STATUS OF FOREST BIOMASS AND CARBON STOCK ASSESSMENT IN SOUTH ASIA

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ABSTRACT

In this paper, the status of forest biomass and carbon stock assessment in South Asia has been reviewed based on the reports of Forest Resource Assessment (FRA) -2010 published by FAO. The quality of the data reported to FAO is medium to high. The countries heavily depend on growing stock volume from National Forest Inventory reports for biomass and carbon estimation. While the National Forest Inventory is being carried out in India at regular intervals, other countries are attempting or in the process of undertaking periodic forest inventory. Besides updating the existing database of volume and biomass allometric equations, the regional/country specific biomass and carbon conversion factors are required to improve the present biomass and carbon estimates.

Key words : Forest biomass, Carbon stock, South asia.

Introduction

Biomass estimates are useful for the computation of carbon storage and biomass energy values. The forest biomass includes the aboveground and belowground living mass of trees, shrubs, palms, saplings, other understory components, vines, epiphytes, etc., and dead plant mass such as fine litter and wood (Brown, 1997). It is referred to as biomass density when expressed as mass per unit area e.g., tons per hectare. The total biomass for a region or country is obtained from the product of biomass density and the corresponding area of forests.

Methods aiming to estimate the biomass using non-destructive measurements of structural characteristics such as stem diameter and height are referred to as allometric approaches. There are broadly two types of approaches recognized in the literature (Brown, 1997).

Approach 1

Biomass density can be calculated from volume over bark per hectare (VOB/ha) by first estimating the biomass of the inventoried volume and then "expanding" this value to take into account the biomass of the other aboveground components.

Aboveground biomass density (t/ha) = VOB*WD*BEF

where,

WD = volume-weighted average wood density (oven-dry biomass per unit of green volume)

BEF = biomass expansion factor (ratio of aboveground oven-dry biomass of trees to oven-dry biomass of inventoried volume).

Approach 2

Another approach for the estimation of biomass density is derived from the application of biomass regression equations to stand tables. The method basically involves estimating the biomass per average tree of each diameter (diameter at breast height, dbh) class of the stand table, multiplying by the number of trees in the class, and summing across all classes. Biomass regression equations are also developed at tree level. In order to upscale biomass at various spatial scales, the allometric relations are calibrated using (Light Detection And Ranging) LIDAR data and remote sensing images.

South Asian Countries employ Approach- 1 discussed above for biomass estimation. In this paper, the status of assessment of the forest area, growing stock volume, Biomass Conversion Factor (BCF)/Biomass Conversion and Expansion Factor (BCEF), biomass and carbon in South Asia with reference to the years 2000, 2005 and 2010 have been reviewed. The review includes data quality, calibration, estimation and forecasting methods used to arrive at biomass and carbon estimation for the reference years.

Data source

The major sources for the review are the country reports of Global Forest Resource Assessment (FRA)- 2010 published by FAO (2010) based on the data officially

A review on the status of forest biomass in South Asia suggested improving data quality, updating of tree volume and biomass allometric database and developing region specific biomass and carbon conversion factors.

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submitted by the countries following the methods suggested by FAO/FRA. The countries were requested to provide the best possible estimates based on National Forest Inventory taking into consideration FAO/FRA categories and definitions. If national BCF/BCEF is not available, the default BCEF values from Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines were used for the biomass estimation.

Results and Discussion

Extent of forest and other wooded land

The review shows that the use of remote sensing in estimating forest area is not clear with respect to many countries (Appendix-I, Table 1). In order to estimate and forecast for the reference years, the linear extrapolation/interpolation was employed based on annual growth rate. Four out of seven countries viz., Bangladesh, Bhutan, Pakistan and Sri Lanka undertook calibration of forest area in order to comply with FAO/UN Land area statistics. In the case of Nepal, there was no mention about the calibration. With respect to Maldives, only one time information is available.

Growing stock

Growing stock estimates are mostly based on one time national level inventory/partial inventory/ Pre-investment survey/sub-national level working plans (Appendix-I, Table 2). India undertakes forest inventory at regular intervals. Some countries initiated or in the process of undertaking newest forest inventory.

