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Community perspectives on conservation of water sources in Tarkeshwar sacred groves, Himalaya, India

Purna Jana[a,*], Rajiv Pandey[b], Teodoro Semeraro[c], Juha M. Alatalo[d], Roberta Areteno[c], Nagendra P. Todaria[a] and Ravi Tripathi[e]

[a] Department of Forestry & NR, HNB Garhwal University, Chauras Campus, Srinagar, Garhwal 246174, Uttarakhand, India
[b] Biodiversity and Climate Change Division, ICFRE, Dehradun 248006, India
[c] Department of Biological and Environmental Sciences and Technologies, University of Salento, Lecce 73100, Italy
[d] Department of Biological and Environmental Sciences, College of Arts and Sciences, Qatar University, P.O. Box 2713 Doha, Qatar
[e] Department of Civil Engineering, Indian Institute of Technology (BHU) Varanasi, Banaras Hindu University Campus, Uttar Pradesh 221005, India
*Corresponding author. E-mail: purnajana1986@gmail.com

ABSTRACT

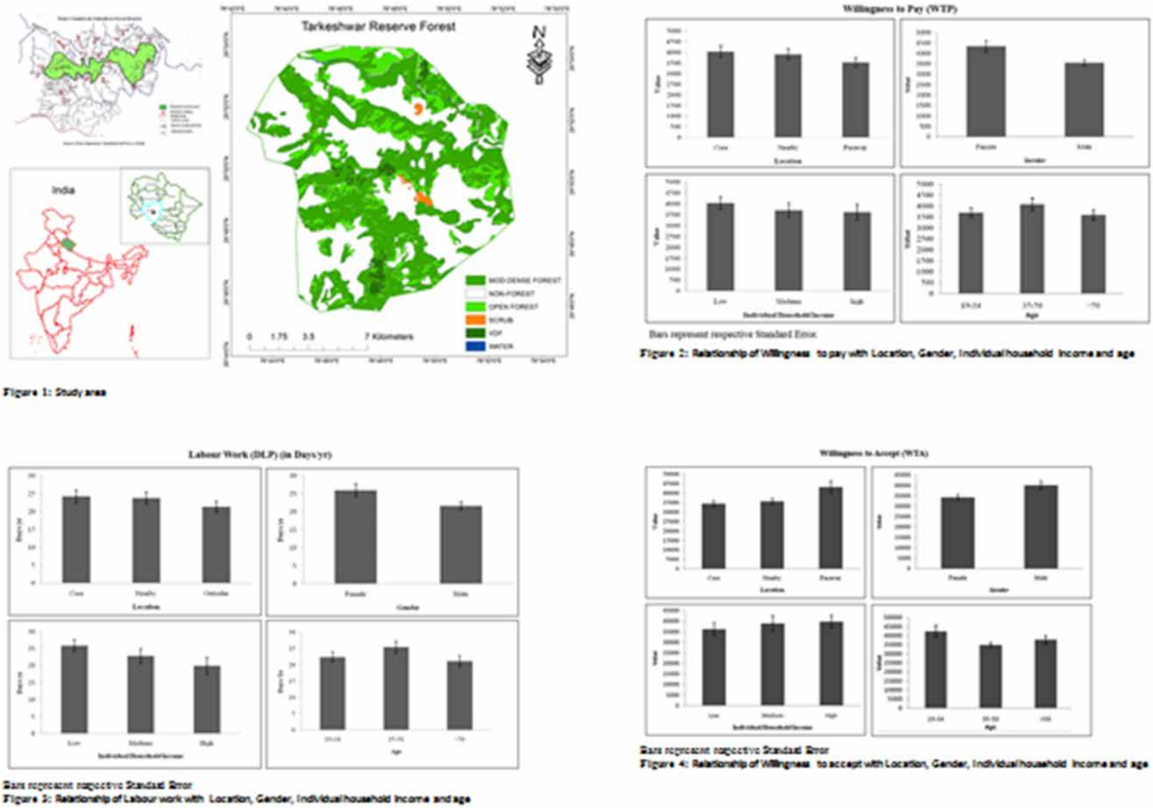
Sacred groves have significance in socio-culture and biodiversity conservation. This study evaluated local people's perceptions regarding conservation of sacred groves for water services, through willingness-to-pay (WTP), willingness-to-accept (WTA) and willingness-to-labour-work (DLP). Data were collected through a pre-tested questionnaire from 107 randomly selected households in 18 villages of Uttarakhand. The villages were categorised into 3 classes (core, nearby, faraway) based on proximity to the forests. The contingent-valuation method was used to evaluate WTP [Rs 3,802 (≈$57)] and WTA [Rs 38,224 (≈$571)] for water as an ecosystem service and statistical analyses were performed to evaluate whether factors such as gender, age, household income and location explained differences in the parameters. It was found that gender had a significant impact on WTP, with women having higher WTP, and that location had significant impact on WTA. The result shows that WTA increased with increasing distance from the sacred groves (Rs 43,077 ± 21,139 in faraway villages and Rs 35,323 ± 10,483 in core villages). The results indicated that consideration of gender inequality and education status in villages should be included in planning and decision making about participatory forest management of sacred groves. These findings facilitate forest resource management in mountains and provide guidance for programmes and policies dealing with irrigation, drinking water and community development.

