

An ecological economic valuation of forest ecosystem in Dindigul District of Tamil Nadu, India

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Abstract

Objectives: To evaluate the total economic value of hill ecosystem by studying the direct, indirect, optional, existence values and the ecotourism.

Methodology: Direct use values were analysed using hill area, timber production, non-timber hill products, recreational value and employment generation. Indirect use value was measured with replacement cost. Option value was measured as the ratio of the usable income to the present use value. Contingent valuation was used to study the Existence value of the hill ecosystem. Travel cost was estimated by fitting the semi log function for consumer surplus estimation.

Findings: Sirumalai hill had higher direct use value of 311.22 lakh rupees as compared to Palani hill with 89.77 lakh rupees and it was higher by 246.68%. Sirumalai hill had higher indirect use value, option value and existence value than the Palani hill by 33.31%, 10.59% and 10.19% respectively. Sirumalai hill thus had higher total economic-ecological value than the Palani hill by 10.09%. Consumer surplus per trip per person was estimated as the inverse of the travel cost coefficient and it was ₹3704 for Sirumalai hill. The number of visits undertaken per person was 4 for Sirumalai hill and hence the consumer surplus per annum per person was ₹14816. Taking into account the number of persons visiting the site, the estimated total consumer surplus for Sirumalai hill was ₹86.90 crores.

Application: Such a comprehensive ecological- economic evaluation of hill ecosystem and application of travel cost model was not carried out in Tamil Nadu and the study is a novel one.

Keywords: Direct use value, indirect use value, Option use value, Existence value, Consumer surplus and Travel cost

1. Introduction

The forest cover in the state is 26281 sq km which is 20.21% of the state's geographical area. In terms of forest canopy density classes, the state has 3672 sq km under very dense forest, 10979 sq km under moderately dense forest and 11630 sq km under open forest. The recorded forest area of the state is 22877 sq km which is 17.59% of the state's geographical area. The Reserved, Protected and Unclassed Forests are 88.70%, 7.79% and 3.51% respectively of the recorded forest area. The total carbon stock of forests in the state is 229.338 million tonnes (840.906 million tonnes of CO₂ equivalent) which is 3.24% of total forest carbon of the country. A net increase of 73 sq km in the forest cover of the state can be attributed to plantations and conservation efforts within Recorded forest areas. The negative change observed in some areas is mainly due to harvesting of trees outside forests and developmental activities.

The total forest cover of Dindigul district in Tamil Nadu as per the 2017 Assessment is 1876 Square kilometre in the total geographical area. Forest plays important role in providing fuel –wood, fodder, timber and paper generate pressure on forest resources which in turn triggers deforestation. Therefore, there is a need for appropriate valuation of forests to account for the benefits and costs involved in conservation and maintenance of forest cover while considering the scope for compensation. And also Tourism plays a pivotal role in the socio-economic and cultural development of any economy. The main economic impact of tourism includes its contribution to the government revenue, and creation of employment, along with the creation of new business opportunities, improvement in the standard of the living.

The present study is proposed on Ecosystem valuation through different environmental valuation techniques for Palani and Sirumalai forests and Ecotourism services for Sirumalai hill. The present study was undertaken in Forest Ecosystem of Dindigul district of Tamil Nadu, India with the following objectives.

1. To evaluate the total economic value of hill ecosystem by studying the direct use value, indirect use value, future use value or option value and existence value.
2. To study the ecotourism in hill ecosystem.

2. Methodology

1. Choice of the study area

Dindigul district was purposively selected for the present study in the first stage which has 22.17 per cent of hill area to the total geographical area of Dindigul district. In the second stage, Palani and Sirumalai hills were purposively selected for the present study as a result of more hill cover having 18463 and 13988 sq.km respectively. Five villages were selected randomly from each hill for this study. Villages in Palani hill included Puliyampatti, Neikkarapatti, Balasamudram, Iravimangalam, Pushpathur villages. Villages in Sirumalai hill included Pudhur, Palaiyur, Velanpannai, Thalakadai and Thavittukadai villages. From each selected village, 12 farmers were selected at random and thus the total sample size was 120 and hence multi stage sampling technique was adopted for the study. In order to study the travel cost of Sirumalai hill, 30 respondents were randomly selected.

