THE DEVELOPMENT OF FOREST ACCOUNTING IN THE PROVINCIE OF TRENTO (ITALY)

Ilaria Goio, Geremia Gios, Claudio Pollini[1]

Ilaria Goio: corresponding author researcher at IVALSA- CNR, San Michele all'Adige, Trento, Italy Foundation for Scientific Research Projects, PAT, ilaria.goio@ivalsa.cnr.it, tel.: 0039 0461 391617;
Geremia Gios: Full professor of Environmental Economics, Department of Economics, University of Trento, Via Inama, 5, 38100 Trento (Italy), geremia.gios@economia.unitn.it, tel.: 0039 0461 882224;
Claudio Pollini: Researcher at IVALSA- CNR, San Michele all'Adige, Italy, claudio.pollini@ivalsa.cnr.it, tel.: 0039 0461 660206.

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ABSTRACT

In the increasing scientific debate about sustainable forest management, a crucial role is played by the development of adequate instruments of evaluation and survey. The proposed system of national account (SNA) underestimates the full value of forest resources and does not permit a correct evaluation of the total contribution of forests to economic welfare. The SNA reflects, partially, the consumption of forest natural capital or the costs of loss of forest quality. This is due to the fact that it registers only the value of produced outputs that are traded in the marketplace. The non-market functions provided by forests (recreational, aesthetic, ecological and protective) are definite “non-SNA functions” and are not taken into account. As many study have demonstrated, forests have a higher value than that connected to production aspects. This paper focuses on results of a tentative accounting system in order to estimate and integrate the benefits of non traded-goods and services provided by forests located in the Province of Trento (northeast Italy). The forests, which cover about 50% of the whole surface, have to be valued.

Keywords: national accounting, green accounting, market functions valuation, non-market functions valuation.

1 INTRODUCTION

The aim of this paper is to present the results obtained when comparing different techniques used in estimating the benefits produced by forests. The evaluation was carried out on forests in the Autonomous Province of Trento (Italy). However, we feel that the considerations to be drawn from this research may be valid generally and could lead to a re-examination of the way in which the benefits produced by forests are evaluated. With this aim in mind, we firstly report the values derived from the application of standard national accounting procedures and those obtained by the methodologies put forward in the ambits of national green accounting, Secondly, we report the estimates relating to other benefits that forests produce, but which at present are not usually considered in the course of standard national accounting practice.

The paper is divided into four main parts. The first consists of an analysis of the evaluation methods used for the forestry sector in standard national accounting procedures, with the results obtained when these were applied in the areas examined.

The second part briefly describes the methodologies used and the results obtained by green accounting, in determining the potential value of timber products from the same forests. The third part presents the results of an evaluation of certain benefits not considered in either standard national accounting or green accounting. In the final part, these results are compared and some proposals are advanced towards achieving a more complete evaluation of all the benefits produced by forests.

2 THE MULTI-FUNCTIONALITY OF FOREST RESOURCES

It is important to remember that a forest is at the same time both a productive factor and a product. From here arises the fundamental distinction between timber capital (the mass of standing trees) and the timber produced. The first simply indicates the number of standing trees that together make up the forest and since this is a resource that is renewable over time, the size of the timber capital may increase or decrease due to natural events or human activity. Whereas, the timber produced is the main, if not the only, product to be extracted from forests and consequently constitutes the primary element in the traditional productive function of forestland.

However, those studying forest economy have long realised that the productive function is only one (and perhaps not even the most important) of the functions performed by forests, which are in reality multifunctional. Indeed, alongside their productive function, we can also recognise their protective function (soil conservation and protection, watercourse protection, avalanche prevention…..), their landscape and recreational function (hunting, excursions ….) and their ecological function (protection of biodiversity, carbon cycle ….). So forests do not only produce timber and non-timber goods, but also “intangible (Wibe, 1995)” services, “creating multiple (economic, social and environmental) benefits for society (Price *et al*., 2003)”. It goes without saying that on one hand the importance of these various functions “is strictly linked to the socio-economic and environmental context of which the forest is a part (Mammuccini, 2004)”, and on the other “the integration of the various functions is not always without conflict (Janse and Ottitsch, 2005). For such reasons it would appear essential to obtain an economic evaluation of the different functions if the forest itself is to be used efficiently.

