Mangrove Conservation Efforts and the Local Economy: A Case Study

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A Case Study

Mangrove ecosystems are valuable due to the several direct and indirect services humankind derive from it. The general stability of a coastal system, including that of its socio-economic and biophysical environment, depends on the nature of human-mangrove relationships. But official conservation strategies very often intervene in the process by imposing restrictions on fishing and mangrove use. The present study analyses and quantifies the socio-economic impact of such restrictions on local economic activities and per capita income of a mangrove dependant coastal population on the east coast of India. Restrictions have led to instability of the local economy in the concerned villages, which may pose a risk of further denudation of forests, making the goal of a holistic management approach even further unrealisable.

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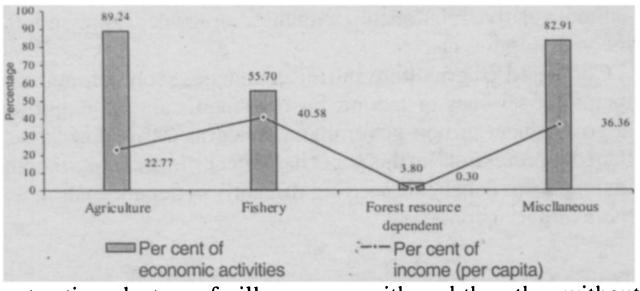
Mangrove ecosystems are valuable to humankind, both in terms of their direct market values and indirect ecological services. The most well known ecological service provided by the mangroves is the support they provide to local sustenance and commercial fishing, acting as nurseries and shelters for many fin fishes and crustaceans [Bann 2000]. Most of the coastal communities inhabiting most of the mangroves of the world depend on marine and estuarine fisheries, crab fisheries and aquaculture. The intrinsic economic value of these coastal resources represents a "natural capital" that supports the economic health and society [Sanchez-Gil et al 2004]. The growing environmental concerns, however, are increasingly opposing the free ride on fisheries and other mangrove resources. Various regulations in the regional or local context are being imposed to limit the adverse impact of human activities on environment. Regulations driven by environmental concerns are often more stringent and economically non-viable than the regulations that tend to facilitate sustainable resource exploitation by reducing over-harvest. Such regulations being specifically well documented in the fisheries sector, several maritime countries need not only to consider the social benefits of environmental protection, but also need to take into account potential economic costs sacrificed for such protection [Cai et al 2005]. Otherwise, any scientific and technical management planning often results in implementation failure. These may be attributed to three major reasons, viz, poor communication between administrators and sectoral stakeholders, resistance from local stakeholders and mono-disciplinary definitions of resource management aims. In recent years, a holistic concept of sustainability integrating social objectives is being advocated. This generally goes beyond the classical ecological economic "take no more than the eco-system provides over a given time period" approach [Glaser 2003].

Bhitarkanika wildlife sanctuary covers an area of 672 sq kms and is situated at the estuary of Brahmini and Baitarani rivers in Orissa. The core of 145 sq kms mixed forest with dominant mangrove species has been declared a national park in 1998. The declaration imposed restrictions on the free access to mangrove resources and also on the fishing activities at the rivers flowing through the national park. The Orissa Marine Fishing Regulation Act (1982) and the Orissa Marine Fishing Regulation Rules (1983) imposed restrictions on free movements of all mechanised fishing activities within five kms of the coastline [Pandav et al 1998]. This has, in particular, been extended up to 20 kms from the Gahirmatha coastline – the famous Olive Ridley rookery [Patnaik and Kar 1999]. The area has also been declared as Gahirmatha marine sanctuary in 1997.

It is reported that introduction of more flexibility in implementation of the restrictions for all practical fishing conditions through dialogue with stakeholders may lead to a higher degree of voluntary compliance at very low cost [Nielsen and Mathiesen 2003]. Again, rather than selecting the extreme path of conservation, a more balanced use of natural resources could form the central theme for the sustainable development of national parks [Papageorgiout and Brotherton 1999]. The people in the study area depend directly on mangroves for fuel-wood and fodder, and indirectly the fish and prawn seedlings, for their livelihood. But the imposition of conservation strategies by the government, reducing the free rides on resources that the people had been enjoying for generations, was not taken favourably by the locals [Nanda 2005].

