Forest Carbon Accounting: Overview & Principles

CDM Capacity Development in Eastern and Southern Africa

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Executive Summary
Forests play an important role in the global carbon balance. As both carbon sources and sinks, they have the potential to form an important component in efforts to combat global climate change. Accounting for the carbon within forest ecosystems and changes in carbon stocks resulting from human activities is a necessary first step towards the better representation of forests in climate change policy at regional, national and global scales.

The United Nations Development Programme (UNDP), as part of the *UNDP-UNEP CDM Capacity Development Project for Eastern & Southern Africa*, is seeking to promote carbon projects in sub-Saharan Africa, in the important bio-carbon sector and others. This report reinforces UNDP's capacity building efforts by presenting the main principles, practices and challenges of carbon accounting in the forestry sector.

Forest carbon accounting can be divided into three forms. *Stock accounting* assesses the magnitude of carbon stored in forest ecosystems at a single point in time. *Emissions accounting* assesses the net greenhouse gas emissions to the atmosphere resulting from forests. *Emission reductions accounting* assesses the decrease in emissions from project or policy activities, often so that they can be traded.

Forest carbon accounting identifies the carbon-density of areas, providing information for low-carbon-impact land use planning. It prepares territories for accounting and reporting of emissions from the forestry sector. It allows comparison of the climate change impact of the forestry sector relative to other sectors, as well as allowing comparison between territories. Finally, it enables trade of project emission reductions on carbon markets and for emission reductions to be included in policy targets.

Good practice in forest carbon accounting must be adhered to. In particular, transparency in methods and accuracy and precision in accounting are required for public and political acceptance of resultant estimates. A basic knowledge of the principles underlying forest carbon accounting is also beneficial. Understanding biomass dynamics and flows between carbon pools in forest ecosystems enables more effective accounting.

The practice of forest carbon accounting requires clear identification of the accounting boundary in both space and time. Stratifying the forest into areas with similar carbon characteristics further improves the accuracy of carbon accounting. Data for accounting can be gathered from a variety of sources, including existing secondary data, remotely sensed data and primary data through field surveys. The amount of data from each source depends on the quality of the source as well as the trade-offs that must be made between accounting accuracy and costs of resources and time.

All forest carbon accounting estimates contain uncertainty. Practitioners should identify, minimise where possible, and quantify this uncertainty through statistical analysis, published information and expert judgement. Uncertainty of model variables and components, once quantified, can be aggregated through simple propagation of errors or simulated through Monte Carlo analysis. The existence of substantial uncertainty can undermine efforts to reduce carbon emissions from forestry and can erode political support for the accounting process.

Forest carbon accounting guidance from the Intergovernmental Panel on Climate Change (IPCC) has become the primary source of information for methods, accounting equations and parameters. However, IPCC guidance is vast and often difficult to navigate. In response, a number of tools for forest carbon accounting have emerged. These vary in terms of geographical coverage, forestry activities and the carbon pools accounted for, as well as the level of data input required. In light of such diversity, practitioners require an understanding of the forest carbon accounting process, irrespective of whether these tools are utilised.

Despite substantial progress in the field of forest carbon accounting over the last decade, challenges still remain. Terminology relating to forests and managed lands is ambiguous and requires standardisation between stakeholders. More scientific research into forest biomass characteristics is also required to better incorporate the heterogeneity of forests, their growth dynamics and the fate of carbon in harvested wood products into forest carbon accounting methods.

Forest carbon accounting is a multi-disciplinary task. Building capacity is essential. Investment is also necessary to improve and standardise carbon accounting methods. If future climate change policy and strategy are to adequately reflect the substantial role forests play in the global carbon balance, good forest carbon accounting is imperative.

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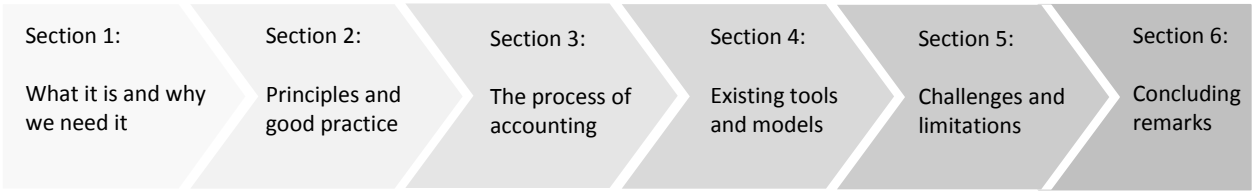
1. Introduction

1.1. Report structure

There has been considerable and growing interest in forest carbon and its role in international climate change policy. This interest stems from the substantial greenhouse gas (GHG) emissions that arise from the forestry sector and the potential for forests to deliver cheap-and-deep emission reductions.

