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Synergies between biodiversity conservation and ecosystem service provision: Lessons on integrated ecosystem service valuation from a Himalayan protected area, Nepal

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ABSTRACT

We utilised a practical approach to integrated ecosystem service valuation to inform decision-making at Shivapuri-Nagarjun National Park in Nepal. The Toolkit for Ecosystem Service Site-based Assessment (TESSA) was used to compare ecosystem services between two alternative states of the site (protection or lack of protection with consequent changed land use) to estimate the net consequences of protection. We estimated that lack of protection would have substantially reduced the annual ecosystem service flow, including a 74% reduction in the value of greenhouse gas sequestration, 60% reduction in carbon storage, 94% reduction in nature-based recreation, and 88% reduction in water quality. The net monetary benefit of the park was estimated at $11 million year^{-1}. We conclude that: (1) simplified cost-benefit analysis between alternative states can be usefully employed to determine the ecosystem service consequences of land-use change, but monetary benefits should be subject to additional sensitivity analysis; (2) both biophysical indicators and monetary values can be standardised using rose plots, to illustrate the magnitude of synergies and trade-offs among the services; and (3) continued biodiversity protection measures can preserve carbon stock, although the benefit of doing so remains virtual unless an effective governance option is established to realise the monetary values.

1. Introduction

For centuries, protected areas (PAs) have played a fundamental role in the conservation of biodiversity and ecosystems (Juffe-Bignoli et al. 2014; Mascia et al. 2014; Palomo et al. 2014). Conservationists have argued for the designation and effective management of PAs and for the protection of critical sites for biodiversity – such as Important Bird and Biodiversity Areas (IBAs; BirdLife International 2014), Alliance for Zero Extinction sites (Ricketts et al. 2005) and other Key Biodiversity Areas (Eken et al. 2004) – on the basis of their international importance for the species, biotic communities or habitats they contain, often

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emphasising their degree of threat and/or irreplaceability (Brooks et al. 2006). However, these arguments, which emphasise the intrinsic value of biodiversity and the associated ethical reasons for its conservation, have not become comprehensively mainstreamed with the wider public or political decision-makers. This is evidenced by the continued decline of biodiversity (Butchart et al. 2010, Tittensor et al. 2014) and widespread downgrading, downsizing and degazettement of PAs over the last century (Mascia et al. 2014); a trend which continues to threaten biodiversity.

To address these issues, many conservationists have sought to strengthen the case for conserving sites by demonstrating that they also provide significant benefits (i.e. ecosystem services) to people, and that these benefits can often be attributed a monetary value that resonates at a policy level (Balmford et al. 2002; Fisher et al. 2014). Communicating the economic value of goods and services from a site, and their contribution to well-being, helps highlight the growing costs to people of biodiversity loss and ecosystem degradation (TEEB 2010). However, assessing economic benefits of biodiversity and ecosystems alone cannot capture a comprehensive picture of nature's services. In order to account for the true value of the site, it is essential to recognise value pluralism (i.e. multiple distinct values derived from nature that are not reducible to a single [economic] metric) and therefore to measure not only the monetary value but also the site's sociocultural and ecological values (i.e. an integrated ecosystem service valuation; Martín-López et al. 2014; Palomo et al. 2014).

Moreover, benefits from protected areas are generally distributed broadly (i.e. globally) and the costs are often accrued locally, especially in less-developed countries (Balmford and Whitten, 2003; Adams et al. 2004). Even at the local scale, the influence of the social, political and cultural contexts under which resources and benefits accrue to people is important, and reflect the issues of equity and imbalances in power. Many interventions have (sometimes unwittingly) altered the distribution of natural resources benefits, creating winners and losers (especially among those people most directly dependent on natural resources), so undermining their development objectives and becoming the basis of local opposition and rejection (Vira et al. 2012). Pre-existing conditions influence whether people are able to access decision-making processes, resources and hence benefits and specific land uses will result in asymmetries in the distribution of environmental benefits and costs between beneficiaries (McDermott et al. 2013). This context has an impact on the subsequent design and implementation of management strategies that build from the ecosystem services assessment.