The present work assesses the observable socio-economic impacts and future implications of the restrictions on fishing and on other resource uses in and around the Bhitarkanika National Park. Calculation of opportunity costs of the mangrove in terms of energy and other livelihood materials enables the researchers assessing the mangrove dependence and economic vulnerability of the local residents in the post-1998 period. Significant loss of livelihood due to fishery restrictions near forest areas have been clearly witnessed through a comparative study between two

Figure 1: Economic Activities and Their Income Shares in the Study Area as a Whole



contrasting clusters of villages, one with and the other without access to marine and estuarine fishery.

Socio-economic Profile of Study Area

Villages in and around the Bhitarkanika National Park are under the administrative jurisdiction of Rajnagar community development block in Orissa. All the necessary secondary baseline data pertaining to the particular block were procured from government and semi-government agencies. However, in order to assess the dependence on the forest and its products on the livelihood of the local people the present study uses primary data collected from the villages located at the fringe of the forest. Nearly 16 per cent of all the inhabited fringe villages (n = 87) of the Bhitarkanika Park were chosen randomly. Ten per cent households from each of the sampled villages with a minimum of three households per village belonging to different religions, ages, sexes, castes and professions, were surveyed during April 2004 to March 2005.

Direct one to one interviews were conducted with the members of sampled households (158 households from 14 villages consisting of the total population 1,178), using semi-structured questionnaire, prepared and standardised on the basis of a trial sample survey in the same area based on 28 households covering a population of nearly 180 from 14 different villages. The purpose of the study was explained to all the respondents, and their personal consents were taken prior to initiation of the interview. In a few cases, evasive attitude of the respondents were noticed, at the midway of the interview. The interview was resumed only after receiving the full consent of the subject concerned for disclosure of the facts. Most of the questions, asked during the interviews, were open ended, and the respondents were allowed to express themselves.

General demographic and occupational context: Out of the total sampled population nearly 79.7 per cent were migrants.[1] Most of them, immigrated in the area in the 1950s, when the forest reclamation started for agricultural lands [Chadha and Kar 1998]. The tendency continued till the establishment of the wildlife sanctuary in 1975. However, the people of the fringe mangrove area still depend on mangrove resources for their subsistence livelihood especially for fuel biomass resource. The average family size of the area is 7.5 with higher male population than female. Agriculture (89 per cent), fishery (55.7 per cent) and wage labour (59 per cent) with overlap constitute the major occupations of the local people; the average per capita monthly income is Rs 281.83 only.

Mangrove dependence and opportunity cost of conservation: Local residents in and around the Bhitarkanika National Park, are dependent on the mangroves predominantly for firewood and fodder [Nanda 2005]. But they also harvest construction materials and other livelihood supports, viz, Suaeda spp as vegetable, honey, medicines, etc. Their contributions in the total opportunity cost (OC) calculated during the current study are not very significant. The survey revealed that 98.7 per cent households depend on the forest in some ways, the dependence is as high as 96.8 per cent for firewood, followed by 59.49 per cent for fodder or cattle ranching. In case of construction materials, 92.41 per cent households showed some dependence, but the absolute dependence was found in only 32.3 per cent cases. However, the extent of the use has reportedly reduced under pressure of pro-conservation forest officials.

The OC approach represents a pragmatic perspective on the valuation dilemma, without being a valuation technique [Santhakumar et al 2003]. The OC of biodiversity conservation is defined as a value equivalent to the net benefits for the foregone income (sacrificed value) of potential current uses [Griffiths and Southey 1995]. Here we use the approach little differently, not to value the potential benefit of conservation, but to assess the scarified values or the economic burden of local residents due to conservation measures in and around the protected forestland since 1998. The sacrificed values of fishery activities including crab and prawn seedling collections are not included in this analysis.

We assessed only the direct market values of major mangrove resource for both the potential value of the existing mangroves and the value sacrificed for conservation. It has been noticed during the study that the foregone benefit is maximum in case of construction materials, which mostly involves felling of healthy mangroves. On the other hand, although the ranching propensity has reduced to some extent, but firewood and fodder collection is continuing.

The calculated OC for conservation as it is being practised presently at the study area amounts to Rs 15.63 per capita/month, whereas had maximum restrictions (no access) been imposed the value would have been as high as Rs 54.97 per capita/month (Table 3). Considering the total population of the study area as per 2001 Census, the annual value of OC for conservation at Bhitarkanika becomes Rs 84,52,204 and Rs 2,97,26,017 respectively for present and what corresponds to the maximum restriction imposed for conservation.