Key words: ecosystem service, perception, water management, willingness to accept, willingness to pay

HIGHLIGHTS

- Sacred groves have a role in biodiversity conservation.
- Gender has a role in WTP, women especially are more willing to pay for conservation.
- Distance from sacred grove has an important role in WTA.
- In planning and decision making about participatory forest management of sacred groves, gender equality and status of education should be considered.
- Identification of this aspect will facilitate forest resource management in mountains.

GRAPHICAL ABSTRACT



INTRODUCTION

There is increasing awareness in society that habitat degradation, overexploitation, climate change and pollution are major threats to biodiversity and ecosystems across the globe (Ayvaz & Elci 2012; Pereira *et al.* 2012; Mohammadi *et al.* 2020). Ecosystem degradation and biodiversity loss undermine the functioning of ecosystems and their ability to provide goods and services, which are of fundamental importance for the well-being of present and future generations of people world-wide (de Groot *et al.* 2002; Sinha & Mishra 2015). Therefore, ecosystem degradation and biodiversity decline not only represent an irreversible loss to the planet, but can also threaten the wellbeing of humanity (Díaz *et al.* 2006).

The ecosystems that provide renewable and non-renewable goods and services are referred to as natural capital, a stock that yields a flow of services over time (Costanza & Daly 1992). However, ecosystems cannot provide benefit to people without the presence of people (human capital), their communities (social capital), and their built environment (built capital) (Costanza *et al.* 2014). Therefore, the capacity of natural capital to provide various human benefits depends on its complex feedbacks and trade-offs with the three other forms of capital (Costanza 2008; Costanza *et al.* 2014). Maintaining healthy ecosystems so that they provide people with the goods and services needed to prosper is now a key challenge for society. Hence, it is important to manage all forms of capital more effectively and sustainably (de Groot *et al.* 2012; Costanza *et al.* 2014). Policies and programmes should thus be orientated to support effective utilisation of ecosystem services by the community concerned. Expressing the value of ecosystem services to the community in monetary units is an important tool to raise awareness and convey the (relative) importance of these ecosystem services to policy makers. Monetary valuations of ecosystem services can also serve as a powerful information tool to support more balanced decision making regarding the trade-offs involved in land use options and resource use (de Groot *et al.* 2012; Costanza *et al.* 2014). Economists have developed several techniques to value unpriced or non-market goods and services. Among these, the contingent valuation method asks people what they would be willing to pay for an ecosystem good and service (Mitchell & Carson 1989). This kind of approach has been widely used in compensation schemes (Lindhjem & Mitani 2012).

Forests provide numerous and diverse ecosystem services on spatial and temporal levels, including provisioning, regulating, cultural and supporting services, such as biodiversity, soil and water protection, fibre, fuel, non-wood forest products, carbon sequestration and socio-cultural values (Shvidenko *et al.* 2005). In particular, forests play an important role in supporting water-related ecosystem services such as: water quality (forests provide water with low levels of nutrients and chemical contaminants), flow regulation (forests can regulate surface water and groundwater flows that benefit people), water supply (forests can increase minimum flows during dry seasons) and aquatic productivity (fisheries) (Johnson 2000). Thus, water resources can be managed by conserving and protecting forest resources to fulfil the demand for water by communities. It is estimated that by 2025, there will be 1,800 million people living with absolute water scarcity and two-thirds of the world's population could be living under stress conditions. Climate change will further exacerbate the risks associated with variations in the distribution and availability of water resources (UN Water 2015). The global water crisis is a crisis of governance (UN Water 2006) much more than a crisis of resource availability. Therefore, the importance of forests for management of water services needs consideration and policy perspectives on managing the resources forests provide are required (UN Water 2015).

There have been only a few attempts to value the forest-derived services in India (Joshi & Negi 2011), or to apply the value of biodiversity conservation in a policy perspective (Ninan *et al.* 2007). The value of forest ecosystem services for fresh water, non-timber forest products and soil nutrients for Indian forests has been estimated to represent 7% of national GDP (Sukhdev 2009). However, studies conducted in various regions of India are not sufficient to provide a full picture due to the huge diversity of India's forests. Moreover, research on the willingness of rural people in India to facilitate systematic management of natural resources at a local level through their contribution in terms of labour and money is limited to a single study by Maharana *et al.* (2000). Besides the issue of willingness among local people, the complexities of global change add to the difficulty of managing the resources in a sustainable way. Therefore, studies on valuation of resources and how communities value them are needed to allow for effective conservation and management of natural resources and for formulation of appropriate policies and plans.

The availability and quality of drinking water in many regions of the world is being increasingly threatened by overuse and misuse. Catchments covered by forests are a source of a high proportion of water for domestic, agriculture and other uses by the community in both upstream and downstream areas. Under ongoing global change, a key challenge is optimising exploitation of forests without negative effects on water resources and ecosystem functions. These challenges can be addressed by evaluating the interface between forests and water, by determining potential community responses for effective water use and by including the knowledge gained in policies for better management of forests and their services (Hamilton *et al.* 2008).

