Private and Public Incomes in Dehesas and Coniferous Forests in Andalusia, Spain[1]

Paola Ovando[2,3], Pablo Campos[3], Jose L. Oviedo[3], and Alejandro Caparrós[3]

Abstract

We apply an ecosystem accounting system to estimate the total social income accrued from private and public products in a group of agroforestry farms in Andalusia (Spain). We provide bio-physical and economic indicators for two contrasting farm types, a sub-group of 15 publicly owned coniferous forests and a sub-group of 24 privately owned dehesa farms. Total social income attained, in 2010, an average value of €140 per hectare in public forests and €352 per hectare in private dehesas. In public forests, social and environmental targets prevail over the demand for revenues from agroforestry private uses. Public landowners are willing to transfer the potential incomes from agroforestry uses to other economic agents including the consumers of public products. In private dehesas landowners are willing to accept cash losses from traditional agroforestry uses such as livestock breeding and game in return for the enjoyment of private amenities attached to land and animal's tenancy. Both farm types provide diverse public non-market products that display higher aggregated values in the areas where public forests are located.

Key words: ecosystem accounting, environmental income, multiple-use, private amenities, public non-market products

Introduction

The quantification and integration of economic and physical environmental indicators to support decision making could play a key role for targeting policies and incentives to conserve the natural variety of ecosystems. Nonetheless, most ecosystem conservation strategies are underpinned by the circumstance that the value of many public environmental services is not captured in final market products, and, consequently it is not reflected in economic accounts.

This research applies the Agroforestry Accounting Systems (AAS) (Campos and others 2001, Caparrós and others 2003) to estimate the total social income accrued from a large selection of market and non-market products delivered by agroforestry ecosystems (table 1). This AAS ecosystem accounting approach is applied to 39 large agroforestry farms in Andalusia (Spain). Technical and economic data collected at farm level focus on market outputs and costs for different private agroforestry products (Ovando and others, in press). This information is then completed using the results of larger

[1] An abbreviated version of this paper was presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, November 3-6, 2014, Visalia, California.

[2] Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Sciences (LSE). Houghton Street, London WC2A 2AE, UK. (P.Ovando-Pol@lse.ac.uk).
[3] Institute of Public Goods and Policies (IPP), Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain. (pablo.campos@csic.es; jose.oviedo@csic.es; alejandro.caparros@csic.es).

scale studies that provide simulated or imputed exchanges values for private and public non-market products and government expenditures in Andalusian forest, shrubs and rough grasslands (hereinafter jointly referred to as montes). The technical and economic study at farm level and the investigations that model the production and simulate the exchange value of different non-market products were developed in the frame of a large scale forest accounting project in Andalusia (RECAMAN) (Campos and others 2014).

Our research provides a set of detailed biophysical and economic indicators, in order to characterize private dehesas and public forests managements. The results derived from this study allow us to examine the main factors that contribute to private and social incomes in public forests and private dehesas and how they could affect agroforestry management decisions.

Methods

Case studies

The economic unit of analysis is an agroforestry farm, in which the monte covers more than 50 percent of its total surface. This study focuses on 24 privately owned dehesas and 15 publicly owned coniferous forests that are distributed across Andalusia (fig.1). Private dehesas average a useful agricultural surface (UAL) of 674 ha; with 88 percent of the farms larger than 200 ha and 46 percent larger than 500 ha. Close to 78 percent of the dehesa surface is covered by open oak and wild olive woodlands, 4 percent by softwood forests, 3 percent by other woodlands, 10 percent by treeless shrubland, 3 percent by rough grasslands and 2 percent by crops. Public forests are much larger, with an average size of 3647 ha of UAL, having all the farms a surface bigger than 500 ha. In this case softwood forests cover 60 percent of the farm surface, meanwhile open oak woodlands scarcely a 5 percent of this surface, other woodlands 16 percent (mainly gallery forests), treeless shrubland 14 percent, and similarly to private dehesas, rough grasslands and crops occupy 3 percent and 2 percent of UAL, respectively.

