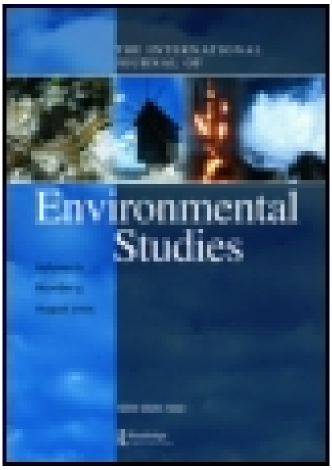

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The shared knowledge behind payment for rural ecosystem services: a case study

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The shared knowledge behind payment for rural ecosystem services: a case study

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This paper investigates the shared knowledge held by a rural population of the ecosystem services supplied by rural landscapes and woods in the Rome Province of Italy. It is part of a wider research initiative conducted to estimate the non-use values of the same ecosystem services elicited through the contingent valuation method. Our findings demonstrate that: (i) most of the information on ecosystem services comes from a deep-seated community shared knowledge; (ii) some gaps exist between official (scientific/normative) and shared knowledge in the study site; and (iii) stated economic preferences are driven by both consequential motivations, as predicted by the standard economic model, as well as some others. Making explicit the motivational framework behind environmental economic estimates allows one to represent the socio-cultural legacy indispensable for providing a monetary value useful to inform public decision and policies. The use of this approach could contribute to the development of payment for ecosystem services schemes in rural policies affecting common goods.

Keywords: Rural landscape; Woods; Willingness to pay

Introduction

Semi-natural landscapes offer more goods and services than primary production, but these benefits are hardly used in planning and policy-making [1–3]. Monetary estimation of common and/or public goods supplied by ecosystems can simplify negotiation and then decision processes for public purpose, once it is clear that the aims are not to reduce nature to money [4,5].

There is growing evidence that ecosystem services, especially those without a direct market price, can diminish because of the depletion of the ecological functions which support them, and that there is a significant risk that they will collapse if pushed beyond certain thresholds.

For this reason, there has been an effort in the last decade to assess the importance and value of ecosystem services. The production of literature and dedicated journals on these topics has been impressive and it has influence on policy-making [6–8]. This research falls under the broader research initiative of a public body, the Province of Rome, Italy. The territory, which is the focus of the project, was established in the local government planning and policy framework. The aim of the project was not to address the importance of the ecosystem services provided by this territory, but rather to estimate both the market and non-market components of the total economic value of the rural landscape and woods as

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mapped and classified in national and/or local planning documentation [9,10]. We carried out similar research in the same province on what is left of the wetlands, which, compared to woods and rural landscapes, no longer have a direct economic role [11].

Following the definition of Turner *et al.* [12], the total economic value can be defined as the total amount of resources that citizens would be willing to forego to maintain or increase the amount of ecosystem services, in this case those supplied by the County rural landscape and woods listed in table 1. The non-market component of the total economic value, e.g. the value of the ecosystems without a direct market price was estimated by means of the contingent valuation of the willingness to pay for ecosystem services in a credible proposed market [13,14]. This valuation effort underpinned a bottom-up governance policy fostering:

- The use of ecosystem services values in negotiation or transaction processes among private and/or public actors (e.g. local activation of payments for ecosystem services, environmental damage definition and restoration, land use change decisions, policy – e.g. rural development – or land planning investments).
- A better governance of natural resource (effectiveness: comparison of values and investment for ecosystem services management; efficiency: comparison of values and rate of overlapping investment for ecosystem services of different bodies/actors; policies/planning: reconsidering the non-market goods' role in decision-making coherently with the social awareness of tax payers).

This makes publicly available by a body of public interest (in an open access and transparent way and on a mapped basis) benchmark values of the market (through official commodities' statistics) and non-market components of the ecosystem services listed in table 1, related to mapped ecosystems [15].

The present paper focuses only on the role of the citizens' shared knowledge [16,17] about the ecological functions and benefits of the rural landscape and woods in the willingness to pay for them. The communities' shared or cultural [18] ecological knowledge is based on the social memory (i.e. the body of knowledge and beliefs shared in the community by cultural transmission [17]), built on the trial and error selection of information about natural resource management, mainly linked to the registration of their harmfulness and utility. This concept is more and more used in natural resource research and programs [19–21].