Forests also provide various spiritual and recreational services. The existence of 'sacred groves' is a physical manifestation of this spiritual role and has contributed to forest conservation (Shvidenko *et al.* 2005). Sacred groves are tracts of virgin forest with rich plant diversity that have been protected by local people for centuries owing to cultural and religious beliefs and taboos; for example, so that deities that reside in the forest protect the villagers from calamity (Khan *et al.* 2008). The role of sacred groves in the conservation of biodiversity has long been recognised in the academic literature (Malhotra *et al.* 2001). Sacred groves have various ecological values and maintain ecological balance, conserve biodiversity and supply various resources to the community, including water for various household uses. However, with ongoing modernisation, poor information transfer from gatherers to decision makers, changing socio-economic conditions, better education and financial support for conservation initiatives, the world's existing sacred groves are degrading rapidly (Khan *et al.* 2008). This degradation of sacred groves is altering the provision of ecosystem services to local communities and threatening the preservation of biodiversity. Economic incentives based on valuation of the ecosystem services that sacred groves provide and dissemination of relevant information to the stakeholders concerned can help to rejuvenate and conserve the cultural and ecological uniqueness of sacred groves (Sinha & Mishra 2015). Suitable strategies for effective management of sacred groves must be based on the willingness of local people to support their conservation for provision of a constant flow of services, including water.

This study analysed the willingness of local people to conserve forest resources in Tarkeshwar sacred groves of Uttarakhand in the Indian Himalayas. Empirically, the willingness of people was measured in terms of willingness to pay (WTP) and willingness to accept (WTA). WTP relates to the maximum amount a person would be willing to offer for the use or protection of a type of environmental item or service, while WTA is the minimum monetary amount required for an individual to accept the loss of some type of environmental good or service, or to bear some harm (Carson 2000). Some villagers were unwilling to pay some money and, rather, were interested in doing labour work for protection and conservation of the groves. Therefore, willingness to act as daily labour for conservation work, termed as labour work (in days/yr) (DLP), was also assessed.

MATERIALS AND METHODS

Study area

Uttarakhand, a state in northern India, has many sacred groves, such as Binsar, Tarkeshwar, Goldev, Deeva, Hariyali Devi, Kot, Nandisain and Jageshwar, which are integral parts of confined conservation areas with the local communities (Bisht 2014).

The present study was conducted in what is known as Tarkeshwar sacred groves, which have a rich biodiversity and complex ecosystems and form a forest reserve conserved in pristine condition that contains a holy shrine of Lord Shiva. The reserve is situated at 29°50′05″N, 78°47′35″ E and an altitude of 1,650–1,805 m, in the inner ranges of the Himalayas (Bisht 2014). Climatically, the Tarkeshwar area experiences three distinct annual seasons, summer, a rainy season, and winter, with mean temperature varying between maximum 15 to 38 °C and minimum 3.5 to 22 °C.

The vegetation in the study area is composed of forest species such as Deodar, Oak and Pine. The prevalent forest types are Ban Oak forest, and West Himalayan upper Oak/Fir forest (Figure 1). Various villages are situated near and within the Tarkeshwar forest reserve and the villagers receive various intangible services from the nearby ecosystems.

Sampling

For the purposes of this study, the 18 villages situated around Tarkeshwar sacred groves were divided into three groups, based on distance from the groves, in order to assess household potential to manage the water resources. The management potential of water resources was based on people's willingness to pay (WTP) for an improvement in environmental quality and their willingness to accept (WTA) compensation for foregoing improvements in the water obtained from the forest ecosystems. The three groups were (Table 1): (i) core villages

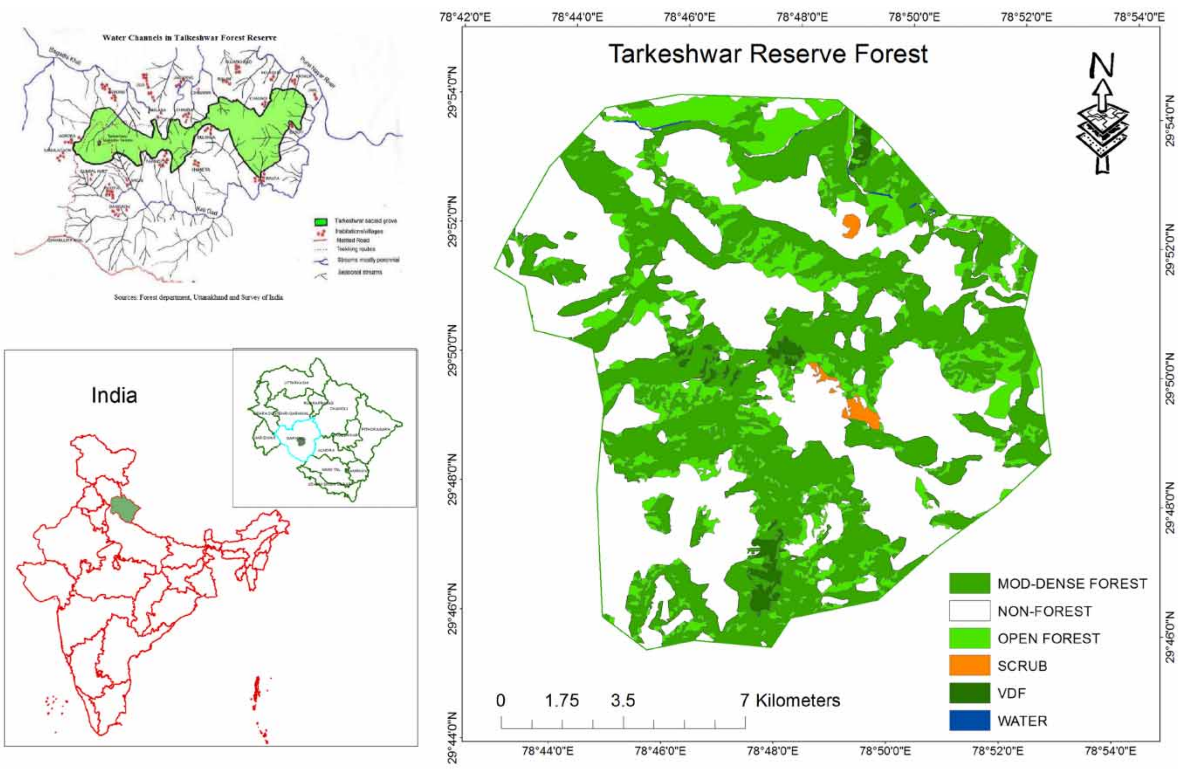


Figure 1 | Map of the study area near Tarkeshwar sacred grove, Uttarakhand, India.

