

## LANDSCAPE ECOLOGY OF THE PAMPA RIVERINE ECOSYSTEM

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### Introduction

Rivers from their early existence have played a significant role in molding the development of a region. They provide water to quench thirst, fertilize lands and a means of transportation of goods and services. They also provide a habitat to many living organisms, from planktons to fin and shell fishes. Thus as an ecosystem, rivers have an incredible role to play in maintaining ecological balance. River channels comprise only a small part of a landscape, yet their environmental and economic significance far outweighs their biological value. River systems are recognized to have a number of values, including intrinsic, economic, cultural and aesthetic values. They have economic value in so far as they are scarce and capable of generating human welfare. Failure to account for the ecological and economic value of river systems has led to patterns of economic use with many detrimental environmental consequences.

In spite of the environmental, ecological, cultural, social and religious importance of the Pampa riverine ecosystem, it is one of the most congested and polluted rivers in south India. Over the years, its landscape ecology has changed. Sewage and Industrial effluents, deforestation in the upper catchment areas of the river, sand mining from the river beds (Padmalal, Maya, Sreebha, & Sreeja, 2008), reclamation and construction activities on the river banks have all contributed to changes in the landscape ecology of the Pampa. Increased influx of pilgrims has indirectly influenced the anthropogenic intervention on the ecosystem.

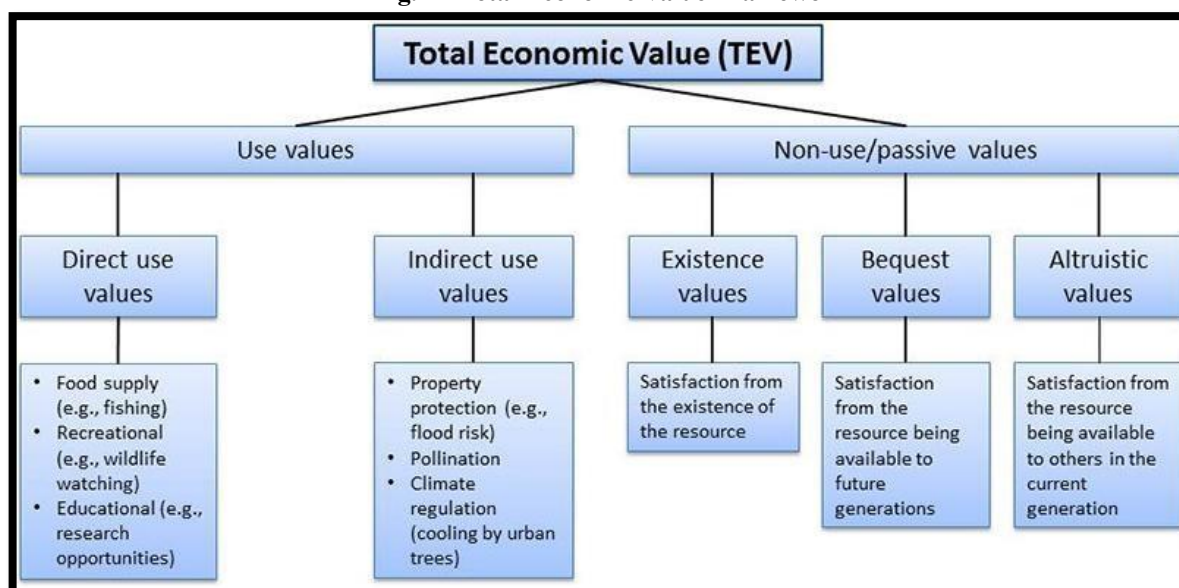
Unless the total economic value of an ecosystem is monetarily recognized, it will never be protected. Policy decisions are most frequently determined on the basis of economic criteria. Yet, it is widely acknowledged that market transactions provide an incomplete picture of the total economic value of any ecosystem. Ecosystem benefits which are not normally exchanged in markets (e.g. flood control, breeding grounds, optional use, existence use etc.) are generally ignored in decision-making. Stakeholders use an ecosystem partially, hence they always tend to undervalue it. Undervaluation introduces inherent distortions to efficient resource allocation and policy decisions regarding ecosystem use. This shapes land use patterns and decisions that change the landscape ecology of a system. Its wholistic value is rarely recognized until the entire system is irrevocably and irreversibly degraded.