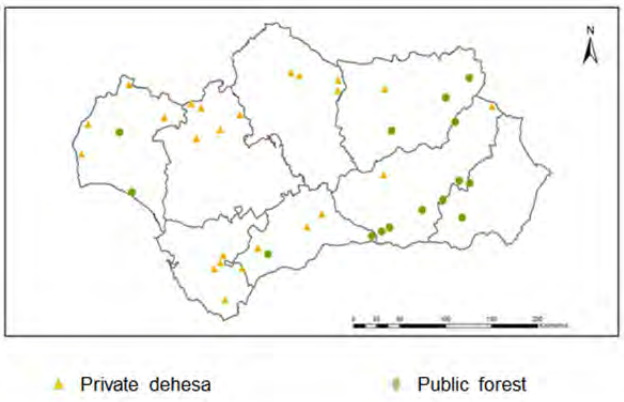

Figure 1—Private dehesa and public case studies distribution in Andalusia.

Total social income estimation

Total social income (TI) is estimated using the AAS' production and capital accounts (Caparrós and others 2003). The production account records the flow of market and non-market outputs (TO) and costs (TC) associated to single and aggregated agroforestry products over the accounting year, and gives, as a balancing item, the net operating margin (NOM= TO − TC). The capital account depicts the values and variations borne by work-in-progress (growing trees and animal inventories) and fixed assets (breeders, land, trees yielding repeated outputs and manufactured assets) over the period. Those variations are taken into account for the estimation of capital gains (CG).

Table 1—Methods and data sources for estimating market and non-market output and cost

Concept	Definition and valuation criteria
TIMBER, CORK, FIREWOOD	GROWTH, WORK IN PROGRESS USED (HARVEST), SALES, INVESTMENTS AND CAPITAL GAINS BORNE FROM WOODY PRODUCTS REVALUATION. GROWTH AND STOCK ESTIMATIONS DEPART FROM FOREST INVENTORIES AT FARM LEVEL, AND ARE VALUED FOLLOWING CAPARRÓS AND OTHERS (2003).
CONSERVATIONIST FORESTRY	Direct government payments to landowners for applying concerted forestry treatments that enhance the production of public ecosystem services. Those payments generate an intermediate output in the private forestry account that is consumed in the production process of public landscape and biodiversity services.
GRAZING RESOURCES	Acorns, herbs, browses and fruits produced in forest, grass and crop lands and that are consumed by livestock, game and other wild species. Game species grazing has an economic value only if there is an opportunity cost for these resources that is when the hunting ground is fenced, irrespective of the presence of livestock.
LIVESTOCK	Extensive breeding of cattle, fighting bulls, sheep, goat and equines. Livestock activity also includes fat stockbreeding (mainly *montanera* pigs) and apiculture.
GAME	Game breeding and hunting. This activity considers species with information on their population dynamics (Iberian red deer, wild boar, partridge and rabbits) and species for which we lack of this dynamic (turtledove, quail, hare). Game environmental prices are taken from a survey of 741 hunting grounds in Andalusia.
PRIVATE AMENITIES	The economic value of private amenities comes out of the exclusive enjoyment by private non-industrial landowners of recreational opportunities, legacy options and other non-market services attached to the tenancy of land (Campos and others 2009). Private amenities' value is taken from a survey of private monte owners in Andalusia (765 questionnaires).
OTHER PRIVATE PRODUCTS	Other private products include crops, housing services for both the landowner and farm workers, and the production and sale of industrial nuts.
MUSHROOMS	The quantity of edible mushrooms that could be collected in the monte was obtained from a telephone survey (8,076 interviews) of adult residents in Andalusia. Mushrooms are valued at the farm gate using market prices net of manufactured costs.
PUBLIC RECREATION	Public recreation values are taken from a regional study in Andalusia. The monetary value of this product is estimated using two structured non-market valuation surveys with face-to-face interviews of adults. First, a survey of open access visitors in different natural areas of Andalusia (4,030 questionnaires), that provides the willingness to pay (WTP) for a visit to those areas. Second a survey

