Preface, 2012 ForestSAT Special Issue

1. Introduction

Papers published in this special issue of Remote Sensing of Environment are based on presentations at the 2012 ForestSAT conference held on 11–14 September 2012 in Corvallis, Oregon, USA. ForestSAT has emerged as one of the most popular, international remote sensing conferences. From the beginning, the conference series has emphasized operational aspects of remote sensing for practitioners, state-of-the-art and emerging technologies, and associated spatial techniques, all for forestry and environmental applications; of note, the “SAT” in ForestSAT abbreviates “Spatial Analysis Technologies.” The first ForestSAT conference was organized by the British Forestry Commission in 2002 as an outgrowth of a European Union program that linked partners in Sweden and the United Kingdom. Subsequent conferences were held in Borås, Sweden, in 2005; in Montpellier, France, in 2007; in Lugo, Spain, in 2010; and in Corvallis, Oregon, USA, in 2012. The 2012 conference brought together more than 270 researchers, data providers, and practitioners from 29 countries in a common forum to discuss the development and application of remote sensing techniques and tools. The 2014 ForestSAT conference will be held on 4–7 November 2014 in Riva del Garda, Italy (http://forestsat2014.com/).

Multiple similarities between this and past ForestSAT special issues are of interest (McRoberts, Donoghue, & Deshayes, 2009; McRoberts, Donoghue, & Olsson, 2007). First, as for past conferences, the authors of the majority of special issue papers reside in the region hosting the conference. Of these 14 special issue papers, the authors of nine reside in the USA with the remainder residing in Germany, France, or Austria. Second, spectral sensors, particularly Landsat, continue as the remote sensing data source of choice. Third, active sensors, particularly lidar, continue to emerge as a useful source for assessing attributes such as aboveground biomass (AGB) and height. A distinct dissimilarity with respect to past special issues is the current focus on change estimation. Of the 14 published papers, 10 involve some aspect of change detection including forest area change, deforestation, AGB change, and the ecological and economic consequences of various kinds of disturbance.

Because of the traditional ForestSAT emphasis on operational applications of remote sensing and spatial technologies, the papers in this special issue are reviewed in three categories related to their forestry objectives: forest attribute prediction, forest ecosystem disturbance, and statistical inference for estimating forest change.

2. Forest attribute prediction

The four papers in this category focused on improving the accuracy of methods for predicting forest attributes. Ohmann et al. (2014–in this volume) used nearest neighbors techniques with forest inventory, topographic, climatic, and Landsat data to assess the effects of scale on forest vegetation map accuracy. They found that no spatial scale was optimal for all diagnostics, but that accuracies were greater for larger assessment scales. Accuracy assessment grain (resolution) and number of nearest neighbors strongly influenced diagnostics, whereas imputation grain had little effect. Schlund et al. (2014–in this volume) found that the bistatic features from the TanDEM-X (Synthetic Aperture Radar) mission improved the separability of forest classes with more than 50% canopy cover and those with less than 50% canopy cover (e.g., shrubland and forest land). An increase in classification accuracy greater than 10% relative to monostatic features resulted in an overall accuracy of 85%. Koukal et al. (2014–in this volume) investigated different approaches for extracting spectro-directional information from digital airborne imagery. Two widely used semi-empirical models of the bidirectional reflectance distribution function were tested for purposes of forest type classification. The 3-parameter version of the RPV model was found most effective, increasing classification accuracy from 72% to 85%. Zhang et al. (2014–in this volume) estimated AGB using Landsat-based estimates of leaf area index and Geoscience Laser Altimeter System (GLAS)-based estimates of maximum canopy height. The estimates corresponded well with three other estimates, all based to some degree on inventory data. A comprehensive uncertainty assessment identified many sources of uncertainty that are typically ignored and incorporated many of their effects to produce a credible lower uncertainty limit.

