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Mapping the monetary value of forest-based recreation: a case study in the Italian Carnic Prealps

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Abstract In the last decades, ecosystem services are increasingly of interest to the scientific community and policy makers, due to their ability to improve people's physical and mental well-being. To better target forest management interventions, it is important to assign a spatially explicit monetary value to ecosystem services provided by forests. This study aims to defined a procedure to assess and map the monetary values of outdoor recreational in a case study in the north-east of Italy (Cansiglio Orientale forest). For that purpose, a zonal Travel Cost Method and a spatial analysis were implemented in order to map the outdoor recreation value in different forest areas. During the summer 2023, 118 questionnaires were collected through face-to-face administration on the site. The results showed an annual consumer surplus of 13,961,789 € that corresponds to 15.36 € per visit per person. According to the spatial analysis, accommodation facilities, points of interest, and roads and paths network are the elements that most affect the distribution of the outdoor recreation value.

Keywords: ecosystem services; user perception; economic value; spatial analysis; Cansiglio Orientale forest (Italy).

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Introduction

In recent years, it is having been widely recognised that ecosystem services (ES) provided by natural resources are a key aspect for human health and well-being (Häyhä et al. 2015, Menezes da Silva et al. 2023). ES are a topic that involves an increasingly large audience of social actors such as academics, policy makers, practitioners and ordinary people (Leca et al. 2023). According to the main international reports (MEA 2005, TEEB 2008, Haines-Young & Potschin 2018), ES are defined as the direct and indirect contributions of natural ecosystems to human well-being and can be classified into three categories: provisioning services (e.g., food, timber and fresh water supply); regulating services (e.g., climate, floods and diseases control); and cultural services (e.g., recreational, historical and spiritual values). In addition to these, supporting services (e.g., primary production, soil formation and retention, provisioning of habitats) are a transversal category e necessary for the production of all other ES (Marta-Pedroso et al. 2014).

Forests provide a large number of ES that can benefit society and markets (Winkel et al. 2022), but many ES do not have a value recognized by the market (Schägner et al. 2013). This fact may give rise to a weakness in forest management decision-making processes for the valorisation of ES as there is a risk of favouring assets with a traded value over those without a traded value.

In literature, valuing ecosystem services in monetary terms is recognized as a difficult challenge to address, but of key importance for policy makers (Chivulescu et al. 2024). Regarding ES not traded on market, it is necessary to apply methodologies that allow values to be assigned considering the preferences and utility recognised by society (Ezebilo 2016). On the other hand, many studies showed that the economic value generated by some ES is extremely relevant in the local and global market (Lupp et al. 2016, Müller et al. 2019, Fagarazzi et al. 2021). As a consequence, several authors stated that the inability to incorporate the monetary value of ES into decision-making processes is the main cause of biodiversity loss and degradation of natural resources (Rands et al. 2010, Reyers et al. 2012). In addition, the trade-off between ES and the choice of the most appropriate management methods to be adopted are further aspects to consider in decision-making processes (Brodrechtova 2024). Possible trade-offs between ES can be resolved through appropriate management on a landscape scale (Cordingley et al. 2016). To this end, assigning a monetary value to ES without a real market is of pivotal importance for analysing trade-offs and synergies between ES considering the temporal and spatial scale (Martín-López et al. 2014).

Forest-based recreation can be considered one of the most important cultural ES provided by forests to society without a recognized spatially explicit market value (Scholte et al. 2018). Forests, parks and rural landscapes are fundamental spaces for outdoor recreation that offer important opportunities for physical and mental regeneration for people and who have few possibilities to come into contact with nature frequently (Navrátil et al. 2015). Forest-based recreation has a key importance among the cultural ES due to its capacity to facilitate social interactions, foster empowerment and social cohesion (Cortinovis et al. 2018), as-well-as to generate positive direct and indirect effects on local economy (Paletto et al. 2023). In fact, forests are able to provide attractive scenery for consumptive and non-consumptive activities such as hiking and trekking, mountain biking, hunting, bird watching, non-wood forest products (NWFP) collection (Grover et al. 2023). The integration of economic analysis in the tourism-recreational sector is quite recent, but it represents a fundamental field for the enhancement of natural resources taking into account supply and demand (Menegaki et al. 2021).

Economic analysis is conditioned by the fact that there is no real market to estimate recreation in forests; therefore, it is necessary to rely on environmental evaluation methods to assign a monetary value to this ES. Among the numerous environmental evaluation methods proposed in literature, the Travel Cost Method (TCM) appears to be the most widely adopted method for estimating the recreational value of forests (Hanley & Spash 1993, Hanley & Barbier 2009, Bujosa Bestard & Riera Font 2010, Leh et al. 2018).

Many studies apply TCM to estimate outdoor recreational activities in which it is necessary to travel, even for long distances, to enjoy the natural environment often located far from the urban areas from which most visitors come from (Fagarazzi et al. 2021, Juutinen et al. 2022). TCM is classified as a revealed preference method and it is based on two main assumptions (Hotelling 1949, Riera et al. 2012): i) the value of a site reflects the costs of visiting the site itself; ii) the visits' frequency to the site decreases as costs incurred increase.

Another key aspect to support forest management choices is to make the monetary value of forest-based recreation spatially

explicit in order to consider trade-offs and synergies with other ES (Schägner et al. 2013). As emphasized by Hauck et al. (2013) and Peña et al. (2015), maps of ES are valuable representations of real conditions and powerful instruments for communicating complex information in a simple way to decision makers and civil society. First, a biophysical mapping of ES allows to investigate both the functions and the flows of services deriving from natural resources (Häyhä et al. 2015). Indeed, often the physical attributes of the territory are used to represent the distribution of the ES, such as the recreational potential of a natural environment (Scholte et al. 2018). However, ES mapping requires an interdisciplinary approach to be efficient, integrating ecological and biophysical aspects with economic ones (Schägner et al. 2013). The spatialization of the monetary value of ES (or their social utility) allows to evaluate their distribution on the territory in combination with other information available at geographical level (Bernetti et al. 2013).

