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Research Paper

Valuation of Water as Forest Ecosystem Service in a Sacred Grove of Garhwal Himalaya, India

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A B S T R A C T

The present study was conducted considering the fact that natural-resource water has immense importance in life and its quality and quantity must be conserved. The aim was to evaluate the perception of people regarding their understanding on sacred grove conservation i.e., in other words conservation of the source of water and other livelihoods. A pre-tested questionnaire was formed and data were collected from 107 randomly selected households from 18 villages of Uttarakhand. The selected villages were categorized into 2 classes based on proximity to the forests. A contingent valuation method was used to calculate willingness-to-pay (WTP) and willingness-to-accept (WTA) for water as forest ecosystem-service. The study revealed that villagers are well aware of the importance of natural-resource water and its origin sacred-grove. Average WTP was Rs. 3802 / year / household. WTP was significantly differed based on age, gender, education level and number of household member. There was no significant effect of distance on WTP. However, WTA was significantly differed based on distance, age, gender, number of household member number and education-level. Villagers are well aware of the changing environmental condition of sacred grove and degradation of forest. Therefore, they are sincerely interested in conservation of the sacred forest for the sake of their own well-being. Villagers are sincerely willing to pay for the conservation of their sacred grove that is also the source of their livelihoods.

***Key words*:** Contingent valuation method, Willingness to pay, Willingness to accept, Livelihoods, Ecosystem service, Sacred grove

Ecosystem services either directly or indirectly support the life of human being on earth as well as their survival and well-being also depend on them [1]. Therefore, for sustainable supply of these services maintaining and improvement of the ecosystem's health is important [2], [3]. The concept of ecosystem service is becoming an important criterion for assessment of conservation and hence it is attaining importance among policy-makers and researchers [4], [5]. Therefore, in order to make decision on conservation at different scales a consistent and robust means is important to map, measure, model and calculate the value of ecosystem service [6], [7], [8]. Several workers recommend that in order to cease the biodiversity loss during maintenance of incomes and livelihoods, economic valuation of biodiversity and ecosystem services is the most powerful tool [9]. A number of researches on valuation and impact of ecosystem services have been done at a regional/global scale, only their measurement methods differed [10], [11]. In India where forests have significant role in providing various ecosystem services, little attempt has been undertaken in order to put value to the benefit of biodiversity conservation though it is emphasized in policy circle. Due to being a mega biodiversity country, forests of India provide wide range of ecosystem services but most of them are not counted in economic terms [12]. Several workers [13], [14], [15] noted that few studies are available regarding ecosystem service valuation for a larger area. While [16] specified that to determine the rural peoples' willingness to pay in order to manage the natural resource based on community perception at local level in a systematic way is limited in India. Indian forest, ecosystem service valuation for fresh water, non-timber forest products, and soil nutrients was about 7 of national GDP which was 57% of rural Indians' income [17]. Thus, the need for ecosystem service valuation at local level has been felt. The concept of sacred grove and its socio-cultural belief system to conserve the biodiversity even in remote region is very well known across the world [18]. But several workers notified degradation of these groves across the country India due to several reasons including modernization, poor information transfer from gatherers to decision makers, changing socio-economic condition, education and financial support for conservation initiatives [19]. To rejuvenate and conserve the cultural cum ecological uniqueness of sacred grove, ecosystem service valuation based economic inducement and spreading information to concerned stakeholders might be one of important tool. Therefore, in order to make people sensitize about the landscape's economic as well as ecological and cultural significance research on these landscapes should be undertaken at micro level. The present study in Tarkeshwar sacred grove has been attempted

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to identify the water as forest's ecosystem service and to evaluate the willingness to pay of local people to conserve the Tarkeshwar grove. Moreover, their perception regarding change in sacred grove environment, conserve their forest as well as to protect their water source coming out of the grove.