3. Detecting, mapping, and characterizing forest ecosystem disturbance

All six papers in this category emphasized forest ecosystem change resulting from various kinds of disturbance. Williams et al. (2014–in this volume) used a series of Landsat-based disturbance maps to estimate the areas of forest land in various age classes. An inventory-based model of post-disturbance carbon trajectories was then used to estimate net forest carbon uptake resulting from growth and decomposition for selected forested regions of the USA. At both landscape and continental scales, regrowth carbon sinks varied considerably as a result of differing management practices and natural disturbance phenomena. Griffiths et al. (2014–in this volume) used a series of large area Landsat composites to construct forest type maps and to assess forest disturbance and recovery dynamics in the Carpathian region of Eastern Europe. Overall accuracies were 86% for the disturbance map and as great as 73% for the forest type maps. Kane et al. (2014–in this volume) used a combination of Landsat and lidar data to assess the effects of fire on forest structure. They found that post-fire structural trajectories depended on fire severity and forest type, and that low to moderate severity fires best replicated historic forest structures.
Krofcheck et al. (2014—in this volume) successfully used Landsat and RapidEye data to investigate drought-induced structural changes in piñon–juniper woodlands. They found that post-drought canopy loss was readily detected, but that recovery was more difficult to detect. In addition, they found that post-mortality regrowth was mostly limited to regions below dead tree crowns, whereas loss of canopy inhibited re-growth between dead tree crowns. Sulla-Menashe et al. (2014—in this volume) characterized the major strengths and weaknesses of MODIS time series data for forest change monitoring at large scales. They found that successful disturbance detection depended on the size and severity of the event and factors related to disturbance history. Pflugmacher et al. (in this volume) constructed a model of the relationship between airborne laser scanning (ALS)-based pixel-level predictions of AGB and Landsat-based estimates of forest disturbance and recovery metrics. The model was then used to map AGB and AGB change. The magnitude of disturbance, post-disturbance condition and post-disturbance recovery were the best predictors of AGB. Large area estimates corresponded well with inventory estimates.

4. Statistical inference for forest change estimation

The four papers in this category addressed aspects of forest change with emphasis on statistically rigorous methods for estimating variances and constructing confidence intervals. Sannier et al. (2014—in this volume) and McRoberts (2014—in this volume) both used Landsat data to estimate forest/non-forest change. Sannier et al. (in this volume) used visual interpretation of Landsat data to estimate deforestation in Gabon. The combination of a two-stage accuracy assessment sampling design and the model-assisted regression estimator produced efficient and precise estimates which were significantly different from zero for 1990–2000 but not for 2000–2010. McRoberts (2014—in this volume) used post-classification methods with two dates of forest inventory and Landsat data to estimate gross afforestation, gross deforestation, and net deforestation. Both model-assisted and model-based approaches to inference were used to produce statistically rigorous confidence intervals. Both Andersen et al. (2014—in this volume) and Skowronski et al. (in this volume) used repeated ALS acquisitions to estimate change in AGB. Andersen et al. (in this volume) estimated changes in AGB and canopy structure metrics resulting from low-impact selective logging. A statistically rigorous, model-based approach to inference was used to quantify the significance of lidar-observed changes in biomass between the 2010 and 2011 flights. Differences in 2010 and 2011 lidar canopy metrics were sufficient to detect a decrease in tall canopy of 4.1% as statistically significantly different from zero. Skowronski et al. (2014—in this volume) estimated AGB and change in AGB using repeated airborne data and corresponding ground-based forest biomass measurements. Estimates obtained using model predictions of AGB change and a statistically rigorous, model-assisted regression estimator were more precise than comparable simple random sampling estimates and estimates based on differences in model predictions of AGB.

Three trends in these special issue papers merit brief comments. First, the importance of national forest inventories as sources of training and/or accuracy assessment data cannot be ignored. Half the papers in this special issue reported using such data. Second, as remote sensing-based studies increasingly extend mapping to estimation, the importance of statistically rigorous approaches to inference gain prominence. The use of model-assisted and model-based estimators by the authors of at least four papers represents important progress in this direction. Third, the use of dense time series of image data to characterize change was prominent at the conference and five papers in this special issue represent this advanced development in forest monitoring.

Finally, the guest editors thank the organizers for an excellent conference and the authors for their contributions and patience. Special thanks are extended to Professor Marvin Bauer, editor of Remote Sensing Environment, for allowing us to publish this special issue and to Betty Schiefelbein, Managing Editor, for her guidance, patience, and efficiency in guiding this issue to completion. The numerous reviewers for this special issue deserve special thanks for their diligence and insightful critiques that greatly improved the quality of each paper.

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18 February 2014