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Mechanisms mediating the contribution of ecosystem services to human well-being and resilience

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ABSTRACT

Human benefits from ecosystems result from complex interactions between ecological and social processes. People affect ecosystems' capacity to deliver services that contribute to the well-being of humans and their resilience. The delivery of ecosystem services (ES) has often been considered as a linear and direct flow from nature to people without feedbacks or human inputs. We adjusted the widely used ES cascade to highlight how humans mediate each step in the ES delivery. We then applied the proposed framework to empirical field studies in Indonesia. We focused on the role of forested landscapes to increase rural people's resilience to climate hazards such as drought and floods. We found that human actions determine benefits from ES through several mechanisms (ES management, mobilization, allocation-appropriation, and appreciation). These mechanisms are influenced by peoples' decisions along the ES cascade, which depend on specific factors related to rules, assets, values, and spatial context. By facilitating or hindering ES flows, some stakeholders can determine who benefits from ES and influence the well-being of others. A better understanding of the mediating mechanisms, factors, and feedbacks in ES delivery can support the design of sound environmental assessments and sustainable land management practices.

1. Introduction

People continuously modify ecosystems, either to satisfy livelihoods needs, to gain economic benefits, or to adapt to social and environmental changes (Reyers et al., 2013; Steffen et al., 2015). The tight interactions of people with the environment are the essence of complex social-ecological systems (Cumming et al., 2006; Gunderson and Holling, 2002). An example of interactions in social-ecological systems are ecosystem services (ES) that represent nature's benefits to people (MEA, 2005a). Benefits from ecosystems include provisioning services (e.g. clean water, food, timber), regulating services (e.g. climate and water regulation), and cultural services (e.g. spiritual experience, recreation). Because ES are jointly produced in social-ecological systems, both ecosystem processes and human actions contribute to deliver ES (Comberti et al., 2015; Reyers et al., 2013). Several interdisciplinary research initiatives have explored the ways humans transform and interact within social-ecological systems to increase their well-being. These studies include the Millennium Ecosystem Assessment (MEA, 2005b, Carpenter et al., 2009) and the Resilience Alliance (Folke et al., 2004; Kantsler and Steinberg, 2005; Olsson et al., 2004).

Studies on ES have differentiated the supply by ecosystems, the demand of society, and their actual or realized benefits. In this way, they highlight the role of humans in ES delivery (Spangenberg et al., 2014b; Villamagna et al., 2013). In fact, whether humans can benefit from ES does not only depend on ES supply. It also hinges on the management strategies of stakeholders, their capacities, their access to ES, and their needs in accordance with different social, economic, and institutional contexts (Daw et al., 2016; Wieland et al., 2016). For example, Hicks and Cinner (2014) used an entitlements approach in coral reef fishing communities. They showed that ES benefits are mediated by key access mechanisms related to rights, economics, knowledge, social relationships, and institutions. In addition, a study in a farming landscape in central Romania (Horcea-Milcu et al., 2015) showed that six groups of

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factors mediate the relationships between ES and human well-being: (i) ES characteristics, (ii) policies, formal institutions, and markets, (iii) social and power relations, (iv) household decisions, (v) perceptions of equity, and (vi) individual values.

The contribution of ES to human well-being happens through different steps as illustrated by the ES cascade framework (Haines-Young and Potschin, 2010). The cascade represents subsequent steps in the generation of ES – from biophysical structures and processes to ecosystem functions and ES to benefits and values. This framework has been widely applied (Fischer and Eastwood, 2016; Maes et al., 2016). It was further developed to better include the socioeconomic processes intervening in each cascade step (Spangenberg et al., 2014a) (Fig. 1) and the role of management (Oudenhoven et al., 2012), governance (Primmer et al., 2015), or socio-political context (Hausknost et al., 2017).

This paper analyses the social-ecological mechanisms and the contextual factors that mediate how a landscape and its ES contribute to human well-being. It proposes a framework that expands the ES cascade to focus more on the socioeconomic interactions between subsequent steps of the cascade (i.e. social-ecological system integrated approach). First, the paper introduces the framework of mediating mechanisms and factors based on existing concepts in the literature. The framework includes the influence of humans along the ES cascade to highlight in which steps and how people interact with ecological processes to produce and deliver ES. It emphasizes social-ecological interactions, in which human actions mediate ES flows through mechanisms, factors, and feedback loops. Taking into account these complexities and anthropogenic feedbacks, the framework helps to understand the role and responsibilities of humans in shaping ecosystems and their services. Then, the framework is tested with case studies from empirical in-situ analysis in Indonesia. We considered ES from forested landscapes that contribute to human well-being in the form of increased resilience to climate variability and hazards (as part of resilience to shock and stress in the security constituent of well-being [MEA, 2005b]). Finally, the paper discusses the importance of mediating mechanisms and factors in shaping the generation of ES benefits and the possible implications for land management and policies. We suggest that including such aspects in ES assessments can help design policies and projects based on ecosystems that are more appropriate and feasible in local contexts.