Table 1—Methods and data sources for estimating market and non-market output and cost

	that provides the number of visits to different natural areas in Andalusia (3,214 questionnaires in Andalusian and 836 in Spanish households).
LANDSCAPE & THREATENED BIODIVERSITY	Landscape and threatened biodiversity are taken from a regional study in Andalusia that carried out a choice experiment conducted with adults by face-to-face interviews (3,214 questionnaires). The survey provides information on the WTP of Andalusian residents to warrant the future provision of those services, in the same quantity and quality as they are supplied today, thought an additional tax during the next 30 years. The individual landscape WTP value is assigned to 10 natural protected areas in Andalusia. The biodiversity WTP value is distributed equally between 235 endangered species.

Table 1—Methods and data sources for estimating market and non-market output and cost (continued)

Concept	Definition and valuation criteria
NET CARBON SEQUESTRATION	Gross carbon dioxide (CO_2) sequestration considers tree and shrub annual biomass growth. CO_2 release, as result of tree or shrub felling, burning or death is assumed to be instantaneous. Carbon is valued using the EU Emissions Trading Scheme prices.
NATURAL WATER YIELD	Natural regulated water accounts for the hydrological flows of precipitation water (and superficial springs) which constitute the input that is transformed by forestland into the output "forest water". Natural regulated water with economic value is made up of the superficial water run-off that reaches a regulated reservoir in Andalusia, and it is valued using the results of a hedonic land price model in Andalusia.
OTHER PUBLIC PRODUCTS	Gross fixed investment and intermediate services delivered by government expenditures on fighting against forest fires and drove ways management.

Source: Own elaboration based on Ovando and others (in press), and Campos and others (2014).

On the other hand, the aggregation of NOM and CG gives the capital income (CI) or the return to capital as a production factor. TI is then quantified by adding CI to labor compensations (LC), and it is estimated at producer prices; that is without accounting for subsidies and taxes on production.

We single out the contribution of environmental (EI) and manufactured assets (MCI) to capital income (CI = EI+MCI). The return to environmental assets or environmental income (EI) is estimated as a residual value from the total social income after labor and other manufactured costs are covered, including the opportunity cost of manufactured capital (Campos 2015).

Market and non-market agroforestry products

Private accounts involve those activities that are under the direct control of the landowner, and include six uses: forestry, livestock, game, crops, market services and the consumption of private amenities as the only non-market product. Public non-market uses include carbon sequestration, natural water regulation, open access mushroom gathering and recreation, and landscape and threatened biodiversity conservation services. Table 1 offers a brief description of the single products that our AAS application considers. Public account records as part of forestry activity the outputs and costs for fighting against forest fires and drove ways management, which are two sub-activities controlled directly by the government. This account also considers the government investment and ordinary expenditures for providing landscape, biodiversity, recreation and mushroom public products.

Results

The results display weighted average values according to the UAL surface that each farm has in the group of private dehesas and public forests. Those average results are not statistically representative of private dehesas and public forest farms in Andalusia, if we consider the relatively small number of case studies, albeit, these outcomes are suitable to illustrate the economic

rationality and trends that drive private dehesa and public forest management in this region, considering that most of its dehesas are private properties and most of its softwood forests are publicly owned.

Biophysical indicators

Cork is the main forestry product in the group of private dehesas, and it is missing in public forests, whereas timber is the chief forestry product. Cork had an extraction ratio of 73 percent over its growth in private dehesas in 2010, while timber an extraction ratio of 46 percent over its growth in public forest over the same period. Livestock and game species in private dehesas consume more than 6.5 times the amount of grazing resources as in public forests. Even so, livestock and game species account for a similar share of total grazing resources consumed in both types of farms (table 2).