Forest Carbon Accounting: Overview & Principles presents the main principles, practices and challenges for carbon accounting in the forestry sector. In order to be accessible, the report is not overly technical and should not, therefore, be considered a stand-alone guide for forestry carbon accounting. It does, however, present guidance for good practice in accounting and indicates further sources of guidance. Section 1 outlines the historic, current and future needs for forest carbon accounting. Section 2 focuses on principles and good practice. The process of forest carbon accounting is outlined in Section 3. Section 4 highlights existing guidance and toolkits available for forestry carbon accounting and Section 5 presents the challenges and limitations to date. Section 6 concludes.



1.2. What is forest carbon accounting?

Carbon accounting is the practice of making scientifically robust and verifiable measurements of GHG emissions. Although characteristics of forests have been recorded for numerous historical purposes, accounting for carbon is a more recent addition to forest inventories. This follows the growing need to quantify the stocks, sources and sinks of carbon and other GHGs in the context of anthropogenic impacts on the global climate.

Historically, forest inventories recorded stand structure, age, growth rate, biomass accumulation, and the wood densities of tree species. These have served both commercial purposes, such as determining merchantable timber volumes and use in the paper and pulp industry, as well as national or regional planning purposes, such as creating forest and land use inventories for land-use permits, land-use plans and agricultural expansion.

In 1946, the Food and Agriculture Organisation (FAO) established the Forest Resource Assessment (FRA) which, published every five to ten years, compiles data gathered through national statistics and country-level reporting processes. Although criticised (see Grainger, 2008; Houghton, 2005), the FRA still provides the most comprehensive assessment of global forest cover, management and trends to date. In combination with the substantial body of forest science research literature, the FRA and similar forest inventories provide the background for carbon accounting.

The forestry sector plays a vital role in the global balance of GHGs. Deforestation alone accounts for approximately 20% of anthropogenic emissions (FAO 2006; Stern, 2006) and the forestry sector represents upwards of 50% of global greenhouse gas mitigation potential (IPCC, 2007). As forests rise

up the climate change agenda, three types of forest carbon accounting have developed: stock accounting, emissions accounting and project emission reductions accounting.

- **Stock accounting**
  Forest carbon stock accounting often forms a starting point for emissions and project-level accounting. Establishing the terrestrial carbon stock of a territory and average carbon stocks for particular land uses, stock accounting allows carbon-dense areas to be prioritised in regional land use planning. An early form of forest carbon accounting, emissions and emission reductions accounting have evolved from the principles established for stock accounting.

- **Emissions accounting**
  Emissions accounting is necessary to assess the scale of emissions from the forestry sector relative to other sectors. It also aids realistic goal-setting for GHG emissions targets. Under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, countries are mandated to undertake some land use, land use change and forestry (LULUCF) carbon accounting (see Box 1). With a significant portion of developing country emissions arising from the LULUCF sector, the forestry sector is likely to play a prominent role in climate change strategies in these countries.

- **Project emission reductions accounting**
  Carbon accounting for forestry project emission reductions is required for both projects undertaken under the flexible mechanisms of the Kyoto Protocol and the voluntary carbon markets. Both necessitate good carbon accounting to ensure that emissions reductions are *real, permanent* and *verifiable*. For projects to generate tradable emission reductions, accounting methods between countries, regions and projects must be standardised in both developed and developing countries.

Past forest inventories and research outputs provide a substantial source of information on forest biomass characteristics. The challenge is to translate this information into carbon estimates, in particular increasing the coverage and/or scaling-up research that often focuses on ecological zones or specific territories. Ultimately, the quality of forest carbon estimates will be governed by a number of factors, not least time and financial resource constraints. Acknowledging that trade-offs between factors in the accounting process are inevitable, the carbon accounting process must adhere to good