Foreward to the Special Issue on Multi-Scale Forestry Applications Supported by Remote Sensing and Spatial Information Systems

THE development, implementation and monitoring of environmental policies is dependent on the availability of sound, accurate information about the state of the environment. Information on forests is particularly important, due to the critical role of the forest sector in many other thematic disciplines, such as climate change, bio-energy, biodiversity and land management. Such data are essential for environmental scenario modeling in both forest-related and multi-disciplinary modeling. They are required at a range of spatial scales from local through to national and global levels. Remote sensing and geographic information systems provide the means for the frequent acquisition and processing of multi-scale forest.

Within this context, national, regional and global forestry information systems are being developed that integrate and make use of Earth observation (EO) data, geographic information systems, spatial data infrastructures and modeling. However, the development of such multi-scale forestry information systems is constrained by limitations related to data harmonization and comparability, and system interoperability. The provision of forest related information is primarily acquired from optical satellite imagery, but EO data acquired from active sensors are increasingly being relied upon for forest parameter estimation and mapping activities.

The papers in this special issue represent the state of the art on forest modelling and mapping techniques to provide up-to-date, consistent information on forests at different scales, ranging from local, regional through to transnational and global scales. The papers can be broadly categorized in two categories: those dealing with passive, optical remote sensing applications with a particular focus on tropical forest cover and biomass mapping, and those describing applications of active remote sensing using either radar or LiDAR applications.

Univariate and multivariate regression models with and without spatially structured random effects were used by Babcock *et al.* to predict several tree structure variables using LiDAR data. Their findings indicate that by accommodating spatial dependence via spatial random effects, they could improve the model fit and resulting predictions. The importance of trees outside the forest have gained importance in recent years as they play a pivotal role within the landscape from an environmental and ecological perspective. Fauvel *et al.* present an approach to map hedgerows using a combination of spectral and spatial (morphological) features derived from very high resolution satellite imagery that illustrates that the spatial distribution of hedgerows can be accurately mapped.

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McRoberts *et al.* offer a focused study on nonlinear model-based inference for the estimation of mean forest area using Landsat-based data in the USA and mean growing stock volume per unit area using LiDAR data in Norway. Their findings suggest that nonlinear models are useful for describing the relationships between national forest inventory (NFI) data and remotely sensed independent variables, while model-based inference can be used to produce estimates and confidence intervals for parameters associated with NFI variables.

Stem-volume was estimated by Antropov *et al.* for two boreal forest conditions in central Finland using multi-temporal spaceborne L-Band SAR imagery and stand-wise forest inventory data. The method employed was based on an inverted semi-empirical boreal forest model. The model allowed volume estimates to be obtained with a root mean square error of approximately 43% of the mean of 110 m^3/ha.

A new methodology to derive forest structural parameters from spaceborne LiDAR is described by Rosette *et al.*. The simulations were based on a radiative transfer model and NASA's Laser Vegetation Imaging Sensor (LVIS), which was tested in a study area in Maine. They conclude that a satellite based LiDAR instrument with a 25 m optimized for vegetation would provide reliable estimates of vegetation height.

A detailed accuracy assessment of a pan-European forest map was carried out by Kempeneers *et al.* using field-based data from European NFIs. The analysis established that the overall accuracy of forest, non-forest was in excess of 85%, but that it differed between countries; the authors outline a number of reasons for the differences that occurred, including the spatial design of the NFIs.

A number of articles appearing in this Special Issue focus on tropical forest mapping and change detection, which is becoming increasingly important in the context of the REDD+ (Reducing Emissions from Deforestation and Forest Degradation) programme. Rasi *et al.* present an automatic segmentation and classification system to map forest cover change between 1990 and 2000, and between 2000 and 2010 using medium resolution satellite imagery, primarily from Landsat TM data. The methodology was tested in two Brazilian biomes and reached accuracies in excess of 91%.

A detailed analysis of forest cover mapping and biomass estimation in the Laos is presented by Hame *et al.* in two parts. In part 1, the authors describe an image classification system that combines satellite imagery from the ALOS AVNIR, Quickbird-2 and Kompsat-2 optical sensors with radar data from the ALOS PALSAR. The unsupervised fuzzy classification method produced reasonable results using ALOS-AVNIR data, but

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achieved poorer results with the PALSAR data. In part 2, the authors applied a similar methodology in the same study area to estimate above-ground biomass using linear regression and probability methods. The validation of the estimates indicated that the root mean square errors varied between 44.2% and 52.8% of the mean biomass. The combination of PALSAR and AVNIR data did not improve biomass estimation compared to the sole use of AVNIR data.

Vollmar *et al.* undertake a comparative analysis of ALOS AVNIR-2 data compared to Landsat TM/ETM+ data for monitoring forest cover change detection in the tropics and concluded that ALOS-AVNIR-2 could be used as a substitute data source to the Landsat data. Desclee *et al.* present a methodology to map forest cover change in central Africa based on image data from the Disaster Monitoring Constellation (DMC) concluding that using the Tasselled Cap transformation they could achieve overall accuracies in excess of 93% for land cover maps for the year 2010.

The global importance of wildfires as threats to forestry and the environment is also addressed in the special issue. Two papers focus on wildfire risk prediction using environmental models. Zhang *et al.* use a binary logistic model in north eastern China, while Trilles *et al.* base their model on a point process spatial model for a province in Spain.

The Guest Editors of this Special Issue would like to thank all of the authors who submitted manuscripts to this special issue. We are indebted to the reviewers for their timely and conscientious reviews of the draft articles and for providing constructive comments to the authors. Last but not least, our thanks go to the Editor-in-Chief and the editorial staff for their time and support throughout the preparation of the special issue.

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Dr. Goodenough is a Life Fellow of the IEEE. He is a recipient of the IEEE Third Millennium Medal (2000). He was President of the IEEE Geoscience and Remote Sensing Society (1992–1993) and served as Past President (1994–1996). He served as General Co-Chairman with Dr. Andrew Blanchard of IGARSS 2000 (Honolulu), and served as Technical Co-Chairman of IGARSS'89 (Vancouver) and IGARSS 2002 (Toronto). He has published extensively (more than 250 papers). He has participated in national and international large satellite missions, serving on Phase A teams, User and Science Teams, and Evaluation Teams. He has received the following awards: Government of Canada's Award of Excellence; the IEEE GRS-S Distinguished Achievement Award; the Canadian Remote Sensing Society's Gold Medal Award; the IEEE GRS-S Outstanding Service Award; a Natural Resources Canada Departmental Merit Award; an Energy, Mines, and Resources Merit Award; and NASA Group Achievement Awards.