We studied this specific aspect in detail because: (1) we believe that the policy use of monetary estimates of public/common goods is suitable as long as it accounts for the cultural capital which generates them; (2) the shared knowledge depicts this cultural capital; and (3) the shared knowledge capital should support the communities' willingness to pay for ecosystem services, assuming that individual preferences should be motivated by the individual information capital.

Therefore, the aims of this paper are: (i) to analyse the character of the shared knowledge which supports the willingness to pay for the ecosystem services listed in table 1; (ii) to compare the shared knowledge about the ecosystem services listed in table 1 with the corresponding official (scientific and/or normative) one; (iii) to analyse the relationship between the motivations delineated by the communities' shared knowledge and those assumed by the standard economic model; and (iv) to remark the implications of our findings on rural policies.

Table 1. The first two sections of the questionnaire used for the research. In the second section, the statements used in the survey and the level of agreement of respondents with scientific/normative knowledge[a] (see Material and Methods for details).

Section 1		
Woods		
This survey is part of a wider research project on the woods of Province of Roma, Lazio region		
Woods are larger than one hectare with a canopy cover higher than 10% and mature trees high five metres at least, which include forest lane or other little clearing, forest strips larger than 20 metres and forestry plantation		
Rural landscape		
This survey is part of a wider research project on the rural landscape of Province of Roma, Lazio region		
One of the typical Roma rural landscape is that of mixed crops (more permanent crops than arable) grasslands, groves and old agricultural layout (embankments, terracings and dry masonry)		
Section 2		
Statements used in survey	**Respondent level of agreement**	***CICES descriptions of ecosystem services*[a]**
Woods		
(1) Woods are important to regulate water circulation and water reservoirs recharging	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Provisioning–regulating and maintenance services: water reserve*
(2) Woods contribute to control green house gas based on C (like Co_2) and climate change sequestering organic matter (that is plant, animal, litter and sediments)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and maintenance services: climate change control*
(3) Woods contribute to reduce environmental risks protecting mountain slopes from landslides, erosion and hydro-geological instability, and improving soils fertility	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and maintenance services: hydro-geologic risk control*
(4) Woods contribute reducing water and air pollution	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and maintenance services: pollution control*
(5) Woods contribute to biodiversity offering a habitat to several plants and animals (insects, birds, mammals and reptilians)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Provisioning–regulating and maintenance services: habitat–biodiversity*

(*Continued*)

Table 1. (*Continued*).

(6) Woods have a recreational function (tourism, visits, wildlife watching and game)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Cultural services: recreation–culture*
<u>Rural Landscape</u>		
(1) The observed rural landscape contribute to regulate water circulation	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and Maintenance services: hydraulic management*
(2) The observed rural landscape contribute to control green house gas based on C (like Co2) and climate change sequestering organic matter (that is plant, animal, litter and sediments)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and maintenance services: climate change control*
(3) The observed rural landscape contributes to reduce environmental risks protecting slopes from landslides, erosion and hydro-geological instability, and improving soils fertility	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Regulating and maintenance services: hydro-geologic and fertility risk control*
(4) The observed rural landscape contribute to biodiversity offering a habitat to several plants and animals (insects, birds, mammals and reptilians)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Provisioning–regulating and maintenance services: habitat–biodiversity*
(5) The observed rural landscape has a recreational function (tourism, visits, wildlife watching and game)	Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement	*Cultural services: recreation–culture*

[a]The last column (in *italic*, not in the questionnaire) specifies the match between the statement the respondents were asked to judge for, and the CICES main group and specific category of the corresponding ecosystem service.

Materials and methods

Research area

The data reported here come from a survey made in Rome County (Italy), a territory centred on the capital area that occupies the final part of the Tiber Valley and characterized by a flat or hilly mountainous landscape. Independent surveys were performed for the (hilly) rural landscape and for the woods in the pre-test (161 overall respondents) and true test (1075 overall respondents), during the 2010 summer (July–September). The surveys did not consider single ecological functions of woods or rural landscape, but the overall ecological services as perceived by citizens.

Data collection: general design

To define the relations between the sample individuals' profiles and the communities' shared knowledge about the ecological functions of the rural landscapes and woods, we used some sections of the questionnaire designed to reduce the biasing factors of the contingent valuation method adopted for the economic estimate. In particular, we used the first two sections of the questionnaire, which were designed to provide a clear starting point and scenario acceptance for the willingness to pay questions and to allow each respondent to activate personal cognitive maps [22].

