



Demand and supply of ecosystem services in a Mediterranean forest: Computing payment boundaries



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ABSTRACT

This study assesses the feasibility of a mechanism of payment for ecosystem services to improve the provision of ecosystem services by private forest owners. The range of the potential payment is defined by the opportunity costs of a change in forest management as the lower boundary, and by the willingness to pay of society for the improved supply of ecosystem services as the upper boundary. We assess these two boundaries in four hypothetical management scenarios for Aleppo pine forests in Catalonia (north-eastern Spain): (i) passive; (ii) active timber-oriented; (iii) biodiversity improvement; and (iv) wildfire prevention. The upscaling of the outcomes to the regional level shows that the value of the social demand covers the opportunity costs of the landowner. We argue that these figures prove the feasibility and likely acceptance of introducing a payment for ecosystem services based on an earmarked tax. This study represents an initial step for policy instrument design.

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1. Introduction

Since the late 1960, the countries of the Northern rim of the Mediterranean have witnessed a decrease of traditional land use activities, resulting in a more homogeneous landscape with a steady accumulation of woody biomass (Gil-Tena et al., 2007), which has increased forest fire risk (Moreira et al., 2011) and reduced biodiversity (Torrás et al., 2009). These changes in ecosystem structure and diversity threaten the dynamic supply of ecosystem services (ES) (Costanza and Daly, 1992:38). Thus, a set of relevant regulating, provisioning and cultural ES provided by Mediterranean forests are in risk of deterioration: soil protection (Shakesby, 2011), water quantity and quality (Cosandey et al., 2005), wood and non-wood products (De Miguel et al., 2014), recreation and aesthetics (Englin et al., 2001; Blasco et al., 2009).

Aleppo pine forests are spread along the highly populated Western Mediterranean coast and constitute a good example of such dynamics. In Catalonia (north-eastern Spain), similarly to

other Spanish regions, Aleppo pine (*Pinus halepensis*) was intensively used in reforestation programmes (Pausas et al., 2004); moreover, this species rapidly colonizes abandoned agricultural fields and massively regenerates after moderate forest fires (Espelta et al., 2008). Yet, its slow growth, low timber quality and expensive mobilization reduce its economic profitability, and hence Aleppo pine forests are seldom sustainably managed, generating less ES.

Simultaneously, social demand for forest ES in the Mediterranean is steadily increasing (Croitoru, 2007). These demands are often disregarded in forest management planning, as most ES are not traded in conventional markets and hence do not enter landowners' financial calculations, based primarily on wood revenues.

To close the gap between ES supply and demand, payments for ecosystem services (PES) have emerged as a means of channelling monetary flows from ES beneficiaries to ES providers. Wunder (2005) defines PES as “a voluntary transaction where a well-defined environmental service (or a land use likely to secure that service) is being ‘bought’ by a (minimum one) service buyer from a (minimum one) service provider, if and only if the service provider secures service provision”. PES main characteristic is the targeted financing of natural resource management actions towards meeting the social demand for ES. The popularity of PES schemes is such that they

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have been proposed in various forest policy processes in Spain (e.g. Valencian Territorial Action Plan, Catalan forest management plan instructions).

The aim of this paper is to explore the feasibility of implementing a PES scheme addressed to enhance the supply of ES by promoting management in private Aleppo pine forests in Catalonia. This translates into the following research questions:

1. Is there enough margin between PES boundaries for establishing a transfer? i.e. Do the social benefits of improving biodiversity or fire prevention exceed the private costs of such targeted management?
2. Does a hypothetical PES render positive social profitability and attractive financial indicators for the forest owner (FO)?

For that purpose we develop management scenarios for the status quo and ES supply and compare the private opportunity costs and the social benefits of changing scenarios, finally testing two hypothetical payments.

The novelty of this paper lies in the analytical comparison of ES demand and supply values within a PES design framework aiming at stimulating active forestry. This is rather singular, as typically valuation scholars do not take into account the costs of the scenarios provided to the interviewees, and forest management modellers and planners usually overlook the demand side.

Flores Velásquez et al. (2008) adopted a somewhat similar approach by combining valuation techniques with estimates of ES supply costs for recreational infrastructure and fire vigilance to control recreationists in public forests; i.e. PES additionality did not stem from changing forestry interventions but from new infrastructure. Daly-Hassen et al. (2010) compared private and social costs and benefits -including non-marketed forest benefits- of forestry actions (mainly afforestation) for watershed improvement in publicly-owned lands and discuss their potential implementation through a PES. Instead, our study focuses on private land managers, forestry changes and a different set of ES.