Forest Biomass stock

The growing stock volume estimates available from National Forest Inventory along with BCF/BCEF following FRA 2010 /IPCC 2006/IPCC 2003 guidelines were used for biomass estimation (Appendix-I, Table 3). The BCF/BCEF values are also modified and applied to suit local conditions. In order to obtain biomass and carbon estimates for the reference years, linear extrapolation/interpolation was used with the available data.

Carbon stock

Most countries follow FRA 2010 /IPCC 2006/IPCC 2003 guidelines for converting biomass to carbon values (Appendix-I, Table 4). One or more carbon categories are not estimated in most of the countries for lack of data. Carbon in dead wood was not estimated in Bangladesh, Pakistan, Sri Lanka and Bhutan. Soil carbon was not estimated in Bhutan and Nepal. There was no carbon estimates available for Maldives.

Conclusions

The countries use the available data of National Forest Inventory and other available reports to provide the best possible biomass and carbon estimates. With respect to some countries, the data used for the estimation and forecasting were outdated or related to only one time point. The region/national/sub-national specific volume and biomass allometric equations, BCF/BCEF and biomass to carbon conversion factor need to be further developed to improve the current estimates. The country needs with respect to financial and technical support should be assessed and supported for periodic national forest inventory. The capacity building programmes on continuous basis would motivate to use the latest technologies and improve the precision of the estimates.

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References

Brown, S. (1997). *Estimating biomass and biomass change of Tropical Forests: a Primer.* FAO Forestry Paper – 134. FAO, Rome (also available at http:// www.fao.org/ docrep/ w4095e/w4095e00.HTM).

FAO (2010). *Global forest resources assessment (2010), Country reports-Bangladesh*, FRA 2010/017 Rome 2010.

FAO (2010). *Global forest resources assessment (2010), Country reports-Bhutan*, FRA 2010/024 Rome 2010.

FAO (2010). *Global forest resources assessment (2010), Country reports-India*, FRA 2010/094 Rome 2010.

FAO (2010). *Global forest resources assessment (2010), Country reports-Maldives*, FRA 2010/124 Rome 2010.

FAO (2010). *Global forest resources assessment (2010), Country reports-Nepal*, March 2009.

FAO (2010). *Global forest resources assessment (2010), Country reports-Pakistan*, FRA 2010/158 Rome 2010.

FAO (2010). *Global forest resources assessment (2010), Country reports-Srilanka*, FRA 2010/197 Rome 2010.

FAO (2010). *Global forest resources assessment (2010)*. FRA, FAO, Rome

IPCC/GPG (2003). *Good practice guidance for land use, land-use change and forestry*. Kanagawa, Japan: Institute for Global Environment Strategies.

IPCC (2006). *2006 IPCC guidelines for national greenhouse gas inventories*. Volume 4. Agriculture, forestry and other land use (also available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/).

APPENDIX–I

Table 1 : Status of forest area assessment in South Asia

Country	Reference years to information sources	Data Quality	Calibration	Notes on estimation and forecasting methods employed
Bangladesh	1958 to 2007	Medium to high	Yes	Linear trend
Bhutan	1989, 1999	High	Yes	Linear trend
India	1990 to 2005	High	No need	Linear trend
Maldives	1990, 2000	Medium	No need	One point information is assumed for other years
Nepal	1985 to 2008	High	Not mentioned	Linear trend
Pakistan	1990, 2000	Medium to high	Yes	Linear trend
Sri Lanka	1992 to 2003	Medium to high	Yes	Linear trend

Table 2 : Status of forest growing stock assessment in South Asia

Country	Reference years to information sources	Data quality	Notes on estimation and forecasting methods employed
Bangladesh	2005-2007	High	(National Forest Inventory) NFI, 2005-2007 was made use of. The growing stock volume of 48.3 m^3/ha for forest and 29.7m^3/ha for commercial species was used. These figures were used for all the years.
Bhutan	1989	High	Pre-Investment Survey's growing stock was made use of.
India	1984-2005	Medium to High	NFI (2002 & 2006) was used for 2005. Per ha increment was applied for the estimation in 2010.
Maldives	Not mentioned	Not mentioned	No data available
Nepal	1985-1994	High	Average stem volume – 96.36 m^3/ha for 1985/86 used for 1990. 177.8 m^3/ha for 1994 used for 2000 and 2005. For other wooded land, the average stem volume 30 m^3/ha was used. Growing stock assessment was not done for 2010.
Pakistan	1990,1992	High to Medium	Weighted growing stock 123.78 m^3/ha was applied.
Sri Lanka	1982-1996	High	Data from NFI-1986 was made use of.