3 FORESTS IN NATIONAL ACCOUNTING

3.1 Standard national accounting: definitions and limits

National economic accounting was introduced during and immediately after the second world war, driven by the work of Keynes. Attention was mainly turned to ascertaining short term information concerning aggregate supply and demand for economic goods.

The "System of National Accounts" established in 1953 (SNA 1953), followed by SNA 1968, was used until the beginning of the nineties. This system, containing parts that were difficult to interpret and others that were outdated by the events of history, was re-examined by the United Nations. This led to the revised SNA of 1993, due to be updated by the end of 2008. The SNA is then adapted by different countries, which may introduce minimal modifications. In the European Union, for instance, reference is made to the ESA "European System of Integrated Economic Accounts". The ESA mirrors the SNA almost completely, differing only in certain marginal aspects in order to facilitate its use within the European Union.

Though useful, the national accounts system did not, indeed still does not, lack criticism and over the last ten years attempts have been made to introduce corrections and additions. The weak points of the SNA are particularly evident in relation to environmental assets.

As Pesso (2000) stressed, "national accounting systems only partially reflect the consumption of natural capital or the cost of the loss of environmental quality, so the value of the environment is not clearly visible in the composition and depreciation of a nation's capital". In effect, if we consider the short term and analyse the production of marketable goods alone, then any collateral effects can be seen as external and without cost (Sammarco, 1993)". On the contrary, in the medium to long term such effects have a negative effect on the production system itself, undermining its capacity to generate wealth and consequently social well-being. The cause of this should be sought in the very nature of environmental assets: "the environment is not only a set of capital resources to be taken into consideration when calculating the consumption power of the economic system of the moment (Musu and Siniscalco, 1993)", it is far more. Using the environment also determines negative external factors that deteriorate and impoverish it, such as pollution or the overexploitation of land for productive purposes. Consequently, if a national accounting system purports to weigh up well-being and changes in the quality of life, as well as income and its growth, then it will necessarily have to evaluate the sum of these effects. "Every economic accounting system that does not include the environment, ignores a dimension of crucial importance to the functioning of the economic system itself and to the well-being of humanity (UN *et al.*, 2003).

To put it in a nutshell, for the "World Conservation Union" (www.iunc.org), "the national accounting system fails to evaluate: a) environmental costs i.e. the cost of prevention and protection against environmental deterioration; b)non-market goods and services; c)the consumption and depreciation of natural capital".

It should be stressed that, on the contrary, information about the environment must, or rather should, increasingly influence economic policy decision-making because this cannot be exempted from a consideration of the environmental effects of economic activities, because of:

- "the increasing population, with the quantity and quality of production necessary to satisfy its requirements, which gives the environment the growing importance of an economic asset in limited supply,
- the effects of deterioration in environmental quality on social well-being,
- the lack of markets that allow for the rationalisation of demand for environmental services through the price system (Beltratti, 1993)".

Over the past decade, various alternative or complementary accounting systems known as green environmental accounting have been introduced in an attempt to remedy the limits of national accounting in identifying and consequently measuring environment associated phenomena, and to supply public decision makers with a useful, appropriate and above all complete support to analysing and planning.

3.2 Forests in standard national accounting

The criticisms of standard national accounting made in the previous paragraph can be clarified and justified further if attention and enquiry is focused on a specific type of natural resource: forests.

In standard accounting, forests are not considered as a single entity. They appear as two distinct elements that are evaluated separately:

- land
- biological goods.

The SNA 1993 defines land as "the ground, including the covering soil and any associated surface waters, over which ownership rights are enforced". On one hand this definition embraces all improvements, of a certain entity, undertaken not merely for conservation purposes, that cannot be separated from the land. On the other hand it excludes areas with buildings and other facilities, cultivated areas, trees animals, non-cultivated biological resources and underground resources (including watercourses). As far as economical exploitation is concerned, it is subdivided as follows (UN, 1993):

1. cultivated land, in other words forest land on which a forestry activity (silviculture) is carried out geared towards timber production;
2. other land, i.e. forest land where no forestry activity (silviculture) is undertaken, though there may be natural growth. This land is considered "non-economic activity".