In contrast to studies analysing opportunity costs of land-use changes within a cost-benefit analysis framework, where bundles of ES are assessed within a total economic value framework (Kremen, 2000; Yaron, 2001; Strassburg, 2007), our study focuses on management changes, assuming the same land-use. In addition, active forestry in these studies implies a decrease in a set of ES, while in our case ES are expected to improve.

2. Methods

2.1. Ecosystem services and PES rationale

We follow the TEEB rationale (de Groot et al., 2010) considering changes in forest ecosystem structure to enhance biodiversity and wildfire prevention; these are proxies – or intermediate services using the framework proposed by Fisher et al. (2009) – for a bundle of final provisioning, regulating and cultural ES. Four ES lacking a specific market and supplied by active forestry in Aleppo pine forests in Catalonia which could improve under active management scenarios were identified: (i) biodiversity, (ii) reduced wildfire risk, (iii) recreation, and (iv) CO₂ sequestration. ES levels and their targeted management scenarios were first draughted from the scientific and grey literature review as well as forest-related policies. Scenarios' actions, benefits and feasibility were later contrasted and fine-tuned with regional forestry expert consultation and interviews, namely technicians of the public agency devoted to private FO management and of the provincial fire prevention department, the manager of the largest FO association, and forestry and biodiversity researchers. The social

demand for the enhancement of these four attributes was then assessed, however, for the purpose of this paper we focus on biodiversity and fire prevention. The ES are both non-excludable and non-rival, and thus of public good nature and benefiting the entire Catalan society.

Assuming a neoclassical microeconomic rationality, preferences are measured individually and can be aggregated. In this context, a PES attempts to align social and landowner's interests. We adopt a model where private non-industrial forest owners respond to monetary incentives maximizing their utility (e.g. Amacher et al., 2003), whereas ES beneficiaries would be ready to pay for increases of ES provision according to their perceived value (Hanemann, 1984). We acknowledge that Catalan forest owners are not just profit-motivated (see Domínguez and Shannon, 2011); however, for the purpose of simplicity we abstract from non-profit motivated considerations.

The rationale behind PES mechanisms lies in the Kaldor-Hicks compensation principle (Pearce, 1998), according to which ES beneficiaries would be ready to forgo part of the ES value in favour of forest owners who are compensated for the costs incurred in changing forest management practices that lead to ES improvements. Fig. 1 shows the payment amount being delimited on the one side by the beneficiaries' willingness to pay for ES enhancement (the maximum boundary), and on the other side, by the opportunity cost of the management change for the FO (the minimum boundary).

The payment mechanism considered gives incentives to landowners for moving from the status quo scenario (passive or timber-oriented management) towards an active management that improves biodiversity or wildfire conditions, and consequently the bundle of associated ES. As these ES are public goods, we consider the whole Catalan society as beneficiary, and hence as potential donor through an earmarked tax. The working hypothesis is that FOs are better-off in the status quo as they minimise silvicultural interventions; thus, incentives should (at least) cover the costs of the additional work requested.

This study compares whether the social benefit from marginal changes in ES exceeds the opportunity costs of enhancing the supply of these ES.

2.1.1. Opportunity cost of ES supply

Private profitability is assessed both in terms of private returns from a management scenario, and of the FO's welfare change (private gains or losses) incurred for the ES supply. To appraise private returns the FO derives from forest management we use Soil Expectation value (SEV) and annuities (aNPV) as financial indicators. We first compute the Annual Current Balance for year t (ACB_t):

$$ACB_t = R_t - C_t + S_t - X_t (+PES_t) \quad (1)$$

where R_t denotes the revenue from timber sales, C_t – cost of

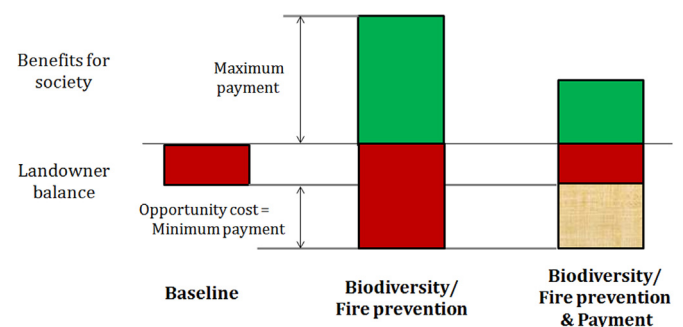


Fig. 1. Boundaries of a PES promoting active forestry. Source: adapted from Pagiola et al. (2004).

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