Starting from these considerations, this study aims to develop a spatial valuation method to support decision-making in forest recreation planning. To this end, the Travel Cost Method (TCM) was used to estimate the value of outdoor recreation, while a mapping procedure was developed and implemented to distribute the estimated value over a study area (Cansiglio Orientale forest, northern Italy). The study was implemented within the project LIFE SPAN - Saproxylic Habitat Network (LIFE19 NAT/IT/000104), which aims to develop and test management solutions within protected areas and productive forests in order to ensure the preservation of forest biodiversity.

Materials and Methods

Study area

The study area is the Cansiglio Orientale forest (46 067° N, 12 405° E) located in the Friuli Venezia Giulia region, north-east Italy (Figure 1). The Cansiglio Orientale forest (henceforth COF) covers over 1,500 ha in three municipalities: Caneva, Polcenigo and Budoia. The ownership of the COF belongs to the Autonomous Region of Friuli Venezia Giulia since 1966. The COF is located in the Carnic Prealps, at an altitude between 1,118 m (Crosetta pass) and 1,694 m (Croseraz mountain). The main land uses are forests with approximately 98% of the total land area – European Beech-Silver Fir-Norway

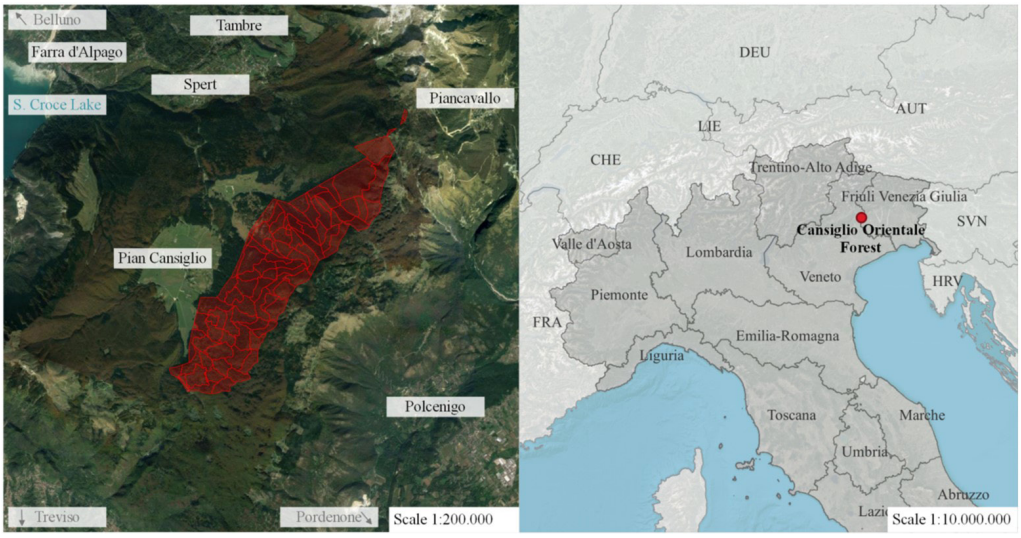

Figure 1 Location of the study area (Cansiglio Orientale forest) in Friuli Venezia-Giulia region, Italy.

spruce mixed forest (37% of forest area), European beech-dominated forest (29%), and Norway spruce-dominated forest (15%) – and grasslands (meadows and pastures) with 1.4%. The remaining forest types are European beech-silver fir forests under natural evolution (18%) and protection forests of the *Cystopteris sudetica* A.Braun & Milde (1%). The COF is a production forest managed according to the principles of forest multifunctionality and the close-to-nature approach (Regione Friuli-Venezia Giulia 2022). On average, timber harvested and placed on the market annually amounts to approximately 3500 m^3. Furthermore, approximately 275 ha (17.7 % of the area) fall within an integral reserve aimed at the biodiversity conservation.

The average annual temperature is 5.1°C and the number of rainy days per year is about 100. The hottest month is July, with an average temperature of 14.5°C, while the coldest is January, with an average temperature of -4.5°C. The highest rainfall is in November, with an average of 230 mm, while December and January are the months with the lowest rainfall (average of 100 mm). The ground is covered with snow from November to mid-March, with an average annual snowfall of 60–150 cm.

Research framework

The research was structured in following three phases in order to assign a monetary value and map the outdoor recreation provided by forests: (i) survey design and administration to collect the preferences and behaviours of visitors to the study area; (ii) data processing to estimate the visitors' preferences and monetary value of the recreational value using the TCM procedure; (iii) mapping the monetary value of outdoor recreation based on the territory characteristics.

Phase 1 - Survey design and administration

In the first step of the study, a semi-structured questionnaire was developed by the research team and pre-tested with four visitors of the study area (October 2022 - January 2023) in order to verify its clarity and identify possible difficulties. After the pre-test phase, two questions were simplified because they were considered too complex, while one question was eliminated because it was not considered consistent with the objectives of the study.