MATERIALS AND METHODS

The State of Uttarakhand is situated in the northern part of India and shares an international boundary with China in the north and Nepal in the east. It has an area of 53,483 km^2 and lies between latitude 28° 43′ and 31° 28′ N and longitude 77° 34′ and 81° 03′ E. The State has a temperate climate except in the plain areas where the climate is tropical. The average annual rainfall of the state is 1550 mm and temperatures range from sub-zero to 43°C [20]. Of the total geographical area of the state, about 19% is under permanent snow cover, glaciers and steep slopes where tree growth is not possible due to climatic and physical limitations [20]. The recorded forest area of the State is 34651 km^2, which constitutes 64.79% of its geographical area [20].

The present study was conducted in sacred grove of Uttarakhand i.e. Tarakeshwar sacred grove. Tarakeshwar is located in Pauri district (N 29° 50′ 30″ to E78° 47′ 31.6″) at an elevation of 1779 m to 1834 m above MSL. This Sacred Grove is dedicated to deity Shiv Sankar (Mahadev). It covers an area of about 20 hectares (Fig 1).

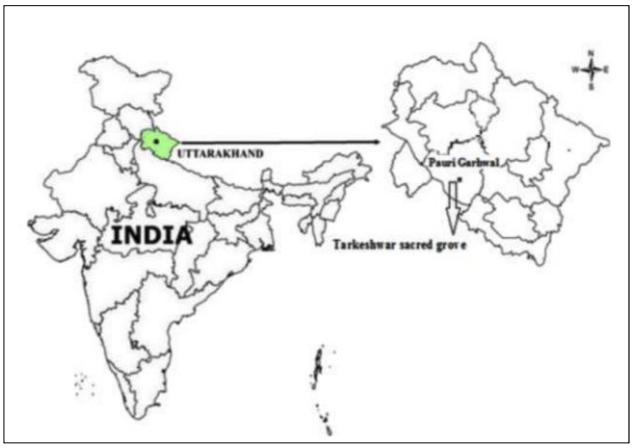

Fig 1 Study area

In Tarkeshwar sacred grove area under Pauri district having population of 6.81% of Uttarakhand, the upper region of the grove is forested land having dominancy of *Cedrus deodara* G. Don forest mixed with *Pinus sp*. L. and *Quercus sp.* L. The middle and lower part having sparsely populated villages with little agriculture practice. The study area is stratified on the basis of the infrastructure and developmental aspect. Villages such as Gamlagao, Agrora, Gundalkhet, Ghotla, Pastmalla, Pastatalla, Jhangoria, Jugunia, Chaura and Malara etc. are under Tarkeshwar sacred grove region.

Sampling

The villages surrounded by sacred groves were divided into two groups for fair assessment of WTP of villagers. viz. i) nearby villages and ii) faraway villages. The nearby villages comprising the villages located in the periphery of the sacred grove and have distance of 5-6 km away from sacred grove whereas the faraway villages comprising both the villagers residing far away from Tarkeshwar sacred grove (10 km away) or have migrated from villages but often visit their villages during festivals. The survey was carried out by the authors by face-to-face interview with the head of household during 2013-2014. A total of 107 respondents were randomly interviewed from 18 villages representing core villages, nearby villages and faraway villages for better understand regarding the people's perception regarding their willingness to pay to conserve their sacred site as well as forest and water source. Detail geographical location has been given in (Table 1).

Valuation method

The water as forest ecosystem service of Tarkeshwar sacred grove has no direct presence in the market and hence it has been quantified by using contingent valuation method (CVM). Due to its flexibility CVM is considered as one of most widely used non-market valuation techniques used to estimate economic values for all sorts of ecosystem services [21]. All respondents were interviewed individually and their responses kept confidential which prevents the biasness due to influence of others' responses. In the present study people were asked about the amount of money they would like to pay as their willingness to pay (WTP/HH/Year) for the water ecosystem service provided by the sacred grove. To calculate the WTP/year/household most of villagers were answered that they were unable to spend liquid cash but they can provide free labour for several days in a year cutting their usual contract provided by Government through MGNREGA scheme [22]. Therefore, the respondents were asked "For how many days in a year you can provide free labour being absent in your usual work place"? Considering their reply, the days were multiplied by a fixed labour wages for Tarkeshwar region as per MGNREGA scheme (Rs. 156/day) and accordingly Willingness to pay per household per year has been calculated. Collected data were coded, cleaned and finally analysis was carried out by using Statistical Product and Service Solutions version 16.

