains derived through growth models and losses derived through estimation) requires information on the extent of degradation activities in order to model associated losses. In reality, reliable estimates can be used to enhance efficiency and accuracy in the use of either accounting method.

Planned activities, namely commercial timber harvest operations (particularly in areas that are not highly vulnerable to post-harvest unplanned tree removal), represent the most consistent and predictable degradation activity. As such, the ability to model and then estimate biomass reductions is greatest for planned timber harvest activities. For a given landscape (e.g., district or province), planned timber harvest may be consistent enough to develop emission factor estimates of reductions in biomass associated with standard silvicultural prescriptions implemented in certain forest types. This library of biomass losses can be generated through developing and refining estimates using remote sensing and field measurements for certain activities in certain forest types. With such a library of statistically modeled estimates, one would only need to know the forest type, the treatment prescription, and have medium resolution remote sensing data to estimate biomass reductions. This could be a very efficient means of estimating changes in carbon density and associated emissions; however, it is a reliable approach primarily where there is a high level of consistency in management activities.

The greatest extent of degradation activities arguably is unplanned degradation activities. These activities will have the greatest extent (occurring everywhere there is access) and they are likely to be highly variable over time and space in response to changing direct and indirect drivers, such as changes in local policies, subsidies, food availability and prices, and environmental quality. Thus, estimating changes in biomass and associated emissions is more challenging for this class of activities. It is possible for statistical estimation techniques to be used to either derive estimates or improve ground-based estimates of carbon loss. The risk of degradation may be more tractable to estimate than degradation intensity, with risk largely being a function of proximity, access, population density, and prosperity.

Monitoring Challenges and Opportunities

Clearly, no one monitoring approach will be most efficient and effective in all circumstances. Similarly, not all degradation activities can be, nor do they need to be, accounted for in a monitoring system. It seems most important to identify and achieve a given level of accuracy and precision in accounting for carbon loss and emissions, and to use whatever tools are available and effective in achieving that objective. In some cases, the greatest losses will be most reliably detected and characterized primarily by using direct field measurement. In other cases, high-resolution remote sensing data might be available and changes in biomass are readily estimates using these data. In most cases, however, it will be a combination of multiple sources of data that will provide the most reliable estimates over time.

The challenges include the following:

- Degradation activities and their characteristics can be highly variable across landscapes – particularly unplanned or customary activities associated with domestic uses of wood - and can change rapidly in their intensity in response to indirect drivers.
- The ecological consequences of forest carbon losses through degradation activities remains unexplored, but they are assumed to be a significant impact on forest quality.
- Given the complexity of human behavior, combined with variability in environmental factors acting on forested ecosystems, the challenge of monitoring changes in forest carbon becomes a socio-economic monitoring and modeling exercise, as much as it is an ecological one.
- Other than planned timber harvest activities, variability in degradation location and intensity makes it difficult to develop a standard set of emission factors associated with degradation even in a given location.
- Lower intensity degradation can be difficult to detect with remote sensing and difficult to quantify reliably using field data.
- Primary limitations of various data sources – moderate resolution remote sensing has low detectability, high resolution remote sensing comes at a higher cost and requires higher internal capacity, field-based data are only as reliable as trained field personnel and sample sizes afford - are likely to persist for 5-10 years into

the future, so we need to develop best practices and expectations based on available methods.

- Debate exists as to under what circumstances degradation is to be included in reference levels for REDD+.
 - Needs to constitute a significant contribution to emissions, but how one defines significant is open.
 - A degradation activity needs to be quantified to some degree before it can be determined to be significant.

The opportunities that lie ahead are the following:

- Broadly applicable tools can be developed that users can implement to estimate emissions associated with more standard, predictable activities, such as planned timber harvest.
- Decision support tools are also being developed that can be used to derive reference levels for REDD+, and decision support tools in general are becoming more readily available and user friendly
- High resolution remote sensing continues to become increasingly available and affordable, but fast-paced changes in technology impact its repeatability, which may make it most useful for training and validation as opposed to as a primary data source for carbon status or change.
- Small scale demonstration projects provide the opportunity to:
 - 1) Identify and validate the type and location of degradation activities that need to be quantified;
 - 2) Determine what detection and description methods best match the spatial and temporal characteristics of the primary degradation sources;
 - 3) Develop and refine modeling approaches that can maximize the efficiency of the monitoring system; and
 - 4) Demonstrate how to link these data in a decision support framework to develop robust reference levels and emission estimates.