USAID | ASIA
FROM THE AMERICAN PEOPLE

LEAF
LOWERING EMISSIONS IN ASIA'S FORESTS

LEAF TECHNICAL GUIDANCE SERIES FOR THE DEVELOPMENT OF A TERRESTRIAL CARBON MONITORING SYSTEM FOR REDD+

Module AD-D: Activity Data for Deforestation

WINROCK INTERNATIONAL

SNV
Connecting People's Capacities

CLIMATEFOCUS

RECOFTC
THE CENTER FOR PEOPLE AND FORESTS

LEAF TECHNICAL GUIDANCE SERIES FOR THE DEVELOPMENT OF A TERRESTRIAL CARBON MONITORING SYSTEM FOR REDD+

Module AD-D: Activity Data for Deforestation

Lead Module Authors: Silvia Petrova

Winrock International

TABLE OF CONTENTS

Table of Contents **1**
Icons within the document **1**
1. Scope **1**
2. Applicability **1**
3. Products **1**
4. Required Inputs **2**
5. Methods and Procedures **3**
STEP 1: Create forest cover map for Time 1 of the time period 3
STEP 2: Identify forest change 4
Step 3: Identify post-deforestation land use and forest carbon strata for the forest change 5
Step 4: Report AD for deforestation 6

ICONS WITHIN THE DOCUMENT

The icons below are found throughout the document and indicate areas that the reader should pay special interests to:

Icon	What does it signify?
	A key decision that must be made.
	A key technical step that must be accomplished before moving forward.
	The need for personnel with specified skill set
	An example
	A key term described in the framework
	A reference to relevant resource

1. SCOPE

This module provides guidance for estimating the Activity Data (AD) for deforestation, i.e. extent of deforestation activities on the ground, using previously developed spatially explicit datasets. The output of this module is one component of a terrestrial carbon monitoring system for REDD+.

The AD are defined spatially based on the post-deforestation land use class and forest carbon strata. The AD for deforestation will need to be tracked for the same deforestation activities or land cover transitions in the historical reference period and the monitoring periods, along with any new deforestation activities not accounted in the historic period.

2. APPLICABILITY

This module is applicable for estimating gross deforestation, defined as the long-term or permanent conversion of forest land to non-forest land. Key prerequisite decisions, data and technical capacity (e.g. hardware, software and experts) must be fulfilled as per the technical guidance for the development of a terrestrial carbon monitoring system for REDD+ Framework document. Experience in spatial analysis is an essential skill for applying this module.

3. PRODUCTS

This module provides the methods and procedures to estimate AD for deforestation reported by main cause and by carbon strata expressed as hectares per year. Forest area change data should be expressed as gross changes, they should be spatially explicit, and they should be able to be tracked into the future.

The output of this module is AD for deforestation, reported on annual basis (ha yr^{-1}) and used to estimate GHG emissions associated with deforestation (Module EM-H).The uncertainty of the AD is inherited from spatial dataset.

4. REQUIRED INPUTS

To complete this module the follow data must have been previously been developed:

1) A land cover map including both forest classes and non-forest classes for at least for the start point the time period of interest (e.g. the historical reference period or the monitoring period). Additional spatial data should include either land cover maps with the same land cover categories or satellite images for the next points in time. Uncertainty of the land cover maps should be known.

Guidance on available satellite images and different RS techniques for creating land cover and forest change maps can be found in the GOFC-GOLD Sourcebook - COP 18 version 1 (http://www.gofcgold.wur.nl/redd/).

2) Forest carbon stratification map for the first point of time.

Guidance on methods for creating a forest carbon stratification map can be found in the stratification module using NFI data (Module STR-NFI) and stratification module using other carbon stock data (Module STR-OTH).

3) The key drivers of deforestation (e.g. agriculture, mining, etc.) and their link to the post deforestation land use classes must be identified previously

- Guidance on how the post deforestation land use classes are linked to the drivers of deforestation can be found in the Framework document and Module DR-D.