The final version of questionnaire was organized into two thematic sections. The first thematic section investigated the recreational activities in the COF. Nine closed-ended questions made up this section focused on: number of past visits to the study site (in the last year and in the last three years); expenses incurred on the current visit (travel, meals, accommodation, equipment, guided tours, purchase of food and wine products or local crafts); reasons for the current visit to the study site (hiking/trekking, sport activities, relaxing into the nature, NWFP collection, wildlife watching, education visit, and work). Reasons for visiting the study site were collected using a 5-point Likert scale format (from 1=not at all important to 5=very important). The second thematic section focused on personal and socio-demographic characteristics of respondents such as: gender; age; level of education (elementary school degree, technical or middle school degree, high school degree, university or post-university degree); membership to environmental associations; forest visit frequency (every day, at least once per week, at least once per month, at least once per year, almost never); and annual income. Subsequently, the collected data were processed to produce the main descriptive statistics related to the analysed sample and to implement the methods identified for estimating the economic value of the recreational opportunities offered by the COF.

The questionnaire was administered face-to-face between June and September 2023. To this end, three sampling points were identified located near the botanical garden (i.e., Giardino Botanico Alpino "Giangio Lorenzoni"), a car parking (i.e., Crosetta parking), and a tourist-accommodation activity located in the Pian del Cansiglio. The criteria used to choose the sampling points were the accessibility and attendance by visitors. The visitors have been

systematically selected by involving in the survey one visitor for every two that arrived in each sampling point in accordance with the procedure proposed by Paletto et al. (2017). Two interviewers were alternatively involved in the questionnaire administration during the sampling period.

Phase 2 - Estimation of the monetary value of outdoor recreation

The data collected with the questionnaire were statistical processed to produce the main descriptive statistics such as frequency distribution for the socio-demographic characteristics of the respondents and mean and standard deviation (SD) for reasons for visiting the COF collected using the 5-point Likert scale. For the reasons for visiting, the Chi-square (χ^2) test was used to highlight statistically significant differences in the importance assigned to the various reasons by the respondents.

The data concerning the number of past visits and expenses incurred on the current visit was used to estimate the monetary value of the recreational service offered by the COF using the Travel Cost Method (TCM). In literature, there are two approaches to develop the TCM (Süer & Sadik 2020): Individual and Zonal Travel Cost models. In this study, the Zonal Travel Cost Method (ZTCM) was adopted as the site is visited mainly by visitors from neighbouring regions and infrequently by visitors from other areas. Furthermore, the ZTCM is the best solution when there are not many repeated visits to the site by sample of visitors (Tobias & Mendelsohn 1991, Fleming & Cook 2008), as in the case of this study (average number of visits of the sample= four). To estimate the recreational values of the COF the following steps have been conducted:

Step 1: Estimation the total annual number of visitors to the study site;

Step 2: Identification of the zonas of origin of visitors estimated through distance travelled from place of origin and study area;

Step 3: Calculation of annual visitor frequency for each zone;

Step 4: Estimation of the demand curve and the resulting consumer surplus.

In the first step, the total number of visitors was estimated based on the visitor count during the days of questionnaire administration. This data has been integrated with the information provided by local tour operators regarding tourists who have stayed on site. A total number of 900,000 daily visitors per year was estimated, representing over 99% of the users of the area, to which must be added a 1% of tourists, who spend at least one night in local facilities. An annual visitor frequency of 901,000 was estimated overall.

During the second step, the zones of origin of the visitors have been identified considering the distance travelled from the visitors' place of origin to the COF. The zones have been identified using administrative boundaries as proposed by Torres-Ortega et al. (2018). Then, for each zones the number of inhabitants and the number of visitors to the COF included in the sample were calculated.

In the third step, the percentage of visitors sampled in the different zonas (60.4% per zone 1, 31.5% per zone 2 and 8.1% per zone 3) was multiplied by the annual frequency of visit to the study site (901,000). In this way, the annual frequency of visitors by zone was obtained, from which to derive the visitation rate (annual frequency per zone per 1,000 inhabitants). After that, the average travel cost per zone has been calculated. The values of the different zones of the visitation rate (dependent variable of the TCM) and the average travel costs (independent variable).

In the fourth step, the demand curve was derived through a statistical regression aimed to determine the function that best interpolated the points obtained by placing the average travel costs per area on the x-axis and the rates of visit per zone on the y-axis (Figure 2a). The exponential function that best fitted to the sample data is illustrated by Equation 1:

$$y=3512.9e^{-0.072x} \qquad R^2=0.9214 \qquad \text{Equation 1}$$

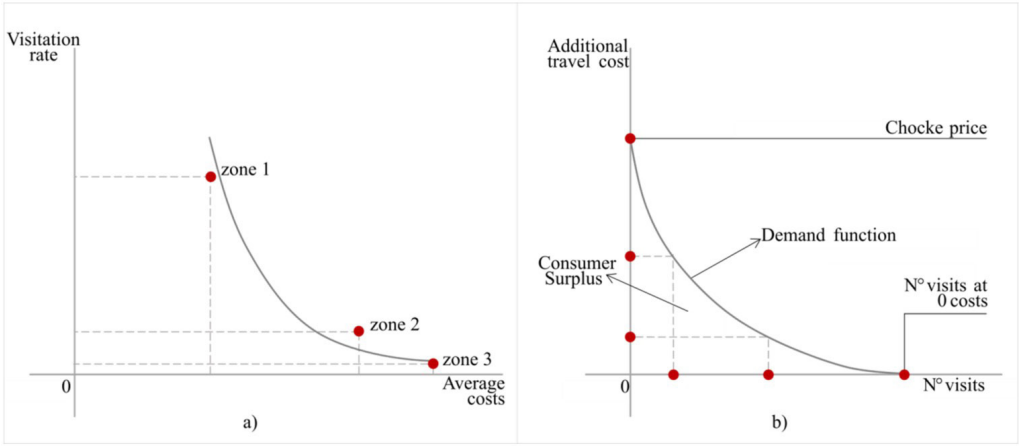

Figure 2 (a) Relationship between average costs and visitation rates per zones; (b) demand curve.

