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An Economic Analysis of Dependence of Coastal Community on Mangroves– A Case Study in Batticaloa Lagoon Eastern Sri Lanka

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Abstract

After Tsunami many of the developing countries today are increasingly facing a paradoxical situation in their attempts to seek solutions to the major problem associated with sustainable livelihood of the coastal community. In the Batticaloa district, Batticaloa lagoon has adversely affected due to natural disaster and unplanned human intervention. In spite of it uniqueness of biodiversity globally and contribution to the economy of Sri Lanka, there is an absence of research in conservation and the livelihood dependence of community on the coastal resources. Against this background, present study focuses on three important objectives are: to assess the economic value of the mangroves in the Batticaloa lagoon, to investigate the extent of dependence of coastal community on the Batticaloa lagoon and to assess the coastal community's perception on participatory lagoon management for sustainable livelihood.

Data were collected by using multistage random sample from 48 fishermen who depend on Batticaloa lagoon in four Divisional Secretariat Divisions. Questionnaire interview and focus group discussion were used to gather data during April and May 2006. Benefit Transfer method with appropriate amendment was used to assess the economic value of the mangroves in Batticaloa lagoon. The mangroves estimated value calculated to be Rs. 304708 per hectare per year. This value can be considered as a bottom bound of the mangroves. Next to income from fishing, fishermen derive significant (20%) cash and non-cash income from the mangroves for their livelihood. The main sources of mangroves income are prawn and poles for fencing and gardening. Removal of mangroves for security purpose and unsustainable harvesting of prawn and increase intensive fishing activities has lead to falling trend in both total income and environmental income of fishermen. Factors affecting attitude of community participation in participatory lagoon management were incorporated in an ordered probit model. Results reveal that coastal community has a positive attitude towards importance of their participation. However serious doubts about non-compliance, withdrawals, control, exclusion, planning and leadership qualities were raised for actual involvement. Income and education have shown some influence in respect to address these problems. The results have implications for participatory management and show that people participation in mangroves conservation is beneficial to the sustainable coastal community. It has been concluded that intervention of the government has become indispensable to implement strong lagoon ecosystem preservation, make people aware about the environmental values and improve the livelihood through participatory process.

Keywords: Coastal community, Mangroves, Livelihood, Dependency, Participatory lagoon management

Introduction

Sri Lanka's coastal line is heavily affected by sea erosion, which is mainly due to the habitat destruction for industrial and urban development activities, sand mining and coral mining etc. Mangroves protect the erosion of coastal lines, thus preventing the loss of valuable agricultural land and properties. Tsunami provided an opportunity to

demonstrate a truly environmentally sustainable approach to coastal zone development. The total extent of mangroves in Sri Lanka is estimated at 12,000ha. The economic role of mangroves cannot be fully realized without taking into consideration its ecological aspects. Although participatory approaches are now standard elements in natural resource management, in practice they are often problematic.

Eastern Province of Sri Lanka covers a land area of 9,635km^2, has a coastal line of approximately 360km in length and supports a population of approximately 1.42million people, 78% of which are rural. The majority of people make a living through fishing and agriculture. The coastal habitats of the Eastern Province are rich and varied. The one of the main coastal habitat is lagoon, which cover almost 40,000 hectares with sizes varying form small water bodies (15ha) to much larger features such as Batticaloa lagoon which at 14,118ha is the largest logon in the country. Lagoons are important part of the cultural landscape of Eastern Sri Lanka. The Batticaloa lagoon is, perhaps, the most celebrated because of its scenic beauty and the "Singing fish". It extends from Kalmunai in the south to Eravur in the north and opening in to the sea at Batticaloa and Kallar. It is a complex ecosystem with rich variety of aquatic life and mangroves ecosystem of 1,303ha. There are about 3,200 – 3,400ha of mangrove in the Eastern Province representing about 30-35% of the total in the country. However, figures are out of date and it is estimated that at least 15-20% has been lost within the last decades (IUCN 2005). There are about 5,500 fishermen from eight of the 11 Fisheries Inspectors Divisions in Batticaloa. The lagoon is famous for its Crabs and Prawns. It is estimated as 56k.m long seacoast with suitable bays at long intervals coupled with their rivers and the estuaries and the innumerable tanks and water holes provide ample scope for this industry.