Table 3 : Status of forest biomass stock assessment in South Asia

Country	Reference years to information sources	Data quality	Notes on estimation and forecasting methods employed
Bangladesh	2005-2007	High	BCEF -2.05; Below ground -0.20.
Bhutan	Not mentioned	High	Weighted basic density for 1989 is 0.459, which was assumed for all the reference years . BEF – estimated from publications. 1990- 1.87; 2000-1.84; 2005-1.82; 2010-1.80. Weighted root to shoot ratio of 0.372 was used @ 60: 40 for conifers: broadleaved following GPG, 2003
India	1984, 1994, 1996, 2000, 2005	Medium to high	NFI. IPCC default values were suitably modified and adopted for various forest types.
Maldives			Not available
Nepal	The biomass estimates for the years 1990 and 2005 are available. However, the methods used for bi omass assessment is not available.		
Pakistan	1990 onwards	High	BEF: Sandra Brown formula was for Asian broad leaved forests. Weighted root shoot ratios based on relative percentage of conifers and non-conifers default factors (GPG, 2003) were used.
Sri Lanka	Not mentioned	Not mentioned	BCEF and root-shoot ratio as per FRA guidelines

Table 4 : Status of forest carbon stock assessment in South Asia

Country	Reference years to information sources	Data quality	Notes on estimation and forecasting methods employed
Bangladesh	2005-2007	High	IPCC, 2006 guidelines was followed.
Bhutan	Not mentioned	High	IPCC, 2006 guidelines was followed.
India	1984,1994,1996, 2000,2005	Medium to High	Carbon content of various species was obtained from the literature. For below ground carbon estimation, default value as given by FAO/IPCC was applied. The carbon in litter (excluding branch) and soil was estimated based NFI 2002-2006.
Maldives			Not available
Nepal	The carbon estimates for the years 1990 and 2005 are available.		
Pakistan	Not mentioned	Not mentioned	IPCC, 2006 guidelines was followed.
Sri Lanka	Not mentioned	Not mentioned	IPCC, 2006 guidelines was followed.

APPENDIX-II

FAO/FRA 2010 Categories and definitions

Above-ground biomass	All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage.
Below-ground biomass	All biomass of live roots. Fine roots of less than 2mm diameter are excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Carbon in above-ground biomass	Carbon in all living biomass above the soil, including stem, stump, branches, bark, seeds, and foliage.
Carbon in below-ground biomass	Carbon in all biomass of live roots. Fine roots of less than 2 mm diameter are excluded, because these often cannot be distinguished empirically from soil organic matter or litter.
Carbon in dead wood	Carbon in all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.
Carbon in litter	Carbon in all non-living biomass with a diameter less than the minimum diameter for dead wood (e.g. 10 cm), lying dead in various states of decomposition above the mineral or organic soil.
Dead wood	All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.
Forest	Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use
Growing stock volume	Growing stock Volume over bark of all living trees more than X cm in diameter at breast height (or above buttress if these are higher). Includes the stem from ground level or stump height up to a top diameter of Y cm, and may also include branches to a minimum diameter of W cm. The standards for X,Y and Z dimensions may vary for various regions.
Growing stock of commercial species	Growing stock (see def. above) of commercial species.
Inland water bodies	Inland water bodies generally include major rivers, lakes and water reservoirs.
Other land	All land that is not classified as "Forest" or "Other wooded land".
Other land with tree cover (Subordinated to "Other land")	Land classified as "Other land", spanning more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 meters at maturity.
Other wooded land	Land not classified as "Forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.
Soil carbon	Organic carbon in mineral and organic soils (including peat) to a specified depth chosen by the country and applied consistently through the time series.