Regression analysis model for willingness to pay

To show the extent of influence of several different socio-economic factors such as age, income, education, village types, household member number (independent variables) on WTP and WTA for forest ecosystem service specially in case of water (dependent variables) a linear regression model has been formed and tested. The model is a dummy variable regression model. For village type (Nearby villages are demarcated as "0" and faraway villages are demarcated as "1") and respondent's gender (Male is demarcated as "0" and female is demarcated as "1"). The model can be specified in the following equation form:

$$WTP/year = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad \text{..... (1)}$$

$$WTA = \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 \quad \text{..... (2)}$$

X_1 represents years of school attended by the respondents
X_2 stands for respondent's age and
X_3 represents household member number
β = constant

RESULTS AND DISCUSSION

In the study area 107 households out of 18 villages were surveyed to collect data on Willingness to Pay (WTP) and Willingness to Accept (WTA) of local dwellers. WTP was in order to save their sacred forest which is their sole source of daily needed water during lean season as well as to save their deity and culture. The average age of respondents was 46 (maximum 87 and minimum 19) and most of the respondents'

age was more than 20. In the study area average persons per household was 5 (maximum 10 and minimum 1) and average household income was Rs. 7985.98/month (maximum Rs. 50,000/ month and minimum Rs. 1000/ month) (Table 1). Among several income sources of local dwellers important were government job, army service, wage labor, private job etc. Most of them have agricultural land but due to unavailability of enough free-flowing water and wild animal interference, half of their lands have become unproductive and local dwellers have switched their earning source instead of depending solely on agriculture. Even for their own household most of them also buy food stuffs including raw materials from market. Education of local dwellers also varied to some extent. There reside illiterate people to people having highest (Master's) degree) education but most of them have studied up-to secondary level. After data compilation and analysis, the result showed that villagers were aware regarding the importance of the presence of sacred grove.

Table 1 Geographical details of the surveyed villages around Tarkeshwar sacred grove

Village type	Village name	Latitude	Longitude	Elevation (m)
Nearby Village	Gamlagaon	$29^0$50'1.5"	$78^0$46'47.2"	1711
Nearby Village	Agrora	$29^0$50'18.3"	$78^0$46'58.9"	1636
Nearby Village	Gundel khet	$29^0$49"51.32"	$78^0$47'4.28"	1842
Nearby Village	Pasta Malla	$29^0$50"27.3"	$78^0$46'23.8"	1535
Nearby Village	Pasta Talla	$29^0$50'55.2"	$78^0$46'20.8"	1389
Nearby Village	Guilyani	$29^0$50'45.1"	$78^0$48'15"	1475
Nearby Village	Jhangoriya	$29^0$50'27.3"	$78^0$45'53.4"	1544
Nearby Village	Ghotla	$29^0$49'28.1"	$78^0$47'42.7"	1646
Nearby Village	Malara	$29^0$50'38"	$78^0$48'45.1"	1689
Nearby Village	Wadda	$29^0$50'58.88"	$78^0$47'53.34"	1490
Far away Village	Jugunya	$29^0$51'6.3"	$78^0$49'2.4"	1391
Far away Village	Chowra	$29^0$50'48.8"	$78^0$49'13.2"	1416
Far away Village	Nunera	$29^0$49'5.24"	$78^0$47'48.08"	1502
Far away Village	Angni	$29^0$49'35"	$78^0$48'7.15"	1473
Far away Village	Bandun	$29^0$51'15.19"	$78^0$47'77"	1278
Far away Village	Babina	$29^0$51'37.85"	$78^0$47'42.81"	1395
Far away Village	Khaneta Talla	$29^0$49'17.94"	$78^0$49'28.69"	1419
Far away Village	Bulekha	$29^0$50'20.62"	$78^0$49'47.2"	1521

While the villagers were asked about their willingness to pay in order to protect the sacred grove forest, 100% villagers replied they are ready to pay for it. Average WTP was Rs. 03802 /year / household to protect the sacred forest as well as the source of water, energy and livelihood. Though in each case the payment mode was not exclusively in terms of money but in several other modes like 100% of them were ready to give free labor in order to provide protection, also they were ready to provide meal, tea snack to the labor, if protection activities are undertaken by government. When the villagers were asked about their Willingness to accept money from government as to compensate the forest and the local dwellers, their average demand was Rs. 38224 (maximum Rs. 100000 and minimum Rs. 15000) (Table 2).