According to Gómez-Baggethun et al. (2014), an integrated ecosystem service valuation of a site should have the following features. First, the multiple values from the integrated valuation should be able to identify the associated trade-offs and synergies between services and between beneficiaries (Howe et al. 2014). Second, the valuation should be based on multiple knowledge systems (e.g. scientific knowledge, lay knowledge, traditional indigenous knowledge, etc.). Third, both qualitative (e.g. narrative records) and quantitative information should be utilised. Fourth, values emerging at different levels of societal organisation (e.g. individual, communities, nations and global) should be considered. Last, the valuation should accommodate different valuation methods. Together, these features of an integrated valuation can help to elicit a deeper understanding of the ecosystem services provided by a site, and how different decisions affect their distribution (and costs) among stakeholders.

Despite the large number of recent scientific publications referring to the ecosystem services concept, there is a paucity of empirical studies that conduct integrated valuation of ecosystem services provided by individual sites (e.g. Bhagabati et al. 2014). Many studies have focused on broad-scale studies at the global or regional level. Among existing site-scale studies, many are based on intensive, long-term research (e.g., EcoAIM – Ecological Asset Information Management; Exponent 2012) or have used desk-based models (e.g., InVEST – Integrated Valuation of Ecosystem Services and Tradeoffs; Tallis et al. 2013) and methods that require advanced technical knowledge (e.g., ARIES – Assessment and Research Infrastructure for Ecosystem Services; Bagstad et al. 2011). However, these approaches require data, capacity and resources that are often limited in those parts of the world where the richest biodiversity is most threatened and where people are most dependent on locally derived ecosystem services.

The general objective of our study was to develop and utilise a practical approach to integrated valuation that could rapidly and relatively cheaply produce locally robust, plural values to help to guide management and policy decisions at a particular site. Specifically, we used the Toolkit for Ecosystem Service Site-based Assessment (TESSA; [Peh et al. 2013a, b]; available at http://tessa.tools/) to quantify the benefits of services provided by a mountain watershed national park in Nepal, in order to investigate if the protection of an area of biodiversity importance also conserves its ecosystem service provision. We compare the hypothetical changes to ecosystem services and their distribution under a highly plausible alternative state of the site (if the protected area had not been established). We then interpret the results in relation to potential management strategies that would protect the site while helping to share the costs and benefits of conservation more fairly among stakeholders.

2. Methods

2.1. Study area

Shivapuri-Nagarjun National Park (hereafter called the park; Fig. 1) was established in 2002 and covers an area of 15,900 ha consisting of two forest blocks located between 27°45′–27°52′N and 85°15′–85°3′E in the central region of Nepal close to Kathmandu. The original Shivapuri forest block (14,400 ha) is demarcated by stone walls; in 2009, the additional Nagarjun forest block (1,500 ha) was gazetted. The park has been identified as an Important Bird and Biodiversity Area for its significant populations of bird species characteristic of the Sino-Himalayan Temperate Forest biome (Baral and Inskipp 2005, BirdLife International 2015) and is the only protected area in the country that falls entirely within the mid-hills mountain range, with its lowest altitude at 1320 m asl and highest at 2732 m asl.

Approximately 82 % of the park area is forested, comprising: (1) oak-dominated forests; (2) *Schima-Castanopsis*-dominated forests; and (3) pine forests (Table 1). The oak (*Quercus semecarpifolia*)-dominated patches are the mature forests that occur on the steep slopes above 2000 m asl. At lower elevations, *Schima-Castanopsis*-dominated fragments are the successional forests, recovering from heavy logging that occurred prior to the 1970s. Pine forests consist mainly of chir pine *Pinus roxburghii* introduced for afforestation purposes. Much of the remaining area is shrubland with small areas of grassland. Approximately 3% remains as agricultural land due to the continued presence of two human settlements with a total of 350 households. These settlements are permitted to remain inside the park but they are not allowed to harvest wild species within the area.

The park includes major parts of the watershed for the Bishnumati, Mahadev Khola and Bagmati rivers of the Kathmandu Valley, and it therefore influences water delivery patterns into these river systems. There are 28 Village Development Committees (VDCs) with a total of 80,000 inhabitants living in close proximity to the park's boundaries. The immediate area around the park is a mosaic of