Land Use Policy 50 (2016) 479–489

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Measuring total social income of a stone pine afforestation in Huelva (Spain)

Paola Ovando[a,b,*], José L. Oviedo[b], Pablo Campos[b]

[a] Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science (LSE), UK
[b] Institute of Public Goods and Policies (IPP), Consejo Superior de Investigaciones Científicas (CSIC), C/Albasanz 26-28, Madrid 28037, Spain

ARTICLE INFO

Article history:
Received 26 January 2015
Received in revised form
29 September 2015
Accepted 9 October 2015
Available online 10 November 2015

Keywords:
Ecosystem services
Public services
Private amenities
Conservationist forestry
Non-market valuation

ABSTRACT

We apply an experimental ecosystem accounting approach aimed at estimating the contribution of ecosystem services to total social income accrued from a Stone pine (*Pinus pinea* L.) forest as the result of afforestation in Huelva Province, Spain. The study encompasses private market products such as timber, pine cones, and forest conservation intermediate services; and non-market final services that include private amenities and public services such as landscape, free-access recreation and carbon sequestration services. We show how the total income of each single product is distributed amongst the factorial rewards to labor, and environmental and manufactured assets. Private products account for 46% of the average total income that the Stone pine forest would yield over its rotation, while public services comprise the remaining 54%. Our results also suggest that the production of public non-market services would offset the government compensation payments to support Stone pine afforestation and management. Finally, the results show that, on average, 7% of the estimated total income would be captured by the current System of National Accounts for forestry if applied to our case study (including only the net value added from timber and pine cone production and from plantation investment) and that 14% of this income would be dislocated into the government institutional accounts.

1. Introduction

Ecosystem services (ES) are increasingly being called upon to support and inform natural resources regulation and management (MA, 2005), and ecosystem accounting is gaining attention as an approach to integrate ES and their related assets into decision making (Hein et al., 2015). The interest in developing this approach, as an instrument to quantify and integrate complex ecosystems biophysical data in connection with economic activities, has prompted a rapidly expanding literature. This progress particularly focuses on the spatial assessment and modeling of physical flow accounts describing the supply of materials, and the regulating and cultural categories of ES (Wolff et al., 2015). In contrast, the conception of multiple market and non-market services and products that could be derived from ecosystems (Pearce, 1993), as well as the use of valuation techniques to price them, have been core to environmental economists for many decades (Pascual et al., 2010; Atkinson et al., 2012).

Notwithstanding the progress in these fields, only a few studies tackle the consistent integration of ecosystems economic accounts in line with the accounting principles of the System of National Accounts (ECC et al., 2009) (SNA), which are based on exchange economic values rather than on welfare values (e.g., Caparrós et al., 2003; Campos and Caparrós, 2006; Edens and Hein, 2013; Hein et al., 2015; Remme et al., 2015; Sumarga et al., 2015). Concerns about how to display the value of single ecosystem services embedded in SNA outcomes prompted the development and revision of the System of Environmental—Economic Accounting, whose recently published Central Framework (SEEA-CF) serves as the international statistical standard for environmental accounting aligned with the production boundaries of the SNA (Bartelmus, 2013; UN et al., 2014a). The SEEA-CF underpins the estimation of environmental asset accounts for individual natural resources that provide materials or space to SNA economic activities (e.g., timber for forestry activity).

The present debate on challenges of the SNA extension addresses the interest in measuring the spatial contribution of private and public ecosystems services to the economic benefits beyond the SNA production boundaries (MA, 2005; UN et al., 2014b). The SEEA-CF partially provides this approach but is based

* Corresponding author at: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science (LSE), Houghton Street, London WC2A 2AE, UK.
E-mail addresses: P.Ovando-Pol@lse.ac.uk (P. Ovando), jose.oviedo@csic.es (J.L. Oviedo), pablo.campos@csic.es (P. Campos).

http://dx.doi.org/10.1016/j.landusepol.2015.10.015
0264-8377/

on single marketable natural resources, which is far from the conception of ecosystems as functional units delivering multiple products. The recently released SEEA Experimental Ecosystem Accounts (EEA) discusses the recommendations for valuing ES on the basis of the SNA principles, and calls for testing experimental extensions of the SNA to include ecosystem services and benefits omitted by the SNA economic activities (UN et al., 2014b; Hein et al., 2015). However, the SEEA-EEA lacks the international statistical standard conferred on the SEEA-CF, and the scope of the experimental extensions to the SNA is still under discussion.

The SEEA-EEA discusses two alternative models for integrating ecosystems into the institutional sectors and economic activities of national accounts: (i) it considers ecosystems as an economic unit providing services to other units (i.e., farmers); and (ii) it identifies ecosystems as an environmental asset that contributes to the production function of farmers' economic activity. In both cases, the approach falls short of recognizing that government and landowners (farmers) hold a shared responsibility in the production process of ecosystem products (Edens and Hein, 2013). In many European countries, government expenditures targeting natural resources management and conservation have been significant in recent decades (ECC, 2009) and economic accounts of ecosystems cannot overlook this relevant element.