5. METHODS AND PROCEDURES

The estimation of the AD for time period can be broken down into four main steps: (1) create a forest cover map for Time 1 of the time period; (2) identify forest change; (3) Identify post-deforestation land use and forest carbon strata for the forest change; (4) report AD for deforestation (Figure 1). The same steps can be used to estimate deforestation AD for historical reference or for the monitoring period.

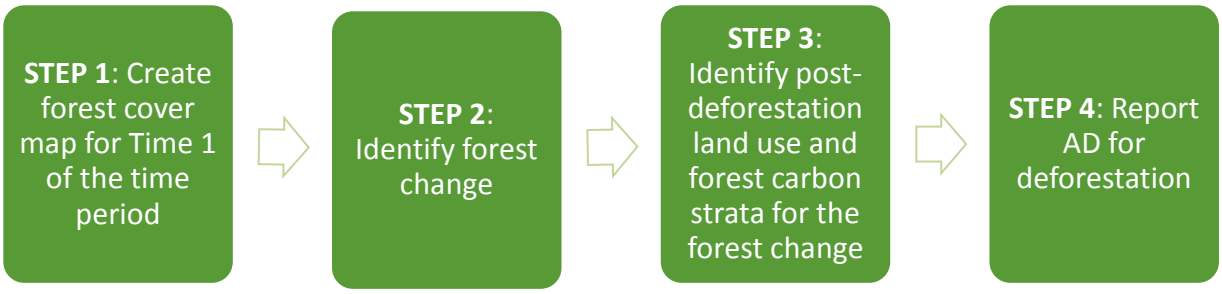

Figure 1: Steps for estimating AD for deforestation using land cover maps derived from remote sensing data.

To illustrate the procedures, a hypothetical example is presented to walk the reader through the steps for estimating AD for a historical reference period for a country "X". For this example, land cover maps for 3 points in time (2000, 2005 and 2010) for a historical reference period 2000-2010 are available and each map depicts four forest type categories and three non-forest categories, including water. A forest carbon stratification map for 2000 containing 4 forest carbon strata has been previously developed.

STEP 1: Create forest cover map for Time 1 of the time period

The forest map (also referred to as a forest mask) defines the area where a forest loss will be tracked as deforestation during the period of interest. All changes due to deforestation must be identified from the Time 1 forest map. Time 1 refers to the date of the first map used in the historical or monitoring time period.

A Time 1 forest cover map should be created by combining forest types from an existing land cover map for Time 1. For the monitoring period this map represents the forest benchmark map.

In our hypothetical example, the forest map for 2000 is created by combining all forest type classes in the land cover map for 2000 (Figure 2).

