Stakeholders' Preferences and Economic Value of Forest Ecosystem Services: an Example in the Italian Alps

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Abstract

Alpine forest environments provide a wide range of ecosystem services essential for human life and well-being. Albeit the benefits they yield, ecosystem services' value is often underestimated because it is not reflected in a market price. Ecosystem services generate very high economic, ecological and social values largely enjoyed by the stakeholders, who live in their surroundings. Hence, stakeholders' preferences for both marketable and non-marketable ecosystem services, as well as the possible relationships between stakeholders' preferences and the economic value of ecosystem services should be broadly investigated to provide better informed and more effective natural resources management. Based on these considerations, the present contribution assesses the economic value of bundle of forest ecosystem services (timber and fuelwood production, carbon sequestration, natural hazards protection, recreation including hunting) and stakeholders' perceived importance of ecosystem services in a case study in the Italian Alps (Valle di Non, Province of Trento). At first, economic value of the ecosystem services is estimated using different environmental valuation techniques (market price, replacement cost method and benefit transfer method). Secondly, stakeholders' preferences on ecosystem services were assessed by using a semi-structured questionnaire. Finally, the ranking of the ecosystem services values and the stakeholders' preferences were compared in order to underline the differences between the perceived importance and the estimated economic value. The results showed that the ecosystem services with the highest economic values were natural hazards protection (103.6 €/ha/year), timber production (78.4 €/ha/year) and recreation in forests (70.8 €/ha/year), while the regulating ecosystem services (natural hazards protection and carbon sequestration) were perceived as the most important. No statistically significant relationship was obtained in the comparison between the economic value and the perceived importance of the forest ecosystem services. Furthermore, many non-tangible and non-marketable ecosystem services (e.g. natural hazards protection and recreation in forests), often neglected during the implementation of forest management plans, were highly perceived by the stakeholders and at the same time economically valuable.

Key words: Forest ecosystem services, stakeholders' preferences, economic value, environmental valuation techniques, Valle di Non (Italy)

Introduction

Alpine ecosystems provide many important ecosystem services. Ecosystem services represent the benefits that human populations derive from ecosystems, ecological processes or functions (Costanza et al. 1997, De Groot et al. 2002). Costanza et al. (1997) divided ecosystem services into 17 major categories such as gas, climate, disturbance and water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia, food production, raw materials, genetic resources, recreation and cultural. Afterwards, De Groot et al. (2002) provided more detailed information, expanding this list and identifying 23 different ecosystem functions, important for natural cycles and human daily life maintenance. In particular, these authors introduced new ecosystem functions such as nursery function, medicinal resources, ornamental resources, aesthetic information, spiritual and historic information, science and education (De Groot et al. 2002). Over the years, this list was modified and, in particular, Millennium Ecosystem Assessment (MEA 2005) listed a classification of ec-

osystem services, based on their functions: provisioning services, regulating services, cultural services and supporting services. Subsequently, De Groot et al. (2010) reclassify ecosystem services replacing supporting services with habitat services (i.e. nursery habitat, gene pool protection).

According to the MEA (2005), many ecosystem services essential for human life and well-being, have been exploited heavily over the last 50 years. This is an alarming fact that highlights the need of specific policy and management strategies for the conservation of ecosystem services for future generations. The evaluation of ecosystem services, which aims at quantifying the importance of ecosystems to human well-being, is seen as a support for designing better policies for conserving and ensuring sustainable management of ecosystem services.

As many authors pointed out, ecosystem services' value is often underestimated or taken for granted (Farber et al. 2002, Hein et al. 2006, Fisher et al. 2007, Carpenter et al. 2009). Due to the public good nature of many ecosystem services, markets are often unable to provide a suitable unit of account (Boyd and Banzhaf 2007), except for those resources that can be directly exploited (i.e. timber, wildlife gaming, non-wood products). In absence of a market price, the economic value of some ecosystem services is not clearly defined; leading to common misperception that the cost for ecosystem services conservation is usually higher than the benefits ecosystem services provide. For this reason, many valuation techniques have been developed and applied for the assessment of the economic values of different natural resources (Garrod and Willis 1999). In spite of their approximation and non-exhaustiveness, economic valuations are important to have a rough estimate of the magnitude of the ecosystem services' value (Nijkamp et al. 2008, Valatin and Starling 2010) and to help decision-makers in defining policies oriented towards more and better conservation.