The demand curve obtained from the exponential function has on the x-axis the hypothetical increase of the frequency of visit and on the y-axis the hypothetical increase of the costs incurred by the visitors (Figure 2b). Through the demand curve it was possible to identify the lowest price at which the visit demand is zero (i.e., the choke price), or in other words the cost for which no visitor is willing to pay.

The last step, the Consumer Surplus (CS) – the measure of perceived utility in monetary terms for recreational activity in the study site – was estimated considering the measure of the area covered by the demand curve.

The software Microsoft® Excel® 2010 (version 14.0) was used for processing the ZTCM data.

Phase 3 Mapping the monetary value of outdoor recreation

In the last phase of the study, the monetary value of outdoor recreation in the COF was spatially distributed considering the characteristics and peculiarities of the territory. To this end, the mapping procedure was developed in the following steps:

Step 1: Identification of biophysical sub-indicators (characteristics of the territory) that influence the outdoor recreational value of a forest;

Step 2: Distribution of the biophysical value of outdoor recreation based on sub-indicators;

Step 3: Aggregation of the six sub-indicators to produce a recreational attractiveness global indicator;

Step 4: Creation of the map of monetary value of outdoor recreation.

In the first step, six sub-indicators of the biophysical characteristics of the forests that influence the outdoor recreation have been identified: accommodation facilities, points of natural and cultural interest, paths and roads, grasslands, watercourses, forests. The accommodation facilities and points of natural and cultural interest of the site were mapped considering as attractive elements a buffer of 1 km to consider the reinforced attractiveness of the site (Laws 1995; Lee et al. 2010). Within the buffer zone, the attractiveness surrounding accommodation facilities and points of interest were distributed according to the fuzzy function represented in Figure 3a. The presence of roads and paths was considered as a positive element for the recreational attractiveness of the site as emphasized in literature (De Meo et al. 2015; Laws 1995). The roads and paths network was mapped considering a threshold of 10 m of buffer. This dimension was valued approximately valid as during the survey it was detected that the vast majority of visitors tend not to move away from the paths unless a few steps. The fuzzy function presented in Figure 3b was used to allocate the attractive value of the roads and paths network.

The sub-indicators grasslands, watercourses and forests were mapped using the current Forest Management Plan 2022-2036 (Proprietà Forestale Regionale del Cansiglio Orientale

2022) of the COF. The grasslands (meadows and pastures) are considered a positive element of recreational attractiveness as highlighted by Garrido et al. (2017) and Gołos (2013). The recreational attractiveness of the forests was distinguished between pure conifer, pure broadleaved, and mixed forests. Recreational attractiveness is maximum for mixed forests and minimum for pure conifer forests as emphasized by some studies (Termansen et al. 2013, Grilli et al. 2014). Finally, water elements (e.g., lakes, rivers, wetlands) are considered elements that contribute positively to the recreational attractiveness (Abildtrup et al. 2013, Pastorella et al. 2017, Rzetala 2016). In this study, a threshold of 20 m of buffer was considered as the maximum distance at which to visually appreciate a water element (Figure 3c).

In the second step, a biophysical map for the distribution of recreational value was realized according to the procedure illustrates in Figure 4. The procedure was developed through a raster analysis implemented with the IDRISI Selva 17.0 software (trial version).

During the third step, the six sub-indicators – accommodation facilities, points of interest, paths and roads, grasslands, watercourses, forests – was aggregated in a single indicator of recreational attractiveness using the Analytic

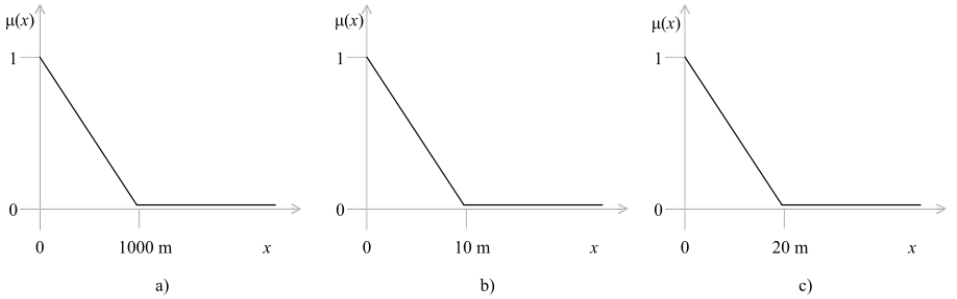

Figure 3 Membership functions for accommodation facilities and points of interest (a), paths and roads (b), and watercourses (c) as positive elements for recreation, where x represents the distance in linear metres (m).

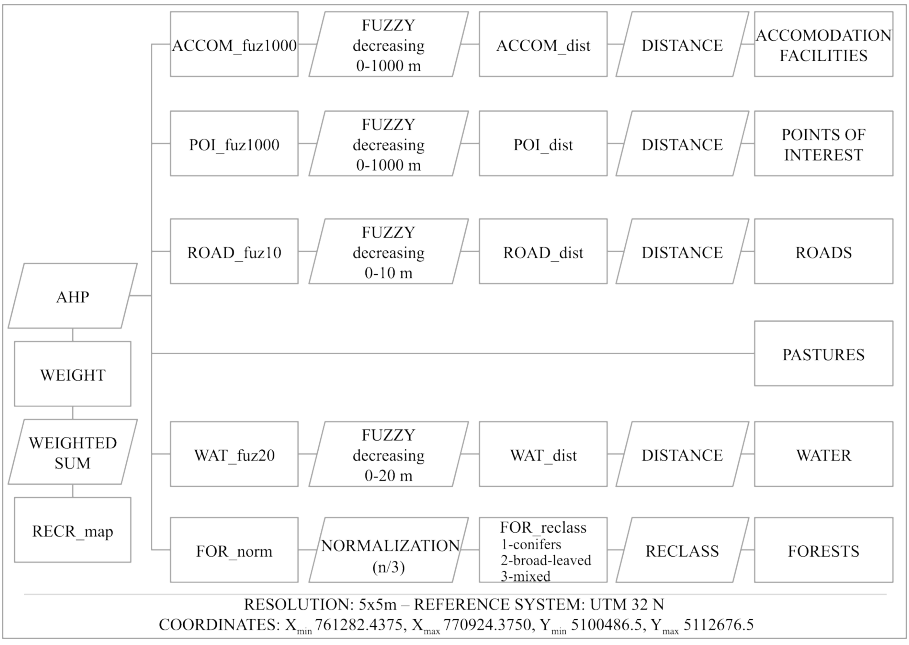

Figure 4 Flowchart of the mapping model for the recreational value provided by the COF.