The greatest challenge faced by the people of the district is poverty. The majority coastal Batticaloa people are poor and about 70% receive living allowance (Statistical hand Book, Batticaloa, 2004). Poor people are depending in coastal resources like mangrove dependant fishing, prawn harvesting, shell collection, for their livelihood. It is quite evident that mangrove ecosystem provide direct and indirect ecological services

for sustenance of other economic systems was not properly understood and conservation benefits did not receive due attention. Though there is a vast amount of literature existing with regard to the general overview of wetlands and their ecological services, the economic studies relevant to mangroves ecosystem management are very limited. More over, the application of environmental valuation studies relevant to specific mangroves areas of the island is quite few. Apart from the some socioeconomic data relevant to specific mangrove of the island, data, functional relationships, the valuation techniques used for the detailed economic analysis of mangroves are scare.

Results available form post-tsunami surveys show that losses have been greatest in those areas where human activities had already caused habitat degradation. This has made a high realization of ecological restoration and conservation for sustainable livelihood of the coastal communities. The mangroves of in many South Asian countries including Sri Lanka support a number of coastal households, are of high national and international ecological value and represent a base for sustainable economic exploitation if carefully managed. In the past, activities in the area such as shrimp farming and charcoal production have been carried out in a way detrimental to the mangrove resource. The important of local people of participation on participatory management have been realized in all the natural resource management strategies. In this respect participatory management has been considered as one of the most viable options for combining poverty reduction and conservation of ecosystem. Participation in coastal management in Sri Lanka has had a high priority. A National Mangrove Committee was set up in 1990 by the Forest Department and a National Mangrove Conservation Project was started in 1992. A pilot project was designed, on the participatory management basis, to conserve mangroves habitat at Seguanthive in Puttalam District. A mangrove conservation society was formed and management plan was developed and adopted with the fishermen and local authorities. This approach has shown some success on user participation (Liyanage 2000). However people with low knowledge and poor income may have different attitude due to their poor living condition. The quality of participation is doubtful, the quantity

of participants rather than quality of the participation frequently being stressed. This study focuses on the underlying assumptions of participation in Batticaloa District.

Objectives of the Study

This study focus on three important objectives, they are to assess the economic value of the mangroves in the Batticaloa lagoon, to find out farmers' awareness and perception level about the importance of conserving mangroves ecosystem and the extent of dependence of coastal community on the Batticaloa lagoon and to evaluate how socio-economic factors influence coastal community's participation in conserving Batticaloa lagoon for their sustainable livelihood.

Materials and Methods

Valuation of Mangroves

In the environmental economics literature, a host of valuation techniques for natural resources have been developed over the last decades. Potential economically significant values of the mangrove ecosystems have been compiled according to the total economic value framework proposed by Barbier (1994). Among the many non-market valuation methods available, this study used the benefit transfer approach. Benefit transfer refers to the practice of using values estimated for an alternative policy context or site as a basis for estimating a value for the policy context or site in question. This method was considered as a appropriate technique, because of time and budgetary constraints make more detailed and robust primary research infeasible. This avoids duplication of analysis. The economic value of mangroves was carried out to Puttalam Vannathivillu Kaloya Delta in 2005 by IUCN was used for this purpose because both districts face have similar threats to the respective lagoon and almost identical socio economic conditions prevail on the respective coastal communities. Two methods of benefit transfer estimates were adopted in this benefit transfer approach. One is transfer of the entire benefit from the study sites Puttalam was directly transferred to the policy site with appropriate amendments specific to the Batticaloa lagoon. In the second approach, the estimated benefit function (fishing) for the study site was used to compute the policy site

benefits using the coefficients of the study site benefit function.

Dependence on Mangroves

Researchers have concluded that poverty has been an important cause of forest degradation in developing countries and co-management has been considered as one of the most viable options for combining poverty reduction and conservation of forests (Adhikari et. al. 2004; Agrawal 2001; Ostrum et. al. 1999, Thiruchelvam and Sujeetha 2006). They have also argued that socio-economic heterogeneity matters in terms of resource use and individual incentives to cooperate for collective action. It has been often argued that poor people extract more resources from the commons due to their great reliance on natural resources. On the other hand, it is also claimed that although the poor may depend more on the commons in reality terms in comparison to the non-poor, their dependence is lower in absolute terms (Dasgupta 1995; Heltberg 2001). It is hypothesized that mangroves based income is closely and positively related to total income. The dependence on mangroves will be quantified in terms of income derived from mangroves based activities. Key sources of mangroves ecosystem income such as wild foods, fuel, fodder etc were modeled in the following form.

$$\mathbf{Yi = a + b\sum Xi + e}$$

Where Yi is total monthly income of the household a and b are coefficients Xi income form mangroves ecosystem and e is error terms.

