Global Environmental Change 52 (2018) 238–247

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Capturing complexity: Forests, decision-making and climate change mitigation action

M.J. Klapwijk[a,*], J. Boberg[b], J. Bergh[c], K. Bishop[d], C. Björkman[a], D. Ellison[e,l], A. Felton[f], R. Lidskog[g], T. Lundmark[h], E.C.H. Keskitalo[i], J. Sonesson[j], A. Nordin[k], E.-M. Nordström[l], J. Stenlid[b], E. Mårald[m]

[a] Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden
[b] Swedish University of Agricultural Sciences, Department of Forest Mycology and Pathology, Uppsala, Sweden
[c] Linnaeus University, Department of Forestry and Wood Technology, Växsjö, Sweden
[d] Swedish University of Agricultural Sciences, Department of Aquatic Resources and Assessment, Uppsala, Sweden
[e] Ellison Consulting, Baar, Switzerland
[f] Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre, Alnarp, Sweden
[g] Örebro University, School of Humanities, Education and Social Sciences, Örebro, Sweden
[h] Swedish University of Agricultural Sciences, Department of Forest Ecology and Management, Umeå, Sweden
[i] Umeå University, Department of Geography and Economic History, Umeå, Sweden
[j] Skogforsk, Uppsala, Sweden
[k] Swedish University of Agricultural Sciences, Department of Forest Genetics and Plant Physiology, Umeå, Sweden
[l] Swedish University of Agricultural Sciences, Department of Forest Resource Management, Umeå, Sweden
[m] Umeå University, Department of Historical, Philosophical and Religious Studies, Umeå, Sweden

ARTICLE INFO

Keywords:
Global change
Socio-ecological system
Forest industry
Forestry
Governance
Adaptation

ABSTRACT

Managed forests can play an important role in climate change mitigation due to their capacity to sequester carbon. However, it has proven difficult to harness their full potential for climate change mitigation. Managed forests are often referred to as socio-ecological systems as the human dimension is an integral part of the system. When attempting to change systems that are influenced by factors such as collective knowledge, social organization, understanding of the situation and values represented in society, initial intentions often shift due to the complexity of political, social and scientific interactions. Currently, the scientific literature is dispersed over the different factors related to the socio-ecological system. To examine the level of dispersion and to obtain a holistic view, we review climate change mitigation in the context of Swedish forest research. We introduce a heuristic framework to understand decision-making connected to climate change mitigation. We apply our framework to two themes which span different dimensions in the socio-ecological system: carbon accounting and bioenergy. A key finding in the literature was the perception that current uncertainties regarding the reliability of different methods of carbon accounting inhibits international agreement on the use of forests for climate change mitigation. This feeds into a strategic obstacle affecting the willingness of individual countries to implement forest-related carbon emission reduction policies. Decisions on the utilization of forests for bioenergy are impeded by a lack of knowledge regarding the resultant biophysical and social consequences. This interacts negatively with the development of institutional incentives regarding the production of bioenergy using forest products. Normative disagreement about acceptable forest use further affects these scientific discussions and therefore is an over-arching influence on decision-making. With our framework, we capture this complexity and make obstacles to decision-making more transparent to enable their more effective resolution. We have identified the main research areas concerned with the use of managed forest in climate change mitigation and the obstacles that are connected to decision making.

* Corresponding author at: Ulls väg 16, 75651, Uppsala, Box 7044, 75007, Sweden.
E-mail address: maartje.klapwijk@slu.se (M.J. Klapwijk).

https://doi.org/10.1016/j.gloenvcha.2018.07.012
Received 2 November 2017; Received in revised form 21 July 2018; Accepted 26 July 2018