Hierarchy Process (AHP) approach (Kordi & Brandt 2012). This approach has been used in the past in other studies in order to map the recreational value (Lee et al. 2010, Caglayan et al. 2020, Asilioglu & Cay 2023). In this study, during a focus group panel of forestry experts compared the importance of the sub-indicators in pairs followed by a calculation of the priority value of each sub-indicator using the eigenvalue method. The sub-indicators were compared in pairs by forestry experts according to the following scheme:

Sub-indicator A	5	3	1	1/3	1/5	Sub-indicator B

The outcomes of the pairwise comparison are represented in a reciprocal matrix where the relative weight is expressed by a_{ij} located at the right side of the diagonal and its reciprocal as $1/a_{ij}$ is located in the opposite side of the diagonal.

$$A = (a_{ij}) = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix}$$

In the matrix, the row indicates the relative weight of each sub-indicator compared to the others. When i=j, then $a_{ij}=1$. Next, the transpose of the vector of the weights w is multiplied by matrix A to obtain the vector represented by $\lambda_{max}w$, that follows the principle:

$$(A - \lambda_{max}I)w = 0 \qquad \text{Equation 2}$$

where λ_{max} is largest Eigenvalue of matrix A and I is the identity matrix of size n. The value of λ_{max} is always positive, equal or higher than n (number of rows or columns in the matrix). The consistency of the respondents information depends on how much the value of λ_{max} deviates from the value of n. In cases where λ_{max} equals n, the responses are perfectly consistent (Saaty 1990).

Subsequently, a weighted sum was adopted to aggregate the six sub-indicators through the following Equation 3:

$$Accommodation\ x\ W_{acc} + POI\ x\ W_{poi} + Roads\ x\ W_{roa} + Grasslands\ x\ W_{gra} + Water\ x\ W_{wat} + Forests\ x\ W_{for} \qquad \text{Equation 3}$$

where:

W_{acc} is the weight for the sub-indicator of accommodation facilities;

W_{poi} is the weight for the sub-indicator of points of interests;

W_{roa} is the weight for the sub-indicator of roads;

W_{gra} is the weight for the sub-indicator of grasslands;

W_{wat} is the weight for the sub-indicator of watercourses;

W_{for} is the weight for the sub-indicator of forests.

In the last step, once the biophysical map of the recreational attractiveness of COF has been obtained, the total economic value for the area was spatialized by the following monetary value of outdoor recreation (I_{MR}):

$$I_{MR} = \frac{i_R \cdot WTP_R}{\sum i_R} \qquad \text{Equation 4}$$

where:

i_R is the recreational value of the i-th pixel,

WTP_R is the estimated annual total CS for the study area.

Finally, the total annual CS has been spatialized considering the biophysical characteristics of the study area in order to produce the map of the outdoor recreation value.

Results

Socio-demographic characteristics of respondents

At the end of data collection step, 118 respondents completed the questionnaire. The average non-response rate was 72%. The number of visitors counted during the survey days were used to understand tourist flows in the study area.

The sample of respondents consisted of 58.1% of males and 41.9% of females with a majority of respondents aged between 51 and 60 years old (24.6%). Regarding the income of the respondents, the results showed that 51.9% have an individual income of between 15,000 and 30,000 € per year, followed by those with less than 15,000 € per year (19.4%).

About the level of education of respondents, the results highlighted that the majority of respondents have a high school degree (54.2%), followed by those who have a bachelor's or post-graduate degree (30.5%).

Table 1 Socio-demographic characteristics of the sample of respondents (n=118).

Characteristic	Frequency distribution (%)
Gender	
Male	58.1
Female	41.9
Age	
18-20 years old	0.8
21-30 years old	22.9
31-40 years old	19.5
41-50 years old	11.9
51-60 years old	24.6
61-70 years old	16.9
More than 70 years old	3.4
Level of education	
Elementary school degree	2.5
Technical school degree	12.7
High school degree	54.2
University or post-university degree	30.5
Income	
No income	9.3
Less than 15,000 €	19.4
15,001-30,000 €	51.9
30,001-45,000 €	13.0
More than 45,000 €	6.5
Membership in an environmental association	
Yes	8.6
No	91.4

Finally, the results showed that 91.4% of respondents are not members of environmental associations, while the remaining 8.6% are members.

The socio-demographic characteristics of respondents are summarized in Table 1.

Visitors' attitudes and behaviours

The results showed that most of the respondents visit the forest once a year (36.2%), followed by once a month (35.3%) and once a week (19.8%). Only 3.4% of the respondents said they visit forests almost every day, while the remaining 5.2% said they almost never visit forests.

In particular, 15.9% of the respondents was the first visit to the COF since the last 12 months, while 50.4% of respondents had already visited the area between one and four times in the last 12 months.