In 2001, the Secretariat of the Convention on Biological Diversity (CBD 2010) produced a report with a literature review regarding the economic value of a wide list of forest ecosystem services. This and many other scientific contributions and initiatives are a response to the increasing concern about forest ecosystem services conservation issues, though further efforts should be made to identify, assess and value ecosystem services at different spatial scales and across several types of natural ecosystems (Chiabai et al. 2011). In addition, it is widely accepted that the value of natural resources is greatly influenced by the views, needs and perceptions of the stakeholders (i.e. local population, tourists) having an interest in the resources (Hein et al. 2006, Nijkamp et al. 2008). Stakeholders, being in contact with natural resources, have a clear understanding of the resources' utility and of the need of preserving them from anthropogenic pressures, even in absence of a well-functioning market. For this reason, it is important to investigate stakeholders' needs and perceptions, in order to take into account their preferences and views, and carry out management strategies with a bottom up approach. In particular, stakeholder-based approaches facilitate the evaluation of different management strategies and are important instruments to achieve sustainable forest management and multi-functional forestry objectives. Besides, the analysis of stakeholders' preferences and perceptions are a useful tool for increasing the social acceptance of the decisions and the social sustainability (Kishor and Belle 2004, Paletto et al. 2014).

Based on these considerations, the main objectives of this research are to analyze the stakeholders' preferences and to assess the economic value of forest ecosystem services in an Alpine area. Moreover, the research focuses on economic evaluation of the main forest ecosystem services, taking into consideration stakeholders' preferences for marketable and non-marketable forest ecosystem services. The innovative aspect is that the study has focused on the relationship between economic value of ecosystem services and stakeholders' preferences (Martín-López et al. 2012, Menzel and Teng 2010). The research has been developed in a case study in the Italian Alps (Valle di Non, Province of Trento), characterized by a high relevance of the forest sector and by a non negligible role of forests in the residents' livelihood and well-being. These kind of studies, based on stakeholders preferences, are relatively new and experiences developed for mountain areas can be useful as support for forest managers.

Materials and Methods

Study Area

Valle di Non (46°21'43" N, 11°2'27" E) is located in the North-West of the Province of Trento, in the Italian Alps. The altitude of the Valley is between 400 m and 2,500 m a.s.l., the climate is cool- temperate and mild continental. Valle di Non occupies 59,674 ha, with a population of 39,134 inhabitants (population density 65.6 inh./ha). Valle di Non is a rural district, characterized by a high economic and socio-cultural importance of the forest and agricultural sectors. About two-thirds of the valley is covered by forests (38,597 ha), out of which 80% are public and common forests and the remaining 20% are private forests. More than 80% of the forest area is under forest management plans and is managed according to sustainable forest man-

agement principles. The main forest types are conifer forests (90%) – mainly Norway spruce (*Picea abies* (L.) H. Karst.) forests pure and mixed with silver fir (*Abies alba* Mill.), European larch (*Larix decidua* Mill.) forests, Scots and black pine (*Pinus sylvestris* L. and *Pinus nigra* J.F. Arnold) forests - and the remaining 10% are European beech (*Fagus sylvatica* L.) forests.

Research framework

The research framework was structured in three steps: (1) valuing forest ecosystem services, (2) collecting stakeholders' preferences on forest ecosystem services, (3) analyzing the relationships between ecosystem services' values and stakeholders' preferences.

In the first part of the research, the assessment of the value of the core forest ecosystem services of the Valle di Non was conducted. In particular, provisioning services (production of timber, fuelwood and game species), regulating services (carbon sequestration and protection against natural hazards), and cultural services (outdoor and game recreation values) were estimated by using different environmental evaluation techniques such as market price, replacement cost method (Freeman III 2003) and benefit transfer method (Rosenberger and Loomis 2001). Forest ecosystem services were then ranked based on their value per hectare of forest.

In the second part of the research, stakeholders' preferences on forest ecosystem services were collected through a semi-structured questionnaire. Ecosystem services were then ranked based on the stated average importance.