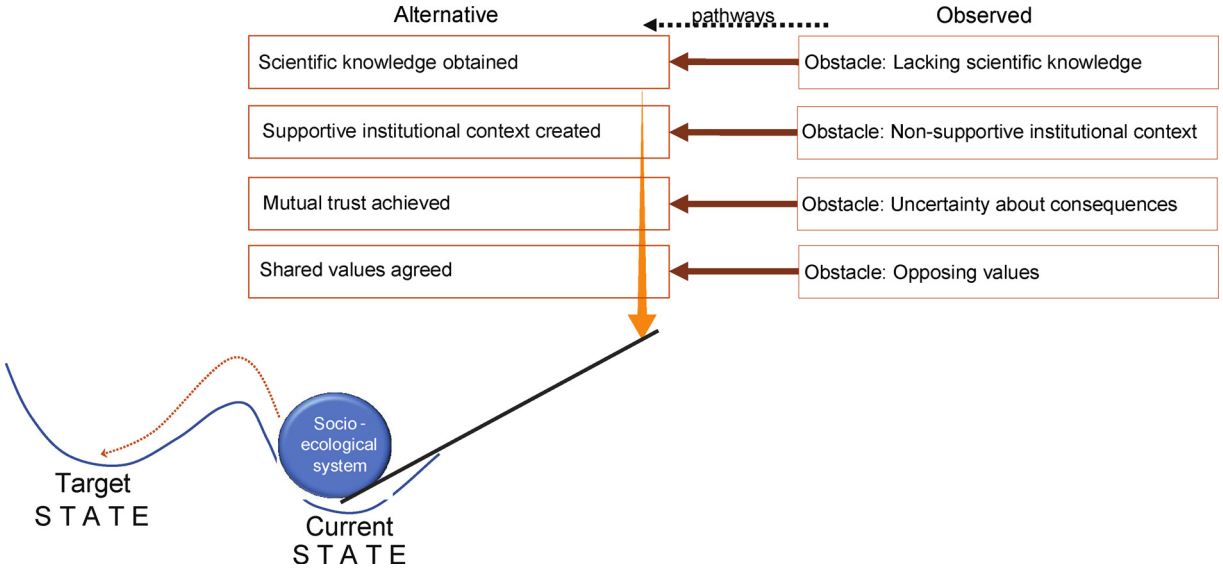

Fig. 1. The conceptual figure based on the underlying assumption that when the model is applied change is desired. The boxes represent the four categories of obstacles but translated to their desired state. By using the four categories of obstacles, the pathway to the 'target state' can be identified and evaluated. In certain situations, the result might be that the solution is 'too costly' or is not feasible, leading to a re-assessment of the initial goal.

1. Introduction

1.1. Background

Issues that involve forest management and climate change mitigation span social and ecological spheres with temporal and spatial dimensions, as well as academic disciplines and value systems. Managed forests are often referred to as socio-ecological systems, where the human-dimension is an integral part of the system (Berkes and Folke, 1998). Decisions related to the use and management of forest resources are, both directly and indirectly, influenced by factors such as collective knowledge, social organization, understanding of the situation and values represented in society (Folke et al., 2016). When attempting to change these types of multifaceted systems, initial intentions often shift due to the complexity of political, social and scientific interactions.

Forest management for the production of biomass affects CO_2 concentrations in the atmosphere through changes in carbon stocks in living biomass, soils and litter, as well as storage of carbon stocks in wood products. The use of forest materials to substitute for high 'CO_2 cost' products, for example concrete, reduces carbon emissions and improves the length of time that forest carbon is sequestered (Eriksson et al., 2011). In addition, the use of forest biomass for bio-energy production releases recently stored carbon into the atmosphere, but avoids the release of historic carbon from the burning of fossil fuels (Gustavsson et al., 2007). Substitution of fossil fuel-based products and energy can reduce the release of CO_2 into the atmosphere (Fares et al., 2015; Lundmark et al., 2014). The idea of using forest management to mitigate climate change was presented for the first time in the 1970s. Two decades later the large potential of forest management in climate change mitigation was emphasized and summarized in the assessments of the Intergovernmental Panel on Climate Change. The boreal forest, the focus of this article, accounts for more than one third of global forest carbon stocks (Bradshaw and Warkentin, 2015; Pan et al., 2011). Efforts are being made to incorporate these forests into climate policy frameworks, but progress has been slow.

Progressing from a general idea about the benefits of using forest management to mitigate climate change to realizing such ambitions in practice is far from straightforward. The IPCC has investigated what hinders the further use of forests in climate mitigation, and concluded that efforts to do so are, i) hindered by the complexity of interactions between the biophysical and social part of the socio-ecological system, and ii) that effective use depends on the adaptive capacity, conditional states, complex interactions and limitations in both systems (Smith et al., 2014). Recognizing this complexity is one step toward facilitating the increased use of managed forest for climate mitigation, via the identification of key bottle-necks or 'dead-locks'. Recognizing complexity will also allow for the identification of obstacles that are caused by interactions between what seems to be a social or biophysical hinder in the social-ecological system. In this study, we propose a systems-approach (Fischer et al., 2015) to identify decision-making pathways to move the socio-ecological system forward.

1.1.1. Aim and purpose

The aim of this paper is to explore a range of interacting obstacles which inhibit the increased use of forests as a climate change mitigation tool. To capture this, we present an heuristic framework to increase our understanding of the type of socio-ecological issues that influence efforts to establish possible pathways to increase the contribution of forests to climate change mitigation goals. We define components of decision-making based on previous sociological research, where Lidskog and Löfmarck (2015) have captured complexity related to decision-making by dividing uncertainty into four different dimensions. For our purpose, we extend these dimensions to identify the state of four components of decision-making – cognitive, strategic, institutional and normative. Lidskog and Löfmarck (2015) argue that this multi-dimensional approach to uncertainty makes it possible to identify, separate and understand different challenges, thus increasing the potential for finding strategies to address them. Importantly, these components of decision-making do not act in isolation, but also interact; the cognitive component describes the knowledge that is needed to make a decision, the institutional component describes the political environment in which the decision is being made, the strategic component feeds in to the long-term consequences of a decision and the normative components are the values and attitudes that underlie a decision.

In order to help visualize these interactions, we connect the four components of decision-making to the key obstacles within each component which may restrict or prevent a system from moving from the 'current' state to a 'target' state using a conceptual figure (Fig. 1). Hence, by combining the four components of decision-making and the conceptual figure, the heuristic framework first enhances the potential to grasp complex socio-ecological relations regarding forests and