Regarding the current visit, 83.1% of respondents used the car to reach the COF, while no one used public transport to reach the site. Regarding the visiting time, 39.3% of respondents took less than one hour to reach the COF from their place of residence, while 47.0% took between one and two hours. In addition, 63.1% of visitors had lunch in a restaurant on the day of the interview while 36.9% had a packed lunch and the remaining 5.4% at home. About the accommodation of tourists, the results highlighted that only 26.0% spent at least one night in a hotel or B&B.

Observing the results about the visit reasons, the results showed that the most important reasons to visit the COF are: relaxing into the nature with, an average value of 4.42 (SD=0.85) in a 5-point Likert scale; followed by hiking/trekking (3.51±1.34); wildlife watching (2.87±1.60); sport activities (2.16±1.31); and education visit (2.11±1.68). Conversely, the two least important reasons are: NWFP collection (1.43±1.04) and work (1.56±1.31). The results of χ^2 test showed statistically significant differences between the various reasons (Observed value: 255.508; Critical Value: 42.980; Degree of freedom: 24; $p<0.0001$). The reasons to visit the COF by socio-demographic characteristics of the respondents are shown in the Table 2.

Table 2 Reasons to visit the Cansiglio Orientale Forest by socio-demographic characteristics of respondents (mean±SD in a 5-point Likert scale, n=118).

	Hiking	Sports	Relax into nature	NWFP collection	Bird watching	Education visit	Work
Gender							
Female	3.85±1.48	1.57±1.06	4.52±0.96	1.52±1.18	3.14±1.55	1.57±1.22	2.14±1.79
Male	3.55±1.40	2.56±1.57	4.33±0.87	1.24±0.72	3.00±1.65	2.53±1.81	2.03±1.71
Age							
Less than 31 years old	3.27±1.42	2.05±1.49	4.04±1.07	1.50±1.12	2.70±1.58	2.77±1.90	2.61±1.92
31-40 years old	3.82±1.33	1.94±1.39	4.18±1.10	1.00±0.00	3.33±1.50	1.73±1.16	1.87±1.64
41-50 years old	3.82±1.33	1.50±0.84	4.90±0.32	1.86±1.57	2.71±1.70	1.33±0.52	1.33±0.52
51-60 years old	3.95±1.31	2.33±1.41	4.56±0.80	1.43±0.86	2.71±1.69	1.08±0.46	2.00±1.82
More than 60 years old	3.56±1.73	3.00±2.10	4.63±0.65	1.00±0.55	4.18±1.40	3.75±2.43	1.00±0.55
Level of education							
Elementary or middle school diploma	3.50±1.24	2.40±1.67	4.78±0.55	1.20±0.63	3.20±1.81	2.50±2.00	1.00±0.50
High school diploma	3.50±1.48	2.06±1.46	4.31±0.91	1.41±1.11	2.71±1.59	2.33±1.85	1.72±1.50
University/post university diploma	3.97±1.40	2.10±1.43	4.38±1.02	1.36±0.85	3.42±1.48	1.78±1.24	2.59±1.91
Membership in an environmental association							
Yes	3.43±1.27	4.00±1.73	4.17±1.17	1.33±0.82	3.00±1.58	3.40±2.14	2.67±2.16
No	3.71±1.45	1.95±1.32	4.44±0.99	1.38±0.98	3.10±1.61	1.95±1.53	2.05±1.73
Income							
No income	3.67±1.03	2.17±1.60	4.29±0.76	1.50±1.22	3.00±1.41	3.13±1.89	3.00±2.19
Less than 15,000 €	3.00±1.66	1.45±0.98	4.18±1.24	1.58±1.27	2.67±1.54	2.83±2.02	2.50±1.93
15,000-29,999 €	3.76±1.20	1.94±1.28	4.46±0.85	1.24±0.80	3.18±1.67	1.66±1.27	1.88±1.60
30,000-44,999 €	4.08±1.44	3.00±1.93	4.83±0.39	1.50±0.95	3.14±1.21	1.80±1.38	1.20±0.63
More than 44,999 €	3.40±2.07	3.75±1.87	4.60±0.89	2.00±1.41	3.20±2.07	1.50±0.96	3.00±2.38

Costs incurred for the visit

Costs incurred by visitors for the recreational activities at the COF have been divided into the following categories: transportation, accommodation, meals, rental equipment, guided tours, purchase of local food and wine products or local crafts. With regard to the travel-related costs (fuel and motorway toll costs), the amounts referred to the round trip from the place of origin. Table 3 shows the zones of origin of the visitors with their respective characteristics, while Table 4 highlights the average costs incurred by respondents in the different categories taken into consideration.

The results showed that the type of expenditure incurred mainly after transport costs is represented by the meals with an average value of about 18.6 € per person, followed by the purchase of local food and wine products with an average value of 18.2 €.

Considering the ZTCM and the statistical regression function, an annual CS of 13,961,789.11 € was estimated, which corresponds to an individual value of 15.36 € per visit. Multiplying the value thus obtained by the average annual frequency of visit to the COF (i.e., four visits per year) recorded by the sample, an individual annual CS of 61.44 € and a total value of 55,847,156.45 € for the total number of visitors of the COF annually were estimated.

Table 3 Number of inhabitants, number of individuals sampled, visitation rates and average travel costs divided by area of origin of visitors.

Zones	Ter	N° inhabit.	N° visitors	% visitors	Visitation rates	Cost €
1	A	1,925,528	67	60.4%	284,980	31.7
2	B	5,180,233	35	31.5%	55,336	66.1
3	C	13,799,656	9	8.1%	5,341	83.8

Note: Ter: territories: A - Belluno and Treviso provinces in the Veneto region; Pordenone province in the Friuli-Venezia-Giulia region; the Autonomous Province of Trento; B - the provinces of the Veneto and Friuli-Venezia-Giulia regions not included in zone 1; the Autonomous Province of Bolzano; C: Emilia Romagna, Piedmont, Tuscany and Marche regions; Cost: Average travel costs.