In the first section (table 1), we introduced the issue so as to reduce interviewee wariness and proposed a definition of woods and rural landscape. The original official classifications of mapped woods and rural landscapes [9,10] were carefully put in a complete yet popular form and the rural landscape definition was supplied with a set of four photographs to allow the respondents to identify the landscape types.

In the second section (table 1), we listed as separate statements, both for rural landscape and woods, the full set of ecosystems services/benefits as classified by official (scientific/normative) knowledge [1–3,23], excluding the direct use marketable ones (cf. below). Each statement corresponded to a main (provisioning, regulating or cultural) and specific ecosystem service category. Maes *et al.* [24] examine correspondence among MA, TEEB and CICES classifications.

In the third section, not considered in this paper, we used a close-ended format to simplify the answering process for the contingent valuation with an incentive compatible mechanism.

In the fourth section, we collected the demographic, socio-economic, cultural and spatial information of the respondents, which was expected to reveal how the shared knowledge sample is affected by the characteristics of the community, which is in turn expected to influence the nature of the stated preference [25–28]. We selected a minimum number of variables to balance simplicity, clarity, and admissible interview time and, considering the econometric approach used for the monetary estimates for the economic standard model theoretic expectations [22]. Data were grouped to be transformed in an ordinal scale and used as independent variables: **age** (17–30, 30–44, 45–64 and >64); **schooling** (none, lower school, junior high school, high school, Bachelor's degree, Master's degree and PhD); **employment** (Housewife–student–unemployed, workman, pensioner, white collar, manager, self-employed and professional); **income** (t €/year: 0–9, 10–19, 20–29, 30–39, 40–59 and >60); **respondents' family** (1, 2–4 and >4); **association belonging** (none, other, rural union, environmental and fishing–hunting); **sex**; respondents' **residence** (urban, urban fringe and rural); GIS based **distance** of the respondents' domicile from the nearest rural landscape and/or wood (0–19; 20–39; 40–79; 80–99 and >100).

Shared knowledge data collection: assumptions and limits

We adopted the concept of shared knowledge of Berkes *et al*. [17] and Davidson and Berkes [16] without using their measurement method, or other techniques (open and semi-structured interviews, stakeholder focus groups and workshops) implemented for other purposes, such as creating a participatory process for managing natural resources [29,30]. Instead, we estimate the level of shared knowledge of ecosystem services asking the respondent to indicate a level of agreement with the statements listed in (table 1). Thus, we had to face two problems: (1) the items (ecosystem services) to be included in the questions; and (2) the framing of the sentences.

In the first case, we did not search for all the potential ecosystem services perceived by the considered communities [31], but we used the full list of ecosystem services (excluding the directly marketable, cf. below) as outlined by the official/normative knowledge. In fact: (i) we had to compare shared knowledge with official/normative knowledge; and (ii) we had to analyse what motivated respondents' willingness to pay for the same functions/benefits, which supported the concrete policy effort related to the broader research mentioned in the premise [15]. Therefore, the possible bias caused by the (actually improbable) exclusion of some very significant service should not affect the meaning of the obtained results.

In the second case, all the statements were written in clear, simple language designed to be easily understood by all the population strata, and respondents were asked to score the statements on a Likert agreement scale (Total agreement; Agreement; Uncertainty; Disagreement; Total disagreement). We could not alter the statements written as negative or neutral assertions for the same reasons above, but we systematically asked all respondents a follow-up question for every statement in order to rule out complacency bias and simultaneously obtain information about motivation and beliefs. In this way, considering the pooled samples, with free riders filtered out [22], we verified that the complete disagreement scores (38 out of 1.075 respondents) were systematically maintained after the follow-up question, whereas the disagreement cases (32 out of 1.075 respondents) were largely followed up by statements indicating uncertainty ('but I'm not sure'; 'perhaps, but I don't know'; etc.). The 'true' disagreement cases were so irrelevant that we merged the disagreement class with the 'uncertainty' class, obtaining a four-point scale.

Shared knowledge and informed preference comparison: assumptions

To avoid double accounting in the estimate reported in the public map [15], we excluded statements regarding the direct use marketable goods provided by the rural landscapes and woods, entered on the Total Economic Value map as mean current market prices.