2. Tools of analysis

1. Production change method

The production change method included outcome 'q' quantifiable examples that is exchanged in market with the price of 'p'. The productive services of the difference in contribution of factors are the value of the production change that would lead it at sustained factor than other inputs. In [1] quantified the Direct Use Values (DUV) of Paralakhemundi forest division. In this study, benefits obtained from both Palani and Sirumalai hills were analysed using hill area, timber production, and quantity of non-timber hill products, recreational value and employment generation of both the Palani and Sirumalai hills.

2. Replacement cost method

This is the cost incurred to replace damaged asset, not avoiding the damage but certainly this will occur. E.g. for deterioration of groundwater resources, replacement cost is developing alternative water sources. In the Present study, indirect use value of Palani and Sirumalai hills was measured with this method. In [2] used the replacement cost method to measure the indirect use value of Paralakhemundi forests by using six environmental services with the value of ₹15.7 lakhs in 1980-81 prices and by applying organic matter of 9 tonnes per hectare. The results showed that indirect use value of Paralakhemundi forests accounted ₹65099 lakhs.

3. Contingent valuation technique

Contingent valuation method was used to study the Existence value of the hill ecosystem in both Palani and Sirumalai hills. Contingent Valuation method is the highly used method of assessment of personnel's which is mainly for the increment in the particular good/services or reduction in the quantity of resources/services which is contingent upon a hypothetical market. It is a one of the procedure in order to create a monetary value in economic terms which is for a particular good or services through asking people willingness that they are ready to pay for those goods/services. Using this method, determination of range of payment that they are ready to pay or ready to accept the compensation for the degradation of any resources or services can be possible. This is the method of valuing the positive and negative effects of particular environment. It is mainly based on obtaining willingness to pay using interview method by the demanders, who declare their desire found on their income and other aspects. Contingent valuation method is concerned with questioning people who are WTP for the advantage of any resources.

In [3] used contingent valuation technique and showed that the amount of Willingness to Pay of ₹1800 per annum for seriously affected farmers which were high in both Avaniyapuram and Sakkimangalam because of more pollution in these areas. Further, for the economic valuation of hill ecosystem, details on timber production, hill cover, and quantity of non-timber products and revenue were collected from District hill division, Dindigul, Hill Survey of India 2017 and Tamil Nadu Tourism Development Corporation.

4. Travel cost model

This method is used for valuation of environmental amenities. This method decides demand for a plot based on variables like consumer, income, price and socio-economic attributes. Price is the amount of perceived cost components like entrance price to the plot, cost of traveling to site and foregone earnings or opportunity cost of time spent. Consumer surplus related with demand curve yields measure of value of recreational site. The demand for recreational hill takes the semi-log form, where V_r is the expected number of trips, t_c is the travel costs per trip, and X_n represent other individual characteristics (independent variables) that might affect demand for recreational trips. In [4] used the travel cost method and the consumer surplus per trip per person was Rs. 5000 for mangrove forest and ₹1111 for silver beach.

$$V_r = \beta_0 + \beta_1 t_c + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \beta_n X_n$$

$$CS = -1/\beta_1 t_c$$

Regression

$$\text{Visit} = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + U_1$$

Y = Number of visit per year

X_1 - Travel cost (in Rs./family) which included

1. Entry fee (in Rs./ family)
2. Expenditure (in Rs./family)
3. Loss of pay on the day of tourism (in Rs./ family)

X_2 - Size of group

X_3 - Distance from native (kilo meter)

X_4 - Annual income of tourists (in Rs)

3. Results and Discussion

3.1. Ecosystem valuation through different environmental valuation techniques

Forests plays important role in providing different environmental functions which could be measured with Total Economic Value (TEV) which comprises of direct use value, indirect use value, option value and existence value. These environmental valuation techniques for Palani and Sirumalai hills are presented in this section.

1. Direct use value

The direct use value of Palani and Sirumalai hills included value of timber, non-timber hill products, employment and recreational value.