In the first case (cultivated land), standing timber trees are defined as "productive activity" and their added value, corresponding to timber growth, is included in the GNP only when the timber is harvested. (Eurostat, 1999).

Biological goods on forest land consist of the trees, fauna and other forest flora (UN, 1993). Biological goods are also subdivided into (UN, 1993):

- Cultivated: meaning animals and plants whose natural growth, equal to increase in value, or regeneration, is under the direct control, responsibility and management of an institutional entity. These are "productive property assets".
- Non-cultivated: animals and plants that produce wealth over which property rights have been established although their natural growth or regeneration is not under direct control, responsibility and management of an institutional unit. These are classified under the item "non-productive property assets".

From what has been said we can see that the information about forests deducible from standard national accounting is essentially limited to those forest resources that are exchanged on the market or that are object of market transactions and that therefore produce economic benefit and are associated with ownership rights (Battellini *et al.*, 1996; Eurostat 1999; Doldan and Chas, 2002)[2]. We are therefore dealing with "resources belonging to forestry companies that place unprocessed forestry products on the market. Consequently all our forestry heritage that is not controlled and managed for economic purposes by any of the institutional sectors and is not utilised for production purposes, is excluded from the realms of national economic accounting (Battellini *et al.*,1996)". The same situation is witnessed by Chopra *et al*. (2001), who says that inaccessible natural assets and those not managed, do not contribute to the current economic activities of a country.

Another important aspect of forests is associated with their multi-functionality. Standard national accounting makes a net distinction between productive functions and other functions performed by forests (protective, aesthetic-recreational, ecological).

These latter functions are defined as *non-SNA functions* (Eurostat, 1999). By using this expression Eurostat (1999) stresses that functions other than productive ones are not registered or taken into count by the national accounting system. This remains true although various studies have demonstrated that the non-productive functions of forests may even be of higher value than their strictly productive functions (Mattson and Li, 1994; Scarpa, 1998) and despite the fact that they contribute directly or indirectly to the well-being of the entire community. These functions are not counted in standard accounting because they are not included in what is defined as the "production boundary" of the SNA (Haripriya, 2000), when referring to the total range of economic sectors. According to the SNA 1993, the "production boundary" includes all production actually destined for the market, whether for sale or barter, all goods and services provided free to individual households or collectively to the community by governments unit, all goods produced for own final use, own-account production of housing services by owner occupiers and services produced by employing paid domestic staff (UN, 2001). We should remember that the term "production" usually indicates an activity, carried out under the responsibility, control and management of an institutional unit, that uses inputs of labour, capital and goods and services to produce outputs of other goods and services (UN, 2001).

It follows that, in our opinion, the SNA 1993 incompletely reflects the consequences of a reduction or increase in forestry value on the economy of a nation and take into consideration only the productive function.

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[2] The natural asset boundary in the System is determined, in compliance with the general definition of an *economic asset*, by whether the assets are subject to effective ownership and are capable of bringing economic benefits to their owners, given the existing technology, knowledge, economic opportunities, available resources and set of relative prices. Environmental assets over which ownership rights have not or cannot be established such as open seas or air, are excluded (UN, 1993)".

3.3 The production value of a forest according to the SNA

In this paragraph we report the results achieved by applying the methodology set out in the SNA. The data shown refer to the average figures[3] for 2002/2003.

As we have already seen, the value of the productive function of a forest equals the value of production utilised. Therefore this value must be identified with reference both to timber products and to non-timber products. Apropos we note that:

- The value of timber products utilised can be obtained by multiplying timber actually cut by the corresponding price (stumpage price). The values are shown in the following table.

Table 1. The value of timber products

Year	Industrial round wood			Firewood			Total value
	Total used (m^3)	Average price (€/m^3)	Value	Total used (q)	Average price (€/q)	Value	
2002/2003	295,281.50	46.39	13,698,108.79	951,113	2.15	2,044,892.95	**15,743,001.74**

Source: Author's elaboration.

- Non-timber products to be evaluated in the forests of Trento are:
  - non-wood products (from trees): chestnuts and hazelnuts;
  - non-wood products (from plants): strawberries, raspberries and bilberries;
  - mushrooms and truffles;
  - game, hunted in the forest[4].