The economic standard utility model conjectures that individuals express their willingness to pay based on a well-informed preference. Therefore, having reduced the double accounting problem, we had to assume that: (i) the motivations underlying respondents' willingness to pay were to be found on the complete list of functions/benefits categories outlined; (ii) the level of agreement (or disagreement) inversely to the level of uncertainty expressed with a statement regarding a function/benefit reflects the level of information influencing the preference – the willingness to pay – for the said function/benefit.

Sampling

To maximize the homogeneity of the performance we chose a face-to-face interview procedure coupled with interviewers' training [32]. The questionnaires were tested by focus groups and interviewers were trained to reduce wariness of the interviewees (research neutrality). A pre-test was performed mainly in the railways stations between Rome and the selected rural/woodland villages to intercept the commuter flux. During the true test the random interviews were also fairly distributed in the centres of rural/woodland villages (shops, main streets and market place) and overall five segments of the day.

Statistical models

We used standard statistical modelling to get robust data which may be easily comparable with other environmental contexts studied by earlier authors. Friedman's ANOVA and the Kendall concordance coefficient were used to group the set of ecosystem services listed in table 1 by means of the simultaneous relatedness between the disagreement – agreement – uncertain judgments ranking.

The knowledge of ecosystem services shared by the members of each group is relatively similar. The relatedness of the degree of ecosystem services' knowledge is significantly different among groups

We used logit models to resolve complex interactions among predictors which may have been partially auto-correlated [33]. We selected on an ordinal scale predictors which were sufficiently non-auto-correlated ($r < 0.70$) and contrasted them with the dependent variable (expressed judgment by the interviewees) through a series of univariates' logit models, using backward logistic regression modelling, with a uni-band option and iterations terminated when $p < 0.001$ [34]. In the models, a maximum of 50 iterations were done and constant was always included. Multinomial models robustness was evaluated by F-value (α = 5%) and the second-order Akaike Information Criterion [35], which allows for ranking various competing models based on their relative likelihood and does not rely on any threshold value (alpha-level). The AIC selects a model according to the principle of simplicity and parsimony [36] reflected by the number of parameters, and models with lowest ΔAIC were chosen.

Analyses were done with STATISTICA (StatSoft release 10), SPSS [37] and R [38].

Results

The samples were representative of the considered populations (table 2) with a very slight bias in the expected categories [39, 40]: young people were over-represented when compared with older age classes (and in particular women); lowest and higher schooling categories were, respectively, under- and over-represented.

Both graphic analyses (figure 1) and Friedman's ANOVA (table 3) showed a similar and significant pattern regarding the shared knowledge of the ecosystem services stated of both

Table 2. Overview of the statistical representativeness of the samples. Values are expressed in percent values.

	Rome County (4,062,013 inhabitants)		Woods (536 respondents)		Rural landscape (539 respondents)	
Sex						
Male	48		49		50	
Female	52		51		51	
Age						
17–30	16		19		23	
30–44	29		29		33	
45–64	32		27		27	
>64	23		24		17	
Schooling						
No	4		2		0	
Elementary	17		12		9	
High	29		18		18	
Diploma	36		42		44	
Bachelor	2		8		11	
Master	12		18		16	
PhD			1		2	
Employment	♂	♀			♂	♀
Housewife/unemployed/student	6	22	6	22	7	14
Working class, retired	19	10	19	10	20	17
Director positions	18	15	18	15	15	17
Free lancers, working alone	7	3	7	3	9	7

