APPLIED MULTIPLE USE FOREST ACCOUNTING IN THE GUADARRAMA PINEWOODS (SPAIN)

A. Caparrós [1], P. Campos [2], G. Montero [3]

[1] Centre International de Recherche sur l'Environnement et le Développement (CIRED, CNRS-SMASH). 45 bis, avenue de la Belle Gabrielle. 94736 Nogent-sur-Marne Cedex. France. (Previously IEG-CSIC)

[2] Institute of Economics and Geography. Spanish Council of Scientific Research (IEG-CSIC). Pinar, 25 - 28006 Madrid. Spain

[3] Forest Research Centre (CIFOR-INIA). Crtr. Coruña km. 7,5 - 28040 Madrid. Spain.

caparros@centre-cired.fr

SUMMARY

The paper discusses in detail the application of a methodology capable to estimate the hicksian income generated in a multiple-use forest incorporating in a homogenous manner commercial and non-commercial incomes. Real market values are used where available and market conditions are simulated where goods and services are presently outside of markets. The case study is a *Pinus silvestris* L. area close to Madrid (Spain) with high value timber production and with an important affluence of recreational visitors. Results show the relevance of non-commercial incomes and the fact that the landowner appropriates only a minor part of the total income generated.

KEY WORDS: Green national accounting
Hicksian income
Commercial values
Environmental values
Contingent valuation

INTRODUCTION

The system of national accounts presently applied to forests (Eurostat 1996, 1997) does not offer a theoretically correct measure of income and does not incorporate relevant benefits provided by forests but not internalised by markets. Extensive research has been undertaken to overcome this limitations, both by the scientific community and by the national statistics institutions (United Nations, 1993; Van Dieren, 1995; Eurostat, 1999a and 1999b; Peyron, 1998; Nordhaus and Kokkelenberg, 1999; Bergen, 1998; Merlo and Jöbstl, 1999; Vincent, 1999; Kristrom, 1999; and Campos, 1999a and 1999b). In this context, Campos (1999a) has developed an Agroforest Accounting System (AAS) that enables the measure-

ment of hicksian income with origin in an agroforest land, provided that the different values to be included in the accounting system are already known and are homogeneous. In Caparrós, Campos and Montero (2001) this methodology has been formalised and extended (i) to cover in an homogenous manner commercial and non-commercial revenues, and (ii) to make it applicable to multiple use timber forests. Working on these precedents this paper presents and analyses in detail an application of the methodology described in Caparrós, Campos and Montero (2001). The mentioned paper used part of the application here described for illustration purposes, without incorporating gathering incomes, but the limitations of an essentially methodological paper prevented a full discussion of the application.

The *Pinus silvestris* L. areas of the valleys of Lozoya and Valsaín in the *Guadarrama* mountains are studied. The area is recognised as one of the best locations for Pinus silvestris in Spain, and has an intensive recreational use due to its proximity to Madrid, about one hundred kilometres. It can also be seen as a great example of a multiple use forest, since several uses are present apart from timber and recreation. The incomes analysed in this paper are: (i) timber, (ii) grazing resources, (iii) hunting, (iv) mushrooms gathering, (v) recreational services, (vi) carbon fixation, and (vii) conservation. The incorporation of gathering, and its interrelations with the remaining recreational services as discussed below, has the effect that not only overall results but also partial values where this activities are present differ from the ones presented in Caparrós, Campos and Montero (2001).

METHODOLOGY

As stated above the valuation methods described below are used to fulfil the information requirements of the extended AAS described in Caparrós, Campos and Montero (2001). The extended AAS organises information in three different accounts and enables the estimation of hicksian income (Hicks, 1946). The *social production account* incorporates all the economic flows related to the production process that occur during the accounting period. Capital variations are incorporated in two different balances: the *production in progress balance* and the *social fixed capital balance.* The first balance incorporates variations in products which remain for more than one period in progress, and the second includes variations borne by fixed capital. The reason for distinguishing between the two balance sheets is due to the particular need in forests to account for goods which remain for longer than one period in the production process.

Following Caparrós, Campos and Montero (2001) commercial values (Vanoli, 1998) are estimated for the different activities analysed. Where market prices and quantities are available they are taken, and where not, the market is simulated to obtain the prices that would exist and the quantities that would be traded if a market with well defined property rights was established.

With respect to capital values, they are calculated by discounting the future stream of revenues associated to each activity. In the case of the timber activity, future revenues associated to the activity are separated in two values: (i) one associated to the presently existing generation of trees (registered in the products in progress balance), and (ii) another one associated to the future generations of trees (incorporated in the land value and therefore in the fixed capital balance).

An additional characteristic of the methodology is that it sums up a variety of incomes, irrespective of final beneficiaries: forestry owners, forest workers, stockbreeders, mushroom pickers, recreational visitors, hunters or the society as a whole.

Commercial timber

Costs associated to silviculture are obtained from the historical accounts of three estates, two publicly owned and one private (the figures used correspond to the mean of the data of five years (1993-1998) at 1998 prices). The private enterprise owns almost all the pine area of the Lozoya valley, one of the public enterprises owns the pine area in the Valsaín valley and the second public enterprise is located in Navafría, close to the study area. The analysis is based on data from the first two enterprises and mainly on data of the private enterprise, since it is supposed to have a more market oriented management. Data from the third enterprise is collected only for contrasting purposes.

