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Managing forest risks in uncertain times of climate change

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Abstract

Key message: Managing forest risks in uncertain times of climate change necessitates novel and adaptive forest decision approaches. Multiple risks (biotic and abiotic) and sources of uncertainty should be identified, and their quantities over decision horizon should be propagated in searching for robust solutions. The solutions may ask for changes in classical forest decisions, e.g., rotation age or beyond, e.g., forest insurance.

Keywords: Adaptation, Risk, Uncertainty, Mitigation, Global change

The topical collection "Risk Analysis" provides state-of-the-art insights on managing forest risks in the uncertain times of climate change. Main contributions to this collection originate from the biannual Risk Analysis (IUFRO 4.04.07) Conference 2016: "Managing Risk in Uncertain Times." The event and topical collection were coordinated with the intention of exploring the potentials of multi-disciplinary risk analysis framework (or methodology) to a multi-faceted issue: how to manage risk during a time of rapidly changing climatic conditions.

Forest management planning and decision-making have been able, in the past, to give only slight consideration to risk and uncertainty. Empirically derived knowledge regarding the factors that are important in achieving desired ecosystem goods and services was plentiful, and uncertainty in this knowledge was generally not thought to be an important consideration. Today, our climate is changing at an unprecedented rate, and this rapidly changing climate is dramatically increasing our level of uncertainty regarding the biotic and abiotic processes that will determine the delivery of desired ecosystem goods and services. Under a changing climate the frequency and severity of natural disturbances are changing, post disturbance (including post-harvesting) silvics are changing, and our models that attempt to capture these relationships are increasingly complex and uncertain. Overlaying all is a basic uncertainty in the details of our future climate and society's response to it. Forest resource management is developing novel approaches, such as adaptive management, to deal with the uncertainties. At the same time, risk perception by decision-makers and multiple stakeholders (with competing demands) will play a major role in determining management strategies. The 10 publications in this topical collection address three ultimate research questions:

1- What are the major risks affecting forest ecosystems and their predictions uncertainty?
2- What adaptation and risk management approaches could be useful to cope with the identified risks and uncertainties?
3- What are the ecological outcomes and economic implications of applying novel adaptation approaches in forestry?

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Special attention is given to the socio-economic drivers of decision-making processes and how the risk and uncertainty perceptions and knowledge base of forest managers and decision-makers may affect defining and implementing forest adaptation strategies.

Novel adaptation approaches such as forest insurance against risk and robust decision-making (RDM) are proposed to go beyond traditional forest management approaches which are eventually not capable of dealing with the risk management issues. Investing in forest insurance schemes by paying risk premiums to the financial insurance sector (risk transfer) would ensure that intact forest ecosystems are re-established after disturbances. Brunnette et al. (2017) highlighted that when climate change imposes an uncertain probability of the occurrence of the natural event, it may be essential to include adaptation efforts in the insurance contracts especially for risk-averse forest owners. Moreover, proactive adaptation approaches such as RDM are proposed and discussed as an essential strategy to sustain the provision of ecosystem goods and services from highly valuable and simultaneously vulnerable forest resources (Radke et al., 2017). Both insurance and RDM approaches are costly strategies but reduce the uncertainty of forest risk management. The studies disentangle the effects of economic factors, e.g., discount rate, price/cost, rotation age on the final adaptive decisions, and their expected economic efficiency.

The ongoing debate about the appropriate discount rate to apply in forestry is affected by the risk and time preferences of foresters. Sauter and Mußhoff (2018) studied the discounting behavior in an economic experiment with 142 German foresters and found that foresters' risk attitudes were mostly characterized as risk-averse and their time preference discount rates were 4.1% on average. A study by Hengst-Ehrhart (2019) revealed that adaptive action on both stand and forest enterprise (business) levels is missing in forest management and recommended that, to promote adaptation, beyond the cognitive dimension, affective and cognitive aspects should be promoted. Studying the historical effects of silvicultural adaptations for mitigating storm risk, Müller et al. (2019) found an increasing conditional value at risk and decreasing average damage loss considering historical cost and price fluctuations. In their study and among the silvicultural systems, the recently recommended group selection system, showed the highest mitigation efficiency towards storm, compared to past regimes of thinning from below or thinning from above.

Multiple studies dealt with the rotation age-related implications of risk management in forestry. Möllmann and Möhring (2017) introduced a practical way to integrate risk in forest management decisions using the concept of expected losses for finding the optimal rotation period and choice of tree species. Bréda and Brunette (2019) examined the reduction of forest rotation as an adaptation strategy for a Douglas fir stand affected by drought. They applied a water balance model and an economic modeling approach and showed that, from an economic perspective, immediate or delayed reduction of rotation ages is always superior to no change in rotation age. Moreover, Mezei et al. (2017) examined the effects of protection strategies on the mortality of Norway spruce and found that under an outbreak scenario modulated by earlier natural disturbances (wind and bark beetles) in a buffer zone, the effects of sanitary management on tree mortality may remain limited due to the migration of bark beetles from unmanaged areas, however, sanitary management in buffer zones may remain essential for the isolation of bark beetle outbreaks in unmanaged areas.

Gray (2017) quantified the epistemic sources of uncertainty in a predictive model of future spruce budworm outbreaks. The sources included the historical forest compositions (data) with which the model was constructed and its spatial resolution, and the future climate and forest compositions that will drive the future outbreaks. The greatest contributor to uncertainty in the predictions was the uncertainty in historical forest composition (used in model building and calibration), followed by the uncertainty of the future climate (RCP scenario, regardless of climate model) driving the outbreak. He concludes that forest management strategies must, therefore, include alternatives that present a reasonable likelihood of achieving acceptable, as opposed to optimal, ecosystem goods and services outcomes over a wide range of possible future climates.

The studies in this special issue have disentangled a diversity of aspects relevant to risk analysis in forestry especially under climate change. They agree upon the complexity of adaptation actions and decisions, ranging from reactive to active and robust adaptation, to cope not only with the risks but also with the uncertainty of future predictions and expected forest management outcomes (Yousefpour, Augustynczik, and Haneewinkel, 2017).

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