Climate Change Mitigation

Forest Ecosystems: Measurement and Modelling of Biomass and Carbon

First edition

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Aims and scope

Climate change is one of the pivotal and dynamics which have always been part of the universe history. The change in the climate system has triggered the Earth formation as well as the Earth's history. The climatic aspects of environmental change affect lakes, water levels, disappearing glaciers, sea level rise, desertification and dwindling water resources. Recent human activities have resulted to an unprecedented increase of the greenhouse gases with serious consequences on the climate systems which have impacts on biodiversity, human health and availability of natural resources. The forest ecosystems still contribute to about 20 % of the global emissions. For climate change mitigation, forest growth enhancement and also reducing emissions from deforestation and forest degradation will play a crucial role.

The aim of this book is to present to students, technicians, researchers, scientists, managers the various techniques for measuring and modeling biomass and carbon from forest ecosystems.

Preface

Since the industrial revolution, there have been considerable changes in concentrations of greenhouse gases in the atmosphere growing at an unprecedented rate and magnitude. Global warming has been caused over the last half-century largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation.

In the past decades, deforestation and forest degradation accounted for about 20% of greenhouse gas emissions showing that the mitigation of global warming cannot be achieved without the implication of forest contributions in international agreements. The Global Forest Resources Assessment noted that the overall rate of deforestation remained alarmingly high, although the rate was slowing. This report shows disparities between the six regions (Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, the Near East and North America) on the major trends in the extent of forests, on the changes in the rates of forest loss,

as well as on the current state of productive and protective forests. Forests store large amounts of carbon and need accurate estimation of biomass and the related carbon content in wood. Estimation of biomass is done through traditional forest inventory and destruction of trees and construction of allometric relationships. Implications linked to destruction makes that in many forest ecosystems true data are lacking for biomass estimations. In Africa for instance, the absence of site species-specific or mixed-species allometric equations has led for many decades to a broad use of general equations also known as pan-tropical equations in most forests. Data not collected locally for development of allometry to be used in other locations for estimation of tree biomass and carbon budget raise many discussions on the validity of these allometry and their results.

Forest inventory and biomass estimation require the use of remote sensing data and GIS information. Remote Sensing Technology in combination with Geographic Information System produces reliable information for land use change, land use dynamics, land use management, etc. The progress made in remote sensing and GIS these recent years have made that there is a lot of applications in forestry. The applications range from the creation of thematic maps, monitoring deforestation and land use change in the tropics and in other areas around the world, estimation of biomass and carbon content in the forests.

This book aims at providing to students, forest scientists, researchers, biologists, physical geographers, and environmentalists a manual in which they will find all the necessary information for estimation of biomass and carbon budget from forest ecosystems. This book describes the importance of forest ecosystems, the statistic and sampling techniques needed for biomass estimation and ecosystems management as well as all the techniques and methods of forest and biomass estimations. Many parts of this book contain detailed information making that this manual can be used to provide lectures in class as well as handbook for field data collection.

The book is organized in eight chapters as described below.

Chapter 1 describes the world forest ecosystems, their importance, distribution, and their development since the Holocene Epoch. This chapter also explains how the climate has changed over time as well as the greenhouse gases that may influence this change. The international agreements may influence the emissions of greenhouse gases and the contribution of forest ecosystems either on carbon estimations or on mitigation of climate change impacts. This chapter describes also the present and the future challenge of the climate regime conventions as well a functional system to involve forest ecosystems and in particular tropical forest ecosystems in the regimes as well as local population.

Chapter 2 and **chapter 3** describe the statistical notions and the sampling techniques needed for biomass estimations, forest inventories and forest management. **Chapter 4** deals with forest classification and explains to readers the classification criteria used for vegetation or forest ecosystem classifications, the different classification systems used for land use management.

Chapter 5 deals with the basis of remote sensing for forestry applications. This chapter explains all the basics of remote sensing such as the physics concepts of remote sensing, the various

type of data support, how to do interpretation with aerial photographs, how to use aerial photographs to measure trees and forest stand parameters. This chapter also describes the photogrammetry techniques and their application for biomass measurements. The development of thematic maps is usually involved in forest inventories and biomass estimations. This chapter shows to the reader how to develop thematic maps from various data sources such aerial photos, satellite images, radar data, lidar data, etc.

Chapter 6 describes the different types of forest inventories and explains for each type the procedures for planning, data collection, and data management. In this chapter, the reader will learn how the national forest inventories are carried out in 10 countries selected randomly around the world for the global forest assessment reporting and also for the national management strategies. This chapter also explains to the reader the concept of angle count sampling and their use to measure the stand parameters such as basal area, stand density and also tree parameters such as height, form factor, volume, etc.

Chapter 7 explains in details all the techniques for measuring aboveground and belowground biomass for the allometric relationship development. This chapter shows how to do plot design, species and tree selection for this type of measurements. The reader will also learn from this chapter all the destructive and non-destructive methods for aboveground and belowground biomass estimation and also the techniques and methods for measuring climbers such as lianas.

Chapter 8 explains how to develop allometric relations for biomass and carbon estimations. This chapter shows to the reader how to develop site specific allometric equations, mixed species relations and general allometric which can be applied in the same climatic condition at a regional level.

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