In order to improve the efficiency of resource allocation two steps are necessary: an estimation of the total economic values of services provided by an ecosystem and the design of appropriate mechanisms to capture the estimated economic values so that they are internalized in policy decisions. The total economic value of a river ecosystem cannot be accurately estimated since many of the functions it performs do not have a market to value them. Thus, people's value perception of the landscape ecology of a river ecosystem has a great role to play in how the ecosystem is perceived, protected and how its landscape ecology evolves over the years. Greater the value perception, smaller will be the number of unsustainable intrusions and modifications to the ecosystem.

### Material and Methods

The current study aimed at a non-market valuation of the total economic value generated by the Pampa river system. Total economic value is an expression of the total value of the benefits derived from a marginal change in an ecosystem, expressed in monetary terms (Admiraal, Wossink, Groot, & de Snoo, 2013). In the absence of well functioning markets, people's stated preference gives an indication of the immense value of the system to users and non-user who are willing to pay for its conservation. Accordingly, the study attempted an identification of the use and non-use values of the Pampa river system and a non-market estimation of the direct, indirect and non-use values of the Pampa river system.

**Fig. 1 - Total Economic Value Framework**



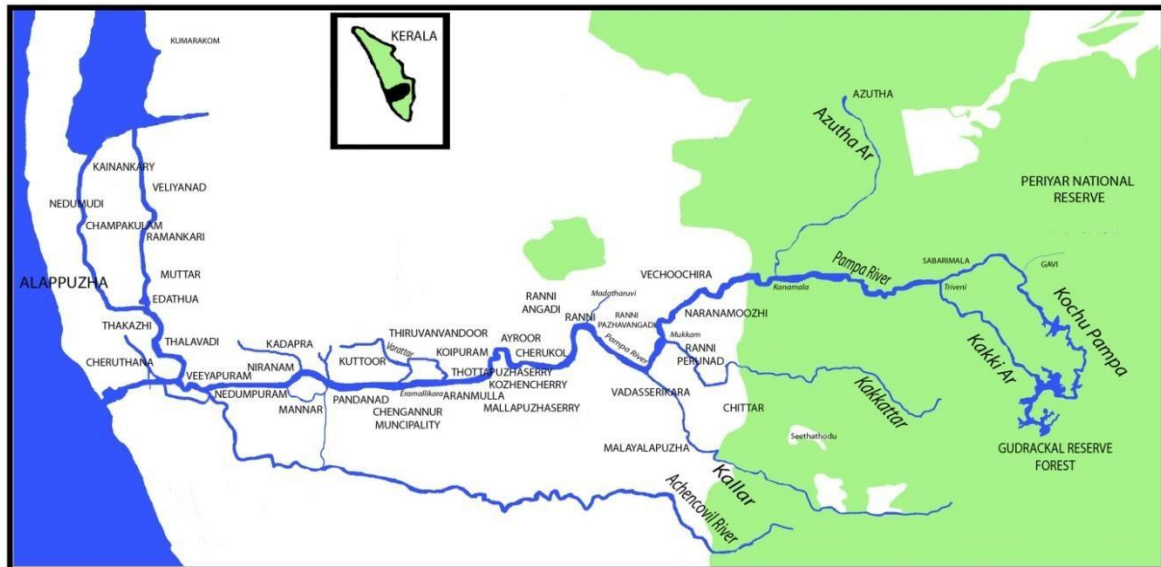
(Federal Resource Management and Ecosystem Services Guidebook , 2016)

The Pamba river system provides diverse forms of livelihood opportunities for a large section of the population both directly as well as indirectly. However, over the years population and developmental pressures have led to huge patches of the river systems being altered or destroyed. Added to this, the overuse and often misuse of the river ecosystem space has contributed to the gradual degradation of the river system. Local populations, directly depending on river system have voiced concern over the declining state of the river system whenever it affected their livelihood activities. The study makes use of a non market valuation methodology called the Contingent Valuation Methodology (CVM) to estimate values for the benefits provided by the Pamba river system. Contingent Valuation (CVM) is a stated preference method in which due to unavailability of any direct means of measurements, a hypothetical market scenario is constructed and presented to the respondents and an interview schedule is used to elicit willingness to pay values from the respondents. The hypothetical nature of the contingent valuation method permits it to obtain monetary values for goods and services rendered by a natural resource, including that for indirect benefits provided (Hoevenagel, 1994).