Awareness and Perception on Participation

Although attempts to quantify farmers' awareness on environmental degradation ill effects may be considered as subjective as analysis, the survey dealt with direct environmental and livelihood related questions to mangroves conservation management issues questions only. Thus respondents were asked to state their awareness and attitude level of mangroves dependence for their livelihood and health in accordance with simple five-point scale as Likert scaling method. Awareness and attitudinal scales were composed of approximately equal numbers of favourable and unfavourable statements concerning the pesticide use

in vegetable cultivation, environment and health. Fishermen were asked to respond to each statement in terms of their own degree of agreement (agree, undecided, or disagree) or position (positive, natural, or negative). Efforts were made to assess the level of awareness and attitude level of participatory management. The mean and standard deviations of measurements were used to categorize the respondents' knowledge and attitude on ill effects of over extraction of mangroves as low awareness (1), medium awareness (2) and high awareness (3). To determine the factors that influence perceived ill effects of over extraction of mangroves use, the above-calculated dependent variable was then regressed on the set of socio economic variables, using the ordered probit model is described below.

Ordered Probit Model

To understand the factors influencing the success of participatory lagoon management a simple descriptive and non-parametric statistics were used. Since ordered probit model can facilitate an analysis of the kind of rating data, to determine the factors that influence participatory management perception, the three categories of dependent variables(Y*) were then regressed on the set of explanatory variable, using ordered probit regression analysis.

Models for ordinal dependent variables can be formulated as a threshold model with a latent dependent (Ordinal) variable:

$$Y^* = \beta^{'} X + \in \quad (1)$$

Where Y^*, is a latent opinion, value, etc. What observe is

Y= 1 (or Low awareness or attitude) if $Y^* \leq \mu_o$ (2)

Y= 2 (or medium awareness or attitude) if $\mu_o \angle Y^* \leq \mu_1$ (3)

Y= 3 (or High awareness or attitude) if $\mu_1 \angle Y^* \leq \mu_2$ (4)

μ_1 and μ_2 are unobserved threshold parameters in the probit model (also termed cut points). It determined in the maximum likelihood estimation procedure for the ordered probit. Following form of ordered model was employed in this study.

$$Y^* = \beta_0 + \beta_1 FSIZE + \beta_2 FEDU + \beta_3 OEMP + \beta_4 EXPE + \beta_5 KNOW + \beta_6 FINC + \beta_7 SOCI + \varepsilon$$

Where:

The dependent variables – the indicators of perceived participatory management success – were the following

Y^*_1 = Perceived trends in the participation in lagoon management

Y^*_2 = Perceived trends in threats to the mangroves ecosystem

Y^*_3 = Perceived compliance trends in participatory management.

FSIZE = Number of member of the farmers' family

FEDU = Number of years of farmers' education

OEMP = Fishing = 1 or part time fishing = 0,

EXPE = Years of Experience in fishing

KNOW = Knowledge about the mangroves

FINC = Household monthly income in Rs.

SOCI = Social participating

β' = A vector of unknown parameters to be estimated

ε = error term assumed to be normally distributed with zero mean.

This study's overall guiding null hypothesis was that farmers' house hold, socio economic characteristics do not have any influence on the farmers' attitude towards participating lagoon management.

The study was confined to Baticalloa lagoon mangroves in the Batticaloa district. The survey was carried during April and May 2006 in four purposely-selected four tsunami-affected villages in four divisional secretariat divisions close to the Batticaloa lagoon. Multistage, stratified,

cluster and random sampling procedure was used to select twelve fishermen families in each selected village. Primary data were collected from 48 fishermen by using pre-tested questionnaires. Information on income from lagoon and their opinions/attitudes regarding knowledge about mangroves, perception for participation and knowledge on environmentally friendly use of mangroves were collected. Secondary information was collected through key informant discussions.