Timber: It could be noted from the table that value of timber production was assessed using average production of timber and forest gate price of timber for both Palani and Sirumalai hills. Mean annual increment value was 0.79 cum per hectare per year for Palani and Sirumalai hills which was taken from Forest Survey of India, 2017. Net incremental value was 0.50 cum per hectare per year which equals to 63 per cent of mean annual increment value of both hills. Actual forest cover of Palani and Sirumalai hills was 18463 and 13988 hectares respectively. Possible wood production was the product of net incremental value and forest area which were 9232 cum per year and 6994 cum per year for Palani and Sirumalai hills respectively. Sustainable timber component was 40% of possible wood production which were 3693 cum per year and 2797 cum per year for Palani and Sirumalai hills respectively. Forest gate price of timber value was ₹6130 Rs/cum for both hills during 2018. Value of potential timber was calculated using the product of sustainable timber component and forest gate price of timber which accounts ₹226.38 and 171.46 lakh rupees of Palani and Sirumalai hills respectively. Value of current timber output was ₹28.11 lakh rupees and ₹21.29 lakh rupees for Palani and Sirumalai hills. On comparison of both the hills, Palani hill had higher timber output than the Sirumalai hill by 32.03%.

2. Non-timber hill products

Firewood: The value of firewood was calculated using maximum possible firewood production (60 per cent of wood production) and Ex-forest price of firewood during 2018 for both Palani and Sirumalai hills which were ₹59.48 lakh rupees and ₹45.07 lakh rupees.

Other Non-timber hill products: Nelli, Gall nut and Bodghai grass accounts ₹47265 and ₹35742 of Palani and Sirumalai hills respectively. Tamarind accounts ₹12001 and ₹9142 of both Palani and Sirumalai hills. The total other Non-timber hill products were ₹59266 and ₹44884 of Palani and Sirumalai hills respectively.

3. Employment generation

There was no direct employment for the tribals in Palani and Sirumalai hills. Self-employment generation by providing loans through Joint Forest Management Programme only helps to increase income of tribals which accounts ₹1.59 lakh rupees and ₹1.21 lakh rupees of both Palani and Sirumalai hills respectively.

4. Recreational value

Recreational value of Sirumalai hills were calculated by multiplying number of tourists per annum with per capita expenditure of tourists. Number of tourist per annum was 58720 for Sirumalai hills. Per capita expenditure was ₹450 for Sirumalai hills and the recreational value of Sirumalai hill was ₹264.24 lakh rupees. The recreational value exercise was not attempted in the study in Palani hill since no tourist spot is found in Palani hills and hence no visitors are coming to Palani hills for scenic beauty.

5. Total direct use value

It was delivered from the table that Recreational value occupies higher amount of ₹262.24 lakh rupees among all other values in Sirumalai hills by 79.53% and there was no recreational value for Palani hills. Value of firewood had the next highest contribution with ₹59.48 and ₹45.07 lakh rupees of Palani and Sirumalai hills respectively and Palani hill had higher firewood value than the Sirumalai hill by 31.97%. Timber value occupied the next position for Palani and Sirumalai hills with a proportion of ₹28.11 and ₹21.29 lakh rupees of respectively and Palani hill had higher timber value than the Sirumalai hill by 32.03%. Employment generation value accounts ₹1.59 and ₹1.21 lakh rupees of Palani and Sirumalai hills and said value is higher for Palani hill than the Sirumalai hill by 31.40%. Value of other Non timber hill products such as, Nelli, Gall nut, Bodghai grass and tamarind occupied least proportion which was about ₹0.59 and ₹0.45 lakh rupees for Palani and Sirumalai hills and it differs by 31.11%. On comparison of both hills, Sirumalai hill had higher direct use value of ₹311.22 lakh rupees than the Palani hill of ₹89.77 lakh rupees and it is higher by 246.68%.