The amount stated by the respondents in response to the scenario question, according to economic theory, would be representative of the value he/she had for the environmental resource (Pamba ecosystem). It would be equal to what people would be actually willing to pay to avoid a specified environmental damage, to achieve a stated improvement in environmental quality or to receive a specified supply of an environmental good.

Respondents were told that a Consortium of different State agencies and people's representatives were willing to initiate a conservation programme for the Pamba river system with the help of the people. The design, therefore, of the contingent valuation questionnaire, was guided to evaluate the value of river systems conservation for the people by asking respondents for the amount of money that they would be willing to pay to maintain current levels of river systems functions and service provided in contrast to allowing the river system to degrade further. This would give an indication of the value of the indirect benefits performed by the river systems ecosystem to the people. Attitudinal questions were also asked to check whether the willingness to pay estimates stated by respondents were genuine or not. The contingent valuation interview schedule was executed among heads of households/housewives whose age ranged between 25 and 65, randomly selected from 16 panchayats along the riverbanks, from the districts of Pathanamthitta and Alappuzha. According to the Blue Ribbon Panel's testing protocol, a sample size of at least 1,000 respondents is required for a dichotomous choice method. A total of 1,127 personal interviews were administered by trained interviewers in respondents' home during April to August, 2022. Completed questionnaires were checked. Questionnaires with contradictory or erroneous responses were rejected and new sets executed through different interviewers again. The survey yielded 1,000 usable interviews. Enumerators rated 127 as being of poor quality. Both primary and secondary data was used for the study.

Fig. 2 – Map of the Study Area



Regression was fitted to the CVM data using a Multinomial Logit Model with marginal effects. The statistical package *limdep* was used to run the regression and estimate values. Goodness of fit of the model was explained using pseudo  $R^2$ . A lognormal distribution with a spike falling at zero was fitted to the probability distribution (Table 1).

## Results and Discussion

Ecosystem services provided by the Pamba River can be categorized into four: production, information, regulation and habitat. In addition to the direct benefits, the Pamba provides many indirect benefits to the local community such as flood regulation, groundwater replenishment, habitat for biodiversity, aesthetics of landscape and green lung, opportunities for recreational activities, etc. Indirect benefits provided by rivers do not have markets and hence are seldom valued or considered important in the decision-making process.

A lognormal distribution with a spike falling at zero was fitted to the probability distribution. The spike model was estimated using the Maximum likelihood estimation method, the height of the spike representing the probability of having zero willingness to pay (WTP). It was calculated as 0.39 which is very negligible. A probability density function was worked out<sup>1</sup>. A regression was fitted to the data using a Multinomial Logit Model with marginal effects. The statistical package *limdep* was used to run the regression and estimate values. Goodness of fit of the model is explained using *pseudo*  $R^2$ . This was obtained using the formula  $(1 - (\log \text{unrestricted} / \log \text{restricted}))$ . It was estimated as 0.11. The significance of *pseudo*  $R^2$  is given by significance of Chi square statistic (103.5). Table 1 gives the details.

Table 1 - Regression Results for WTP Amounts

| Multinomial Logit Model      |          |
|------------------------------|----------|
| Maximum Likelihood Estimates |          |
| Dependent variable           | WTPDUMMY |
| Weighting variable           | ONE      |
| Number of observations       | 1000     |
| Log likelihood function      | - 448.51 |
| Restricted log likelihood    | - 511.8  |
| Chi-squared                  | 103.5    |
| Degrees of freedom           | 11       |
| Significance level           | .0000000 |

Source: Calculations from Primary Data

Table 2 below gives regression results of estimated WTP on selected environmental and socio- economic variables. It can be seen that education was not significant (as the probability column shows). All the respondents were aware of the true value of the Pamba and were willing to pay for its rejuvenation irrespective of educational qualification. Gender was also insignificant. Age had very little impact on WTP and was negatively related to probability of WTP. As age increased by 1 unit, the probability of WTP decreases by 0.27 percent. Coefficients of all income dummies were significant at 1 percent level. All the coefficients explained above are based on the marginal effects coefficients obtained in the last column.