Private non-market amenities attain a final output of € 247/ha in private dehesas, while in public forests the consumption of this service cannot be realized (its NOM equals 0 €/ha) due to the public nature of land tenancy. Dehesa and forest case studies have similar biophysical yields for mushroom and net carbon sequestration; meanwhile the yield associated to biodiversity and recreation is higher for public forests and the value of natural water is bigger in dehesa case studies. Public forests are located in natural areas that received double the amount of visits to areas in which private dehesas are to be found. In addition, the simulated exchange value for a visit to the areas where the public forests are located is 45 percent higher than the price associated to a visit to the dehesa farms' areas. Similarly, the number of species and the final output associated to threatened biodiversity is 37 percent higher for public forests in comparison to dehesas (table 2).

Table 2—Selected biophysical indicators (year 2010)

Concept	Unit[a]	Private dehesa			Public forest		
		Quantity	Price[b]	Value	Quantity	Price[b]	Value
	(u)	(u/ha)	(€/u)	(€/ha)	(u/ha)	(€/u)	(€/ha)
TIMBER HARVEST	m^3	-	-	-	0.6	15.9	9
TIMBER GROWTH	m^3	0.1	1.1	0[c]	1.3	4.3	6
CORK HARVEST	kg	76.2	1.3	98	-	-	-
CORK GROWTH	kg	103.7	0.2	25	-	-	-
GRAZING RESOURCES	FU	571.5	0.04	22	87.7	0.01	1
LIVESTOCK	FU	274.7	0.07	19	43.1	0.02	1
GAME	FU	296.8	0.01	3	44.6	0	0[c]
LABOR	H	16.1	9.4	152	7.3	9.9	72
PRIVATE EMPLOYEES	h	12.3	8.9	109	3.9	5.7	22
PRIVATE SELF-EMPLOYED LABOR	h	0.1	6.6	1	0.1	0.6	0[c]
PUBLIC EMPLOYEES	h	2	21.2	42	2.3	21.3	50
PRIVATE AMENITIES	ha	1	247.1	247	1	0	0
MUSHROOMS	kg	2.3	6.1	14	2.1	2.7	6
NATURAL WATER YIELD	m^3	8,418	0.01	67	9,679	0.01	49
Regulated	m^3	1,035	0.06	67	1,362	0.04	49
Non-regulated (free)	m^3	7,383	0	0	8,317	0	0
NET CARBON SEQUESTRATION	tCO_2	2.8	13.7	38	2.3	13.7	32
PUBLIC RECREATION	visit	2.5	10.4	26	5.3	15.1	79
LANDSCAPE	ha	1	92.1	92	1	100.9	101
BIODIVERSITY	Nº	47.1	0.3	15	58.9	0.3	20

Source: Own elaboration based on Ovando and others, in press.
a FU: Forage unit (1 kg of barley with an energy content of 2,723 kcal); h: hour; ha: hectare of useful agricultural land (UAL), Nº: average number of threatened species; t: metric ton.
b. Average exchange rate in 2010 1 € (euro) = 1.327 US$ (http:\\www.ine.es).
c Values lower than 0.05.

Total social income distribution

Our analysis focuses on the single contribution of private and public products to total social income (TI) over the accounting year, and on how this income is broken-down into labor compensations and the partial returns to environmental and manufactured assets.

In 2010, an average private dehesa generated a total social income of € 352/ha, whereas a public forest produced a social income of € 140/ha. Private products contributed to 33 percent of TI in private dehesas and public products to the remaining 67 percent. In the case of public forests, private products delivered a negative total social income in 2010, which was offset by the income of public products (table 3). The factors that contributed positively or negatively to explain total social income in both types of agroforestry farms are diverse and complex.

Private income is being severely affected by the negative capital gain assigned to private amenities owing to a devaluation of –3.4 percent on land market prices in 2010 (MARM, 2011). The option for enjoying private amenities in dehesas lessens the influence of this capital loss, the contribution of private amenities to TI being €25/ha. In public forests, the consumption of private amenities could not be realized. Although, the variations of land

market prices in the accounting period have an effect on the estimation of the capital gain/loss of private amenities. Indeed, the income of private amenities in public forest is equal to the capital loss associated to land depreciation (table 3).