Table 1. The indirect use value of Palani and Sirumalai hills in lakh Rs

Environmental services	Value of a tree of 50 tonnes over 50 years		Palani hill		Sirumalai hill	
	1980	and 2018 (Rs.'000)	Value/ha /year	Value/yr (after application)	Value/ha /year	Value/yr (after application)
Production of oxygen	250	4370	237	2106	312	2808
Conversion of animal protein	20	348	19	171	25	225
Controlling of soil erosion and soil fertility	250	4370	234	2106	312	2808
Recycling of water and controlling humidity	300	5242	281	2529	375	3375
Sheltering of birds, squirrels, insects and plants	250	4370	234	2106	312	2808
Controlling of air pollution	500	8737	469	4221	625	5625
Total IUV	1570	27437	1471	13239	1961	17649

6. Indirect use value

The indirect use values of Palani hill and Sirumalai hill is given in the Table 1. It could be observed from the table that indirect use value included estimates of production of Oxygen, conversion of animal protein, controlling of soil erosion and soil fertility, recycling of water and controlling humidity, sheltering of birds, squirrels, insects, plants and controlling of air pollution. Replacement cost method was used to measure the indirect use value. In [2] has estimated the money value of six environmental services of medium sized trees using experimental data and applying the replacement cost method which accounted for ₹15.70 lakhs in 1980-81 prices. Using these environmental services and by applying 9 tonnes of organic materials per hectare to the estimations of, the indirect use value was calculated in 2018 prices for both Palani and Sirumalai hills which accounted for ₹13239 and ₹17649 per hectare respectively. On comparison of both the hills, Sirumalai hill had higher indirect use value than the Palani hill by 33.31%.

7. Future use value (or) Option value

Option value can be measured by using the formula $U/V=1-1/(1+r)^{n+1}$ which means that ratio of the usable income (U) to the present use value (v) is a function of the rate of discount and the assumed life of hills [5]. In [1] used social discount rate as 5% and the life expectancy of hills as 30 years and stated that option value amounts to 22% of the present use value. The present use value of Palani and Sirumalai hills was ₹2534 and ₹2801 lakh rupees respectively. By using these present use values, Option value accounts ₹557 and ₹616 lakh rupees for Palani and Sirumalai hills respectively. On comparison of both the hills, Sirumalai hill had higher option value than the Palani hill by 10.59%.

8. Non-Use value or Existence value

Contingent valuation technique was used to study the non-use value (or) existence value of Palani and Sirumalai hills. Willingness to pay (WTP) for the existence of hills in Palani and Sirumalai hills was ₹856 and ₹1051 per year per person respectively which is based on the survey of 60 respondents from each hill. Hence, the total Existence value of Palani and Sirumalai hills was ₹74.60 and ₹67.70 lakh rupees respectively which were computed for the whole area of both the hills.

9. Total Economic - Ecological value

Economic-Ecological Value of Palani and Sirumalai hill was ₹3165.68 lakh rupees and ₹3485.00 lakh rupees respectively. Indirect use value of Palani and Sirumalai hill was ₹2444.31 lakh rupees and ₹2468.74 lakh rupees which were high among all use values and the said value for Sirumalai hill was higher than Palani hill by 0.99%. Secondly, Future use value was next higher and it was high in Palani hill with ₹557.00 lakh rupees than the Sirumalai hill with ₹616 lakh rupees by 10.59%. Direct use value followed next and it contributed to the total economic value which was ₹89.77 and ₹332.26 lakh rupees of Palani and Sirumalai hill and it was higher for Sirumalai hill than the Palani hill by 270.12%. Non-use value contributed last to the total economic-ecological value but it is the important value for any forest ecosystem which was ₹74.60 and ₹67.70 lakh rupees of Palani and Sirumalai hills respectively and the said value for Palani hill was higher than the Sirumalai hill by 10.19%. On comparison of both the hills, Sirumalai hill had higher total economic-ecological value than the Palani hill by 10.09%.

Table 2. Travel cost of tourists for Sirumalai hill

S. No.	Cost	Sirumalai hill
1	Travel expenditure (₹)	590.00 (60.95)
2	Entry cost (₹)	0
3	Wage loss(₹)	378.00 (39.05)
4	Total	968.00 (100.00)

3.2. Ecotourism in Sirumalai hill through travel cost model

The estimates of the travel cost incurred by the tourists visiting the Sirumalai hill are presented in Table 2. It could be depicted from the table that the travel cost incurred by the tourists visiting Sirumalai hill was ₹968 per visit. The travel cost included the travel expenditure, entry cost and wage loss.

Of the total travel cost, travel expenditure accounted for the highest proportion with 60.95% followed by wage loss with 39.05%. There was no entry cost for Sirumalai hill.