Table 1 | Geographical details of the three types of study village around Tarkeshwar sacred grove, Uttarakhand, India

Village type	Village name	Latitude	Longitude	Elevation (m)
Core village	Gamlagaon	29°50′1.5″	78°46′47.2″	1,711
	Agrora	29°50′18.3″	78°46′58.9″	1,636
	Gundel khet	29°49″51.32″	78°47′4.28″	1,842
	Pasta Malla	29°50″27.3″	78°46′23.8″	1,535
	Pasta Talla	29°50′55.2″	78°46′20.8″	1,389
	Guilyani	29°50′45.1″	78°48′15″	1,475
Nearby village	Jhangoriya	29°50′27.3″	78°45′53.4″	1,544
	Jugunya	29°51′6.3″	78°49′2.4″	1,391
	Ghotla	29°49′28.1″	78°47′42.7″	1,646
	Chowra	29°50′48.8″	78°49′13.2″	1,416
	Malara	29°50′38″	78°48′45.1″	1,689
	Wadda	29°50′58.88″	78°47′53.34″	1,490
Faraway village	Nunera	29°49′5.24″	78°47′48.08″	1,502
	Angni	29°49′35″	78°48′7.15″	1,473
	Bandun	29°51′15.19″	78°47′77″	1,278
	Babina	29°51′37.85″	78°47′42.81″	1,395
	Khaneta Talla	29°49′17.94″	78°49′28.69″	1,419
	Bulekha	29°50′20.62″	78°49′47.2″	1,521

(situated at a distance of 0–5 km from the groves), (ii) nearby villages (situated at a distance of 5–10 km from the groves) and (iii) faraway villages (situated at a distance of more than 10 km from the grove). A survey was carried out in 2013 and 2014 through face-to-face interviews with the heads of households. These households were randomly selected from the 18 villages and a total of 107 questionnaires were collected concerning the WTP (in Indian rupees, Rs) or, alternatively, provide labour (in days per year) by local residents to conserve forest ecosystems and guarantee water provision, and also concerning their WTA to forgo ecosystem services.

Willingness to pay was evaluated according to the standard protocol, based on the premise that valuation of ecosystem services can provide useful information and help formulate recommendations for decision making, therefore facilitating real-world conservation and development issues (de Groot *et al.* 2002). In the present context, the valuation in terms of WTP for water provided information about the range of benefits obtained by the local communities from ecosystem services and their role in conservation of these services (Semwal *et al.* 2007).

Statistical analysis

Multivariate analysis in socio-ecological systems analysis most often attempts to investigate interactions between natural and social systems on natural deliverables and/or community characteristics in a particular area. This coupled socio-ecological system consists of many components, leading to production of various deliverables, and each deliverable is generally treated as a separate response variable when analysing the data. The perceived response of the system is generally qualitative or ranked. Therefore, the data set generated from the system usually has preferences or counts of responses at each of several sites or in each of several observation units. The system response focuses on the situation where a particular hypothesis is tested. In this context, the main agenda is to rigorously test explicit hypotheses concerning patterns generated by the multivariate cloud of data by reference to *a priori* groups or relationships with predictors, such as community characteristics or location of natural system (Anderson 2002).

PERMANOVA and ANOSIM are non-parametric tests (Anderson 2001) that facilitate hypothesis testing with spatial and temporal variables (Edgington & Onghena 2007). In the present work, PERMANOVA was applied to test the differences between groups of villages and ANOSIM was applied to test the difference within groups. ANOSIM is more sensitive to differences in location, dispersion or correlation structure within groups than PERMANOVA (Anderson & Walsh 2013). These methods are flexible and based on distance or dissimilarity measures, and allow partitioning of variance using the linear model of interest. P-values are obtained by use of an appropriate permutation strategy for each particular term in the model (Anderson 2001). PERMANOVA was applied here to evaluate the importance of various factors such as location, gender, household income and respondent age in determining the levels of WTP, DLP and WTA regarding Tarkeshwar sacred groves. The analysis was based on consideration of all four factors as a fixed effect and the permutation method used was permutation of residuals under a reduced model with 999 permutations. The null hypothesis (H_0) tested by PERMANOVA is that, under the assumption of exchangeability of the sample units among the groups:

H_0: 'The centroids of the groups, as defined in the space of the chosen resemblance measure, are equivalent for all groups'

That is, if there is support in favour of H_0, this indicates that the observed differences among the centroids in a given set of data will be similar in size to what would be obtained under random allocation of individual sample units to the groups (i.e. under permutation) (Anderson & Walsh 2013).