Results and Discussions

Economic Value of Mangroves in Batticaloa Lagoon

The values of the Benefit Transfer Approach studies, which have been carried out in any other places such as Puttalam Vannathivilluwa and even in Egypt, can be used even in this study appropriately. The information of Puttalam Vannathivilluwa study was used as benefit Transfer for this study of Batticaloa Mangrove Valuation. Accordingly some of the relevant values similar to Puttalam are the following:

In the case of Batticaloa District the local community not very much depends on mangrove for their Fuel wood consumption as in Puttalam. The have enough firewood for their daily usage from other sources such as forest woods, bare land vegetations, cultivated crop debris, palms etc. so we can use 4000k.g per annum. This fuel wood cost is around 80000 Rs / year. Farming community of the Batticaloa region uses some what of mangrove sticks for constructing the boundaries for their land and some amount of mangrove sticks are used as a supportive material in the beetle cultivation especially in Kaluthawalai area. Fishermen also use mangrove sticks to make baskets and to prepare the cages for fishing. This value of the mangrove vegetation is 15000 Rs/year. Other direst uses of the mangrove vegetation such as mangrove habitat amount, value of meat, other products such as honey, medicinal plants, hizopora bark and edible plants are not practiced in Batticaloa so we are unable to include this value of Mangrove in our valuation system. Finally the total economic value of direct uses of mangrove in Batticaloa District is around Rs.95,000 per year.

Table 1: Estimated direct and indirect economic benefits of mangroves in Batticaloa Lagoon and Puttalama Kaloya delta.

Economic Benefits	Value Rs million/ year	
	Puttalama Kaloya delta	Batticaloa Lagoon
Fish productivity	256.90	227.63
Pollution control	81.00	81.00
Shore line/ River bank stabilization	76.62	76.62
Carbon sink	10.56	10.56
Flood Attenuation (damage avoided in terms of agriculture)	0.86	0.86
Timber	0.58	0.015
Preventive expenditure through saline water intrusion	0.19	0.19
Flood attenuation (damage avoided in terms of relief assistance)	0.08	0.08
Wildlife	0.07	0.00
Fuel wood	0.22	0.08
Total Value	**427.04**	**397.035**

This functional relationship can be directly transferred to Batticoloa lagoon fishery. Because we can use the same procedure, but approximate value of 1303ha of mangroves contribution to fish productivity is Rs 76.73 million per year. Here the effort is measured in terms of hours spent in fishing equals to 6hrs and the area of mangroves is measured in terms of sq km equals to 18 sq km. All the other indirect uses such as Pollution control by sedimentation, retention of nutrients and purification of wastewater, Shoreline and River bank stabilization and storm control, Carbon Sequestration, Floodwater control and Prevention of saline water intrusion are attributable to Batticaloa lagoon mangrove. Estimated economic benefits of mangroves considered for this study shows that the mangrove habit in Batticaloa district have

greater impact on livelihood activities in the area and thus to enhance the well-being of the society. Even in the absence of robust primary research of mangroves area due to the time and data constraints. Empirical value shows that annual economic benefits of the community equal to 397.035 million Rs per year. The approximate value attached to one ha of mangroves equals to Rs.304708 per year or 3047 US $. Direct use benefits considered for the Batticaloa district mangroves equal to 95000 Rs per year or 950 US $ per year. The value attached to the one ha of mangroves equal to mangrove Rs.9500 per year or 95 US $ is comparatively low in comparison to the studies conducted in other parts of the world. It's important to note that this mangrove patch considered being a one of the ecosystem in its pristine stage. However we believe this value is lower bounced estimation of the actual direct use values of mangroves.

Characteristics of Households

Households in Batticaloa lagoon are middle age average 44 years. This indicates that they are economically active population, who can effectively contribute to the development of the area. Almost all people in the study area are Tamil of whom little more than two third are Hindus (72%) and the rest are Muslims, revealing the some homogeneity of the population in respect to ethnicity and religion (see table 1). The average family size is 5.8 this is greater than that of Sri Lanka's average family size of 4.3. Fishing is more predominant and about 85.4% of them are engaged in full time lagoon fishing. An average year of experience in fishing is over 18 years, as a result of early entering to fishing. Education Average level of literacy of the coastal people is quite low 6 years of school education only. About 69% of the fishermen have very low level of education (less than grade 3), revealing the low level of educational attainment of the people in the Batticaloa lagoon area. About 89% of the fishing community is dependent on the government subsidy schemes such as samurdhi and food stamp. In general, more than half the families in the area receive a monthly income between Rs.1,200.00 – Rs. 3,100.00, which is below the average monthly family income of Rs. 6,420.00 for Batticaloa district in 2006. Thus Batticaloa depended people are considered as poorest in the District. These people receive significant

share of the total income (20%) form the lagoon ecosystem. According to the survey 89.4% of the fishing community is dependent on the government subsidy schemes such as samurdhi and food stamp because they lie below the poverty line. For their income they are depending on the environmental (Mangrove) resources for their survival.