Average values, obtained by multiplying quantity by respective price, for 2002/2003 are summarised in table 2.

Table 2. Value of non-timber products

PRODUCT	YEAR
	2002/2003
Non-wood products (from trees)	418,633.05
Non-wood products (from plants)	104,016.98
Mushrooms and truffles	7,652,829.92

[3] The decision to present average figures for a two year period enabled us to limit annual variations. Annual variations may be the consequence of extreme weather conditions that lead to the use of trees felled by storms and such like.

[4] Since data supplied both by the Fauna Office and by the Trento Provincial Hunting Association concern the whole province, for the purposes of this analysis attention has been focused on the following area:

1) ungulates: percentage of forest over total productive area minus area under apple and pear production: 2002 69%, 2003 69%;
2) chamois and grouse: forest area above 1000m (about 240,000) hectares over total area above 1000m (373,996 hectares): 64%;
3) species not subject to hunting quotas: percentage of forest area over total productive area: 2002 67.5%, 2003 67.5%.

Game	1,663,082.50
Total	**9,838,562.45**

Source: Author's elaboration.

The total value of forest production according to the SNA system is summarised in the following table.

Table 3. National accounting: value of the productive function of the forests

Year	Value of timber products	Value of non-timber products	Total value
2002/2003	15,743,001.74	9,838,562.45	**25,581,564.19**

Source: Author's elaboration.

4 NATIONAL GREEN ACCOUNTING

National green accounting (Battellini *et al.*, 1996; Cairns, 2001; Kreiger, 2001; Kriström, Skåberg, 2001; Doldan e Chas, 2002) takes the value of potential production into consideration as well as the value of used production, this means it considers variations in the stock of timber and game[5]. The basic idea is very simple: variations in the stock resources constitute a saving or consumption (depending on whether it is a positive or negative variation) which must be taken into consideration. In the case of products mentioned previously, such variations concern the timber mass and the quantity of game.

For the timber mass, it is necessary to identify the current increment rate (separated into building timber and firewood) not used and therefore contributing to increase the timber capital available. As some authors suggest (Merlo and Ruol, 1994) a conservative 50% of the current timber price can be applied to this quantity.

Table 4. Total potential production value of timber products

	Potential production value (industrial round wood) (€)	Potential production value (firewood) (€)	Total potential production value (€)
2002/2003	15,418,056.33	1,367,379.20	**16,785,435.53**

Source: Author's elaboration.

For game, variations in the quantity of game at the beginning and end of the period must be assessed[6]. A conservative 50% of the value of single heads of game is applied to these quantities in a similar way to that undertaken for the mass of timber.

[5] National "green" accounting seeks to remedy some of the main incongruences of the SNA in relation to the evaluation of environmental goods (Eisner, 1988; Repetto *et al.*, 1989; Hartwick, 1990; Bartelmus e van Tongeren, 1994; Hamilton e Ernst, 1996).

[6] In the case under analysis this quantity was estimated only for non-migratory species for which hunting quotas are fixed. No reliable information is available for migratory species or non-migratory species not subject to hunting quotas.

Table 5. The potential value of hunting

	2002/2003
Roe deer	- 2,339.00
Red deer	46,299.00
Mouflon	4,055.00
Chamois	8,304.00
TOTALE	**56,319.00**

Source: Author's elaboration.

The value of the productive function of the forest in national green accounting is shown in table 6.

Table 6. Green accounting: value of the productive function of the forest

	Value of used production (€)	**Value of potential production** (resource stock variation) **(€)**	**Potential value of hunting** (resource stock variation) **(€)**	**Total value**
2002/2003	25,581,564.19	16,785,435.53	56,319.00	**42,423,318.72**

Source: Author's elaboration.

So, in the case under analysis, taking account of the variations in resource stock and therefore of "savings" leads to values that are almost double those obtainable when applying standard SNA.