In regard to the production side, the main problem is that all the estates do have their own associated sawmill, so that an insufficient number of real market transactions for timber could be observed, especially to determine prices for different diameter classes, as required by the applied method (Caparrós, Campos and Montero, 2001). Three methods are used to calculate timber prices for the different diameter classes. The first one is based on Montero, Rojo and Alía (1992). They developed factors (one for each diameter class) which multiplied by the board wood price (known) yield timber prices for a given diameter class. These factors were calculated empirically and have been relatively constant over time. In addition, two models are developed to estimate timber prices based on elaborated wood prices and transformation costs (one model uses detailed costs and the other one uses more aggregate costs). Wood prices are assumed to be set on timber costs plus transformation cost (with the margin as a percentage of total costs). Finally, the mean for the three methods is accepted as the price for each diameter class. A full description of the analysis of the timber activity can be found in Caparrós, Montero and Campos (2000).

To simulate the evolution in time of the pinewood the following dynamic model is used:

$$X_t = AX_{t-1} + B$$

Where $X = \{x_1, x_2, ..., x_i, ..., x_{17}\}$ is a state vector representing existing trees in each of the 17 diameter classes; A is the transition matrix shown below; $B = \{z_1 - e_1, -e_2, ..., -e_i, ..., -e_{17}\}$ the independent terms vector; k: diameter class duration; z: recruitment; e: felled trees; and m: dead trees not harvested.

$$A = \begin{pmatrix} m_1 \dfrac{k_1 - 1}{k_1} & 0 & \cdots & 0 \\ \dfrac{1}{k_1} & m_2 \dfrac{k_2 - 1}{k_2} & 0 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & 0 & \dfrac{1}{k_{i-1}} & m \dfrac{k_i - 1}{k_i} & 0 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & 0 & \cdots & \cdots & \dfrac{1}{k_{16}} & m_{17} \dfrac{k_{17} - 1}{k_{17}} \end{pmatrix}$$

The evolution of the present situation is simulated starting with the inventory data of 1997. The number of trees per hectare for each of the 17 diameter classes considered is known. With historical data of the Lozoya valley pinewood three functions (one for each stand quality) to relate diameter with age are fitted (Table 1), so that the ages associated to each diameter class can be determined. Assuming that in each diameter class the trees are distributed uniformly between the ages associated to each diameter class the dynamic system can be modelled. The number of trees existing in a given age-diameter class are: (i) last year stock, (ii) plus trees from the smaller class which change age-diameter class (since the distribution is assumed to be uniform the number of trees which change class are the total stock in the previous year divided by the number of years which conform the previous age-diameter class), (iii) minus trees that change to the next class, (iv) minus natural mortality and (v) minus extractions. In the first age-diameter class recruitment is added.

Table 1

Diameter-age functions

Stand quality	b_0	b_1	b_2	R^2
I	–2.6312	1.6104	0.0204	0.993
II	–86.7400	6.0950	–0.0433	0.977
III	–72.7500	5.1550	–0.0202	0.996

Source: Own elaboration.

The model is used to assure that current extraction, which is supposed to be constant in the future due to the condition of protected area of the case studied, does not lead the pinewood to extinction (assuming constant future timber extraction implies that part of the standing timber has no economic value as a result of environmental regulation, since only the amount necessary to assure sustainable extraction is valuable). Since with the estimated parameters $\overline{X} = (I - A)^{-1} B \quad X_0$ holds, extraction can be considered sustainable and generated income hicksian (where I: Identity matrix).

Grazing resources

Data for grazing resources income were collected through interviews with local agents. Cattle and horses graze freely in the study area under limited control, as a result an over-exploitation situation currently exists. However, this is not considered since it is expected to change in the near future (due to new regulation) and since it is not possible to estimate the associated timber value decrease. Instead, maximum compatible livestock is estimated, so that maximum hicksian income associated to grazing is measured. To reach this objective the first relevant figure is the quantity grazed. It is estimated by deducting from total theoretical livestock feeding necessities the quantity fatten. Afterwards, the number of alimentation units is multiplied by market prices of similar areas to estimate the value of consumed grazing resources (Campos and Caparrós, 2000a).

Game

Present game activity is concentrated on roe deer and wild boar. Quantities captured could be determined but again prices are not available since currently hunting is free in the area. Following the conventional procedure in national accounting, prices are taken from commercial hunting in relatively similar areas (Campos and Caparrós, 2000a).

Mushrooms

At the present moment mushrooms are gathered freely in the area without real control. Following a similar reasoning than the one described for grazing resources, the income estimated is the maximum possible without affecting future mushrooms regeneration (it is supposed that excluding 20 % of the pinewood each year from recollection will allow sustainability).