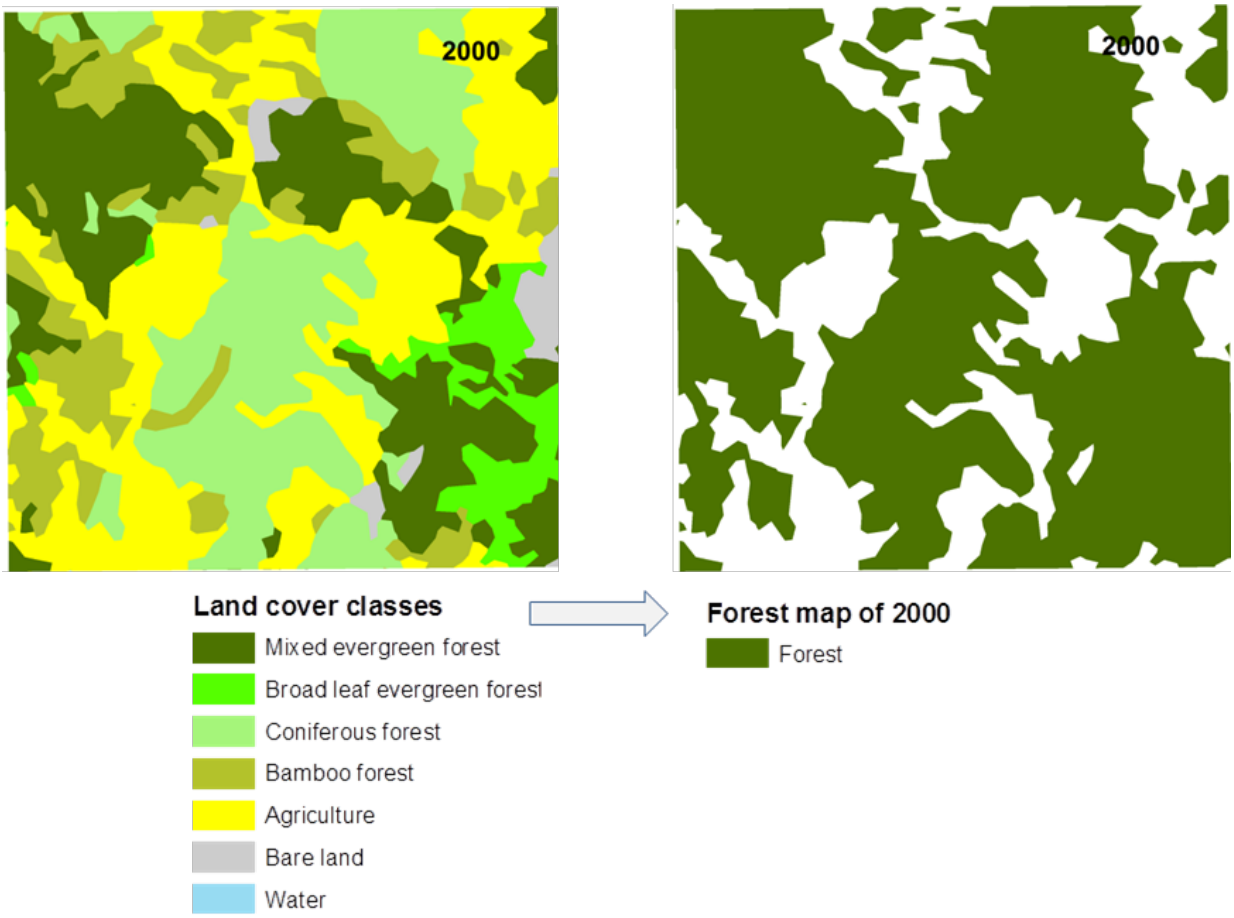

Figure 2: Combining all forest classes from existing land cover map for country "X" to create a forest map in 2000, where the extent of forest loss will be analyzed for 2005 and 2010.

STEP 2: Identify forest change

Two techniques for identifying the forest area change are commonly used – (1) post classification change detection and (2) multi-date change detection.

The first technique, post classification change detection, requires overlaying (or 'stacking') two already classified land cover maps. To identify forest change using post classification change detection technique the forest map of Time 1 should be overlaid with the land cover map for Time 2.

The post classification change technique is used in the hypothetical example, where the forest map in 2000 is overlaid with the land cover map in 2005 to identify 2000-2005 forest change (Figure 3).