ANOSIM was applied to evaluate significant differences within groups in location, gender, age and individual household income inside the variables: WTP, WTA and DLP. The null hypothesis for ANOSIM was:

H_0: 'The average of the ranks of within-group distances is greater than or equal to the average of the ranks of between-group distances', where a single ranking is made across all inter-point distances in the distance matrix and the smallest distance (highest similarity) has a rank value of 1 (Anderson & Walsh 2013).

RESULTS

It was found that people residing in faraway villages had a higher level of education than people living in villages closer to the sacred grove (core and nearby villages). In terms of land availability for cultivation, core villagers have a mean of 0.40 ha, nearby villagers 0.26 ha land and far away villagers 0.36 ha. Most of the residents in nearby villages relied on water from the sacred groves and they wanted to protect the groves, the forest and the heritage site. However, they reported that some permanent structures built in the area for pilgrimage amenities have restricted the former smooth flow of the stream. Moreover, they reported that the pilgrims use water to satisfy their needs and pollute the environment by producing solid and liquid wastes.

The average age of respondents was 46 years (maximum 87, minimum 19) and the average number of persons per household was 5 (maximum 10, minimum 1). The average monthly household income was Rs 7,986 (≈$119) and it was highest for faraway villages (Rs 9,385 $\pm$ 7,618) and lowest for nearby villages (Rs 6,622 $\pm$ 4,877), while for core villages it was intermediate and much less variable (Rs 7,855 $\pm$ 99). The main employment opportunities for local residents are in government services, waged labour and agriculture. Most households have agricultural land but, due to lack of water and interference by wild animals, half of the land is become unproductive, reported villagers. For this reason, a number of local residents have extended their source of income, so that they no longer depend exclusively on agriculture. The education level of local residents also varied, from illiteracy to Master's degrees, but most householders had studied up to secondary level.

During the survey, many respondents mentioned a growing water crisis across the area. Severe scarcity was reported by the households in the core villages. This is probably caused by their location, as they are located on the upstream side and, therefore, are above other sources of water flowing downhill. Moreover, the water provided by the sacred groves flows in the opposite direction to the location of the core villages. However, the households in the core villages are able to extract water from the sacred groves because of their proximity to these (0–5 km).

During the survey, it was observed that all villagers were willing to pay for maintenance of the sacred groves and were well aware of the changes taking place in the groves. The mean annual WTP per household was reported to be Rs 3,802 (≈$57), with the value being highest in core villages (Rs 4,028 $\pm$ 1,452) and lowest in faraway villages (Rs 3,548 $\pm$ 1,371). In contrast, the mean annual WTA was highest (Rs 43,077 $\pm$ 21,139) in faraway villages and lowest in core villages (Rs 35,323 $\pm$ 10,483). The higher average WTP in core villages can be explained by these villagers benefiting more from the natural resources, including water, provided by the sacred grove forests than the residents in the other two types of villages. The reason for the higher WTA in faraway villages may have been their disadvantageous location, which means that they are unable to benefit from the heritage sites located in the sacred groves.

The PERMANOVA test revealed that gender was the principal factor determining differences in WTP. Moreover, the interaction between location and household income and the interaction between location, gender and household income were relevant in determining differences in WTP (Table 2). In particular, females showed higher average WTP than males, while there were no particular differences as regards the factors location, age and household income considered individually (Figure 2). The ANOSIM test produced a low R statistic for

Table 2 | Results of individual PERMANOVA tests on willingness to pay (WTP), willingness to provide daily labour (DLP) and willingness to accept (WTA) and the effect of different levels of main effects and interaction effects of location, gender and age

Source of variation	df	WTP MS	WTP P (Permutation)	DLP MS	DLP P (Permutation)	WTA MS	WTA P (Permutation)
Location	2	2.62E + 06	0.24	89.88	0.38	8.21 E + 08	0.05
Gender	1	9.97 E + 06	0.02	300.37	0.08	2.11 E + 08	0.39
Age	2	1.62 E + 06	0.40	140.85	0.20	1.73 E + 08	0.50
Household income	2	8.11 E + 05	0.64	200.44	0.10	4.56 E + 07	0.83
Location × Gender	2	5.67 E + 05	0.73	1.90	0.97	4.19 E + 08	0.21
Location × Age	4	2.59 E + 06	0.21	90.18	0.38	2.65 E + 08	0.38
Location × Household income	4	5.30 E + 06	0.04	253.63	0.04	1.09 E + 08	0.76
Gender × Age	2	1.55 E + 06	0.43	44.68	0.62	2.04 E + 07	0.91
Gender × Household income	2	7.34 E + 06	0.64	13.38	0.87	3.34 E + 07	0.85
Age × Household income	4	7.83 E + 05	0.80	40.13	0.75	2.35 E + 08	0.43
Location × Gender × Age	4	2.66 E + 06	0.20	128.69	0.22	1.06 E + 08	0.73
Location × Gender × Household income	3	6.27 E + 06	0.02	264.41	0.02	5.77 E + 07	0.82
Location × Age × Household income	6	2.38 E + 06	0.24	106.96	0.33	2.18 E + 08	0.48
Gender × Age × Household income	2	1.62 E + 06	0.40	41.74	0.61	6.78 E + 07	0.71
Location × Gender × Age × Household income	1	6.69 E + 06	0.07	298.97	0.06	1.50 E + 08	0.42
Residual	65	1.81 E + 06		86.68		2.45 E + 08	