Table 2 Demographical survey of all surveyed villages surrounding sacred groves

	Factors* (N=107)					
	HHM	INC	YS	Rage	WTP/HH/year	WTA
Average ± SE	5 ± 0.185	7985.98 ± 736.498	12 ± 4	43.55 ± 1.626	3802.08 ± 143.021	38224.30 ± 1448.968
Range	1-10	1000-50000	0-19	19-87	500-7988	15000-100000

HHM = Household member number, INC = household income, YS = Year of school attended by respondent, Rage = Respondent's age, WTP/HH/year = Willingness to pay/household/year, WTA = Willingness to Accept. SE = Standard error
*Shows significance at 5% level

Regression analysis model for willingness to pay

A linear regression model has been formed and tested to illustrate the extent of influence of several different socio-economic factors such as age, income, education, village type, household member number (independent variables) on WTP and WTA for forest ecosystem service specially in case of water (dependent variables) resource. Linear regression analysis shows that the WTP/year depends on respondent's age, their year of schooling and household's member number (Table 3). WTA was significantly varied between male and female respondents. In determining WTA respondents' age, their year of schooling and type of villages based on distance from sacred grove were significant factors for the water as forest ecosystem service in Tarkeshwar sacred grove based on linear regression analysis which was constructed and tested as per equation 2 (Table 3).

In this study WTP and WTA were combined in a single questionnaire as per [23]. During the survey more male candidates were surveyed because in the surveyed area male residents were much more educated [24] as well as believed to take better decision in economic matter in case of their willingness to pay to protect their sacred forest as well as the source of water. Although in these hills' women folk is more affected by dwindling natural resources viz. fuel wood, water, fodder etc. as these works are carried out mostly by women folk [25], [26].

The most surveyed members were more than 20 in age as at this age they are supposed to have control on their family as well as become aware/ conscious to think about their environment and related issues. They can also actively work in field to protect the forest in case of accidents like forest fire. Based on their average household income per month a very good response beyond expectation has come out of the study. Due to several problems like unavailability of plenty water supply as well as very high rate of land damaged by wild animals, their agricultural crops have been badly affected and hence these lands have turned into infertile grass lands which are currently used as grazing field for domestic animals. Therefore, the villagers have shifted their dependency and occupation to some jobs other than agriculture [27]. There is visible increase in rural non-farm activities as multi-occupation strategy to sustain their livelihoods [28] [29].

Table 3 Regression model for WTP/HH/Year and WTA (based on distance from sacred grove and gender wise)

Value	Model form	Actual model for estimation of WTP/year/HHM	Adj. R^2	F (*p* value)	SE
WTP	Linear (n=107)	WTP/year = (156.564 HHM + 31.461 RA + 131.403 YS)*	0.838	185.943(0.00)	1.63
Village type 1: Villages having distance 5 Km from sacred grove					
WTA Male	Linear (n=32)	WTA = (553.188 HHM + 281.792 Rage + 1717.879 YS)*	0.931	145.772(0.00)	10201.00
	Linear (n=32)	WTA = (305.209 Rage + 1845.549 YS)*	0.933	223.764(0.00)	10080.53
WTA Female	Linear (n=24)	WTA = (795.469 HHM + 303.705 Rage + 1435.129 YS)*	0.941	127.623(0.00)	7688.68
	Linear (n=24)	WTA = (336.5 Rage + 1620.303 YS)*	0.939	186.232(0.00)	7779.79
Village type 2: Villages having distance 10Km from sacred grove					
WTA Male	Linear (n=41)	WTA = 3044.458 YS *	0.78	146.137 (0.00)	22819.27
WTA Female	Linear (n=10)	WTA = (2261.279 HHM+269.952 Rage+977.303 YS)*	0.951	66.163(0.00)	7258.04
	Linear (n=10)	WTA = (351.806 Rage+1464.77 YS)*	0.95	96.866(0.00)	7325.30