1. Semi log function

Consumer Surplus per trip was estimated first by fitting semi-log function and then estimating it as the inverse of the travel cost coefficient. The estimated semi log function for Sirumalai hill is offered in the Table 3. It could be observed from the table that distance from native negatively influenced the number of visits(Y) for Sirumalai hill which implies that as the distance from native increases, the number of visits to the tourist spots decrease. On the other hand, size of group of tourists and annual income positively influenced the number of visits for Sirumalai hill.

Table 3. Semi log function for Sirumalai hill

S. No.	Variable	Sirumalai hill
1	Regression coefficient	0.47*
2	Travel cost	-0.00027
3	Size of group	0.35**
4	Distance from native	-0.005*
6	Annual income	0.0000045**
7	R ²	0.81
8	$\overline{(R^2)}$	0.90

2. Estimation of consumer surplus

The results of consumer surplus estimation are presented in Table 4. It could be seen from the table that the consumer surplus per trip per person was estimated as the inverse of the travel cost coefficient and it was ₹3704 for Sirumalai hill. The number of visits undertaken per person was 4 for Sirumalai hill and hence the consumer surplus per annum per person was ₹14816. Taking into account the number of persons visiting the site, the estimated total consumer surplus for Sirumalai hill was ₹86.90 crores. This high amount of consumer surplus for the tourist spot suggested the need of government initiatives for development as a tourist spot.

Table 4. Estimation of consumer surplus

S. No	Particulars	Sirumalai hill
1	Consumer surplus per trip per person (₹)	3704.00
2	Average number of visits/ person	4.00
3	Consumer surplus /annum/ person(₹)	14816.00
4	Average number of persons	58720.00
5	Total consumer surplus (Crores)	86.90.00

4. Conclusion

Sirumalai hill had higher use value of 3485 lakh rupees than the Palani hill of 3165.68 lakh rupees by 10.09%. Indirect use value of Palani and Sirumalai hill was 2444.31 and 2468.74 lakh rupees which were high among all use values and the said value for Sirumalai hill was higher than Palani hill by 0.99%. Secondly, Future use value was higher in Sirumalai hill of 616 lakh rupees than the Palani hill of 557 lakh rupees by 4.87%. Direct use value contributed amount to the total economic value which was 89.77 and 332.26 lakh rupees of Palani and Sirumalai hill and it was higher for Sirumalai hill by 270.12 per cent. Non-use value contributed last to the total which was 74.60 and 67.70 lakh rupees of Palani and Sirumalai hills respectively and the said value for Palani hill was higher than the Sirumalai hill by 10.19%. The consumer surplus per trip per person was estimated as the inverse of the travel cost coefficient and it was ₹3704 for Sirumalai hill. The number of visits undertaken per person was 4 for Sirumalai hills and hence the consumer surplus per annum per person was ₹14816. Taking into account the number of persons visiting the site, the estimated total consumer surplus for Sirumalai hill was ₹86.90 crores. This high amount of consumer surplus for the tourist spot suggested the need of government initiatives for conservation of Sirumalai hill.

5. Policy implications

The total economic-ecological value was high for both Palani and Sirumalai hills with ₹3165.68 lakh rupees and ₹3485 lakh rupees respectively and hence the hill ecosystem should be well maintained and conserved by the Tamil Nadu government. Indirect use value was high with ₹2444.31 lakh rupees and ₹2468.74 lakh rupees for Palani and Sirumalai hills. Also, future use value was high with ₹557 lakh rupees and ₹616.00 lakh rupees for Palani and Sirumalai hills as compared to direct use value of ₹89.77 lakh rupees and ₹332.26 lakh rupees for Palani and Sirumalai hills. The existence value is also significant for Sirumalai hills and Palani hills with ₹67.70 lakh rupees and ₹74.60 lakh rupees respectively. These values are not reflected in market prices but contribute to the ecological soundness of the hill ecosystem. Hence the forest Department should keep it mind and conserve the hill ecosystem. The travel cost model estimated total consumer surplus for Sirumalai hill was ₹86.90 crores and hence the Sirumalai hill could be well developed as a tourist spot by the Tamil Nadu Government.

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