# Section Summary

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Techniques for monitoring deforestation and associated changes to forest carbon stocks are widespread and well published. In contrast, techniques for monitoring forest degradation are relatively untested in developing countries despite their inclusion in UNFCCC REDD+ negotiations. In the Mekong countries, forest degradation may contribute a substantial portion of the total carbon losses from forests. There is a critical need to assess approaches for monitoring forest degradation, particularly at the sub-national level. One potential obstacle in assessing monitoring approaches for the region is the lack of consensus on the definition of forest degradation. In addition to a common definition, management objectives must be determined, i.e. what desired threshold of degradation needs to be detected. Monitoring approaches should recognize common themes among countries regarding drivers of degradation, while taking into account the unique circumstances of each country, especially in regard to capacity for operationalizing any recommended protocols.

Monitoring Carbon Stock in Areas Subject to Shifting Agriculture

Conversion of natural forest to agricultural land is one of the most influential land use changes on the loss of both carbon stock and biodiversity in ecosystems. However, forestland designated for agricultural use can sometimes continue to be classified as forest when the residual amount of tree canopy cover remaining meets the accepted definition of forested land. Vegetation change induced by shortening of the fallow period of the slash-and-burn (swidden) agricultural cycle may result in increased forest degradation or eventually deforestation if the fallow period is too short to allow vegetation to grow back enough to meet the definition of forest land. Forests in northern Lao PDR are subject to intensive slash-and-burn agriculture and have been degraded by shortening of the fallow period. For such forest degradation, a practical approach to monitor carbon stock change is to use the parameter of plant community age. Destructive sampling for allometric equations for bamboo was conducted and a model using plant community age to monitor forest degradation was developed in Lao PDR (Kiyono et al. 2007). For cyclic land use that includes a tree-removal stage, chronosequential changes in carbon stock can be estimated by determining the ages and spatial distribution of cleared land. Long-term ecosystem carbon stock change under different land use patterns can be simulated (Inoue et al. 2010). To estimate carbon stock under a shifting agriculture chronosequence, an integration of both ground-based measurement and remote sensing data are needed.

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Forest carbon stock can be calculated by multiplying forest area with averaged carbon stocks per land area for given land use. Kiyono et al. (2011) assessed non-destructive approaches for monitoring anthropogenic greenhouse gas (GHG) emissions from tropical dry-land forest under the influence of various forms of human intervention. A matrix was developed to rank the suitability of each approach, including costs, potential to obtaining data in a large land area, technical difficulties, and applicability to various anthropogenic activities, including degradation drivers such as reducing fallow period of slash-and-burn agriculture, logging, and fuel wood collection. This matrix is complex and comprehensive; however, the assessments of the various approaches need to be examined in greater detail. According to the matrix rankings, no reasonable remote-sensing methods exist at present to monitor carbon loss due to forest degradation in forests with high biomass. To enable practical and frequent monitoring of all types of forests, it is vital to devise a new methodology to detect changes in high-biomass forests.

Monitoring Forest Degradation at the Sub-National Level

The Lowering Emissions in Asia's Forests (LEAF) program of the United States Agency for International Development/Regional Development Mission for Asia (USAID/RDMA) recently asked the United States Forest Service to assess options for monitoring forest degradation at sub-national levels in three Mekong countries: Cambodia, Lao PDR, and Vietnam. The three focus areas were the Central Cardamom Protection Forest in southwestern Cambodia, the Xamtai and Viengxay Districts in the Houaphanh province of northern Lao PDR, and the district of Con Cuong, in Nghe An Province of north-central Vietnam. The study areas included all forested lands regardless of ownership or land use designation. The assessments followed a similar conceptual framework, which includes: 1) define biomass references for monitoring in each forest strata of interest, 2) identify and assess the scale and intensity of forest degradation drivers, and 3) identify and assess monitoring approaches based on defined biomass change thresholds. Three main monitoring approaches, including ground-based field measurements, remotely sensed imagery, and predictive modeling, were assessed using a qualitative ranking system. The results were then used to develop an integrated monitoring system for each study area that combined applicable elements of all three approaches. Emphasis was placed on cost efficiency by using existing infrastructure and data sources as much as possible. For each recommended monitoring system, workflow diagrams were developed which illustrate the relationships between the various data sources and analysis methods.

One issue that emerged during the forest degradation monitoring workshop discussion was: should a monitoring system be designed to efficiently utilize existing capacity only, or should capacity building be a part of the recommendations? The monitoring systems for all three study areas include reasonably attainable recommendations for building capacity necessary for implementing monitoring. However, capacity-building goals may need to be set higher, if increased capacity is needed in order to implement a robust monitoring system. As REDD+ programs are implemented, increased funding may become available to support forest degradation monitoring. Therefore, flexibility should be incorporated into recommended monitoring systems to provide the ability to adjust to changing institutional capacities. Monitoring systems should also be implemented in an

iterative fashion with full consultation of relevant stakeholders, with the initial recommendations used as a starting point from which refined protocols and methods are developed according to local circumstances and conditions.