Finally, the two rankings were compared and the relationships between stakeholders' preferences and economic value of ecosystem services was analyzed through the correlation test of Spearman ($\alpha = 0.05$). The Spearman correlation test is a non-parametric test of association between two variables whose coefficient varies from -1 to 1 (negative or positive correlation between both variables, respectively). This test was chosen for the present analysis because it does not impose any normality assumption over the distribution of the variables.

The comparison allowed to identify similarities and differences between the economic valuation and the stakeholders survey concerning ecosystem services. This comparison was used to draw important information to support sustainable management strategies for the policy site of the Valle di Non. The collected data support decision makers (forest managers and planners) in choosing and applying strategies to implement sustainable forest management and reduce social conflict. In particular, they can better understand which ecosystem services may run the risk of being over-exploited. At the same time, the economic valuation of ecosystem services could be useful in cases of trade-offs between different ecosystem services (for example, timber provision and natural hazards protection). In addition, the economic evaluation of marketable and non-marketable goods and services provided by forests allows decision makers to have a comprehensive and exhaustive knowledge of the context from the economic point of view. On the other side, the knowledge of stakeholders' preferences concerning forest ecosystem services takes in consideration the social aspects of the issue, by incorporating social preferences in forest management. Sustainable forest management can be achieved with a proper balance between environmental, economic and social issues.

The economic valuation of the ecosystem services

The economic evaluation techniques employed to assess the value of selected ecosystem services, are summarized in Table 1. From a theoretical point of view, our intent was to calculate the ecosystem services' economic value through a market price method when possible, i.e. in the case of marketable goods. We are conscious of the uncertainty associated with the use of market price method, which underestimates the ecosystem services value, by excluding non-use and existence values. Still, we opted to use this lower bound approach, in order to make conservative estimations, as advised in literature (Bateman et al. 1999).

Table 1. Selected ecosystem services and associated economic evaluation techniques

Ecosystem services	Economic evaluation techniques
Timber production	Market price
Fuelwood production	Market price
Harvested game	Market price
Carbon sequestration	Market price
Natural hazard protection	Replacement cost value
Tourism-recreation	Benefit Transfer
Game recreation	Benefit Transfer

Timber and fuelwood production

Timber and fuelwood production have been estimated through the market approach, using the official statistics of the Forest Service of Autonomous Province of Trento. The formulas used for the estimation of timber and fuelwood production, respectively, are the following:

$$V_t = \sum_{n}^{i} \sum_{m}^{i} Q_t \cdot p_t \ , \qquad (1)$$

where: V_t = total value of timber (€); n = number of tree species (Norway spruce, silver fir, European larch,

Scots pine, black pine and beech); m = number of wood assortment; Q_t = quantity of timber subdivided per species and wood assortment, m³; p_t = price of timber subdivided per species and wood assortment, €/m³.

$$V_f = \sum_{n}^{i} Q_f \cdot p_f \ , \quad (2)$$

where: V_f = total value of fuelwood. €; n = number of tree species (Norway spruce, silver fir, European larch, Scots pine, black pine and beech); Q_t = quantity of fuelwood subdivided per species. t; p_t = price of fuelwood subdivided per species. €/t;

Quantities of timber and fuelwood were provided by the annual report of the Province of Trento (average value period 2006-2012), whereas prices were derived from the local wood market statistics.

Harvested game

Game species were estimated considering the main hunted wildlife species like roe deer (*Capreolus capreolus* L.), red deer (*Cervus elaphus* L.), chamois (*Rupicapra rupicapra* L.) and black grouse (*Lyrurus tetrix* L.), on the study area, using market prices. In particular, this productive forest function was estimated considering the annual weight of animals harvested subdivided per species. The unit of output is the single animal, hence the price is calculated per animal using data on price per trophy, hide and per kilogram of meat. The formula used is the following:

$$V_h = \sum_{n}^{i} [(Q_m \cdot p_m) + (Q_t \cdot p_t) + (Q_h \cdot p_h)] \ , \quad (3)$$

where: V_h = total value of harvested game. €; n = number of game species (roe deer, red deer, chamois and wild grouse); Q_m = quantity of meat obtained. kg; p_m = price of meat. €/kg; Q_t = quantity of hide obtained. kg; p_t = price of hide, €/kg; Q_h = quantity of trophy, unit; p_h = price of trophy, €/unit.