5 ESTIMATING THE OTHER FOREST FUNCTIONS

Recognising the multi-functionality of forests means understanding that their value depends on a wide variety of factors and that these factors must be evaluated. Although quantifying the productive function does not present significant problems, the same cannot be said of the other benefits produced by forests: their so-called non-market functions. These are referred to in this way because, in presenting the characteristics of public goods i.e. of goods for collective consumption that can neither be excluded nor made competitive, they are not exchanged on the market. Since such benefits are not susceptible to appropriation and do not have a market, it clearly follows that they do not have a price. These are therefore benefits of value to society, but for which there is no market where such values can find expression (Zhongmin *et al.*, 2003). So, in order to attribute forests with their "true and complete" value we must identify evaluation methodologies that enable these functions to be estimated. "Economic evaluation is one of the tools that can be used to attribute quantitative values to goods and services produced by natural resources (Seenprachawong, 2003)". Similarly, Merlo (1986) stresses that the evaluation of a forest's public services is the central issue for any rational definition of the use of environmental resources. In literature on the subject "numerous methods exist for measuring the economic value of non-market functions (Wibe, 1995)".

Some authors make an initial distinction between "demand based methods (Bateman and Turner, 1993)" and "price based methods (Merlo, 1991)", the latter modelled on traditional estimate[7]. These can further be "divided into direct and indirect methods (Signorello, 1986; Oates, 1992)" Direct methods estimate the value of the environmental good by constructing so-called hypothetic or contingent markets, in other words using consumer preferences expressed in terms of willingness to pay or willingness to receive compensation. On the contrary, indirect methods, "otherwise known as market parallel, estimate the demand for an environmental good by implicitly deducing it from consumers' willingness to pay for another type of good (Silvestri, 2003). It follows that uncertainty about methodology, lack of basic information, and incomplete awareness of the utility flows produced by forests, introduce margins of ambiguity and error into such estimates.

Briefly outlined below are the methodology used and results obtained, in the case under examination, when estimating the various functions mentioned.

5.1 Landscape value

As for rural landscape (Novelli, 2005; Cicia and Scarpa, 1999; Dillman and Bergstrom, 1997) we believe that the benefits of forest landscape can be traced to three components: scenic (or landscape) value, recreational value and nostalgic (or evocative)value.

"Scenic value, i.e. the value of benefits produced by observing certain typologies of landscape, and recreational value, i.e. value deriving from the possibility of carrying out tourist-recreational activities in environmental contests of quality, require direct use of the good. On the contrary, nostalgic (or evocative) value "derives from the desire that a landscape attributed with aesthetic functions should exist, and from knowing that its associated traditions, culture and lifestyles continue to exist through its conservation (Novelli, 2005). This value was not considered for the purposes of the project in question, so only benefits in terms of scenic and recreational value have been evaluated.

The landscape-recreational value of forests concerns two different aspects: game and the forest as such. Since all the necessary information was not available for game in general, only the landscape-recreational value for hunters was considered. For this category of people this value can be estimated as equal to hunting value, from which the value of carcasses and trophies already valued in the productive function must be subtracted.

The hunting value can be defined as "an economic quantification of the satisfaction felt by hunters when hunting various wild species (Zeni, 2002)"[8]. It was estimated at € 5,743,580.62. If we subtract the productive element (€ 1,663,082.50) we obtain a landscape-recreational value for game, for hunters alone, of € 4,080,498.12. As mentioned previously, this is only a partial value in that we can hypothesise that game also holds landscape-recreational value for non-hunters. However, on one hand the

[7] Their main limit is that they only take partial account of the forest's social value (Merlo, 1986).

[8] This value is derived from the annual costs met by hunters: gun licence, insurance, guns, cartridges, clothing, hunting licence etc. To obtain the overall value, costs met by individual hunters must be multiplied by the total number of hunters in the province of Trento.

value deriving from the presence of animals in the forest may also be considered a part of the landscape-recreational value of the forest itself and on the other, since adequately reliable information was not available for non-hunters, we preferred to adopt a more cautious line and leave out this particular component.

For the landscape-recreational value of the forest as such, we must firstly possess realistic estimates of the number of visits made, on average, per hectare of forested area in a year, how long ago the last visit was made and how long it lasted.

In our case, a quantity evaluation model for tourist-recreational pressure on the forest resources in the province of Trento was built up from a sample survey (Scrinzi *et al.*,1995) conducted in the nineties. This information was integrated with the results of a contingent valuation survey, conducted in 2002 in the forests of Trento (Bettiol, 2004; Notaro *et al.*, 2005), which enabled visitor willingness to pay (WTP) to be estimated.