*Shows significant at 5% level

YS = Year of school attended by respondent, RG = respondent's gender, RA = respondent's age, HHM = household member number

Education was very important factor in determining both WTP and WTA of Tarkeshwar region. As the education increases, the awareness and realization of people regarding the significance of natural resource conservation also increases (specifically in case of ecosystem services) because education helps them to learn how to appreciate and value the services from social and ecological view-points. It is also worth to point out that people based on scientific understanding rather than being influenced by religious values only, become bit more rational in case of attributing values to ecosystem services. For these reasons' education became important factor to determine both WTP and WTA at Tarkeshwar region. Apart from education, age of respondent was also important factor to determine both WTP and WTA. With increase in age, rational thinking, experience and also viewpoints in terms of clarity and scale get increased. Therefore, age also has important influence on both WTP and WTA. Gender also influenced the WTP and WTA of Tarkeshwar region. Male respondents have higher education than female respondents and they are the main earning member of their family. Therefore, due to have higher education they can think in more synchronized, organized and technical way to pay willingly to protect the sacred forest. Household member of a family also affects the WTP of that household [30]. With increase in number of family member in a household the average expenditure also increased per family member leading to strains on income/services. Therefore, there is a tendency to pay lesser amount as WTP when the numbers of family members are higher. Similarly, income of the household also has impact on WTP. In the study area most of the villagers declared that they cannot spend liquid cash as WTP. Instead, they agree to provide free labour towards the well-being of the sacred grove.

WTA was significantly varied between male and female respondents. Male respondents have higher education than female respondents and they are the main earning member of their family [31]. Therefore, their higher education may give them opportunity to think in more synchronized, organized and technical way to demand money as compensation for the sacred forest.

Most of villagers' perception is that the environment of the sacred grove has changed. [32] and [33] stated that Orans (sacred groves of Rajasthan) of Shekhala village are becoming degraded as a result of peoples' changing attitude towards conservation of biodiversity. In the sacred grove of Karnataka due to developmental activities there is visible and considerable change in the physical extent, vegetation structure and nature of worship in sacred grove. Villagers also think that the changed sacred grove environment has been affecting their daily lives. For this reason, they think of paying money in order to protect their forest and save their energy. From the education point of view, it is worth to mention that most of the people have education at least up to secondary school. Therefore, it was obvious that they would feel for the protection of their forest and will understand easily that in order to get water year-round there is need to protect their forest. There was no association of the willingness to pay response with income and in reality, there is no association between them [34]. The selection of sample has been proved right from the responses out of questions related to sacred

grove environmental change, effect of the changes on individual family, need to protect the environment and should be compensated or not etc. Moreover, their very good response in their willingness to pay in order to protect the forest as well as source of water was not only in terms of money but also by providing their labour proved that the villagers were strongly aware of global environmental climate change and upcoming difficulties. Also, from their responses it was obvious that they were keen to protect their sacred forest not only to protect their cultural site but also to protect their livelihood, energy and water source. On the other hand, that may be due to respondent's over estimation of their willingness to pay [35]. Willingness to accept was higher than willingness to pay [36]. When compared within coniferous forest, the WTP/person/year for *Cedrus deodara* G. Don. forest was lower than *Pinus sp.* L. forest [37]. The reason may be due to a larger number of ecosystem services provided by those studied forests (both Pinus sp. L. and Quercus sp. L. forest). Above all, villagers think that the sacred grove must be protected at any cost. Many of them think that it is their responsibility to take care of their sacred grove, others think by the intervention of Government the protection could be much better. The villagers of Rajasthan have also realized that as the forest belongs to them therefore, it is their duty to protect the forest themselves [38].

CONCLUSIONS

Education, age and gender play significant role in determining both WTP and WTA of Tarkeshwar region. Distance does not have any effect on WTP but has effect on WTA. Number of household member of a family also affects the WTP and WTA. More or less villagers are well aware of forest degradation and changing environmental condition of sacred forest. They are sincerely interested in up gradation of the forest condition as well as in conservation of their forest for the sake of their own well-being.

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