Quantities and prices of the hunting activity were estimated through the data obtained from the local fauna management plan and from interviews with the hunting associations' representatives.

Carbon sequestration

Market approach was used for valuing carbon sequestration in forest ecosystems of Valle di Non, using the volunteer carbon market prices. The procedure used to estimate the quantity of carbon stored follows the For-Est approach (Federici et al. 2008), based on the Intergovernmental Panel on Climate Change (IPCC) "Good Practice Guidance for Land Use, Land-Use Change and Forestry" (IPCC 2003). IPCC guidelines are focused on the accounting of the stock present in the five main carbon pools (above-ground and below-ground biomass, deadwood biomass, litter and soil). In order to have an estimation of the annual forest capacity to transform atmospheric carbon into biomass, we considered only above-ground and below-ground biomass. The choice of excluding the other pools was driven by their intrinsic characteristics: the carbon stock of litter, soil and deadwood is characterized by multi-year dynamics and changes in the annual increment of carbon stock are negligible. In addition, understorey vegetation was not considered, due to the lack of the necessary data. The quantity of above-ground biomass (AGB) was estimated with the following formula (Federici et al. 2008):

$$AGB = I \cdot BEF \cdot WBD, \quad (4)$$

where: I = annual volume increment, m³/year; BEF = biomass expansion factor (usually forest volume is referred to stem volume, and the expansion factor accounts for components such as branches, and leaves); WBD = wood basal density. kg/m³.

Similarly, below-ground biomass (BGB) was estimated with the following formula (Federici et al. 2008):

$$BGB = I \cdot WBD \cdot R, \quad (5)$$

where: R = the roots/shoot ratio, which convert AGB in roots biomass.

The coefficients BEF, WBD and R vary with tree species and were taken from the literature (Vitullo et al. 2008). In literature, the carbon content is assumed to be about 50% of total biomass (Sollins et al. 1987, Coomes et al. 2002). Finally, the total value of carbon sequestration can be expressed as the product of two factors: the carbon quantity, estimated using the aforementioned procedure, and the mean voluntary carbon market price related to 2012, which is around 4.59 €/tC (Peters-Stanley and Yin 2013). The formula used to estimate the value of carbon sequestration is:

$$V_c = [(AGB + BGB) \cdot 0.5] \cdot p_c, \quad (6)$$

where: V_c = value of carbon sequestration in above and below-ground biomass, €; AGB = above-ground biomass. t; BGB = below-ground biomass. t; 0.5 = coefficient of carbon content; p_c = mean carbon price of the voluntary carbon market, €/tC.

Natural hazards protection

In the evaluation of the protective function of the forest, the effect of forest to contrast hydrogeological risk was considered. The replacement cost (RC) approach, i.e. a cost based evaluation technique (Free-

man III 2003), was used. The RC is a method to assess the cost incurred by replacing ecosystem services with artificial substitutes, such as bio-engineering works (Busch et al. 2012). In this case, the RC estimates the costs for replacing hydrogeological protection of forest with artificial engineering constructions (Dixon et al. 1997). The formula used to estimate the RC of forest protection is (Notaro and Paletto 2012):

$$V_p = \frac{uC \cdot r}{(1+r)^{-t}}, \quad (7)$$

where: Vp = value of protective function of forest, estimated used the replacement costs method, €; uC =unit cost of the substitute construction, €/m²; r = interest rate. 2%; t = substitute construction lifetime, years.

Natural hazards risk maps of the Province of Trento were used to identify four risk categories: hydraulic one, hydrogeological one, avalanches and landslides. For each risk category, protective forests are subdivided into four risk level classes, characterized by different risk levels (from very low to very high risk). The study focused on the hydrogeological risk, since in the provincial map hydraulic risk and landslide risks are the sub-groups of hydrogeological risk, while avalanche risk is basically irrelevant in the valley. The second and the fourth class covered very small areas, so they were grouped together with the first and the third class, respectively. The class having low-risk covered an area of 15,500 ha and the class having high risk covered just 115 ha. As substitute construction for the low risk class we supposed a simple palisade, while live fascines for the high-risk one. The costs of these bio-engineering works were derived from the official pricelist of the Province of Trento, while their lifetime span was obtained from the literature (Notaro and Paletto 2012). Finally, a conservative interest rate was chosen and fixed at 2%, according to Freeman's III (2003) ranges.

