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Nudging service providers and assessing service trade-offs to reduce the social inefficiencies of payments for ecosystem services schemes

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ABSTRACT

Socially inefficient payment for ecosystem services (PES) schemes result when adverse shifts in the provisioning of other ecosystem services (ES) or overpayment to service providers occur. To address these inefficiencies, a holistic evaluation of trade-offs between services should be conducted in parallel with determining land owners' service provisioning preferences. Recent evidence also suggests that nudging stakeholders' preferences could be a useful policy design tool to address global change challenges. Forest owners' landscape management preferences were nudged to determine the impact on the social efficiency of PES schemes for biodiversity conservation and climate change mitigation in Finland. ES indicators for biodiversity conservation, carbon storage, and the albedo effect were included with traditional provisioning services (i.e. timber) and bioenergy to assess the consequent intra-service trade-offs. Synergies in provisioning of regulating services were identified, but were found to be more efficient when the management objective is for biodiversity conservation rather than climate change regulation. Nudging led to marginal gains in service provisioning above the baseline management and above neutral owner preferences, and increased aggregate service provisioning. This demonstrates the importance of considering intra-service trade-offs and that nudging could be an important tool for designing efficient PES schemes.

1. Introduction

Changes in landscape utilization decisions, intended to increase the provisioning of regulating ecosystem services (ES), are shaped by numerous social, economic, and environmental pressures resulting from competing objectives and trade-offs (Millennium Ecosystem Assessment, 2005; Heller and Zavaleta, 2009; Salafsky, 2011; McShane et al., 2011; Howe et al., 2014). Policy makers should avoid allocating all of the realized opportunity costs from these shifts to private land owners in an effort to maximize social well-being. Payments for ecosystem services (PES) are one policy measure designed to address this misallocation by making socially desirable practices profitable for private land owners (Pagiola, 2005; Engel et al., 2008). Still, socially inefficient schemes emerge when service providers are paid more than the social value of the services or when socially undesirable land uses are incentivized leading to adverse intra-service trade-offs (Engel et al., 2008). To avoid creating these socially efficient schemes, careful policy design is required.

Recent research has demonstrated that there are a number of different approaches for dealing with socially inefficient PES scheme design. Chan et al. (2006), Howe et al. (2014) and others recommend that a holistic trade-off analysis be adopted to account for provisioning synergies between different ES, which can be used to address potential overpayment by a given PES scheme (Pagiola, 2005; Carpenter et al., 2009; Obersteiner et al., 2010). This can lead to the 'stacking'[1] or 'bundling' of complementary ES, those with

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[1] Stacking is defined here as the bundling or stacking of multiple connected or interdependent ecosystem service offerings within a singular PES scheme, and not *credit stacking* that refers to many ecosystem service offerings being sold in multiple PES schemes for the same site (Robertson et al., 2014).

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connectedness or interdependence in provisioning, within a singular PES scheme, which aims to reduce the risk adverse intra-service trade-offs by incentivizing co-provisioning of service offerings at socially efficient levels (Simonit and Perrings, 2013; Turner et al., 2014). Engel et al. (2008) and Hejnowicz et al. (2014) also note that selectively targeting service providers an important approach for reducing costs and social inefficiency, and ensuring additionality within a PES scheme.

Still, if forest owners' preferences change over the course of the PES scheme, the resulting 'ideal' targeted service providers could temporally and spatially shift. Additionally, when stakeholder preferences are considered, trade-offs between regulating and provisioning ES frequently favor the latter and often lead to human-centric normative judgments[2] (Rantala and Primmer, 2003; Rodriguez et al., 2006; Margolis and Naevdal, 2008; Rockström et al., 2009). Consequently private management preferences can result in socially sub-optimal levels of ES, but excluding stakeholders from the planning phase may also reduce the viability of the policy (Gregory and Keeney, 1994; Chan et al., 2007; Bennett et al., 2009; McShane et al., 2011).

Dickinson et al. (2013) have recently proposed framing stakeholder consultations to nudge their preferences as an alternative, and potentially important, tool for designing policies intended to generate greater action on climate change mitigation (Thaler and Sunstein, 2008; Moser and Dilling, 2007; Sussman, 2009; Huutoniemi and Hukkinen, 2014). The concept of nudging refers to a way of influencing people's choices (i.e. about forestry management) without forbidding choice options or changing the economic feasibility of the alternatives (Thaler and Sunstein, 2008). We propose that nudging stakeholder preferences should also be considered as an additional tool for improving the social efficiency of PES; particularly in cases where forest ownership is private and fragmented across a large number of owners, as in southern Finland. By considering stakeholder preferences, we assume that future forest management shifts are not certain and that the PES schemes' success relies on acceptance by key stakeholders.