Mushrooms' gathering is the only activity where no primary data is produced. Instead, data is imported from Martínez (2001). The study from Martinez is located in the *Pinar Grande* in Soria (it has 12,068 ha of forest and 70 % of Pinus silvestris). The pinewoods of Soria and Guadarrama are relatively close, are in similar climatic areas and management practices are very alike.

In both cases two types of pickers exist, recreational visitors and local pickers (the latter are supposed to perceive no recreational benefit). It is assumed that neither of them does get any payment for labour, since no opportunity cost exist. Additionally, no intermediate consumption is assumed, so that all the value of the recollection is margin for the private agent (not so for society since public expenditures are involved).

Nevertheless for visitors, gathering has a strong recreational component. In the following sections the income associated to recreational use is estimated. It is assumed that the value of the mushrooms gathered is incorporated in the willingness to pay (WTP) expressed by visitors before renouncing to the recreational trip. Hence, the value of the mushrooms recollected by recreational visitors is deducted from total estimated recreational value.

Following Martínez (2001) a total production per hectare recollected of 8.43 kg/ha of mushrooms *(Boletus edulis* B.F. and *Boletus pinophillus* P. & D.) and a mean price of 3.56 euros of 1998/kg is accepted, yielding 24 euros per hectare for the overall pinewood.

Martinez (2001) further estimates, through a telephonic survey, that 56 % of the production of mushrooms (kg) is recollected by local pickers while the rest is recollected by recreational visitors. This information permits to quantify the value to be deducted (10.66 euros/ha) from the estimated recreational value.

Free access recreational service

Interest in simulating a market on a good presently not internalised excluded the hedonic prices method; so that the main potentially suited methods were contingent valuation and travel cost. The first one is used to avoid the large confidence intervals frequently associated to travel cost method (Garrido *et al.,* 1996) that obtained extremely wide coefficient intervals in another area of the Guadarrama mountains).

A pilot study of 139 open ended questionnaires was made to determinate the values to offer in the main dichotomous survey, where 520 questionnaires were completed. Interviews were undertaken with pollster. Interviewing days were set randomly, within the four temporal layer established based on *a priori* information (affixation was proportional). Individuals to interview selection was systematic, the first one who came after finishing the previous questionnaire from 10 a.m. till dark.

The values offered in the dichotomous questionnaires were determined following the operative recommendation of Alberini (1995) for double-bounded surveys of setting the first bid in the four quintiles of the previously estimated log-normal and the second bid in the median of the distribution truncated at the first bid (lower bound if the first answer was yes, an upper bound if the first answer was no). The concrete wording used can be found below and corresponds to equivalent loss if the hicksian measure were estimated. This format has proven to be the best suited for contingent valuation studies (Bateman *et al.*, 2000).

> [As you know **trip costs** have changed in the last decades (i.e. gas prices have gone up and down). Now we are going to ask you to imagine that **total expenditures** of your visit increase for this reason, even though you realise exactly the same activity you have done (same transport, same food...)]
>
> 10. If the **PER PERSON total expenditures of your visit** would have been ..... pta more than the quantity you have just calculated, would you still have come today? Please take into account that we are asking you to imagine a real payment and that you could not spend the money in alternative uses.
>
> ☐ *yes (ques. 11)* ☐ *no (ques. 12)* ☐ *don't know (ques. 15)*
>
> 11. *If yes:* And if the increase in total personal expenditures would have been ..... pta, would you still have come today? *(ques. 13)*
> 12. *If no:* And if the increase in total personal expenditures would have been ..... pta, would you still have come today?

After eliminating as usual protest responses, logit and log-logit *censored regressions* (Cameron, 1988) are estimated using the information of the first answer solely (single-bounded). Bi-normal and log-bi-normal *censored regressions* are also estimated using the information of both answers (double-bounded) and permitting that the first and the second answer correspond to different underlying valuation functions (Cameron and Quiggin, 1994).

Similar fitting were obtained for single-bounded logit and for log-logit estimations, so that logit estimations are preferred due to easier interpretation. Double-bounded estimations are almost equal to single-bounded estimations (reducing slightly the confidence interval). The latter are preferred for simplicity. A detailed description of the functions and values estimated can be found in Caparrós (2000a and 2000c).

The values obtained are reduced to incorporate the influence of the visit of other areas. The methodology followed is to apply the method that supposes a bigger reduction from the following: (i) estimate the function only with the respondents which did not visit other areas, (ii) reduce the value estimated for the overall sample by the percentage resulting from the subjective valuation of the importance of the study area in the decision of undertaking the trip done by the visitors (valuation from 1 to 5). The valuation of the approximation journey itself is taken into account assuming that the visitors which affirmed to value the trip, or part of it, valued the time passed on the journey equally to the time spent in the study area.

Since the accounting system is based on market prices, therefore marginal prices, commercial values are simulated for recreation (simulated market price times simulated

quantity). A complete analysis of the reasons of this approach, and of its implications, can be found in Caparrós, Campos and Montero (2001), as mentioned in the introduction.

