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PREFACE

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Forest ecosystems and environments: scaling up from shoot module to watershed

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Terrestrial ecosystems are experiencing rapid changes of their structure and function as a result of an ever growing pressure by human demands on natural resources. Over the past decades, forcing by direct and indirect human activities has reached a point that is now rivaling the natural forcing that has shaped the Earth system over millennia. This unprecedented phenomenon has attracted a major investment by the scientific community to detect the impacts, attribute the changes to processes, and explore future trajectories. This scientific information is fundamental to creating the knowledge base that will inform policy development and will allow human societies to mitigate and adapt to these rapid changes.

With the goal of developing a novel research agenda in support to the above objectives, the ''Global Change and Terrestrial Ecosystems'' core project (GCTE, Walker et al. 1999; Canadell et al. 2005) was created in 1991 under the auspices of the International Geosphere-Biosphere Programme (IGBP). By contrast with other components of the Earth system, terrestrial ecosystems are constructed with short-lived and long-lived organic compounds with varied diffusivity, resulting in pronounced spatial and temporal heterogeneity. Up scaling and integrating to global scales of such heterogeneous ecosystems in relation to global environmental change has been described and forecasted through the GCTE research agenda.

Other aspects of heterogeneity come from hierarchical and compositionally diversified features of terrestrial ecosystems. Plants create a vegetation framework with organismic hierarchy, from cell physiology to whole individual-level regulation, and biological components at each trophic level characterized by biodiversity related to compositional functional differentiation. Therefore, GCTE has promoted the integration and the study of feedbacks between processes driven by plant and ecosystem physiology, population and community dynamics, and biogeochemistry.

The ''Global Change Impacts on Terrestrial Ecosystems in Monsoon Asia'' project (TEMA) (1995–2003) was the Japanese contribution to the GCTE global effort. Coastal East and Southeast Asia, as the target region of TEMA, are characterized by wet growing seasons influenced by monsoon climates, and species-rich forest ecosystems develop along a latitudinal gradient from equatorial to boreal zone, and an altitudinal gradient from lowland up to the forest limit (Ohsawa 1995). The TEMA aimed to predict the effects of environmental change on the distribution and structure of forest ecosystems in the target region (Hirose et al. 1998). Core parts of TEMA were designed to integrate forest ecosystem processes from leaf physiology to micro-meteorological budgets, and to predict long-term changes of vegetation composition and architecture through demographic processes. The TEMA paid particular attention to watershed processes, where forest metabolism affects ecosystem properties and biogeochemical budgets of freshwater ecosystems. This is particularly important because rivers, wetlands and lakes are experiencing direct and indirect effects of environmental change. The unique challenge of TEMA research was the attempt to integrate various scales of

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heterogeneous ecological processes from fine-scale ecophysiology to watershed ecosystems.

This special issue outlines a synthetic view achieved by TEMA, building from an initial synthesis (Hirose and Walker 1996), a mid-term special issue (Nakashizuka et al. 1999) and numerous research papers. The first section of this issue ''Integration of ecophysiological processes to stand dynamics'' deals with the process-based scaling-up from leaf physiology to population, and to landscape ecosystem production, applying experimental, modeling and monitoring approaches. The second section ''Latitudinal/altitudinal transects of East Asia'' presents case studies and region-wide meta-analysis of forests along latitudinal and altitudinal gradients, followed by a tree demographic process-based modeling approach to geographic forest zonation. The third section ''Monitoring and modeling atmosphere-forest-soil processes'' presents carbon budgets for scales ranging from stand to small watershed of various types of Japanese temperate forests. The last section, ''Forest–lake interface in watershed ecosystems'' presents catchment-scale biogeochemical budgets and regulation, stream water diagnosis of forest soil status, and carbon budgets and methane dynamics of lake ecosystems. The four sections collectively represent the scaling up concept that has driven the intellectual and research development of TEMA over this past decade, a research that ultimately needs to yield integrated and system-level knowledge base for a better understanding of ecosystem functioning (i.e. ecosystem goods and services) upon which the well being of societies relies. Beside this issue, overall TEMA achievements are summarized in Kohyama et al. (2005).

The GCTE project ended in 2003, and the succeeding international projects such as Global Land Project (GLP), Global Carbon Project (GCP), and Monsoon Asia Integrated Regional Studies (MAIRS) are already in place or in different stages of development. The concepts promoted by TEMA will contribute to, and be extended through these projects.

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