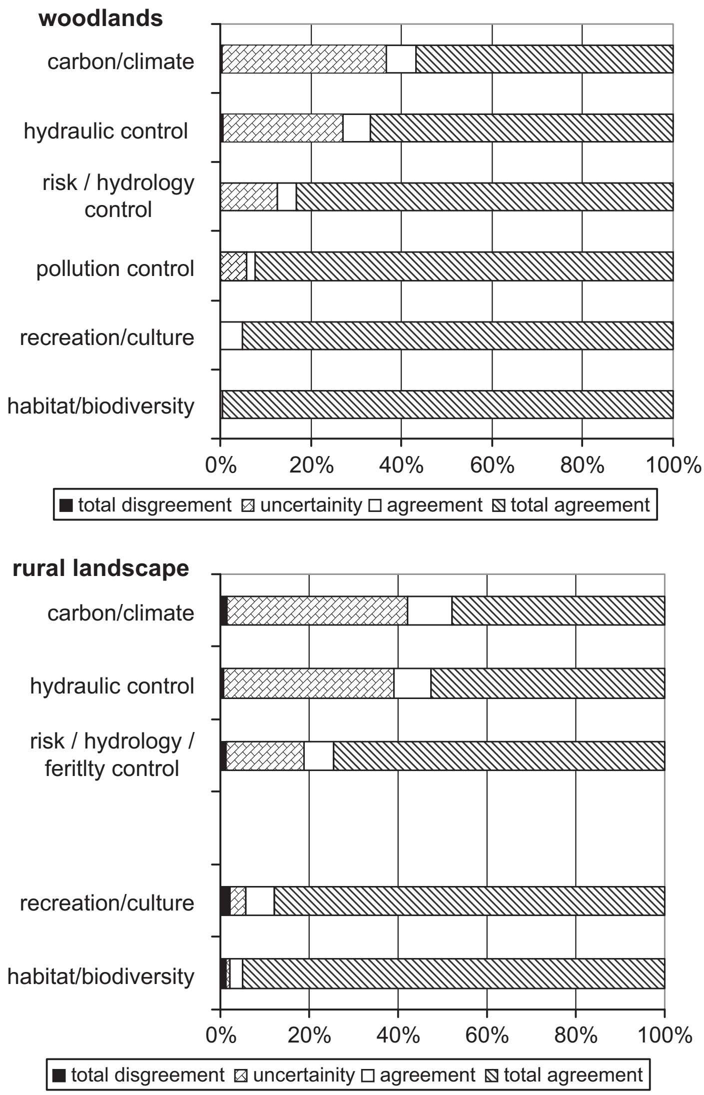

Figure 1. Percent distribution of the shared knowledge of the listed ecosystems services listed in table 1, expressed by a four point scale. For the scaling units see material and methods.

rural landscape and woods: (a) total disagreement was nearly negligible; in other words, almost all respondents agreed with the statement that rural landscapes and woods provide ecosystem services; (b) shared knowledge differed among the various ecosystem services; and (c) certain ecosystem services exhibited statistically similar rates of shared knowledge. The convention adopted in this paper is that the uncertainty about one of the ecosystem services listed in table 1 is inversely proportional to knowledge sharing. For example, if 20% of respondents reported that they are uncertain about the provision of an ecosystem service, while 80% reported agreement, the rate of shared knowledge is calculated as being 80%. As mentioned, different ecosystem services exhibited different rates of knowledge sharing.

Table 3. Significant difference in the shared knowledge of the ecosystems services listed in table 1. The knowledge sharing decreases from the ecosystem services of the group A to the group D (see Material and Methods for details).

Ecosystem services	Grouping of ecosystem services by level of shared knowledge			
Woods	A	B	C	D
Habitat–biodiversity	X			
Recreation–culture	X			
Pollution control	X			
Hydro-geologic risk control		X		
Water reserve			X	
Climate change control				X
Rural landscape	A	B	C	
Habitat–biodiversity	X			
Recreation–culture	X	X		
Hydro-geologic and fertility risk control		X		
Hydraulic management			X	
Climate control			X	

In the case of woods, habitat/biodiversity, recreational-cultural and pollution control showed nearly total (99%) knowledge sharing. Because the sharing is statistically significant, these services were grouped together (group A in table 3). Knowledge sharing decreased for ecological services related to the water cycle risk and reservoir. These services were assigned to two different groups (B and C in table 3) since they were statistically dissimilar. A high level of respondent uncertainty (63%), i.e. lower knowledge sharing, was registered for the role of woods as a CO2 sink in climate change control. This service formed yet a separate group (D column in table 3).

In the case of rural landscape, knowledge sharing was nearly total (96%) for habitat/biodiversity and recreational-cultural ecosystem services. These services were statistically similar and could be grouped together (group A in table 3). Hydro-geologic risk control had a lower rate of knowledge sharing (81%, B column in table 3). The hydraulic and climate change services group (C in table 3) showed higher shared uncertainty (61%). The high rate of uncertainty regarding water cycle functions of rural landscape was unexpected given that the importance of this function has been recognized since ancient times. Table 4 shows the results of the logit analysis where socio-economic and cultural characteristics of the community – defined by selected predictors – were used to explain the rate of sharing of the complex relationship between estimated shared knowledge – i.e. agreement with the stated functions which is inversely proportional to uncertainty regarding these functions – and the socio-economic and cultural characteristics of the community, defined by the selected predictors.