On the basis of this information it was possible to calculate the landscape-recreational value of the Trento forests, which was valued at € 11,164,453/year (Bettiol, 2004). This means that the average value per hectare is € 40.47/year.

This is a lower value than that suggested by other authors for forests in the Italian Alps, so here too we can talk of a conservative estimate. For example, a value of € 55/hectare was estimated for Piemonte (Paletto, 2002), whereas in the case of Friuli Venezia Giulia (Marangon *et al.*,2001) values of € 159/hectare were estimated. The difference in value is not surprising considering the difference in methodologies used and the diversity of the forests in question (Notaro *et al.*, 2005). The difference in estimates for neighbouring areas and the lack of agreement between academics as to the most appropriate methodologies and on their limits for estimation purposes, does not, in our opinion, invalidate the estimates. Of course, adjustments are always possible but the estimated size range of the sums in play is in itself extremely important for the purposes of planning suitable intervention in economic policy.

The overall landscape-recreational function of the forest can therefore be estimated as follows:

Table 7. Landscape-recreational value

	Landscape-recreational function of the forest (€)	**Hunting value[9] (€)**	**Total value (€)**
2002/2003	11,164,453	4,080,498	**15,244,951**

Source: Author's elaboration.

For the case in question, we wish to draw particular attention to the fact that the value of the landscape-recreational function of the Trento forests is only marginally inferior to the estimated value of timber production.

5.2 The carbon-fixing value of the Trento forests

Although we have long been aware of the capacity of forests to act as huge carbon sinks for carbon fixing, only at the world environment and development conference held in

[9] Net of the productive value in hunting.

Rio de Janeiro in 1992 was it officially recognised for the first time. Subsequently the Kyoto protocol (1997), and its ratification by an adequate number of countries, has increased the importance of forests as regulators of the carbon cycle. In a recent work (La Notte and Paletto, 2002) the overall carbon-fixing value of the high forests of Trento[10] was calculated at € 3,672,177. This was calculated considering the value of a tonne of carbon as € 19.90[11]. We can therefore deem that, considering the value of annual increase in deciduous forests, the overall carbon-fixing utility flow from the forests of Trento is € 4,362,546 corresponding to a yearly average of € 12.6 per hectare/year.

5.3 Hydro-geological protection function

We have long been aware of the role of forests, particularly on mountain slopes, in regulating water flow, and forest legislation in alpine countries has long included measures aiming to safeguard the soil and land protection role of such forests. In spite of this there is no consensus of opinion about criteria and appropriate methods to use when evaluating in monetary terms the benefits afforded by the hydro-geological protection function performed by such forests. For some authors (Pettenella and Baiguera, 1997), the best criteria is the cost of a water system able to guarantee similar degrees of protection to that guaranteed by the forest. For others (Marangon and Gottardo, 2001) it is more appropriate to consider the cost of planting and maintaining a meadow in efficient condition, in place of the forest. We know that a meadow is efficient as far as regards hydro-geological protection, though less so than a forest. However, by using suitable coefficients it is possible to reach a sufficiently reliable estimate.

Because the necessary information is more easily available, for the purposes of this research we opted for the methodology recently suggested by Marangon and Gottardo (2001) for the forests of Friuli. Since the importance of the hydro-geological function differs greatly according to the degree of slope of the land covered by the forest, we firstly divided the entire forested area in the province of Trento into different incline groups. The result can be seen in the following table.

Table 8. Autonomous province of Trento: incline groups

Incline groups	Area in ha (2003)
from 0° to 10°	7,646.04
from10° to 20°	66,331.37
from 20° to 30°	122,233.45
from 30° to 45°	112,266.12
over 45°	36,815.95
Total	**345,292.94**

Source: Servizio Foreste, Provincia Autonoma di Trento

[10] Constituting 78% of the forested area

[11] This is also a conservative value, lower than that suggested by other authors for Italian alpine forests (Cesaro, Pettenella, 1994; Marangon, Gottardo, 2001).