Table 4 Average costs (€) incurred by respondents divided in categories.

Type of expense	Mean	SD	Min	Max	N° respondents
Transportation	31.5	32.8	0.0	194.7	114
Accommodation	36.0	30.8	0.0	125.0	38
Meals	18.6	11.1	0.0	60.0	88
Rental equipment	30.1	15.6	6.0	50.0	7
Guided tours	16.5	7.0	6.0	20.0	4
Purchase of local food and wine products	18.2	15.6	5.0	100.0	45
Purchase of local crafts	20.0	0.0	20.0	20.0	2

Mapping of the monetary value of outdoor recreation

First of all, the map of the six sub-indicators were created. Then, the AHP allowed obtaining the weights of the sub-indicators, as shown in Table 5, to be used in the Equation 3.

The Figure 5a shows the map of the distribution of the estimated monetary value for outdoor recreational in the COF. Five classes have been defined as reported in the legend of the Figure 5. The first class, which represents values below 2.0 €/m^2, covers about 42.6% of the study area (666 ha). The second (2.0-4.0 €/m^2) and the third class (4.0-6.0 €/m^2) represent a still relevant percentage of the examined territory, respectively 23.3% (365 ha) and 16.4% (256 ha). The fourth class (6.0-8.0 €/m^2) is a slightly lower area (7.4%, 115 ha) compared to the fifth and last class (>8.0 €/m^2) that covers approximately 10.4% of the territory (162 ha). In this case, the difference between the three forest types and the presence of grasslands and water elements does not particularly affect the distribution of monetary value. Elements of greater influence are accommodation facilities, points of interest, and paths and roads network, as shown graphically by the map. Analysing the map in Figure 5b, it is possible to localize: the areas of maximum value (15.8 €/m^2) in correspondence of the practicability in the immediate vicinity of an accommodation facilities; while areas of minimum value (0.4 €/m^2) are located in the most distant places to accommodation facilities, points of interest, paths and roads.

Table 5 Weights assigned to the recreational sub-indicators for the COF.

Sub-indicator	W_i	Weight
Accommodation facilities	W_{acc}	0.4128
Point of interests	W_{poi}	0.2821
Paths and Roads	W_{roa}	0.1577
Grasslands	W_{gra}	0.0810
Waters	W_{wat}	0.0424
Forests	W_{for}	0.0240

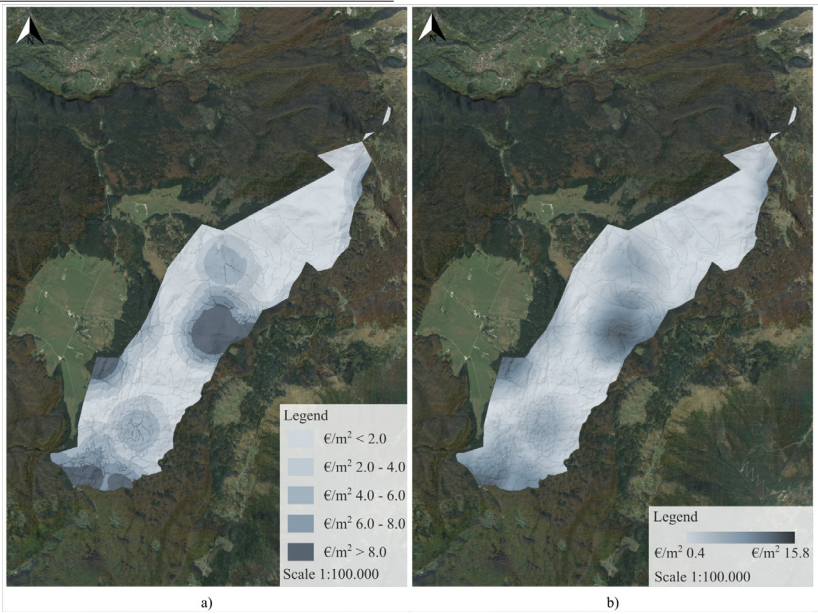

Figure 5 Mapping of the monetary value of outdoor recreation in the COF in classes (a) and on continuous scale (b).

Discussion

The main objective of this study was to define a procedure to estimate and map monetary value of the outdoor recreation based on the biophysical characteristics of the territory.

The non-response rate of visitors to the study site (72%) was higher than the values reported in current literature. In fact, the non-response rate was estimated between 10% and 30% in other studies conducted in Italy using a face-to-face administration (Notaro & Dallapiccola 2000, Gios & Notaro 2001, Pastorella et al. 2016). Our high non-response rate is probably due to the choice of sampling points that were not suitable for retaining people to complete the questionnaire.

Regarding the main reasons to visit forests, our results showed that hiking and trekking, followed wildlife watching and sport activities. In literature, Paletto et al. (2018) highlighted that relax followed by hiking are the two main reasons to visit the forests, while the collection of NWFP can be considered quite negligible in a case study in Central Italy (Monte Morello forest). In another study, Pastorella et al. (2016) found that for the forest visitors of Trentino-Alto-Adige (northern Italy) the main reasons declared by the visitors are: relax into nature, sports and activity of nature contemplation. Other studies have shown that walking and hiking are the main reasons to encourage people to visit the forest in different European countries such as: Austria (Getzner & Meyerhoff 2020), Czech Republic (Šodková et al. 2020), and Spain (Romagosa et al. 2018). Conversely, Kloek et al. (2015) found that the main motivations for outdoor recreation by Dutch visitors is relaxing in nature, while Sergiacomi et al. (2024) found that for the visitors of the University Forest Sailershausen (Germany) the main reasons for visiting are educational visit, followed by wildlife watching and relaxing into the nature In another study conducted in Hungary, Ferencz-Havel et al. (2024) highlighted that the main reasons to visit the Börzsöny and Cserhát mountain forests are hiking and nature walks.