The agreement on the habitat/biodiversity services was so high even for woods or rural landscape that the scores' variability was insufficient to allow any model fitting. For the other ecosystem services, school degree, income and associationism were systematically selected as significant predictors of knowledge sharing. Explanatory variables, like specialized schooling or work experience knowledge, emerged as positively related and statistically significant in explaining knowledge sharing of pollution, hydraulic risk control and climate change control.

Table 4. *F*-values, *P*-values and model selection scores for each wetland function shared ecological knowledge and the predictors used.

Woods					Rural landscape				
Function – Predictor	*F*-value	*P*	AIC	Direct or inverse relation	Function – Predictor	*F*-value	*P*	AIC	Direct or inverse relation
Recreation–culture					Recreation–culture				
family	***0.034***	***0.999***	***−4.333***	+	***schooling***	***17.855***	***1e−07***		+
distance	**0.184**	**0.861**	**−2.998**	+	***income***	***11.131***	***0.000001***		+
employment	**2.030**	**0.132**	**−2.958**		***age***	***7.963***	***0.00039***		−
schooling	***5.945***	***0.0028***	***−2.946***	+					
age	***4.656***	***0.0099***	***−2.941***	−					
income	***3.641***	***0.0268***	***−2.937***						
Pollution control									
schooling	***21.491***	***0.000001***	***−0.777***	+					
age	***13.803***	***0.00001***	***−0.751***	−					
income	***9.036***	***0.00014***	***−0.733***	+					
association	***7.488***	***0.00062***	***−0.728***	+					
employment	***4.782***	***0.0087***	***−0.718***	+					
residence	***3.329***	***0.036***	***−0.712***	+					
Hydro-geologic risk control					Hydro-geologic risk control				
schooling	***23.097***	***0.00001***	***−0.761***	+	**income**	**0.251**	**0.778**	**−0.383**	+
age	***13.698***	***0.00001***	***−0.728***	−	***schooling***	***6.535***	***0.0016***	***−0.2454***	+
income	***9.670***	***0.00001***	***−0.714***	+	***association***	***4.139***	***0.0164***	***−0.237***	+
association	***7.980***	***0.0001***	***−0.708***	+	***residence***	***3.849***	***0.022***	***−0.236***	+
employment	***5.396***	***0.0041***	***−0.698***	+					
sex	***3.559***	***0.029***	***−0.691***	−					
Water reserve					Hydraulic regulation				
schooling	***37.365***	***0.00.001***	***−0.327***	+	***schooling***	***31.935***	***0.000001***	***−0.191***	+
age	***22.737***	***0.00001***	***−0.278***	−	***employment***	***14.032***	***0.00001***	***−0.129***	+

income	***15.268***	***0.00001***	***−0.252***	+	***income***	***13.123***	***0.00001***	***−0.126***	+
association	***8.654***	***0.0002***	***−0.228***	+	***age***	***8.989***	***0.000144***	***−0.111***	+
					association	***6.612***	***0.00145***	***−0.102***	+
Climate change							Climate change		
schooling	***27.884***	***0.00001***	***−0.167***	+	***schooling***	***37.287***	***0.000001***	***−0.175***	+
age	***15.593***	***0.00001***	***−0.124***	−	***employment***	***17.779***	***0.000001***	***−0.109***	+
income	***10.466***	***0.00001***	***−0.106***	+	***age***	***11.152***	***0.00001***	***−0.085***	−
association	***10.493***	***0.00001***	***−0.106***	−	***income***	***10.933***	***0.000001***	***−0.084***	+
employment	***8.865***	***0.00016***	***−0.0998***	+	***association***	***3.310***	***0.037***	***−0.057***	+
sex	***7.026***	***0.0001***	***−0.093***	−					

Notes: Only significant models are shown. Results are ranked for shared knowledge agreement among ecological services within landscapes, and for likelihood (**boldface**) and significance (*italic*) within each ecological service. Higher likelihood and significant scores are reported, and direct or inverse relationships between the dependent variable and the predictor, obtained by model plotting, are symbolized by + or − ; **age** (17–30, 30–44, 45–64 and >64); **schooling** (none, lower school, junior high school, high school, Bachelor's degree, Master's degree and PhD); **employment** (Housewife–student–unemployed, workman,pensioner, white collar, manager, self-employed and professional); **income** (t €/anno: 0–9, 10–19, 20–30, 30–39, 40–59 and >60); respondents family (1, 2–4 and >4); **association** belonging (none, other, rural union, environmental and fishing–hunting); sex; respondents **residence** (urban, urban fringe and rural); **distance** of the respondents domicile (0–24, 25–44, 45–59, 60–99 and >100 km)..