**Table 2 - Regression Results of Estimated WTP on Selected Environmental and Socio- Economic Variables**

| Variable | Coefficient | Standard Error | b/St.Er. | P  Z >z Significance | Mean of X | Marginal Effect |
|----------|-------------|----------------|----------|----------------------|-----------|-----------------|
| EDUDUM1  | 0.1396      | 0.3123         | 0.672    | 0.563                | .30011    | - 0.015         |
| EDUDUM2  | 0.2121      | 0.1945         | 0.786    | 0.3698               | .5534     | 0.0269          |
| INCOME1  | 1.2427      | 0.2951         | 3.432    | 0.0003               | .1095     | 0.1567          |
| INCOME2  | 1.1756      | 0.3015         | 3.874    | 0.0002               | .3378     | 0.1456          |
| INCOME3  | 1.1381      | 0.3104         | 3.812    | 0.0003               | .3592     | 0.1376          |
| INCOME4  | 1.1111      | 0.2970         | 3.899    | 0.0001               | 0.300     | 0.1456          |
| INCOME5  | 4.1263      | 0.6912         | 5.321    | 0.0000               | .1278     | 0. 5421         |
| GENDER   | - 0.191     | 0.2023         | - 0 .93  | 0.3295               | .7245     | - 0.021         |
| AGE      | - 0.022     | 0.0069         | - 3.21   | 0.001                | 39.34     | - 0.002         |
| OCCUDUM  | 0.5652      | 0.2665         | 2.189    | 0.0276               | .1364     | 0.0734          |

Source: Primary Data, 2022

Protest bids were also observed. This was reflected in people's attitudes toward paying for a public good change, paying for public goods in general and a component that is independent of these attitudes but unique to particular beliefs about paying (Jorgensen, Wilson, & Heberlein, 2001). 19.8 percent of the total 1000 samples were unwilling to pay anything towards Pamba river systems management although 95.7 percent of them agreed that river systems functions were of value to mankind.

Approximately 80.2 percent of the respondents were willing to contribute. The study estimated a mean monthly Willingness to Pay (WTP) of Rs.266 while Median willingness to pay (WTP) was estimated as Rs. 150. Table 3 gives the details.

**Table 3 - Willingness to Pay Estimates**

| Annual Income (Rs.) | Percentage of Respondents (%) | Mean WTP (Rs.) |
|---------------------|-------------------------------|----------------|
| < 5,000             | 29.7                          | 152.7          |
| 5,000 - 10,000      | 34.0                          | 242.4          |

<sup>1</sup>

The probability density function worked out for the WTP variable was:

$$f(y) = \frac{1}{\sqrt{2\pi} \cdot (1.8610)} e^{-\frac{(y-3.4563)^2}{2(1.8610)}}$$

|                   |            |              |
|-------------------|------------|--------------|
| 10,000 – 50,000   | 19.3       | 259.3        |
| 50,000 – 1,00,000 | 7.8        | 288.0        |
| > 1,00,000        | 9.1        | 391.1        |
| <b>Total</b>      | <b>100</b> | <b>266.7</b> |

Source: Primary Data, 2022

As is commonly seen in contingent valuation studies, mean took on a higher value than median. To test the validity of contingent valuation responses, the attitudinal and perception questions were checked to perceive whether the estimated parameters had signs that conformed to prior expectations and found to be so.

### Summary and Conclusion

The study estimated a mean Willingness to Pay (WTP) of Rs.266 per month. In a region where average daily wages centre around Rs.700, this is low. The analysis of the attitudinal and perception questions showed a very high degree of environmental awareness and consciousness among the respondents. Although people acknowledge the benefits provided by the Pampa, they are unwilling to pay greater amounts for the protection and continued provision of these benefits. The attitude that it is the Government's duty to protect the ecosystem is widespread. Such value perceptions can only contribute to accelerated speed in the landscape ecology of rivers are changed. Yet, scientific evidence shows that if market mechanisms were to be implemented to replace the provision of functions provided by rivers, the cost involved in the

provision of each individual service would run into crores. Even revenue rich Governments, let alone cash strapped governments would be unable to bear such immense cost.

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