Recreational values

Recreational values were assessed by means of a Benefit Transfer (BT) method. The BT is applied by transferring the results of a research carried out in a site (called study site) to another location with similar characteristics, where policy making is intended to be implemented (the so-called policy site) (Bergstrom and DeCivita 1999, Wilson and Hoehn 2006). The BT is a very useful tool, when there is a resemblance between the policy and the study sites in terms of investigated features. Among the different methodologies available to carry out the BT, we opted for transferring the mean value of a collection of studies, i.e. a meta-analysis, considered to be one of the most effective (Bartczak et al. 2008).

A detailed description of the method used to assess the tourism recreation value in Valle di Non is given in Grilli et al. (2014), where through a literature analysis, 32 papers were collected, published between 1977 and 2013. The assessed recreational values refer to the outdoor activities (walking, picnicking, jogging and landscape viewing) while other activities, such as fishing, mushrooms and berries picking, were not taken into consideration in this work. This restriction was made in order to consider only recreational forest values not associated with the natural resources consumption. The meta-analysis includes only European mountain forests as study sites, motivated by the necessity to compare values related to sites with similar altitude, forest tree composition and tourist target, in compliance with the prescriptions made by Boyle and Bergstrom (1992). It is widely accepted that the transfer errors could be reduced if physical and biological characteristics of the study site and the policy site are similar (EPA 1993, 2000, Rosenberger and Loomis 2001); for this reason, our dataset included sites with features as much similar as possible. Recreational values were analyzed and transferred according to tree species composition (coniferous, deciduous and mixed forests) and forest altitude (above and below 1,000 m a.s.l.).

The study area is characterized by a low density of winter sport infrastructures, and tourists' presences are concentrated in summer season. Consequently, for the present study, only summer tourists were considered.

Recreational value of game was estimated separately, while it was not possible to obtain a value for the non-wood forest products because of lack of available data. In particular, recreation values of game were assessed through a meta-analysis following the data provided by Grilli et al. (2013), who collected 5 studies focused on game recreation in the Italian Alps (Stellin and Rosato 1998, Scolozzi 2012).

The formula used to estimate the recreational value of forests is:

$$V_t = (T \cdot w_t) + (H \cdot w_h), \quad (8)$$

where: V_t = total value of recreation in forests, €; T = annual number of tourist presences; w_t = average value of willingness to pay for outdoor activities in site studies. € per visitor; H = annual number of hunters; w_h = average value of willingness to pay for game activities in site studies, € per hunter.

We present the results of the economic assessment considering the value per hectare of each ecosystem service in order to reduce the effect of the land extension and to facilitate the comparison with present and future studies.

Stakeholders' preferences survey

Stakeholders' preferences on ecosystem services were collected through a semi-structured questionnaire, administered face-to-face to 51 stakeholders.

A preliminary stakeholder analysis was carried out in order to identify the most important groups of stakeholders, who have a direct or indirect interest in natural resources management (Mrosek et al. 2010). The initial list of stakeholders was enriched and integrated during the questionnaire administration, whenever a stakeholder explicitly nominated a person or a group to be interviewed (snowball sampling approach). At the end of the stakeholder analysis, 51 stakeholders were identified and classified in four main categories: 25 public administrations representatives (municipalities, ASUC, Forest and Wildlife Service of the Province of Trento), 7 associations' representatives (hunting and environmental associations), 13 forest-wood chain actors (forest enterprises, sawmills), and 6 tourism sector actors (hotel keepers, agencies of tourism development).

