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Safeguarding ecosystem services and livelihoods: Understanding the impact of conservation strategies on benefit flows to society

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ABSTRACT

Society has always benefited from ecosystems through the provision of ecosystem services. To ensure a continuous flow of these benefits, different strategies aimed at safeguarding ecosystem services are proposed. In this paper we explore how biodiversity conservation measures, particularly protected areas, influence the flow of ecosystem services to different members of society. We highlight the impact of these measures on the poorer members of society because of their strong dependence on ecosystem services to sustain their livelihood. For the Democratic Republic of Congo we mapped five ecosystem services (food production, tourism, carbon, timber and fuel wood production) using spatial landscape indicators, within and outside protected areas, and identified their direct beneficiaries. This illustration was used to feed a round-table discussion on the impact of different conservation strategies on society, held with ecosystem services professionals during the 4th Ecosystem Service Partnership Conference in the Netherlands. The discussion highlighted the need for spatial methods to assess ecosystem service trade-offs, as well as the main challenges for conservation measures to contribute to both livelihood improvement and conservation gains. We argue that, ecosystem services maps can play a crucial role in understanding and managing the trade-offs in ecosystem service flows resulting from conservation strategies.

1. Introduction

Ecosystem services contribute to human well-being worldwide. The Millennium Ecosystem Assessment, among others, highlighted the importance of ecosystem services (ES), in particular for the poorer members of society, as this group often shows a strong dependence on ES to sustain their livelihoods (MA, 2003; Tallis et al., 2008; TEEB, 2008). This dependency is linked to reliance on accessible natural resources, limited adaptive capacity, and vulnerability to natural hazards. Degradation and unsustainable use of ecosystems and their services worldwide now threatens the livelihoods of many poor people. ES provide direct benefits that can also generate monetary benefits when they are paid for (Swallow et al., 2009; Milder et al., 2010; Kinzig et al., 2011). Over the past 50 years humans have changed ecosystems rapidly and extensively leading to a global loss of biodiversity and ES (MA, 2005). There is an urgent need for a change in behaviour in order to avert the negative consequences of human activities on biodiversity and ES. To ensure a continuous flow of benefits to society different strategies are developed to safeguard ES. Such strategies include, among others, coupling of ES with biodiversity conservation policies or creating market incentives for ecosystem protection. These strategies envision win–win situations where biodiversity is conserved because people understand its value, while ecosystem services are used as an argument to justify biodiversity conservation (Turner et al., 2007; Naidoo et al., 2008).

At present several biodiversity conservation policies and strategies include the explicit objective of safeguarding ES (e.g. CBD, 2010; EC, 2010). Establishing protected areas (PAs) is a common conservation strategy which has been pursued for biodiversity conservation and is also seen as an important opportunity to safeguard ecosystem services (Chan et al., 2006; Turner et al., 2007; Nelson et al., 2008; Egoh et al., 2009; Pettorelli et al., 2012). A well-connected and robust network of PAs could provide numerous ES benefits to people, especially to the surrounding local population (Figueroa and Aronson, 2006). Protected areas restrict and control human activities and use, and consequently protect the functioning of natural ecosystems (Dudley, 2008). However, the value of ES as a contribution to human well-being lies in their use which presents a potential conflict when maintaining areas in natural conditions. Biodiversity conservation strategies proposed for ecosystem services

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remain untested and little is known about the potential challenges encountered by the different stakeholder groups when implementing these strategies.

According to the common definition, ES support the well-being of 'society'. To explore the contribution of ES to local livelihoods insight is needed into which part of society is profiting from which specific ES. ES operate at different spatial scales, thus presenting a complex situation of benefit flows. The beneficiaries are not always located at the site of ES supply (Hein et al., 2006; Kinzig et al., 2011) or encounter access barriers to benefit from them (Daw et al., 2011). Therefore, in order to assess the contribution of ES to local livelihoods and the trade-offs between beneficiary groups, flows of services must be understood.

In this paper we explore how biodiversity conservation measures, particularly protected areas, could influence the flow of ES benefits to society, Based on an illustration for the Democratic Republic of Congo, we show how ES indicators and maps, can contribute to a better understanding of trade-offs in ES benefit flows as a result of conservation strategies. Subsequently, we present the outcomes of a round-table discussion among ES professionals on the role of conservation strategies in contributing to both livelihood improvement and conservation gains. The discussion was held during the 4th Ecosystem Service Partnership conference in Wageningen, the Netherlands, in 2011.