2. Conceptual framework of mediating mechanisms and factors

2.1. Multiple human contributions along the ES cascade

Human actions play a key role in mediating the delivery of ES – from landscapes to final beneficiaries – and depend on social-ecological contexts. People regulate the combination of ecological and social processes that creates ES through co-construction (making of meaning) and co-production (making of things) (Díaz et al., 2015; Fischer and Eastwood, 2016). Human actions are determined by the capacity of individuals to act independently and make choices, i.e. human agency (Barker, 2000). In turn, people's capacity to act depends on structural forces such as institutions and norms that constrain or enable certain choices (Giddens, 1984). What individuals can do and be in relation to ES have also been referred to as environmental endowments and entitlements (Leach et al., 1999).

To improve understanding of multiple human contributions, several authors have suggested disaggregating the analysis of ES by specifying the actors involved along the ES cascade and their influences. Analyzing actors, either individuals or groups, is important because their different characteristics (e.g. dependencies, power, interests) give them varying legitimacy and capacities to influence a system (Mitchell et al., 1997). In this direction, several studies have assessed the different social actors' capacities to act on and access ES (Hicks and Cinner, 2014; Spangenberg et al., 2014b), their different power relations (Felipe-Lucia et al., 2015), their aspirations and needs (Daw et al., 2016; Horcea-Milcu et al., 2015), their identities and values (Díaz et al., 2015; Fischer and Eastwood, 2016), and their roles in distributing benefits (Fisher et al., 2009; Serna-Chavez et al., 2014).

We base our ES mediating mechanism and factor framework (Fig. 2) on the ES cascade of Haines-Young and Potschin (2010). It is complemented by Spangenberg et al. (2014a) with the human interactions leading from one step of the cascade to the next. We further modified the framework to better acknowledge mediating mechanisms (processes that lead from one step to the other), mediating factors (contextual factors influencing the mechanisms), feedback loops, and the diversity of stakeholders involved. The mediating mechanisms can represent different steps in the process of ES creation and delivery, which is generically referred to as co-production (e.g. Palomo et al., 2016; Reyers et al., 2013). It

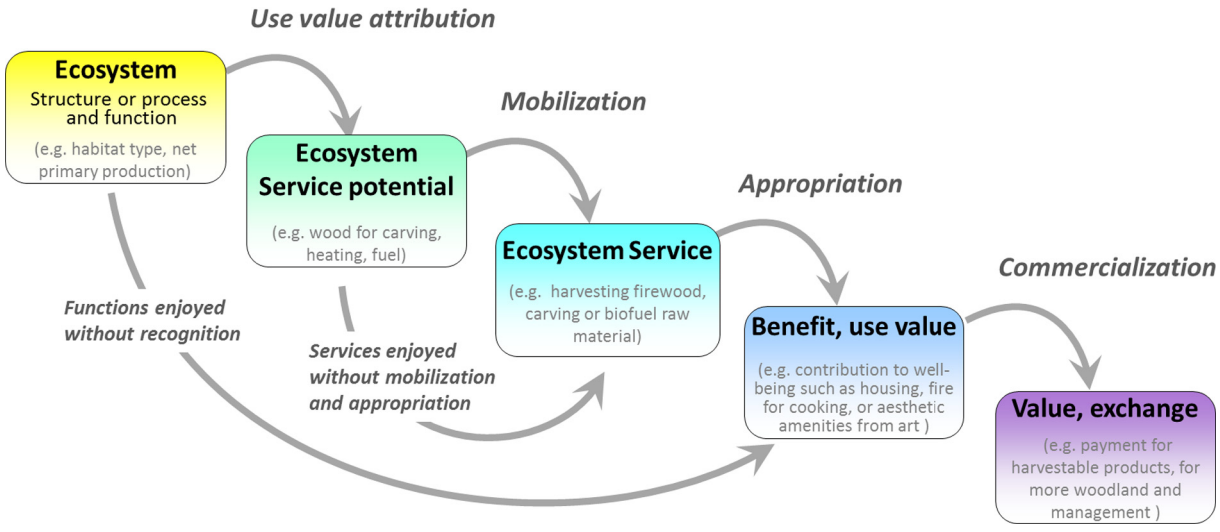

Fig. 1. The ecosystem services cascade with the socioeconomic processes leading from one step of the cascade to the next (modified from Spangenberg et al., 2014a). The ES cascade framework represents subsequent steps (colored boxes) in the generation of ES from biophysical structure and process to human benefits and value. The original framework is from Haines-Young and Potschin (2010) and the processes proposed are by Spangenberg et al. (2014a).