We surveyed Finnish non-industrial private forest (forest) owners to determine their ES provisioning preferences for their regional forested landscape. Half of the forest owners in the survey were nudged to evaluate the potential of this policy tool for improving the social efficiency of PES schemes. Forest owners were presented with management scenarios for Business-as-Usual (BAU), bioenergy, climate change mitigation, and biodiversity conservation objectives, and the associated expected economic returns. The economic returns included compensation for management shifts away from the BAU for two different PES schemes. The PES schemes were evaluated using six ES indicators, following Mönkkönen et al.'s (2014) methods for forested landscape planning, to determine if: the ES trade-offs led to adverse impacts on the provisioning of non-targeted ES, the considered PES price levels resulted in overpayment for service provisioning, or the nudging of forest owners led to increased marginal service provisioning relative to the baseline.

Climate change mitigation and biodiversity conservation form two of the foremost environmental pressures involved in forested landscape management planning (i.e. Carpenter et al., 2009; Anderson et al., 2011). Therefore, the two PES schemes were targeted toward those non-traditional forest management objectives. We define PES as a voluntary transaction for a well-defined ES with at least one buyer and one service provider meeting the conditionality principle (service provider secures service provision) based on the definition provided by Wunder (2007). Using that definition, the climate PES scheme was based on the New Zealand Emissions Trading Scheme (ETS) (Jiang et al., 2009) that uses the international carbon offset price to determine forest owner compensation, and the biodiversity PES scheme was based on the Finnish governments' Trading in Nature Values (TNV) conservation scheme that used private bids for service provisioning contracts (Juutinen et al., 2013).

2. Material and methods

2.1. Description of the case area

In Finland, 52% of forest land is under private ownership and supplies 80% of the harvested wood volume for industrial uses. As such, Finland provides a suitable example of challenges in aligning forest owner's management preferences with the preferences of society. In the study area, forest ownership accounted for 73% of active forest management (FSYF, 2011). Stand inventory data for a 20 km × 20 km area around the Hyytiälä Forestry Field Station in southern Finland was provided by the Natural Resources Institute Finland from the Multi-Source National Forest Inventory (MS-NFI). The data contained land and forest site types and biometric information (Tomppo et al., 2008). Grid points containing forest growing on mineral soil or on ditched peatlands of same fertility were considered. Other peat soil sites (bogs, swamps, etc.) containing trees constituted only a small proportion of the total area (3.2%), and were excluded from the analysis. Forests were classified based on Finnish forest site types including: fertile *Oxalis-maianthemum* and *Oxalis-myrtillus* (OMT), medium fertile *Myrtillus* (MT), and less fertile *Vaccinium* (VT) (Cajander, 1949). These three site types were divided according to six initial stand age classes: 0, 20, 45, 70, 90, and 120 years. All of the scenarios considered a mixture of native boreal species: Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris* L.), and silver birch (*Betula pendula*). Full descriptive statistics of the initial structure and a map of the site location are provided in Section 1 of the Supplementary Material.

2.2. Forest management scenario modeling

Five scenarios were developed for a period of 37 years from 2013 to 2050. By selecting this time period we assumed that climate change mitigation impacts are time-bound and require immediate action. Scenarios were modeled using the stand-level yield and growth simulation model MOTTI, which is an empirically derived forest stand model using Finnish data (i.e. Hynynen et al., 2005; Salminen et al., 2005). MOTTI has previously been used for both stand- and landscape-level forest management modeling (i.e. Ahtikoski et al., 2011). Hynynen et al. (2005) provide a detailed model description.

The five scenarios were: BAU, Bioenergy (ENR), Climate (CLI1), Climate (CLI2), and Biodiversity (BDI). The BAU followed the Finnish Forestry Development Center's (TAPIO) recommended forestry practices (Hyvän metsänhoidon suositukset, 2006). It is considered a reasonable baseline for current management that should be implemented in practice in Finland (Yrjölä, 2002). Matthies et al. (2015) have shown previously that, although this BAU scenario was not economically optimized, it provides a suitable economic baseline. The non-BAU forest management practices were defined by experts at the University of Helsinki and the Natural Resources Institute Finland (LUKE).

In the ENR scenario, the aim was to produce bioenergy through a short rotation and a low investment approach. Regeneration was assumed to be natural, sapling tending and forest thinning were disregarded, and final harvests occurred when annual biomass

[2] Ecosystem services are defined here as an aspect of a given ecosystem that is utilized, passively or actively, in the production of human well-being (Fisher et al., 2009).