Another factor that affects total private income in dehesa case studies is the negative manufactured capital income of livestock, which indicates that the production costs of this activity are not covered in 2010 by its outputs. Game activity also displays a negative manufactured capital income in private dehesas and public forests, while the environmental income associated to this activity represents the value of animals (female breeders and other individuals). This environmental income does not offset the manufactured capital income losses of game in private dehesas, in contrast to public forests in which game delivers positive private capital and total incomes (table 3). In any case, the extent of income losses from livestock and game activities is significantly higher in private dehesas.

Table 3—Total social income distribution by single agroforestry product (year 2010, €/ha)[a]

Class	Private dehesa				Public forest			
	Environ-mental income	Manufac. capital income	Labor costs	Total social income	Environ-mental income	Manufac. capital income	Labor costs	Total social income
Private	234	-227	110	117	-136	-7	23	-120
Timber	1	0	0	1	37	-1	4	41
Cork	175	-25	22	172				
Firewood	6	2	2	9	2	0	0	2
Grazing resources	17	-39	14	-8	1	0	0	1
Game	11	-39	13	-14	2	-1	3	3
Livestock		-99	42	-57		-5	0	-5
Crops		3	6	9		0	0	0
Private amenities	25	0	0	25	-178	0	0	-178
Other private	0	-30	10	-20	0	0	16	16
Public	197	-4	42	235	238	-28	50	261
Recreation	20	-1	4	24	65	-1	9	73
Mushrooms	14	1	0	15	6	1	0	6
Carbon	37			37	55			55
Landscape	49	-1	7	55	49	-25	10	35
Biodiversity	10	1	4	15	15	1	4	21
Natural water	67			67	49			49
Others public	0	-4	27	23	0	-3	26	23
Total	431	-231	152	352	103	-35	72	140

Source: Own elaboration based on Ovando and others (in press).
[a] Average exchange rate in 2010 1 € (euro) = 1.327 US$ (http:\\www.ine.es).

The environmental income associated to public products is 21 percent higher in public forests with respect to private dehesas. The EIs for public uses referred to in table 3 depict lower values than those of public products referred to in table 2, after covering their respective public production costs (mainly government expenditures for the provision of public non-market products). The main differences between dehesas and forests are due to higher environmental income values for public recreation, carbon sequestration and biodiversity in the public farms. The negative manufactured capital income of public products is, in part, a result of the devaluation of the manufactured

assets used to provide public products in 2010. This outcome is also related to the preferences of the Spanish households for assigning no additional landscape values in sites different to the ten areas mentioned in table 1 and, given that the government spends money in these areas to boost landscape conservation, the resulting negative income is assigned to manufactured investment.

Discussion and conclusions

This study examined differences and similarities in the contribution of single and aggregated private and public products to total social income in a group of private dehesas and public forests. Biophysical yields delivered by both type of farms are affected by their spatial extent, vegetation structure and other specific botanical or geographic characteristics, which also affect the quantity and quality of agroforestry products, as well as their prices and production costs. The management aims and strategies of private dehesas and public forests respond to the property rights that can be attributed to different products, but also to legal, institutional and social commitments attached to private or public tenancy of land.

Land tenants at private dehesas stand for non-industrial owners of large private farms whose management strategies are frequently attached to a mixed investor–amenity' consumer rationality. This rationality typifies a landowner that demands, simultaneously, market revenues from her/his investment and the exclusive enjoyment of private amenities attached to land tenure (Campos and others 2009). Our results showed that livestock and game activities diminish private income in dehesas, although those activities are maintained in such farms. This outcome suggests that the mixed investor-amenities consumer rationality also stands for livestock and game management, to which amenities values have not been measured but seem to be internalized into the value of private amenities stated by private monte owners.

In public forests, environmental and social targets prevail over the demand of profits from market products (timber, game, livestock, and others). Timber is the main market product supplied in these farms. Game and livestock activities are marginal, although they do not embrace large income losses for the agents (different from the landowner) that lease the land out for breeding livestock and hunting. This outcome suggests that public forest landowners transfer the potential environmental and manufactured incomes from these agroforestry uses to other economic agents. The provision of non-market public services is also relevant for public landowners, since their management integrates environmental criteria. Indeed, two thirds of private labor costs are due to conservationist forestry practices intended to enhance biodiversity and landscape conservation in those public forests.