The questionnaire was composed of 17 closed-ended questions and grouped into four thematic sections: (i) organization information, (ii) personal information, (iii) social and human capital, (iv) forest management and local tradition. In the "organization information" section, the organization size, the number of employees by level of education and job insecurity were investigated, while the "personal information" section focused on the information of the respondent such as age, gender, level of education. The "social and human capital" section sought to quantify the social capital of the study context (relational and institutional social capital) and the human capital within the organization or association interviewed. Instead, the "forest management and local tradition" section focused on the stakeholders' preferences on forest ecosystem goods and services. A preliminary version of the questionnaire was prepared by the researchers previously involved in the stakeholder analysis and pre-tested with a sample of stakeholders. The present research focuses on the "forest management and local tradition" section of the questionnaire, while taking into account the personal and organization information. With special regards to the ecosystem services provided by forests stakeholders stated their preferences using a 5-point Likert scale (from 0 = very low importance, to 4 = very high importance), and ecosystem services were ranked based on the stated average importance.

Results

Economic valuation of the ecosystem services

The results of the economic evaluation show that there is a remarkable variation among the monetary amounts of the ecosystem services, which range from 16.8 €/ha/year to 103.6 €/ha/year (Table 2). Besides, the results show that from an economic point of view, the most important ecosystem services are natural hazards protection, timber production and recreation in forests. By observing the results we can see that the exploitable goods provided by forests are valued less than no marketed services. Among the exploitable goods only the timber production has a quite high economic value (78.4 €/ha/year), while fuelwood and harvested game have values of 26.2 €/ha/year and 18.5 €/ha/year, respectively.

Table 2. Economic values per year of ESS and stakeholders' preferences in Valle di Non

Ecosystem services	Category of ES	€/ha/year	Stakeholders' preferences mean scores
Timber production	Provisioning services	78.4	2.94
Fuelwood production	Provisioning services	26.2	2.37
Harvested game	Provisioning services	18.5	2.33
Carbon sequestration	Regulating services	16.8	3.27
Natural hazards protection	Regulating services	103.6	3.30
Recreational value (tourism-recreation and game recreation)	Cultural services	70.8	2.84

Provisioning services: timber, fuelwood and harvested game

The productive forests of Valle di Non cover 24,693 ha (64% of forest area), with a standing volume of about 5 million m^3 and an annual increment of 83,000 m^3 per year. The average annual quantity of commercial timber is around 30,000-35,000 m^3, obtained mainly from public forests (85%). The main species traded are Norway spruce (around 65% of total), silver fir (10%) and Scots pine (10%). Concerning fuelwood, the average annual quantity is around 25,000 tons, obtained mainly from public forests (86%) and the remaining from private forests. According to the provincial statistics, the economic value of timber production in Valle di Non was about 78.4 €/ha/year. The economic value of fuelwood production accounts for 26.2 €/ha/year.

Harvested game were estimated considering only the productive activity (value of products). The total economic value of game in the study area is 712,000 € per year, corresponding to a value of 18.5 €/ha/year. The game species, which provide the highest economic value, are the red deer (49%), followed by roe deer (29%) and chamois (21%) (Table 3).

Regulating services: carbon sequestration and natural hazards protection

The economic value of carbon sequestration in living tree biomass (above-ground and below-ground biomass) accounts for a small part of the total eco-

Table 3. Value of harvested game subdivided per species and product (,000 €)

Game species	Meat	Hide	Trophy	*Total*
Roe deer	104	20	84	*208*
Red deer	263	20	68	*351*
Chamois	53	27	70	*150*
Wild grouse	0.26	-	2.5	*3*
Total	*420*	*67*	*225*	*712*

nomic value (16.8 €/ha/year). The total value of this ecosystem service is equal to 648,430 €/year, divided into 71.5% in above-ground biomass and 28.5% in below-ground biomass.

Protection against natural hazard is supposed to be the most important forest function in mountain areas (Merlo and Rojas Briales 2000), especially to protect human settlements and infrastructures from rockfalls, avalanches, landslides and other natural events. In the Province of Trento forests that protect against natural hazards accounts for 3,149 ha (8.2% of total forest area). This percentage is lower than the average of the Province of Trento, where protective forests account for 20% of total forests. This study confirms that protection against natural hazards is the ecosystem services that have the highest economic value (103.6 €/ha/year).