The recreational function of woods emerged as inversely related to age and distance.

On the other hand, family size was positively related to knowledge sharing of the recreational function of woods.

Age was positively related to the dependent variables only for the hydraulic role functions in the rural landscape.

Discussion

The standard economic model postulates that rational preference for an ecosystem service should be driven by the perception and then cognition of the effect of the ecological function being valued on personal net utility. From this point of view, we observed different responses for different ecosystem services in the different systems considered (woods and rural landscapes). We can depict a continuous distribution between two extremes (figure 1, table 3). At one end of the spectrum, there is an almost total knowledge sharing within the community of such ecosystem services, such as habitat and biodiversity. At the other end of the spectrum, there is very low shared knowledge of such ecosystem services, such as the climate change function. We interpret this to mean that there is no shared knowledge of climate change in the community's social memory [17]. Knowledge of the climate change function was shared only by those who acquired it through schooling and/or job training (farmers).

In between these extremes, other functions had varying degrees of shared knowledge, positively related to schooling and income, and inversely related to age and sex. This last result reflects the expected reluctance of elderly – and women in particular – to give judgments on topics they are not familiar with, e.g. Alberini *et al.* [41]. When asked about topics that are usually familiar to elders, such as the hydraulic role of rural landscape, the degree of shared knowledge was positively related to age.

This pattern could be interpreted using the theory of planned behaviour [25], which considers the role of social influence on the individual perceiving and valuing behaviours. The relationship between individuals and society can be represented in terms of attitude toward a certain behaviour (the degree to which a person has a favourable/not favourable evaluation of the behaviour), subjective norms (the perceived social pressure to perform a specific behaviour) and perceived behavioural control (the believed ease of performing the behaviour). The higher the attitude towards a behaviour and its related subjective norms, the stronger the perceived control regarding a specified behaviour and, in turn, the stronger the intention to perform the behaviour.

The universally shared knowledge of the first group of services is very unlikely because of a universal sharing of individually and rationally gained knowledge, e.g. through school or job training. This option can be excluded, given the distribution in schooling level among respondents (see table 2). More plausibly, the shared knowledge is linked to right-based attitudes and subjective norms, where uncertainty or disagreement would be perceived as contrasting with a shared common sense.

The habitat/biodiversity statement was possibly being valued in an instantaneous way by psychic mechanisms [42] connected to their symbolic role in the landscape concept [43, 44]. Although the predictors used in these analyses could not directly test the importance of attitudes, subjective norms and control perception, we hypothesize that the results obtained are less dependent on personal cognition and valuation capacity of the effect of ecological functions effect on the personal utility than on attitudes, subjective norms and control perception. None of the predictors used could discriminate the behaviour detected, even if better results would have been performed with other measures, than that used, of attitudes, subjective norms and control perception [28]. The same universal traits seemed to characterize the recreational-cultural ecosystem services, with some emerging different elements linked to ethical attitudes (e.g. the sense of belonging to a place, an organization or a family, which underline responsibility towards a group) and direct experience of the environment (distance, familiarity). In the case of woods, we found that the shared knowledge of the recreational service was lower among older and less educated citizens (who also expressed a lower willingness to pay). We interpret this to mean that elders perceive woods more as a working environment than a recreational one. The recreational service was instead positively related to predictors underlying cultural (sense of belonging) and ethical (family responsibility) components. It is important to note that the valuing behaviour of habitat/biodiversity and recreational/cultural functions seemed to belong to the systems perceived as 'natural'. Similar results were obtained in the same territory for wetlands [11].

Shared knowledge of some ecological services, like environmental risk control or water regulation, could also be explained by cultural aspects (i.e. sense of belonging, expressed by residence), experience (i.e. schooling, job), or right-based components (association). In particular, we found: (i) an unexpected underestimation of the woods' hydrologic role that is usually a deep-seated cultural heritage of woodland communities [45]; and (ii) a persisting awareness of the hydraulic functions of the rural landscape limited to the elder farmers, possibly because they are familiar with the traditional agricultural hydraulic organization.