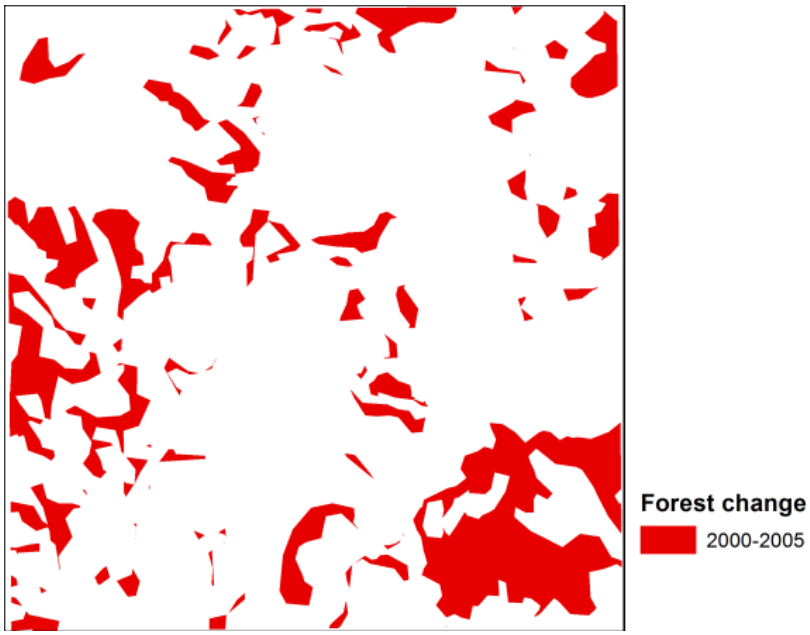

Figure 3: Forest cover change for 2000-2005 time period.

The second technique, multi-date change detection, compares satellite images for the two points in time to identify locations of forest change, based on the difference in spectral characteristics for each pixel. This technique requires high level of Remote Sensing (RS) expertise, but less time and resources and it is preferred for delineating deforestation. For example, to estimate the forest change for Time 1-Time 2 time period, the forest pixels in Time 1 that changed to non-forest pixels at Time 2 are tracked and summed to give the area of forest loss. The areas not covered by forest are excluded from analysis, reducing the area needing to be examined, and thus increasing efficiency. This technique is used in cases where land cover maps for multiple points in time for the time period have not been developed previously.

To assure that only gross deforestation change is detected in the second time period, the identified deforestation from Time 1-Time 2 time period should be masked out from the Time 1 forest map before forest change for Time 2-Time 3 time period is estimated.

Step 3: Identify post-deforestation land use and forest carbon strata for the forest change

When post classification change detection technique is used, the post deforestation land use classes for the forest change should be identified by overlaying the identified forest change map developed in step 2 with next land cover map in the time series. This results in a map of forest change, classified by post-deforestation land use.

When multi-date change detection technique is used, the identified change should be classified using standard classification techniques into post deforestation land use classes.

Once the forest change is classified into post deforestation land use classes, it should be overlaid with the forest carbon stratification map. AD for deforestation should be reported on an annual basis (ha yr^{-1}) per each time period, post deforestation land use class and forest carbon class.

In the hypothetical example, the 2000-2005 forest loss was overlaid with the non-forest classes in 2005 maps to identify the post deforestation land use classes and then overlaid with the forest carbon stratification map. This resulted in creating a map for 2000-2005 forest loss area classified by post deforestation land use class and forest carbon strata (Figure 4).