Recreation values: outdoor recreation and game activities

In the ambit of the Province of Trento, Valle di Non is not a very touristic area and the annual number of tourist presences is equal to 321,059. This value represents around the 2.2% of the total tourist presences in all Province of Trento. The results show that recreation in forests is a very important ecosystem service with a value of 64.8 €/ha/year for the outdoor activities and 5.98 €/ha/year for game activities.

Stakeholders' preferences survey

The stakeholders surveyed are mostly men (88.2% male and 11.8% female) with an age higher than 50 years old (56.9%). Respondents with an age under 34 years are 7.8%, while those with more than 65 years are 5.9%. The background of the respondents is highly variable: 9.8% has a university degree (bachelor's or master's degree), 43.1% holds a high school degree, 15.7% has a technical school degree and the remaining 31.4% does not have a degree.

Results of the stakeholders' preferences confirm the high importance of non-marketable ecosystem services such as the regulating service, namely natural hazards protection and carbon sequestration. Similarly to what evidenced for the economic evaluation, the protection against natural hazards is the most important ecosystem service also according to stakeholders' perceptions (*mean* = 3.30) followed by carbon sequestration (*mean* = 3.27) and timber production (*mean* = 2.94). Surprisingly, the recreational function of the forest is in the lower bound, with a mean value of 2.84. Finally, as in the economic valuation, fuelwood production and harvested game are at the bottom of the ranking, with 2.37 and 2.33, respectively.

The non-parametric Spearman correlation test between ecosystem services values and stakeholders' perceptions found no statistically significant correlations ($r = 0.429$, $p = 0.419$).

Discussion

This study has provided an economic and social analysis of the importance and value of a bundle of forest ecosystem services. The results showed that the non-market benefits provided by forest ecosystem services (regulating and cultural services) accounted for about 60% of the total economic value of the annual environmental flows generated by forest ecosystems in the Non valley. At the same time, they were considered to be very valuable by forest stakeholders.

The timber production has a quite high economic value in the study area due to the high timber quality of two tree species (Norway spruce and European larch) and to the silvicultural treatments applied by the Forest and Wildlife Service of the Province of Trento (i.e. selective cuttings). Also the harvested game has a certain importance from the economic point of view, being an important economic activity in Valle di Non hunting with 38 hunting reserves (covering 32,500 ha) and 856 hunters (Grilli et al. 2013).

The natural hazards protection obtained the highest scores in both analyses, which should not be surprising, since the Province of Trento is a mountainous region and, in this situation, the role of protective forests for human infrastructure and activities is a priority. The high economic value of this regulating service can be also partly attributed to the chosen method of evaluation. The technology required for replacing hydrogeological protection of forests with artificial bio-engineering works is very expensive, meaning that cost-based approaches used to assess this ecosystem service generate relatively high values. On the other hand, the high value highlights the importance of this function for human settlements protection. Nevertheless, the results of economic evaluation of the hydrogeological protection function are comparable to the data reported in the literature on the mountain forests within the same region: Goio et al. (2008) showed an average value of 212.2 €/ha/year for

the entire the Province of Trento (Italy), while Notaro and Paletto (2012) in a small scale forest (Valdastico forest in north-east of Italian Alps) evidenced a value of 284.2 €/ha/year for the hydrogeological protection function.

The economic value of carbon sequestration in the case study is quite low if compared to the other ecosystem services. This low value is mainly due to the current carbon price on the market, rather low in these latest years. If accounting for the other carbon pools in forests, i.e. litter, soil, understorey vegetation and deadwood, the economic importance of forest carbon sequestration could be higher. Carbon sequestration estimated in other European case studies showed values for the above-ground biomass included in a range between 6 and 40 €/ha/year (Goio et al. 2008, Hein 2011, Šišak 2013), consequently the value estimated in the present research (16.8 €/ha/year) is within this range. The wide range of values is due to changes in market prices of carbon credits registered in recent years. Despite the low economic value attributed to the carbon sequestration service, the interviewed stakeholders perceived it to be one of the most important ecosystem services. This shows that the social appraisal on this ecosystem services and the concerns of the potential anthropogenic pressures on this regulating function have not already been embedded in the regional and national economy. Hence, this means that it could be rather challenging to make the economic argument in favour of this ecosystem service, potential trade-offs should emerge. This is not the case in other countries, for instance Sweden, where there is the carbon tax that amounts 120 €/tCO_2 (Lundgren et al. 2015). The social analysis of the importance of the carbon sequestration service is in line with other studies that showed clearly that forests are (internationally) acknowledged as the most important carbon pools, useful to mitigate the climate change effects (Martín-López et al. 2012).