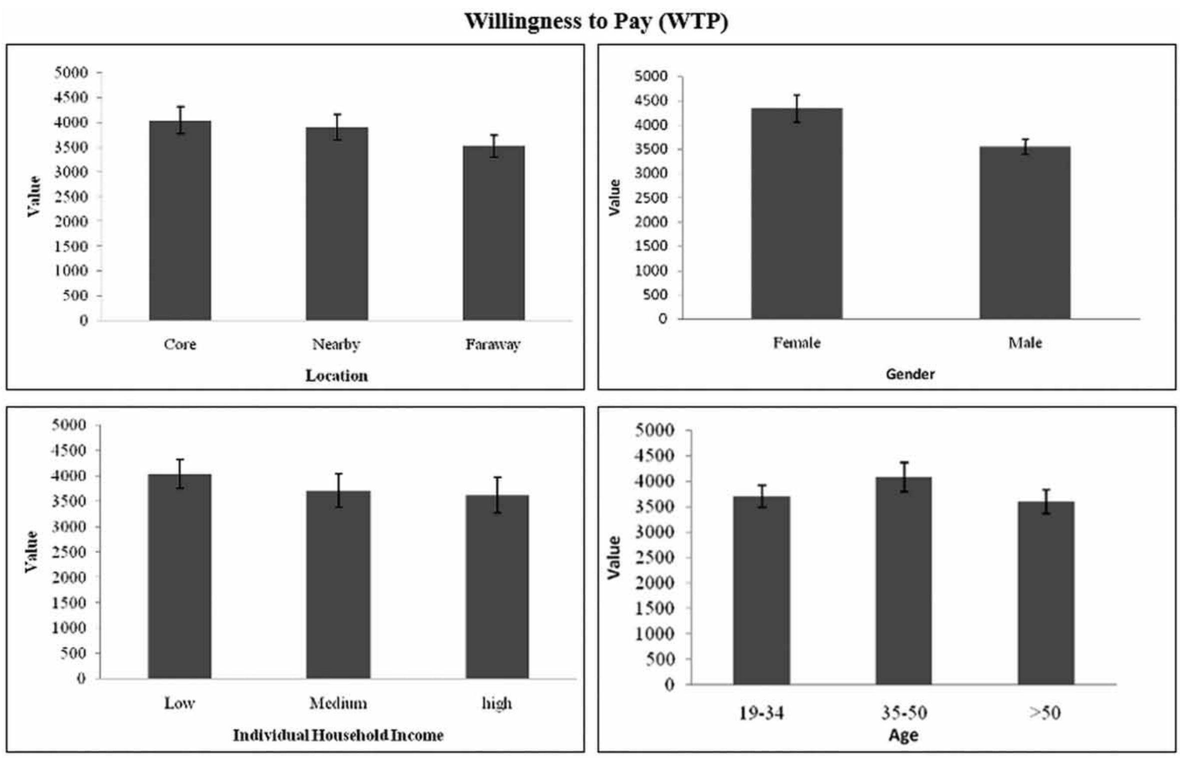


Figure 2 | Mean annual willingness to pay (WTP) with different levels of the factors location, gender, household income and age. *Bars represent respective Standard Error.

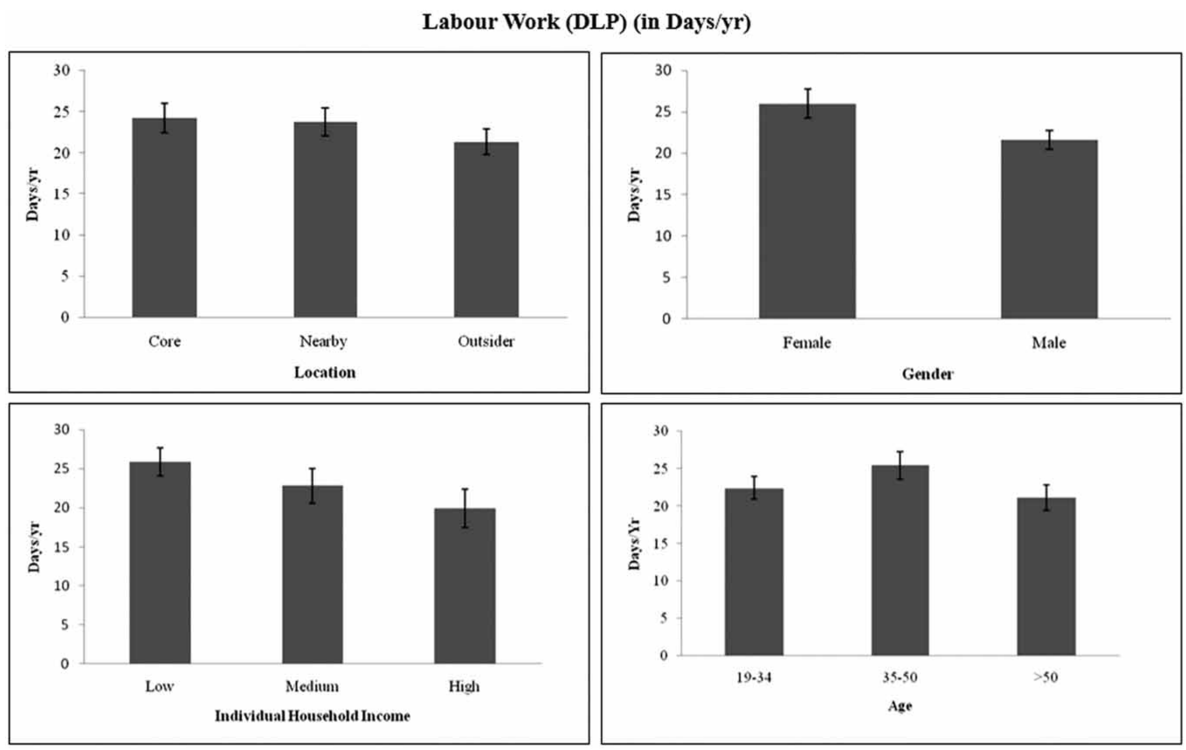


Figure 3 | Mean number of days of labour provision on an annual basis (DLP) with different levels of the factors location, gender, household income and age. *Bars represent respective Standard Error.

