"A century of national forest inventories – informing past, present and future decisions"

Abstract title:		A Monte Carlo simulation approach to estimate historical forest-related GHG emissions in Fiji
Take-home message:		*NFI data are key for the estimation of forest-related greenhouse gas emissions in the context of REDD+. For estimation, NFI data have to be combined with data and information from various other sources. Monte Carlo simulations provide an effective and transparent framework to derive the estimates.*
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General topic, see website: (please double click on the check box and activate the relevant one)	☐	Improving future NFIs by learning from the past
	☒	NFIs today and in the future
	☐	Cutting edge and futuristic inventory techniques and technologies
Preferred presentation form:	☒	Oral presentation
	☐	Poster

A Monte Carlo simulation approach to estimate historical forest-related GHG emissions in Fiji

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Introduction: Several tropical countries aiming to undertake REDD+ (Reducing emissions from deforestation and forest degradation) activities are currently facing the challenge of developing an estimate of their national historical forest-related average annual greenhouse gas emissions. This estimate, called the Forest Reference Level (FRL), will serve as a benchmark against which future potential emission reductions are to be compared. In most countries, including Fiji, NFI data are key to derive the FRL. However, methodologies of past NFIs have rarely been developed and implemented to assess carbon stocks and carbon stock changes, and, therefore, data and information from outside the NFI often need to be integrated to produce an estimate of the FRL. Moreover, the data and information required to obtain the estimate are frequently not available at the national level in developing countries (e.g., no in-country biomass models). A key challenge faced by many countries is to reliably quantify the uncertainty attached to the FRL estimate as data and models from various sources need to be combined. Here, we present the general concept of a Monte Carlo (MC) simulation framework that enables to (i) quantify the precision of the FRL estimate and (ii) assists in identifying areas of improvement to increase the precision of estimates in the future. The framework was developed to derive an estimate of the FRL and associated variances for the Republic of Fiji (only methods and results from the REDD+ activity "deforestation" will be presented).

Materials and methods: To estimate historical emissions from deforestation in Fiji, data on the average annual forest area loss (2006-2016) derived from forest cover change maps were combined with an estimate of carbon stock changes caused by deforestation. The latter estimate was derived from NFI data. To obtain estimates of carbon stock changes, data and information from various sources were used, including e.g., data from Fiji's NFI 2006, Fiji's Permanent Sample Plot program, data available in international wood density databases, spatial products such as data from the Shuttle Radar Topography Mission, as well as 2006 IPCC Guidelines default values. To develop the MC framework, we integrated several methodological approaches published in the literature (e.g., McRoberts & Westfall [2014]). Causes of uncertainty considered in the MC simulations included measurement errors, modelling error and sampling error.

Results: Average annual CO_2 emissions from deforestation in Fiji for the time interval 2006 to 2016 were estimated at 2,131,833 ± 828,166 [$tCO_2e\ yr^{-1}$] (± the semi amplitude of the 95%-confidence interval). Sampling errors represented the largest source of uncertainty. Sampling error was particularly large for area estimates of deforestation obtained from accuracy assessments conducted on the forest cover change maps. The contribution of NFI error (including measurement and modelling errors) on total error was less than 20%. The contribution of measurement and modelling error on the NFI error was moderate (less than 25%).

Conclusion: The implementation of the MC simulation framework allowed to quantify uncertainty in the FRL estimate in an effective and transparent way. Results indicate that in Fiji the precision of estimated average annual CO_2 emissions is low compared to estimates reported by other tropical countries. This may be partly attributed to the fact that measurement and modelling errors are rarely integrated into the estimation of precision in a rigorous manner.

References:

McRoberts & Westfall, 2014, Forest Science, 60(1), 34 – 42

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