Abstract template for the conference "A century of national forest inventories – informing past, present and future decisions"

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On page two, you are asked to fill in your abstract in the format and font size indicated. Please remember to include authors affiliation information in the footer section of page two. The length of the abstract may not be more than one page including references.

Abstract title:		**A generic Markov chain model to simulate the development of forest resources observed by the NFIs**
Take-home message:		*Future development simulations carried out at national levels based on NFI data can reveal interesting development patterns that cannot be straightforwardly deduced from studies based on upscaling from smaller areas. The EFDM approach is very well suited for scenario analyses, where the assumptions for the scenarios need to be flexibly varied.*
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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
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A generic Markov chain model to simulate the development of forest resources observed by the NFIs

Jari Vauhkonen & Tuula Packalen

Introduction: Forest-based bioeconomy and new forest-related policies produce needs for transparent methods to report current and future production possibilities of the forest resources. The European Forestry Dynamics Model (EFDM; Packalen et al., 2014) was developed to simulate the development of the forest and ecosystem services for any given forested area based on data from Europe's NFIs. However, the EFDM as well as other area-based matrix models were applied assuming either even-aged or uneven-aged forest management, although both management systems are often applied simultaneously due to land-use constraints or the rationality of combining the systems.

Materials and methods: We present an area-based matrix model combining two different Markov chain models, one for even-aged and another for uneven-aged forest management. The separate Markov chain models are used to simulate the development of forests according to different management systems and a classification of forests to wood availability categories is assumed to determine which system was applied (Vauhkonen and Packalen, 2017). We demonstrate how the model can be parameterized by the initial forest-area distribution and business-as-usual transition probabilities derived from permanent NFI plots or similar available data sets, such as those produced by forest simulators. In addition, we demonstrate the flexibility of the model

- To incorporate climate-induced tree growth as a time-inhomogeneous Markov chain, which can be used to assess the magnitude of potential uncertainties due to changing climate and forest management in the projections; and
- To allow shifts between management systems, which can be used to assess the impacts of extensively shifting from even-aged management to less intensive forestry that correspond to enforced or voluntary changes in the use of forests.

Results: Simulations of both the climate and extensive shifts from conventional even-aged management to alternative silvicultural systems based on NFI data revealed interesting development patterns that cannot be straightforwardly deduced from studies based on upscaling from smaller areas. For instance, the amount of carbon stored by the Finnish forests can be increased by applying less intensive management, which however has trade-offs for harvests and their costs. The level of trade-offs differed depending on what types of land the shifts occurred and whether areas were also assumed to be completely set aside from forestry. The potential amounts of both the carbon stored and extracted varied considerably depending on the level and allocation of future harvests. Therefore, when defining the reference level for future harvests, it should not be done with respect to a fixed reference period, but based on projections that account for uncertainty.

Conclusion: When modified slightly to allow running two Markov chain models in parallel, the EFDM simulated the development of both the even- and uneven-aged forest structures realistically. Due to the flexibility of the implementation, the approach is very well suited for situations where scenario assumptions need to be varied according to expected changes in future environments.

References:

Packalen et al., 2014, JRC Science and Policy Reports, 93450, EUR 27004, doi:10.2788/153990

Vauhkonen and Packalen, 2017, Forests, 8(9):307, doi:10.3390/f8090307

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