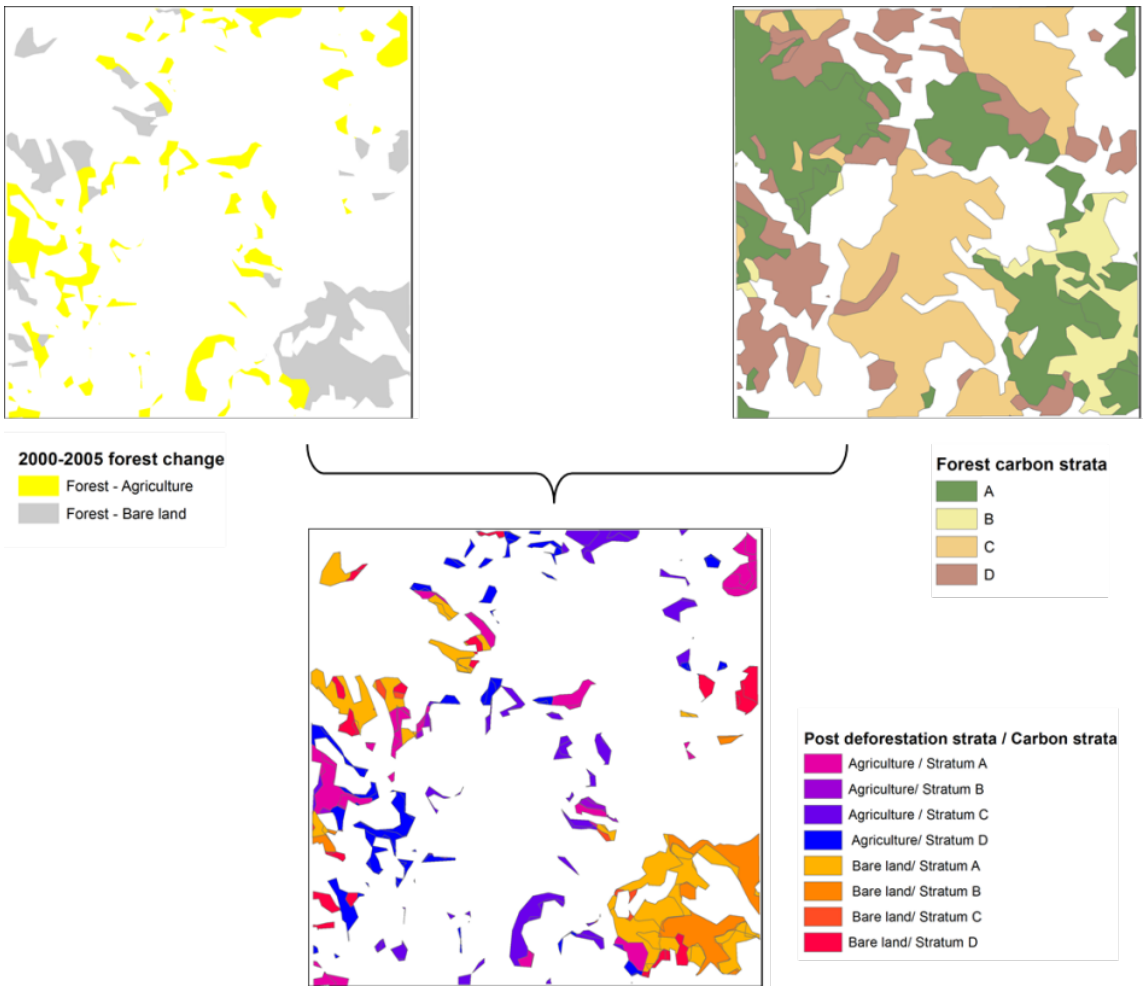

Figure 4: Map displaying the AD for deforestation for 2000-2005 (bottom map) created by combining the map for post deforestation land use classes (excluding water) for the forest change (top left) and forest carbon strata map (top right).

Step 4: Report AD for deforestation

The AD for deforestation should be reported in a table on annual basis (ha yr^{-1}) for each time period per post deforestation land use (driver of deforestation) and forest carbon strata associated with the

Emission Factors (EF). The linkage between the post deforestation land use class and key drivers of deforestation should be identified previously (see Section 4).

In the hypothetical example, the map from the previous step can be used to estimate the total forest change per post deforestation land use class and forest carbon strata and by dividing the total area by 5 (number of years in 2000-2005 period), the AD for deforestation can be reported in a table (Table 1). In a similar way the AD for 2005-2010 time period is reported.

Table 1: Example of AD reported per post deforestation land use stratum, carbon stratum and time period.

Post deforestation land use class (Driver of deforestation)	Carbon stratum	AD per time period	
		2000-2005	2005-2010
		ha yr^{-1}	
Agriculture	A	265	163
(Driver of deforestation - Agriculture)	B	18	8
	C	246	160
	D	237	307
Bare land	A	487	16
(Driver of deforestation - Mining)	B	218	0
	C	1018	4
	D	143	43

Ecosystem Services
Winrock International
carbonservices@winrock.org
+1.703.302.6500
2121 Crystal Drive, Suite 500
Arlington, VA 22202, USA
www.winrock.org/ecosystems

WINROCK
INTERNATIONAL