The area studied is the only mountain resort close to Madrid, so that a monopolistic situation is realistic. The median is the price that would be set by a monopolist who wants to maximise his benefit in the case of a linear demand and absence of variable costs. With the preferred estimated demand curve (single-bounded, logit censored regression) maximisation occurs with the price accepted by 51 % of the population. Nevertheless, for simplicity, and to facilitate comparison with other studies, the median (50 %) is used. Present cleaning and management costs are considered constant, and internalisation with no additional variable costs is assumed. This price is multiplied by 50 % of present visitors to obtain the total production to be included in the accounting system, since the other 50 % would not be ready to pay.

These assumptions are «generous» in regard to capital income but not that much in regard to total income, since most of the obviated costs are labour ones. It is worthwhile to point out that, although the internalisation would suppose additional costs, they would be partially compensated by the decrease in cleaning cost associated to the reduction in visitors. In any case, the proposed solution is far more conservative than the alternative of including all the consumer surplus for non-market goods, as has been done in previous studies, since only a price discriminating monopoly would be capable to internalise all the consumer surplus as commercial value.

Apart from the survey described (type I) a second survey was undertaken, using an entrance fee as payment vehicle (type II). 91 open ended and 221 double-bounded dichotoumous questionnaires were fulfilled. The results show a great divergence between both surveys. For the preferred models (single-bounded dichotomous after eliminating protest responses) the median for the type I study was 12.24 euros per visit (taking into account the influence of the visit of other areas and the valuation of the trip itself) and 4.28 euros per visit for the type II study. The large protest response rate observed in type II (35 %) is the first reason to prefer the results of type I (where only a 3 % protest rate was yield). The second reason is that 81 % of the respondents preferred the establishment of an access limitation based on a maximum total number of visitors per day, instead of a limitation through an entrance fee. This suggests that a relevant percentage of the respondents not eliminated as protest zeros do have a potential protest attitude while declaring their WTP for an entrance fee. A more detailed comparison of both surveys can be found in Caparrós (2000a). However, large difference between the two surveys obliges to see the results used with caution, especially if a real world internalisation is proposed.

Self-consumption of environmental services by landowner is not considered separately since he has no relevant additional rights in comparison with the general public, due to free access and the strong legal regulation (prohibiting, for example, the construction of a recreational secondary residence).

Carbon sequestration

The dynamic model described in the commercial timber section is also used to estimate carbon fixation. With the coefficients and parameters shown in Caparros (2000b) the total carbon fixation in the living biomass and in the long term deposits associated with the current felling practice is determined. Since historical extraction is known the model

is used to estimate, retroactively, the additional permanent fixation occurred since 1990. *Permanent carbon fixation,* as defined in Campos and Caparrós (1999), is considered the only concept able to assimilate to a *no-emission,* and is valued using data from Frankhauser (1995). The use of other sources, as well as other ways of valuing carbon fixation can be found in Caparrós (2000b and 2000c). This reports show that the sensitivity of the results to the physical parameters accepted is not high, but also that the great uncertainty surrounding the carbon price implies that the values included in the accounting system have to be considered as mere approximations.

Conservation

The «conservation» value has also been estimated by means of a contingent valuation study. As it can be seen by observing the wording used in the open-ended question, the estimated conservation value is actually an aggregate of option and existence values:

50. Do you think that conservation of nature is a priority in Spain?
    ☐ yes ☐ no
51. Would you agree to contribute economically to improve environmental politics in Spain?
    ☐ yes ☐ no

    [Apart from the recreational use you have made, the *Peñalara Natural Park* and the *Area of Special Protection for Birds* that surrounds it, covers other environmental functions, as protecting wild animals and plants]
52. Would you agree to contribute economically to a fund dedicated exclusively to the conservation of this natural area?
    ☐ yes ☐ no *(ask reason and go to 54)*
53. What would be the highest annual amount you would agree to spend? *(please remember that this is only one of the natural areas you could be interested in protecting)*
    ..... pta / year

Altogether 568 questionnaires were undertaken to investigate the willingness to pay (WTP) for conservation. 453 had the exact wording shown above, while 115 did not include neither questions 50 and 51 nor the final remainder of the existence of other natural areas with potential interest for the respondent. Since the absence of these remainders induced an increase in the values obtained (Campos and Caparrós, 2000b), the data used for aggregation are based only on the 453 complete questionnaires.

The median multiplied by 100 % of distinct visitors that indicated that they were prepared to pay for the conservation of the area yields total production attributed to «conservation» (distinct visitors are determined dividing total visits by mean number of visits per individual and year). This criterion differs from the method proposed for recreation, but the payment vehicle adopted (a voluntary fund) permits each individual to pay its maximum WTP. As a matter of fact, it even enables to use the mean for aggregation, but the prudence principle (since mean is usually bigger than median), as well as greater dependence of the median on the assumed distribution in parametric estimations, advised using the median. This conservative measure might reduce the effect of potential double accounting if respondents do include their future recreation in the «conservation» value (the question used tries to minimise this effect, but the difficulty of this separation is acknowledged). However, if the valuation question was well understood, the WTP should be referred only to an additional premium for maintaining in the future the present quality (including recreational quality), and, if the natural resources provision does not change in the

future, this premium should be maintained indefinitely, apart from the future stream of actual recreational use.