Following issues are experienced in the coastal resources in Batticaloa district at present. Fishermen have begun to depend on machinery for operations and fishing activities. This has resulted in loss of fishing stock in Batticaloa lagoon. There is a gradual decrease in traditional fishing methods and more mechanized fishing system has been introduced. There was gradual decrease in traditional fishing methods. New generation is reluctant to involve in fishing activities Even though numbers of fishermen are increased. Many government officers do fishing in the lagoon for during their leisure time for their own household consumption

Dependence on Mangroves Ecosystem

Relationship between the total income and the environmental income is given in a simple regression analysis-using log –log model gave the best fit and produced the following results (t—values in parenthesis):

$$\ln Y = -150.97 + 0.918 \ln X$$

(-1.81) (4.33)

R^2 (adj) = 0.78; N = 48

The function is having a higher (0.78) goodness of fit and environmental dependency is 0.918 positive and it is significant at 5% level. This indicates that the elasticity of mangroves based income was close to one. The average household derived as mangroves based income was around 20% of total income. This indicates that mangrove based income serves as income supplements and important safety net in time of hardship.

Factors Influencing Perception on Participation in Lagoon Management

Study results showed that majority of respondents (81%) had higher perception of participation due to their dependence. One half

of the community (51%) was aware that present practices affect on the mangroves ecosystem, while 15% indicated limited awareness. The main reasons offered for perceived decline in the mangrove ecosystem included pollutants entering lagoon form untreated industrial effluents and dumping of solid waste form urban sources.

Table 2: Results of the Ordered Probit Model Analysis for Participation Success

Success Factors	Participation Trends	Eco Sys. Threats Trends	Compliance Trends
Age	0.003** (3.000)	0.003* (1.476)	0.027* (1.674)
Education	0.219** (2.700)	0.219* (0.145)	0.219* (1.554)
Family size	0.013* (1.953)	0.013** (3.972)	0.327** (2.751)
Fishing experience	0.001 (0.510)	0.001 (0.541)	-0.036* (1.597)
Total Income	0.001 (0.001)	0.010 (0.438)	-0.024* (01.582)
Other Employment	-0.0227 (0.031)	-1435 (0.456)	-0.5410 (0.4521)
1st ordinal rating	0.971**(3.215)	-2.432 (3.547)	2.1441*(1.936)
2nd ordinal rating	2.123* (2.178)	-1.932 (1.003)	0.312 (0.578)
n	48	48	48
P value of F test	0.021	0.012	0.014
Pseudo R^2	0.392	0.416	0.467

Figures in parenthesis are t values Significance levels:

*significant at p<0.1; **significant at p<0.05, ***significant at p<0.001.

Knowledge on mangroves sustainable uses and mangrove ecosystem benefits, protection of mangroves for sustainable food and income, prevent the encouragement and important of replanting were used as the variables to measure the perception on participation in

lagoon management. The coastal communities were generally optimistic about preserving the mangroves due to their dependency. Majority (92%) of the respondents have higher knowledge and attitude on coastal resources. About 7% and 1% of the respondents had moderate and low attitude and knowledge on coastal resources respectively.

Conclusion

The present study shows that mangroves ecosystems are valuable in Batticaloa district that must be managed to sustain coastal community. The total economic value of Batticaloa lagoon mangroves is Rs 304708 (US $ 3047.08) per hectare per year. Further this study indicates that the values of coastal community derive form the vegetation are infinite, as long as they do not degrade the coastal eco system. Environmental income constitutes 20%. It is an important share of total household income. Competition has lead to more shortsighted non- sustainable resource use. However, there is community awareness and perception of participation in the lagoon management was positive. Education and family size have shown some influence with respect to participatory management. This gives hope for local involvement in participatory lagoon management to protect the valuable and vulnerable mangroves ecosystem. Therefore, mobilizing and empowering coastal community as real partners in lagoon participatory management are to be enhanced through providing relevant information, education and capacity building programmes are important. In this context, how much capacity building takes place with the external contribution and the fishery cooperatives to be investigated.

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