In reference to the tourist-recreational function of forests, Zandersen and Tol (2009) evidences through a meta-analysis on forest recreation valuation studies in Europe (25 studies), that the values range from 0.66 € to 112 € per visit with a median of 4.52 € per visit. A study in Spain (the Province of Segovia) shows an average value of 6.90 € per visit (Gonzįles et al. 2010). At the light of the presented results, that show a wide range of results of ecosystem services' economic evaluations for different areas and contexts, it is important to highlight that the evaluation of non-marketable ecosystem services is deeply influenced by the environmental evaluation technique used. Our results confirmed the economic role of forests in attracting tourists, according with other previous studies indicating the high economic impact of forest recreation for local development (Pearce 2001). Indeed, tourism in forest is a growing phenomenon worldwide (Stubelj Ars and Bohanec 2010) and especially in industrialized countries, so tourists' demand for nature-based vacations is gaining an increasing high economic importance.

It is important to underline that for the social analysis of the recreational service, the tourists were not surveyed in this study, and this aspect probably influenced the outcomes of the ecosystem services perceptions' survey. The stakeholders ranking could have been different if the local people, who usually go in the forests for tourism and recreation, were interviewed. This depends on the fact that their point of views, expectations and preferences for ecosystem services could diverge from the ones of local stakeholders.

From the economic values of all provisioning services, the timber production alone accounts for 66%, suggesting the high importance of this productive function for the regional economy. Still, the social analysis results place it in the middle range of importance. This result could be strongly affected by the presence of stakeholders that have different interest and perceptions on the values produced in the Valle di Non.

The fact that the two rankings (economic and social) assigned low values to fuelwood and harvested game may be due to the changes that occurred in many regions of the Alpine mountain range after the 1950s. In fact, the abandonment of many mountainous areas and of traditional economic activities, together with the emergence of different models of development (Viazzo 1989), changed the priority order in terms of perception and needs of the population towards the forestry sector. The success of multiple-use forestry in industrialized societies after World War II can be ascribed to the fact that the use of forests for fuelwood has progressively been subject to a loss of interest, whereas requests for non-timber forest resources started to grow (Bengston 1994) and the social and environmental functions of the forest have gained importance. Earlier studies indicated the economic functions of the forest, and especially wood products, are the least valued (Tarrant et al. 2003, Paletto et al. 2013).

There could be several reasons for the absence of statistically significant correlation between the economic and social indicators. For the economics analysis, the adoption of the most suitable evaluation method is often a function of the type of the ecosystem services under investigation and the country or region economy, where the study is implemented, meaning that these economic rankings could change in other country context. For the social analysis, we

should consider the fact that the final ranking is generalized across different type of stakeholders, each associated with both personal and institutional preferences for the ecosystem services in the mountain region. Hence, there is a possibility that the correlation is not statistically significant because of the multitude of calculation and survey dynamics used to obtain both rankings.

Conclusions

The present study aims to analyse the economic value of forest ecosystem services and stakeholder's preferences for them and to compare the economic and social rankings. Both the economic and social analysis highlight the importance of accounting of both market and non-market benefits of the forest ecosystem services, while their comparison addresses several issues related to social perceptions and the regional economic accounting. Forest managers and decision makers of the Valle di Non may use outputs and results of both analyses to support forest management plans implementation. In fact, this study reveals differences and similarities between the estimated value of the forest and the stakeholders' vision of the forest to fulfill the different functions and could be useful to activate management options that consider both aspects.

The authors want to remark stakeholders' based approaches and research are very useful to support sustainable forest management. Especially, when considering fragile ecosystems like Alpine forests, decisions concerning ecosystem management should be made in compliance with local inhabitants and stakeholders being the main actors affected by the choices that managers make.

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