Public expenditures

Public expenditures are attributed to the causing activity where possible (e.g. cleaning activities related to recreational use). General public expenditures are distributed between the different activities proportionally to the margin generated before including public expenditures. The heading *Government labour costs* includes almost exclusively guarding cost, since labour cost is not separated for the case where the public administration delivered a service (i.e. part of the cost included as *Government services* are actually labour costs).

RESULTS

Results are discussed concentrating on the findings of the whole system. A more detailed analysis of the different activities studied can be found in Campos, Caparrós and Montero (2000), Caparrós, Campos and Montero (2001), Campos and Caparrós (2000a and 2000b), and Caparrós (2000a, 2000b and 2000c).

In Table 2 quantities and prices used for the estimation of total production of the different activities studied are shown. For timber the price is the mean resulting from the addition of sales and final stocks at a discount rate of two percent. In the case of recreation, total production before discounting recreational mushrooms production is presented, so that the value differs from the one included in the production account.

Table 2

Total production in *Guadarrama sylvestris* pinewood (1998 euros)

Class	Unit	Quantity	Price (€/ha)	Value (€/ha)
Timber	m^3/ha	2.92	130.67	381.57
Grazing	AU/ha	146	0.08	12.25
Hunting				2.93
Roe deer	*capture/ha*	*0.0028*	*390.66*	*1.09*
Wild boar	*stand/ha*	*0.0382*	*48.08*	*1.83*
Mushrooms	kg/ha	6.74	3.56	24.00
Recreation *	visits/ha	15	12.24	178.43
Carbon	net t C fixed	0.33	20.00	6.53
Conservation	visitors/ha	3	12.02	32.97

* Recreational mushrooms total production is deducted before including recreation in the accounting system.
Source: Own elaboration.

As indicated in the methodology, the extended AAS has three accounts. They can be found in the following Tables: Table 3 shows the social production account, Table 4 the production in progress balance and Table 5 the social fixed capital balance.

As it can be seen in Table 3 only the timber activity has private labour, since in all the rest of the activities all labour figures belong to the distribution of the government labour involved. In the case of grazing this is only true due to the fact that the breeding activity has been considered external to the system, so that only the temporal use of the grazing resources is incorporated in the accounting system. For recreation, and as it was stated in the methodology, some private labour would be necessary if real internalisation had to take place. More generally, Table 3 shows that timber is the only activity with different cost figures, since it is the only activity presently managed by the landowner in order to maximise income.

The criterion used for the distribution of general government expenditures, the margin before including government expenditures, implies that a great share of them is attributed to recreation (in any case part of the 262 euros per 100 hectares of *Government services* (GLC) attributed to recreation belong to services directly devoted to the activity). Nevertheless, even after taking into account government expenditures, almost half of generated social margin has its origin in the recreational activity (remember that 44 % of the mushrooms margin has also a recreational component). However, any analysis based on the margin suffers with the used accounting system from two limitations: (i) the margin does not incorporate revaluations, which do in addition only affect timber, so that the margin is not well suited for comparing purposes, and (ii) the margin depends in this accounting system on the discount rate, since the distribution between margin and revaluation for the timber activity depends upon it (Caparrós, Campos and Montero, 2001). An additional effect of the influence of the discount rate is that the production account shown is only valid for a 2 % discount rate (as a matter of fact all accounting sheets are influenced by the discount rate, as indicated in Tables 3 to 5).

The products in progress balance (Table 4) incorporates only the timber activity, as already mentioned. It shows an entrance smaller than the withdrawal, the maintenance of the stock value and a positive current revaluation. If this situation is related to the rise in timber volume that enables the increase in carbon sequestration registered in Table 3 and Table 5 as *Gross internal investment,* the outcome is somehow surprising. The reason that the stock value is constant even with slightly increase in physical volume is that extraction is supposed to be fixed over time, due to the nature of protected area of the pinewood, so that only the part of timber necessary to yield the amount annually extracted has economic value. The entrance has less value than the withdrawal because the value of the timber felled is formed by the value of the timber growth plus the change in value induced to standing timber through growth as trees pass from one diameter class to the following (the greater the diameter, the higher the value). This last component of the extracted timber value is registered as *Current revaluation* (PPr) in Table 4.

Another implication of the decision to consider the forest in a steady-state from an economic point of view is that the calculated income figures are equal to the ones that would be obtained if the analysis were focused only on extraction, as the present system of national accounts does. Of course, this would not be the case if a non-stationary forest were considered (if the amount of timber in the forest with economic value increases the generated hicksian income is higher than the figure obtained based on extraction, while the contrary is true when the valuable standing timber volume decreases).

