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INTRODUCTION

Quantifying uncertainty in forest measurements and models: approaches and applications

Quantifying uncertainty in forest measurements and models was the theme of a subplenary and two technical sessions at the IUFRO (International Union of Forest Research Organizations) World Congress 2014 held 5–11 October 2014 in Salt Lake City, Utah, USA. The subplenary session presented four keynote talks that highlighted the importance and benefits of estimating uncertainties. Sixteen oral presentations addressed sources of uncertainty in forest ecosystem studies, including spatial and temporal variation, measurement error, model uncertainty, and model selection error. In addition, there were more than 30 posters on this theme. Selected highlights from talks and discussions at the meeting are summarized below.

- Quantifying uncertainty is essential for establishing the significance of findings and making predictions with known confidence.
- Uncertainties influence monitoring designs and management and policy decisions. Estimates of uncertainty are required to guide investments in research and monitoring.
- Conversely, not accounting for uncertainty in forest management decisions could lead to suboptimal management and poor financial decisions.
- In several presentations, model uncertainties within and across models were shown to be substantial for biomass estimation and climate prediction.
- Climate change makes it difficult to forecast the future state of the forest based only on past events, processes, and rates. Forest rotations are usually very long but societal needs and expectations about the forest, including those of industry, are much shorter. Thus, it is imperative to explore multiple future scenarios and their uncertainties.
- Various types of uncertainty and error are ubiquitous in forest-based studies even if they are not quantified. It was recommended that uncertainty should always be assessed and reported.
- Methodologies to assess uncertainties vary with the information available to make such estimates (knowns and unknowns), and therefore, the quality of the uncertainty assessments should be evaluated and disclosed.
- Estimating the true uncertainty may remain an elusive goal, but even an imperfect estimate of uncertainty is better than no estimate at all.

This special feature includes five papers that illustrate the importance of addressing uncertainty:

1. Yang et al. doi:10.1139/cjfr-2015-0302
2. Christina et al. doi:10.1139/cjfr-2015-0173
3. Lehtonen and Heikkinen doi:10.1139/cjfr-2015-0171
4. Freeman et al. doi:10.1139/cjfr-2014-0562
5. Eyvindson and Kangas doi:10.1139/cjfr-2014-0513

Yang et al. (1) explore the sources of the variability in tree tissue chemistry and report large differences among tissue types and nutrients. This type of analysis could be very useful to guide sampling efforts. The next three papers deal with model uncertainty. Christina et al. (2) use a metamodeling approach, as well as sensitivity and uncertainty analysis, to better understand carbon and water fluxes at the tree scale. Their investigations provide a better rating of the sensitivity of parameters used in modelling. Lehtonen and Heikkinen (3) estimate the uncertainties associated with upland soil carbon stock change in Finland using the Yasso07 model. They show that the variability in litter input is critical for estimating the uncertainty of carbon stock change. Freeman et al. (4) use two stochastic modeling techniques, random forest and stochastic gradient boosting, to map the distribution of tree canopy cover over regions of the US. They show that the predictive accuracy of these two techniques is remarkably similar and discuss the pros and cons related to each option. They also discuss the uncertainty related to repeated model runs. Finally, in the last paper of this issue, Eyvindson and Kangas (5) frame their study in the context of evaluating risks for forest management planning. They note that the optimization of forest management plans is usually done under the assumption that there is no uncertainty. They use stochastic programming to investigate the effect of the size of the set of scenarios investigated for future forest development. They investigate the contribution of forest inventory error and growth model errors.

Acknowledgements

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