Ecosystems conservation policies should ideally consider different conservation strategies for public forests and private dehesas. Public forest managers seemed to have internalized the provision of environmental services into their strategies, which may lead to monetary losses. Total social income function in private dehesas depends partially on traditional forestry, livestock and game uses, and it is also reasonable to suggest that social preferences are affected by the resulting cultural landscape. This hypothesis supports the legitimacy of government compensation to landowners as a means of translating non-market values of the environment into real financial

incentives for maintaining and even increasing the provision of public non-market services that the society demands, while keeping multiple agroforestry uses.

Acknowledgments

The authors thank the Andalusia Regional Government and the Agency for Water and Environment in Andalusia for the financial and field work support for developing the technical and economic study in a group of agroforestry farms in the framework of the project RECAMAN (Contract NET165602), which was coordinated by the Group of Environmental Economics of the Spanish National Research Council (CSIC). The authors are in debt to RECAMAN partners. Special thanks are due to Bruno Mesa, Alejandro Álvarez, Cristina Fernández, Begoña Álvarez, Casimiro Herruzo, María Martínez, Juan Carranza, José María Seoane, Gregorio Montero, María Pasalodos, Mario Soliño, Luis Díaz-Balteiro, Eloy Almazán, Mario Díaz, D. Elena Concepción, Fernando Martínez Peña, Jorge Aldea, and Santiago Beguería for their valuable work in generating the biophysical and economic information we used to quantify the private and public incomes of our agroforestry farms' case studies.

References

Campos, P. 2015. **Renta ambiental del monte.** In: Conferencias y Ponencias del 6º Congreso Forestal Español .Cuadernos de la Sociedad Española de Ciencias Forestales 39: 27–63.

Campos, P.; Rodríguez, Y.; Caparrós, A. 2001. **Towards the dehesa total income accounting: theory and operative Monfragüe study cases**. Investigación Agraria: Sistemas y Recursos Forestales. Monograph New Forestlands Economic Accounting: Theories and Applications 1: 45–69.

Campos, P.; Caparrós, A.; Beguería, S.; Carranza, J.; Díaz-Balteiro, L.; Díaz, M.; Farizo, A.B.; Herruzo, C.; Martínez, F.; Montero, G.; Ovando, P.; Oviedo, J.L.; Soliño, M.; Aldea, J.; Almazán, E.; Álvarez, A.; Concepción, E.D.; Fernández, C.; de Frutos, P.; Martínez-Jauregui, M.; Mesa, B.; Pasalodos, M.; Romero, C.; Serrano, R.; Torres, J. 2014. **RECAMAN: Manufactured and environmental total incomes of Andalusian forest**. http://www.recaman.es. (15 February 2015).

Campos, P.; Oviedo, J.L.; Caparrós, A.; Huntsinger, L.; Seita-Coelho, I. 2009. **Contingent valuation of woodland-owner private amenities in Spain, Portugal, and California**. Rangeland Ecology and Management 62(3): 240–252.

Caparrós, A.; Campos, P.; Montero, G. 2003. **An operative framework for total Hicksian income measurement: application to a multiple use forest**. Environmental and Resource Economics 26: 173–198.

Ministerio de Medio Ambiente y Medio Rural y Marino [MARM] 2011. **Encuesta de precios de la tierra año 2010**. Madrid, Subdirección General de Estadística. 55 p. http://www.magrama.gob.es. (15 February 2015).

Ovando, P.; Campos, P.; Mesa, B.; Álvarez, A.; Fernández, C.; Oviedo, J.L.; Caparrós, A.; Álvarez-Farizo, B. [In press]. **Renta y capital de estudios de caso de fincas agroforestales de Andalucía**. In: Campos, P.; Ovando, P., eds. Renta total y capital de las fincas agroforestales de Andalucía. Memorias científicas de RECAMAN. Volumen 4. Memoria 4.2. Madrid, Consejo Superior de Investigaciones Científicas.