The experimental Agroforestry Accounting System (AAS) represents an alternative approach to terrestrial ecosystems that overcomes the production boundary shortcomings of the SNA and SEEA-CF. This system integrates the environmental assets into the agroforestry farm production function to estimate the total social income (total income hereinafter) originated in multiple private and public activities within the agroforestry territory. This total income estimation considers, simultaneously, the flow of incomes arising from the production process (including natural growth) and changes in environmental and manufactured assets (comprising capital improvement, degradation and depletion) over the accounting period (see Caparrós et al., 2003; Campos and Caparrós, 2006 for details). The AAS shares with the standard SNA and the SEEA-CF the principle that only exchange values should be used, and this is applied to both marketable and non-marketable products.

In this study, we offer an innovative application of the AAS to a pure even-aged Stone pine (*Pinus pinea* L.) forest resulting from an afforestation investment in Huelva Province (Spain). We regard this forest ecosystem as a joint private and public asset that constitutes a single functional unit where landowners' and governmental resources and management have an effect on both naturally occurring and manufactured production processes. In this context, we measure total income accrued from a number of private and public forest products. This includes products for which market prices are available, such as timber, pine cones, and forest conservation intermediate services, and non-market final services such as private amenities, public landscape conservation, public recreation and carbon sequestration. These non-market services are integrated into the forest ecosystem accounts as imputed or as simulated exchange values.

We employ a set of accounting criteria to disaggregate total income into the factorial contributions of labor and manufactured and environmental assets to the pertaining forest product. In this framework, the environmental asset comprehends the forest ecosystem (UN et al., 2014b: 156). Our study offers the environmental incomes delivered by the Stone pine forest ecosystem at different periods of its rotation. These AAS environmental incomes are referred hereinafter to as ecosystem services and are arranged into the Common International Classification of Ecosystem Services (CICES) as provisioning, regulating and cultural ES (Haines-Young and Potschin, 2013).

The valuation of ES associated with private and public forest products departs from market or simulated exchange values, using both the resource rent approach (UN et al., 2014b; Remme et al., 2015; Sumarga et al., 2015) and non-market valuation techniques (Caparrós et al., 2003; Oviedo et al., 2010). ES valuation also takes into account landowner and government direct and indirect manufactured costs involved in forest ecosystem production processes. There are few previous applications that integrate private and public non-market values (Campos and Caparrós, 2006) as we do in our study. While the application of extended economic valuation to non-market ES usually focuses on public values (Caparrós et al., 2003; Remme et al., 2015; Sumarga et al., 2015), our results show that landowner values are relevant to forest ecosystem total income.

Overall, our empirical application highlights that only a comprehensive approach to ecosystem production functions, which are independent from SNA accounting structure conventions (i.e., disconnecting government accounts from the ecosystem production function), allows a broad representation of ecosystem accounts and ES valuation. Our approach aims to contribute to the scientific debate on ecosystem accounting and its future implementation within a national accounting context.

2. Materials and methods

2.1. Case study

We selected the countryside and coastline areas in Southern Huelva Province (Andalusia, Spain) as our case study. Stone pine is the dominant native forest species in Huelva, occupying 28% of the area covered by trees in this province, and more than hundred thousand hectares. Holm and Cork oaks (*Quercus ilex* L. and *Quercus suber* L., respectively) are frequently found in the Stone pine distribution area, occupying together 18% of the area covered by trees in Huelva (MAAMA, 2013). Stone pines are part of a mosaic of land uses and vegetations that includes oak woodlands, other broadleaf and conifer forests, scrub, rough pastures and croplands (Montero et al., 2004). These diverse Mediterranean ecosystems are a reservoir for a large number of endemic plant and bird species (Myers et al., 2000). Around 80% of forests in Huelva are privately owned (MAAMA, 2013).

The abandonment of forest management in our case study area is likely to increase fire risk and to favor natural scrub revegetation, and this might affect the joint production of private and public forest products. This situation requires active landowner interventions to maintain the forest ecosystem in a productive condition. In this context, landowners are expected to demand public incentives to take part in afforestation and forestry management to avoid and reverse scrub encroachment. Afforestation with Stone pine has been supported in Huelva Province in the past two decades to boost sustainable forestry and to create permanent forest ecosystems (BOJA, 2008). In this study, we assume that pine afforestation displaces dense scrubs that are not leased out for grazing and hunting purposes. We use the growth and yield parameters estimated by Montero et al. (2004) for pure and even-aged Stone pine forests located in Huelva Province, considering five site qualities (see online Supplementary material for details).

2.2. Total income and ecosystem services valuation

The total income (TI) accounts for the remunerations to the classic production factors: labor and capital, the latter embracing both manufactured assets (those produced by human activities) and environmental assets (those given by nature) (Campos, 2013; Edens and Hein, 2013). The AAS's TI estimation is consistent with the *Hicksian income* concept, which is defined as the maximum potential consumption in the accounting period without reducing