Table 3

Social production account of *Guadarrama sylvestris* pinewood (1998 euros per 100 hectares)

CLASS	Timber	Grazing	Hunting	Mush-rooms	Recrea-tion	Carbon	Conser-vation	TOTAL
1. TOTAL PRODUCTION (TP)	38,157	1,225	293	2,400	16,788	653	3,297	62,813
1.1. INTERMEDIATE PRODUCTION (IP)								
1.1.1. Intermediate raw materials (IRM)								
1.1.2. Intermediate services(IS)								
1.2. FINAL PRODUCTION (FP)	38,157	1,225	293	2,400	16,788	653	3,297	62,813
1.2.1. Gross internal investment (GII)						653		653
1.2.2. Final sales (FS)	23,473	1,225	293					24,991
1.2.3. Final stock (FST)	14,684							14,684
1.2.4. Other final productions (OFP)				2,400	16,788		3,297	22,485
2. TOTAL COST (TC)	30,897	187	45	366	3,263	99	502	35,358
2.1. INTERMEDIATE CONSUMPTION (IC)	25,122	134	32	262	2,572	71	360	28,552
2.1.1. Raw materials (RM)	418							418
2.1.1.1. Own raw materials (ORM)								
2.1.1.2. External raw materials (ERM)	*418*							*418*
2.1.1.3. Government raw materials(GIRM)								
2.1.2. Services (SS)	5,440	134	32	262	2,572	71	360	8,870
2.1.2.1. Intermediate services (ISS)								
2.1.2.2. External services (EIS)	*4,100*							*4,100*
2.1.2.3. Government services (GIS)	*1,340*	*134*	*32*	*262*	*2,572*	*71*	*360*	*4,770*
2.1.3. Production in progress used (PPu)	19,263							19,263
2.2. LABOUR (LC)	5,022	53	13	104	691	28	143	6,054
2.2.1. Employee (LE)	4,651							4,651
2.2.2. Self-employed (LSE)								
2.2.3. Government labour cost (GLC)	371	53	13	104	691	28	143	1,402
2.3. FIXED CAPITAL CONSUMPTION (FCC)	753							753
NET OPERATING MARGIN (NOM = TP – TC)	7,260	1,039	248	2,035	13,525	554	2,794	27,454

Discount rate: 2 %.
Source: Own elaboration.

Table 4

Products in progress balance of Guadarrama sylvestris pinewood (1998 euros per 100 hectares)

Class	Initial stock (PPi)	Entrance				Withdrawal				Final stock (PPf)	Current revaluation (PPr)
		Bought (PPb)	Own (PPo)	Others (PPoe)	Total (PPe)	Utilised (PPu)	Extraordinary destruction (PPd)	Others (PPos)	Total (PPs)		
Timber	643,418		14,684		14,684	19,263			19,263	643,418	4,579

Discount rate: 2 %.
Source: Own elaboration.

Table 5

Social fixed capital balance of Guadarrama sylvestris pinewood (1998 euros per 100 hectares)

Class	Managed Land								Consumable man-made capital			Total fixed capital 12 = 8 + 11
	Timber 1	Grazing 2	Hunting 3	Mush-room 4	Recreation 5	Carbon 6	Conser-vation 7	Subtotal 8 = sums 1 to 7	Infras-tructure 9	Machi-ner y 10	Subtotal 11 = 9+ 10	
1. INITIAL FIXED CAPITAL (FCi)	3,123	51,927	12,411	44,754	676,250	27,676	139,715	1,012,839	24,140	6,774	30,914	1,043,753
2. FIXED CAPITAL ENTRANCE (FCe)						653		653	30	724	753	1,406
2.1. Existing external stock (FCee)												
2.2. Gross investment (FCgi)						653		653	30	724	753	1,406
2.2.1. Internal gross investment (FCii)						*653*		*653*				*653*
2.2.2. External gross investment (FCei)									*30*	*724*	*753*	*753*
3. FIXED CAPITAL WITHDRAWAL (FCw)												
3.1. Sales (FCs)												
3.2. Use (FCu)												
3.3. Destruction (FCd)												
3.4. Other withdrawals (FCo)												
4. FINAL FIXED CAPITAL (FCf)	3,123	51,927	12,411	44,754	676,250	28,330	139,715	1,013,492	24,140	6,774	30,914	1,044,406
CURRENT REVALORIZATION (FCr)									–30	–724	–753	–753

Discount rate: 2 %.
Source: Own elaboration.

The social fixed capital balance (Table 5) indicates the value for society of the land and associated consumable man-made capital. Therefore, the final value of 1,044,406 euros per 100 hectares is not a value that the owner could get in the market, but the value for society. The only case in which both values would be equal were when all the activities considered were fully internalised by the agent, a situation far from reality since the landowner currently internalises almost only the timber values. In regard to timber, it is interesting to point out the surprisingly low value attributed to land due to this activity. The reason for this is that the standing timber value is registered in the production in progress balance, so that the value of 3,123 euros per 100 hectares refers to the amount which a rational agent would be ready to pay for the right to replant the bare land after the final cutting of the trees of the current generation. Once more, the values shown are only valid for a 2 % discount rate.

Interconnections among the three sheets can be found: (i) for carbon sequestration increase produced in the year, registered in the production account (Table 3) and finally incorporated in the fixed capital balance (Table 5), as already said; (ii) for *Utilised* standing timber (PPu), which goes from Table 4, products in progress balance, to the production account (Table 3); and (iii) for the final stock (FST) of timber produced during the year, which is incorporated in Table 4 as an *Own entrance* (PPo). Additionally, and due to the assumption of perfect divisibility and permanence of the infrastructure and the machinery, *External gross investment* (FCei), fixed capital *Current revaluation* (FCr) and *Fixed capital consumption* (FCC) are all equal in absolute value, due to commercial timber steady-state and constant prices assumptions.