Some studies have shown the influence of the socio-demographic characteristics of the respondents on the motivations to visit the forests highlighting that females are more inclined towards contemplative activities (e.g., walking/hiking, relax into the nature) while males towards active ones (e.g., sport activities) (Kouchner et al. 2000). Furthermore, adult men are the most motivated visitor group to frequent forests for collecting wood and non-wood forest products, while young people to practice sports activities (Romagosa 2018, Šodková et al. 2020).

Regarding the economic evaluation of the outdoor recreation in forest, our values are in line with international literature. In the present study, an annual value of 61.43 € per person and of 15.36 € per person per visit were estimated in the COF. In a study conducted in Mallorca (Spain), Bujosa Bestard and Riera Font (2010) estimated an annual CS for forest recreation of 68.60 € per person. In Poland, Bartczak et al. (2012) estimated different seasonal values of CS for forest recreation from a minimum of 11.12 € in winter to a maximum of 48.64 € in fall. In another study, Ezebilo (2016) estimated a CS of 16 US$ (corresponding to 14.62 €) per trip per person for nature recreation in Sweden. For the Grunewald urban forest, an area of 3,000 ha located in the south-western part of Berlin, Bertram and Larondelle (2017) calculated a CS between 14.95 € and 20.66 € per visit per person. Particularly, for what concerns Italian case studies, Grilli et al. (2014) analysed the economic value of forest recreation in alpine valleys through the Benefit Transfer Method (BTM). The 18 studies that applied the TCM showed a mean CS of 14.13 € per visit. In three Italian forest areas, Paletto et al. (2023) conducted a survey to assess the recreational economic value of different forests. By using an individual TCM an individual CS between 7.33 € and 17.37 € per visit was valued.

About the spatial distribution of values, some studies focused on mapping outdoor recreation and ecotourism considering different attributes and variables. The first study available in the international literature that mapped ES values

examined recreational values for Welsh forests through the BTM (Bateman et al. 1995). A map of the potential recreation arrivals surface was elaborated. Bateman et al. (1995) used a direct survey with visitors, from which it turned out that travel time is the most influential factor. Similarly, Peña et al. (2015) implemented a questionnaire to derive the different values of scenic beauty, considered as an indicator for outdoor recreation supply and demand, to be attributed to a variety of landscape unit. Those authors used a GIS-based approach that takes into account both ecological and social factors to map the value of recreation in a varied landscape in the Basque Country (northern Spain). Alternatively, to the spatial distribution of recreational value based on visitors' opinions, Caglayan et al. (2020) involved a group of experts and used the AHP approach for mapping the recreational value of the Belgrade Forest in Istanbul, Türkiye. For what concerns the biophysical site characteristics, Nahuelhual et al. (2013) mapped recreation and ecotourism in a case study in Chile (Ancud municipality) considering the following attributes: singular natural resources, scenic beauty, accessibility, tourism attraction capacity, and tourism use aptitude. In a case study in Austria, Paletto et al. (2015) mapped the monetary value of some ecosystem services provided by forests and grasslands of the Leiblachtal area in Vorarlberg region, including recreational activities. Those authors highlighted the highest recreational attractiveness and monetary value of open areas and mixed conifer-broadleaved forests compared to other land uses, as also shown by the present study.

In summary, it can be stated that the mapping of monetary values can follow different approaches based on the objectives and the final use of the results. In this study, a mixed approach between top-down and bottom-up was adopted. The monetary value of the recreation of the COF was estimated through the costs incurred by visitors using the TCM (bottom-up approach based on visitors' statements), while the attributes and variables for the spatialization of monetary values followed a top-down approach based on experts' opinions.

Conclusions

The economic valuation and mapping of outdoor recreation provided by forests is a useful tool to support the decision-making process of forest management and planning. Spatialization of monetary value based on biophysical characteristics of the forest site can highlight priority areas for outdoor recreation. Furthermore, the results obtained can be used by policy makers and managers in order to consciously target investments for their all-round improvement. On the one hand, the expeditious methodology adopted has allowed containing a lot of time and resources invested for sampling. On the other hand, the estimation produced represents only a small part of the total economic value deriving from the ES offered at local level. In particular, the results of this study can be used by local decision makers in order to plan recreational enhancement interventions in areas currently with a low tourist attendance. In doing so, the advantages are on the one side to decongest the most tourist forest areas and on other side to incentivise areas that are environmentally valuable but currently not frequented by visitors. In addition, mapping the value of outdoor recreation compared to the value map of other ES can highlight trade-offs and synergies between them. In this way, decision makers can assign priority and secondary ES to different zones in a multifunctional forest plan.

From a methodological point of view, the main strength of the study is to provide data that can be used by decision makers (forest planners and managers) to prioritize interventions to enhance the outdoor recreation in the area. A second advantage of the adopted approach is that it provides a procedure for spatializing the value of outdoor recreation based on the characteristics and peculiarities of the territory. Conversely, the main weakness is the low number of sampled visitors due to the high non-response rate to complete the questionnaire. However, the sampling limitation does not

undermine the validity of the findings since the target of visitors to the COF was found to be rather homogeneous both in terms of socio-demographic characteristics and attitudes towards forest visits. The high homogeneity of the target of visitors made this sampling limitation negligible to achieve our objective.

Future studies will be undertaken on other types of ES and with the most suitable economic and mapping methods, to evaluate the best estimation strategy for each ecosystem service investigated.

Conflict of interest

The authors declare no financial or personal interests could influence the work presented in this paper.

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