location, gender, age and household income ($R \approx 0$); that is, far from its maximum value of 1, implying no differences within groups in pair-wise comparisons of different levels of each factors as location, gender, age and household income.

Some of the residents also stated that they were willing to protect the sacred grove forest through their labour. The PERMANOVA test on number of annual labour days provided revealed that none of the factors location, age, gender, and household income significantly influenced the decision to work for the protection of the nearby sacred grove forest. However, the interaction between location and household income and the interaction between location and gender and household income were relevant factors in determining DLP (Table 2; Figure 3). In particular, the females at the three locations reported higher willingness to provide labour than their male counterparts. However, the ANOSIM test gave a low R statistic for location, gender, and age, implying poor separation between these factors. There was only a significant difference between ‘Low’ and ‘High’ groups in household income.

Some of the villagers were willing to accept money in lieu of work for the protection and management of the sacred grove forests. The average annual WTA for this compensation was Rs 38,224 (≈$571) (Table 2). The PERMANOVA test showed that gender and location were significantly different and therefore the main factors for determining differences in WTA between respondents. In particular, females expressed lower average WTA than males, while there was a higher WTA in faraway villages than in core and nearby villages. There was no difference in average WTA as regards age and household income (Figure 4). However, the ANOSIM test gave a low value of the R statistic ($R \approx 0$ for location, gender and household income), implying poor separation of these factors. There was a significant difference only for the factor age, specifically between age groups 19–34 and 35–50 years.

The PERMANOVA Test, applied to the WTP, DLP and WTA variables, showed that the principal factor determining differences in awareness of ecosystem services was location (Table 3).

DISCUSSION

The present work represents an early attempt to study WTP and WTA by communities in the Indian Himalayas for ecosystem services based on ecosystem services management, conservation and awareness. The results could help planners to incorporate the concept of ecosystem services in their choices. The results also show that the interests of the local community in forest management are indirect, with the preservation of water resources

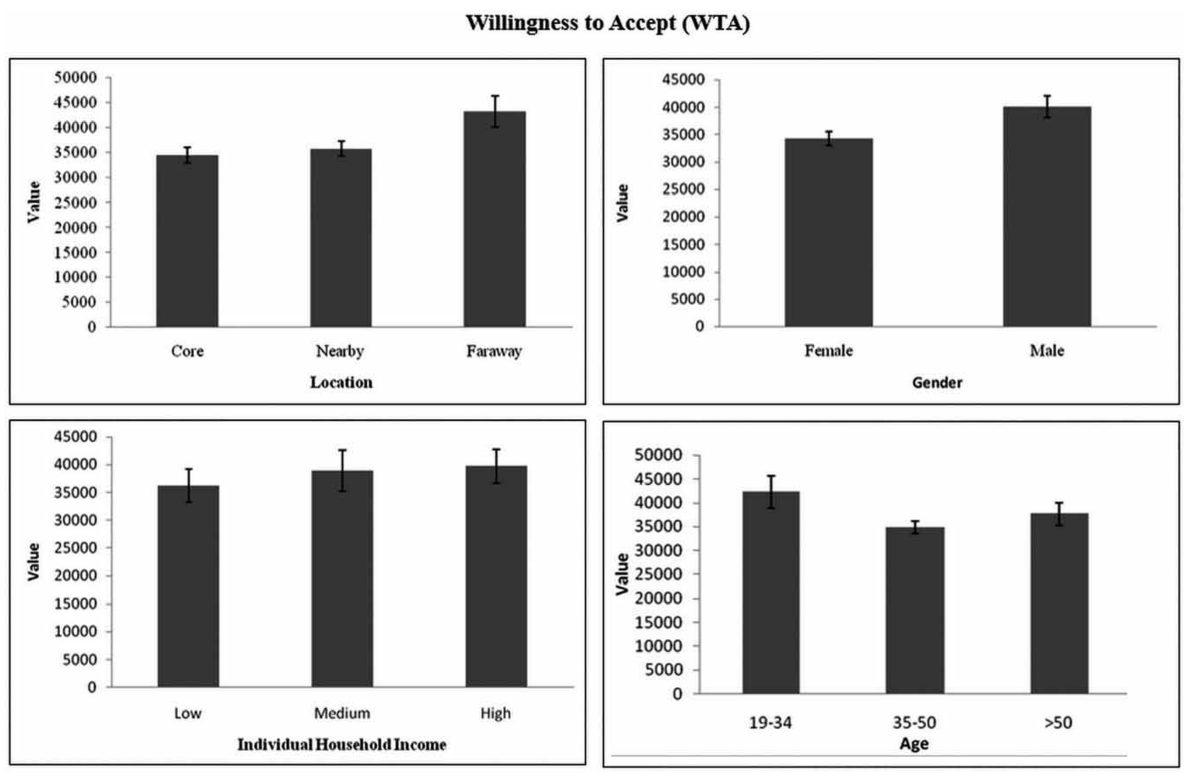


Figure 4 | Mean annual willingness to accept (WTA) with different levels of the factors location, gender, household income and age. *Bars represent respective Standard Error.