The main national accounts indicators are shown in Table 6. As indicated before the margin has the limitation of being influenced by the discount rate. This influence is shared by the Net Value Added (NVA) figures. So, NVA for timber varies from 153 euros of 1998 per hectare for a discount rate of one percent to 74 euros of 1998 per hectare with a five percent discount rate (since NVA for the rest of the activities is not affected by discount rate changes, the proportions of overall NVA generated by each activity also varies with the discount rate). On the contrary, capital (CI) and total income (TI) are free

Table 6

Main national accounting indicators in *Guadarrama sylvestris* pinewood (euros of 1998 per 100 hectares)

	Timber	Grazing	Hunting	Mush-rooms	Recre-ation	Carbon	Conser-vation	Total
Labour (LC)	5,022	53	13	104	691	28	143	6,054
Capital income (CI)	11,839	1,039	248	2,035	13,525	554	2,794	27,454
Margin * (NOM)	*7,260*	*1,039*	*248*	*2,035*	*13,525*	*554*	*2,794*	*27,454*
Revaluation * (Cr)	*4,579*							
NVA *	12,282	1,092	261	2,139	14,216	582	2,937	33,508
Total income (TI)	16,861	1,092	261	2,139	14,216	582	2,937	33,508

* Discount rate: 2 %. CI = NOM + Cr; NVA = NOM + LC; TI = CI + LC.
Source: Own elaboration.

of this influence since they both sum up margin (NOM) and revaluation (Cr) (the change in discount rate affects only the distribution between this two magnitudes). This is the reason why the analysis is mainly focused on these two income figures.

To facilitate comparisons between the indicators of different activities, Figures 1 and 2 represent, respectively, capital income and total income graphically. As Figure 1 clearly shows timber and recreation are the main activities, being recreation the more important one in regard to capital income (once more, it is remembered that part of the income attributed to mushrooms has a recreational component). If total income is considered (Figure 2) the highest value corresponds to the timber activity. This is due to the considerable amount of labour involved in timber production (5,022 euros of 1998 per hectare).

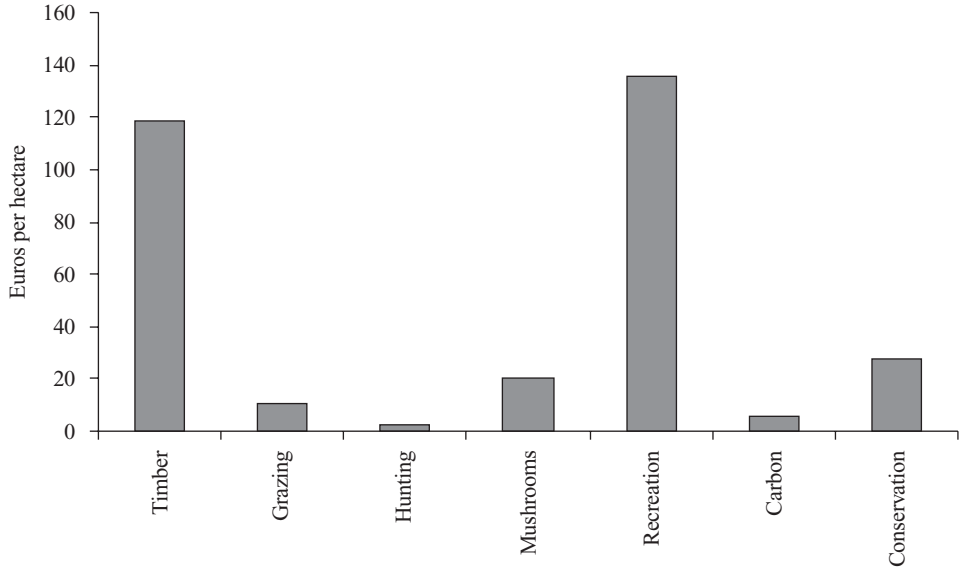

Fig. 1.–Capital income in *Guadarrama silvestris* pinewood
Source: Own elaboration.

The relatively, as well as absolutely (Table 6), low values for hunting and carbon sequestration are also relevant results. Hunting is often supposed to produce high incomes, but the low intensity of use in the study area implies low income values (it is remembered that market prices are used, hence, an explanation of the low values through prices is in principle not applicable). Carbon sequestration has attracted in recent years much attention due to the Kyoto process on climate change control. The results obtained indicate, however, a limited influence on income in existing forests of the internalisation of carbon sequestration. This is a foreseeable outcome since the forest is almost in steady-state, also in physical terms (i.e. the *additional permanent sequestration* reached per year is small). Although this result would not hold for a young forest, it suggests that no great changes in management practices due to carbon sequestration should be expected, at least for existing forests.