Therefore, the valuing capability seemed, in these cases, related to an individual cognition map acquired by (i) study or training and (ii) shared cultural belonging to a community more or less influenced by the perception of nature linked to different cosmopolitan traits [43, 46].

These results have to be interpreted together with the willingness to pay results (Official Research Report, available online [47]) which show a very high rate of citizens who will to pay for the ecosystem services (woods = 90%; rural l. = 94%) and higher willingness to pay for rural landscape (64 € year-1) than woods (59 € year-1).

We infer that this higher willingness to pay for rural landscape comes from subjective norms induced by a strong socially shared legacy. In fact, even if in the same province area, the stated preference was higher for rural landscape than for woods and the knowledge sharing of the A–B groups of ecosystem services was not higher in the same way. On the other hand, for some comparable ecosystem services in rural landscape and woods, like water regulation or environmental risk control, we found differences among the predictors composition of shared knowledge (table 4), such as the belonging to an organization, the age or the place of residence. Finally, it is possible that this difference enters the valuing process because of the unconscious role of some ecosystem services with a direct-use value, carefully left out from the survey (e.g. timber and yields).

In economic terms, therefore, our results suggest that: (i) indirect use components were clearly valued by the population with either direct or indirect experience of them; and (ii) an indirect non-perceived 'climatic change mitigation' component was consistently undervalued at the community level. Moreover, our findings imply that the motivations that underline the shared knowledge holding the 'well informed' individual preference did not come simply from the rational consequence model assumed by the utilitarian philosophy, but from a more complex system of right-based attitudes and social norms.

Conclusions

We found that the ecological services that represent the social shared idea of 'nature' are well rooted in social memory and influenced by deontological attitudes and subjective norms. Notably, a comparable level of shared knowledge of the same set of ecological services led to a different pricing for woods and rural landscape, even when located in the same geographical area. From our data, we inferred that the differentiated knowledge of ecological function is not simply caused by schooling or knowledge acquired from professional experience, but by a different sense of belonging and/or different subjective norms in the communities. These results are corroborated by those reported in our related paper on wetlands, where significantly lower willingness to pay corresponded both to an overall lower shared knowledge, which tends to decrease as the distance from the wetlands increases, and to a different composition of the socio-economic and cultural predictors of shared knowledge [11].

The differences between the shared knowledge and the official knowledge of some ecosystem services were significant. The climate change function did not form part of the social shared awareness despite the dimension of the problem. Only farmers partly exhibited some shared awareness, probably because they were familiar with related rural policy incentives. An unexpected result was the low level of shared knowledge regarding the role of woods in the water cycle. This knowledge was historically shared by woodland communities. The apparent loss of this may be related to a reduced sense of belonging, with this, in turn, being caused by the growing influence of urban life in the metropolitan (Rome) commuting area. Therefore, there is a need to increase social awareness as such environmental issues may be crucial to future public policy.

The standard economic model assumes that monetary estimation comes from a rational valuation of the consequence of the preference on the personal utility in a static equilibrium condition, and that the preference is based on complete, pre-existing, invariant and transitive information. But, the relationship between the motivations outlined by the communities' shared knowledge and those expected by standard economic model in our results suggests that the stated preference is influenced by subjective norms and other, protest or right-based, motivation and beliefs [26,27].

We believe that this should not be a limit of the stated preference methods [28].

Citizens' choices surely reflect ethical and aesthetic considerations as well as social pressure, issues which are not considered by the standard economic model. These choices should not be narrowly interpreted as a price to be paid in exchange for a personal utility linked to some environmental change. Monetary estimates of values associated to environmental change are usefully applied in decision-making processes as long as (i) these estimates transfer an unbiased synthesis of the human and social capital made of awareness and knowledge, and (ii) they have an explicit normative task [48]. The first condition can be obtained by analysing the shared knowledge among ecosystem services as we have done, or using additional motivational predictors [28].

This case study provided the opportunity to complement the information represented by monetary estimates with the multiple motives that reflect the interconnection of ecological services. The aim was to provide average non-use value estimations that could be used to trigger bottom-up environmental negotiation processes among public and private actors. We believe that such an approach could also be useful in other contexts such as the Payment for Ecosystem Services schemes used to implement EU rural development policies.

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