2. Ecosystem services and beneficiaries

An ES is a characteristic of an ecosystem that is considered useful to humans. For example, the presence of fish could benefit society through the provisioning of food, or through recreational fishing as a leisure activity. However, whether something is regarded a service or not depends on the location, time, and perception of (groups within) society (Haines-Young and Potschin, 2010). People will adapt, use, or protect ecosystems based on their own preferences, needs, and values. According to Swallow (2009) stakeholders can have three different roles in their interaction with ES. The first group are the beneficiaries, i.e. people who benefit from the ES. The second group are the stewards, i.e. people whose actions modify the flows of ES. And the third group are the intermediaries, i.e. people who govern interactions among stewards, beneficiaries, and the ecosystem. Decisions that change the ecosystem commonly lead to trade-offs in ES supply, resulting in a variety of winning and losing beneficiaries (Raudsepp-Hearne et al., 2010; Willemen et al., 2012). Well-managed set aside protected areas enhance ES linked to natural areas, such as soil, climate and water regulation, but do not directly improve those ES associated with human-transformed areas, such as crop production. In the context of ES and their role in sustaining livelihoods, Daw et al. (2011) identified besides trade-offs among ES, three other important aspects that should be taken into account: stakeholder access to ES, stakeholders in ES market mechanisms, and the level of dependency on ES. Access to ES is described by the authors as the social relationships, institutions, capabilities, rights, and capital that allow people to benefit from them. A clear example in relation to protected areas is the institutionalized access limitation. Subsequently, the authors emphasise the contribution to well-being through income generation, trade, and employment opportunities. In the case of protected areas this could, for example, be the spin-offs of the international tourism industry. With regard to the last issue the level of dependency reflects on the contribution of an ES to the overall well-being, which is defined by the beneficiary's context and situation (Daw et al., 2011).

The World Commission on Protected Areas (WCPA) has defined six types of management categories for protected areas, which could each have a different impact on the ecosystem services and potential beneficiaries. These management levels vary from strictly setting aside natural areas, thus prohibiting any human interventions, to cultural landscapes with permanent human activities (Dudley, 2008). PAs that are classified as category I or II by the IUCN are areas in which biodiversity, along with its underlying ecological structure and processes, are kept as 'natural' as possible, and include strict nature reserves, wilderness areas, and national parks. Here, human intervention is minimal. In the following section we focus explicitly on the impact of the IUCN I and II categories on ES benefit flows to society.

3. Protected areas and benefit flows in the Democratic Republic of Congo

The Democratic Republic of Congo (DRC) is a country with strong development and livelihood improvement needs (Von Grebmer et al., 2011). According to World Bank data, approximately 70% of the people currently live below the poverty line. A large part of the population relies on direct access to natural resources for their subsistence. The country has an extremely rich, albeit threatened, flora and fauna. In fact, the DRC has the highest level of biological diversity in Africa (UNEP, 2011). Of its 2.3 million square kilometres, the size of Western Europe, ca. 67% of the country is covered with forest (Fig. 1) and roughly 10% of the land is currently situated in a protected area (Eba'a Atyi and Bayol, 2009). In line with Target 11 of the global Strategic Plan of the Convention on Biological Diversity (CBD, 2010), the DRC plans to expand its protected area to approximately 17%.

3.1. Spatial distribution of ES

To assess the relation between PAs and their contribution of ES flows to society we mapped and quantified the provision of ES in the DRC, identified the direct beneficiary groups, and subsequently assessed the impact of PAs on the ES flows.

We used a set of spatial indicators to assess and map five selected ES in the DRC, i.e. food production from agricultural fields, fuel wood provision, timber production, carbon stocks for climate regulation, and tourism. This selection of services is limited to ES that have a direct human use and/or finance mechanisms (commodity goods, future REDD+). Additionally the selected ES provide benefits on different spatial levels, allowing for illustrating trade-offs between beneficiaries across spatial levels.

The suitability for *food production* and underlying spatial explanatory variables are assessed for the DRC using the Africover land cover map (FAO, 2003). As actual production figures are not available, the probability of finding agricultural fields is used to quantify the food production service. The land cover classes of the Africover map are based on the Land Cover Classification System which was visually applied to digitally enhanced LANDSAT TM images acquired during 2000 and 2001. Agricultural classes were extracted from the Africover map and comprised all classes that include crop and agricultural cover (Fig. 1). Based on 5000 randomly sampled points, all locations classified with or without agriculture were regressed against a set of spatial indicators (Table 1). To minimise the uncertainty in the input data in the regression, we only include points that were also classified as agriculture on another DRC land cover map for the same year by Vancutsem et al. (2006). Using a forward step-wise regression, based on Akaike's information criterion scores, the predictive variables were selected. Additionally we omitted all variables with a p-value > 0.10 and a high collinearity (i.e. a Variance Inflation Factor VIF > 10). The final set of variables to explain