Table 3 | Combined PERMANOVA results for willingness to pay (WTP), willingness to provide daily labour (DLP) and willingness to accept (WTA) and the effect of different levels of main effects and interaction effects of location, gender and age

		WTP, DLP and WTA simultaneously	
Source of variation	**df**	**MS**	**P (Permutation)**
Location	2	8.24 E + 08	0.04
Gender	1	2.21 E + 08	0.33
Age	2	1.75 E + 08	0.51
Household income	2	4.64 E + 07	0.81
Location × Gender	2	4.20 E + 08	0.16
Location × Age	4	2.68 E + 08	0.36
Location × Household income	4	1.14 E + 08	0.80
Gender × Age	2	2.20 E + 07	0.52
Gender × Household income	2	3.41 E + 07	0.86
Age × Household income	4	2.36 E + 08	0.43
Location × Gender × Age	4	1.09 E + 08	0.70
Location × Gender × Household income	3	6.40 E + 07	0.82
Location × Age × Household income	6	2.21 E + 08	0.49
Gender × Age × Household income	2	6.97 E + 07	0.72
Location × Gender × Age × Household income	1	1.57 E + 08	0.42
Residual	65	2.47 E + 08	

being the main motivating factor. The driving forces for the interests are backed by the conservation efforts as the only means to grant local people access to planning and decision making for water supply, as also suggested for natural resources management in Kenya (Himberg *et al.* 2009).

The results showed good consistency between the responses in the interviews, which is very important for the credibility of results based on respondents' perceptions. The members of the community interviewed were well aware about their environment. It has been claimed that awareness of the environment, coupled with the decision-making ability and capacity of household members, facilitates better use of natural resources (Sinha & Mishra 2015). The results confirmed the validity of an approach previously recommended by others (Fielmua 2011), which advocates involvement of the community for water management, since local residents interact with their own surrounding environment and carry out activities for household production purposes that have an impact on the environment.

The location factor determines the level of awareness of ecosystem services. It can be argued that people who live nearer to a natural resource can utilise it in an optimal way and thus recognise its value better than those who live farther away. Analysis of variables relating to WTP revealed that the most relevant single factor was gender, while the two-factor interaction between location and household income and the three-factor interaction between location, household income and gender were also important. For WTA, the most relevant single factor was location. For labour provision, the two-factor interaction between location and household income and the three-factor interaction between location, household income and gender were important.

The results clearly showed a direct positive relationship between the value of WTP and labour provision, with core villages, females, low individual household income and respondent age 35–50 years giving high values of both. The groups that are more available to pay to preserve ecosystem services are probably those who are more eager and available to spend their personal time protecting natural resources. The ANOSIM analysis showed that WTP did not differ significantly between the groups, while for labour provision there was a significant difference between 'low' and 'high' individual household income. Paradoxically, people with low income were more willing to devote time in order to benefit from ecosystem services than people with high income. It would be interesting to study whether this result depends on the differing availability of free time between these two groups, assuming that people with higher income have more demanding jobs in terms of time. However, such analysis was beyond the scope of this study. Gender also influenced the WTP and WTA of residents in the Tarkeshwar region. Male respondents were found to have a higher level of education than female respondents and to be the main earner in the family. However, women are usually responsible for water for household purposes and therefore they had higher WTP for water from the degrading sacred groves.

For WTA, there was an inverse relationship with WTP and labour provision. This could be because groups that are less able to pay to preserve ecosystem services could be more willing to accept the loss of ecosystem services to get some benefit. A significant difference in WTA was observed between respondent age groups, with higher WTA for the age group 19–34 years. The lack of statistical significance of the factors tested shows that either the villagers do not rate highly, or are unaware of, the benefits of ecosystem services for humans and their economy, or that they have different priorities in their lives. However, there was an interesting non-significant trend for people who live in core villages to be more environmentally aware than people who live in villages far away from the sacred groves. Core village residents showed a higher average WTP and DLP than those from more distant locations, and a lower WTA. For the Hariyali sacred groves in Uttarakhand, similar observations have been made regarding WTP (Sinha & Mishra 2015). A possible explanation could be that people living far away from sacred groves derive fewer services than people living close by and therefore attribute lower value to the benefits that the forest provides.

Thus in public consultation on the concept of sustainability of ecosystem services, the principle of equity is fundamental to ensure that different groups of people can develop a vision or common perception of the problem and a common focus to be achieved.

The results of the present study can facilitate further planning and decision making regarding participatory forest management of sacred groves; for example, household location and characteristics-based conservation strategies could be applied for effective management of the resources. In addition, the traditional knowledge treasured by the local people and the contemporary knowledge provided here about the interactions between pilgrimage activities and forest conservation practices should be exploited in order to further enrich understanding of forest management-led provision of water services.

CONCLUSION

The conservation of ecosystem services must be achieved not only through complete evaluation of the functioning of ecosystems, but also through adoption of policy strategies by local communities in order to ensure the success of conservation work and enhance services and biodiversity. Ensuring active participation by the community would make implementation of these policies possible, but participation by communities in policy dialogue requires incorporation of their demands and requirements, based on their shared choices.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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