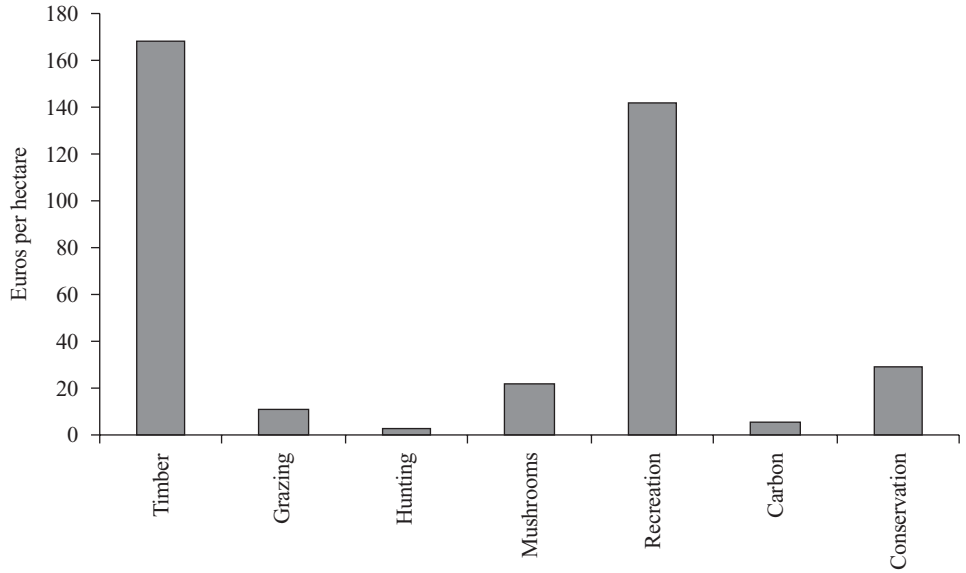

Fig. 2.–Total income in *Guadarrama silvestris* pinewood
Source: Own elaboration.

Table 7 presents the final beneficiaries of the total income generated. The forest owner becomes currently a 31 percent of the total income, while recreational visitors get almost 38 percent of it, divided in 35.51 percent for general recreational activities and 2.35 percent for the value of the mushrooms gathered. A nine percent of total income is

Table 7

Final income beneficiaries in *Guadarrama sylvestris* pinewood

CLASS	Income perceived	
	euros/ha	%
Land-owner	118	31.08
Forest workers	61	15.89
Stockbreeders	10	2.73
Hunters	2	0.65
Local mushroom pickers	11	2.99
Recreational mushroom pickers	9	2.35
Recreational visitors	135	35.51
Society *	33	8.79
Total income	381	100.00

* Includes carbon and conservation.
Source: Own elaboration.

attributed to society, including conservation and carbon sequestration. It has to be added that the value for conservation was estimated for recreational visitors, so that only the value of conservation for them is calculated (implying thus a strong underestimation of the value for the society as a whole).

CONCLUSIONS

The viability of the application of the extended AAS methodology to a multiple use timber forest has been shown, at least at a micro scale. The results have shown a relatively low amount of non-timber commercial incomes and a high relevance of non-commercial incomes. These results point out the necessity to incorporate this incomes in the future extension of the national accounting system, not limiting the improvements to commercial incomes.

In the particular case analysed, the *Pinus silvestris* woods of the *Guadarrama* mountains, among the non-commercial incomes the lions-share corresponds to the free recreational services offered, while the amount attributed to conservation and to carbon sequestration are considerably lower. The reduced amount for conservation is due to the fact that it has only been measured for visitors, underestimating consequently the value for society. The low value for carbon sequestration finds its explanation in the almost steady-state situation of the analysed forest.

Nevertheless, even at a micro scale, difficulties to provide accurate data have been encountered, especially while providing market *proxys* for goods presently outside markets. This emphasises the need for further research to accommodate the findings of the wide literature on non-market valuation techniques to the necessities of the national accounting system extension.

The additional result obtained that the income generated is appropriated by the landowner only to a limited extent is also worthwhile to be highlighted. This fact is due to actual property rights more than to legal ones, and it contributes to explain the interest of public institutions in the regulation and control of forests in the European context.

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RESUMEN

Cuentas económicas del uso múltiple del bosque: una aplicación a los pinares de la sierra de Guadarrama (España)

El trabajo presenta la aplicación de un sistema metodológico de cuentas del bosque que permite estimar la renta hicksiana generada en una tierra forestal con usos múltiples, incorporando tanto las rentas de bienes comerciales como no-comerciales. Se utiliza el valor real de mercado cuando está disponible y se simulan las condiciones de mercado cuando se presentan mediciones de bienes y servicios ambientales. El estudio de caso presentado es un bosque de pino silvestre *(Pinus sylvestris L.)* próximo a Madrid (España) con elevada calidad de la producción maderera y con una importante afluencia de visitantes para su disfrute recreativo. Los resultados revelan la notable importancia de las rentas ambientales así como el hecho de que el propietario privado del bosque recibe sólo una parte minoritaria del total de la renta generada en el pinar.

PALABRAS CLAVE: Cuentas nacionales verdes
Renta hicksiana
Valores comerciales
Valores ambientales
Valoración contingente

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