Secondly, we estimated the planting and upkeep costs for a meadow in each incline group, net of any potentially obtainable products. Finally, we applied a coefficient to account for the different degrees of efficiency in hydro-geological protection afforded by a meadow or a forest.

As Marangon and Gottardo (2001) indicate, the resulting formula for calculating the value of the hydro-geological protection function (B_{id}) for each incline group is the following:

$$B_{id} = (C_a + C_o * r) * CN_m * S$$

Where:
C_a = planting cost
C_o = annual mowing cost
r = interest rate: 1%
CN_m = reduction coefficient to account for different degrees of hydro-geological efficiency
S = surface area

As for the other functions, we opted for extremely conservative evaluations allowing ourselves to ignore the value of hydro-geological protection benefits from forests with an incline of less than 10° (18%). The values reached for the other groups are shown in table 9.

Table 9. Cost of substitute meadow

Incline group	Cost of substitute meadow (€)
from 10° to 20°	165
from 20° to 30°	182
from 30° to 45°	245
over 45°	340

Source: Author's elaboration.

Obviously these are very approximate values, but they are still useful in giving some idea of the degree of hydro-geological benefit produced by forests. In this case too it seems appropriate to underline how the adoption of a conservative criterion has lead to similar values than those suggested by other authors (Marangon and Gottardo, 2001) for forests in other Alpine areas.

On the basis of the information reported, the overall value of the hydro-geological protection function performed by the forests of Trento proves to be € 73,244,000. Therefore, on average, the value of hydro-geological protection benefits is 212.19 euros/hectare, as we said, similar to those proposed by Marangon and Gottardo (2001) for the forests of Friuli.

6 SOME FINAL CONSIDERATIONS

Summing up what we have said so far, the value of benefits produced each year by the forests in Trento is shown in the following table.

Table 10. Benefits produced by the forests of Trento

Item	Overall value	Value per hectare	Percentage of total %
Production value, as in standard national accounting (timber products only)	25,581,564 (15,743,001)	74.35	18.91
Added production value, as in national green accounting (timber products only)	16,841,754 (16,785,435)	48.79	12.45
Landscape-recreational value	15,244,951	44.15	11.27
Carbon fixing value	4,362,546	12.6	3.22
Hydro-geological protection value	73,244,000	212.19	54.15
TOTAL	**135,274,815**	**392.08**	**100.00**

Source: Author's elaboration.

On examining table 10, we can see that estimates obtained by current national accounting methodology considerable underestimate the role of forests. This leads not only to the adoption of inappropriate economic policy measures, but also to mistaken valuations of the importance of the various functions performed by forests. Looking at alpine forests we often think of the timber they produce, but the estimates reported here, despite all the caution of approximation, enable us to affirm that, in reality, timber is one of the least important products supplied by forests. At the same time, timber production is practically the only source of income that enables efficient forest upkeep, also in view of the production of other benefits. In fact, contrary to what we are lead to believe, alpine forests are not natural forests, but they are the result of human intervention on the natural ecosystem.

This transformation of the "natural" has not had catastrophic ecological consequences because, in order to survive, mountain farmers have had to adapt strictly to local ecological peculiarities. In this way a balance has been created that only continuous human intervention is able to maintain. Clearly such intervention must answer to precise principles defined by the close-to-nature silviculture and at present included in current trends towards sustainability.

Finally it should be stressed that the list of forest functions mentioned in this paper is not exhaustive. Neither the function of biodiversity nor of air purification has been considered and it was not possible to evaluate existence values or those associated with maintaining cultural values.

The silviculture aspect of forest management in Trento which has, for decades, been modelled on naturalistic methods of silviculture, is very advanced. However, without a precise evaluation of the benefits produced by forests, in a period when cultivation of the forest is becoming less economically viable consequent to the drastic drop in timber prices, we believe that the forest system may enter a serious crisis. Such a crisis would have consequences not only for communities living in the neighbourhood of the forest, but also for all those who enjoy the positive externality of the forest. In conclusion, we hold for this reason that enquiries aiming to evaluate the various benefits afforded by the forestry sector should be intensified. Indeed, only if reliable information is available about such benefits, will it be possible to define effective action targeted at long term

upkeep of the balance between nature and human intervention that has characterised alpine forests for centuries.

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