Restrictions in Fishery Sector

Data collection was done in two phases. At the first phase the villages, which are situated at the south-west of the national park were covered. Being almost in the lap of the protected forest these villages face restrictions on fishery activities due to conservation

Table 1: Per Capita Monthly Income Share at the Two Regions and the Study Area as a Whole (Minor Incomes from Forest Product Trade Are Excluded)

(Rs/M)

	Monthly Per Capita Income	Per Capita Agriculture Income	Per Capita Fisheries Income	Per Capita Miscellaneous Income
Region A	182.59	58.81	15.82	105.71
		(32.21)	(8.66)	(57.90)
Region B	341.86	67.41	173.97	100.47
		(19.72)	(50.89)	(29.39)
Study area (A and B)	281.83	64.17	114.36	102.45
		(22.77)	(40.58)	(36.35)

Note: Figures in parenthesis denote percentage of total per capita monthly income.

strategies in the forest area. These villages together will be referred to as "Region A" in this paper. Moreover, the silted river mouth of Maipura river – that flows through the particular region, is a natural barrier for larger fishing crafts movements. The second phase of the survey was conducted in villages in the north and north-east of the forest, termed as "Region B" in this paper. This region has comparatively free access to estuarine and marine fishing at the estuary of Dhamra river. Only, seasonal restrictions are imposed on the fishing in this region.

The rivers Baitarani and Brahmini along with their distributaries encircle the study area. The two concerned clusters of villages, i e, A and B regions are situated on either sides of the mangrove vegetation and face similar bounty and fury, except for some different administrative restrictions. Region B having comparatively free access to fishery earns significant proportion of the monthly income from this sector. In contrast, the region A, is almost devoid of any fishery.

A clear distinction in the economic activities of the people in those two regions having significant bearings on the per capita monthly income has been noticed in the present study. The differences in per capita monthly income can mostly be attributed to their income from fisheries sector, including estuarine fishery, prawn seeds collections, aquaculture and income from fishery related infrastructure support systems (Table1).

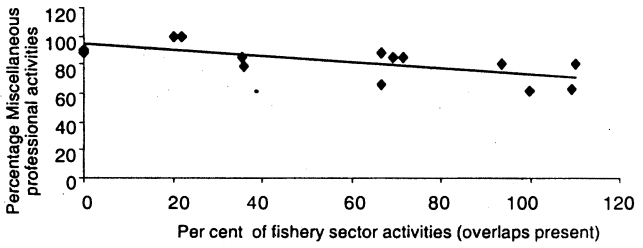
With comparatively lower proportion of people's involvement, highest income potential has been recorded in fisheries showing a direct positive relationship with the average per capita monthly income (Figure 1).

Compared to agriculture and miscellaneous economic activities including services of labour, businessmen, salaried employees at government or non-government concerns (termed as "miscellaneous profession" in this paper hereafter), the per capita monthly income from fishery showed significantly better correlation with the average income.

Regional Fishery

The regional fishery practice of the area involves mostly the estuarine and marine fisheries at the estuary of Dhamra and in the Bay of Bengal. The other sub-sector, aquaculture fisheries for tiger prawn (*Peneous monodon*) in spite of having adverse impacts on the local and regional environment [Hagler 1997], are being practised by 12.66 per cent households of the area. The percentage of people's involvements in both of the fishery sectors differed widely between the two regions. While, 61.85 per cent and 17.52 per cent people of region B are dependent on estuarine fishery and aquaculture respectively, the respective figures are only 13.11 per cent and 4.92 per cent at region A.

Figure 2: Impact of Fishery Practice on Involvements in Miscellaneous Professions



Since the sectors in an economy are interconnected through input-purchase or output-sales, fisheries restrictions would not only directly affect fisheries sectors but would also tend to indirectly influence the other sectors of the local economy through fisheries sector's inter-sectoral linkages [Cai et al 2005]. Here we consider the income generated from the input sectors at the upstream as the backward linkage of the local fishery and the income generated at the downstream of fishery activities as forward linkages. Both the regions A and B are deprived of any well-built infrastructural facilities, and thus, most of the mechanised and motorised fishing crafts land their catches at fishing harbours located outside the area. As a result, the forward linkage remains very weak (2.2 per cent), in spite of a comparatively high backward linkage (11.8 per cent) of fishery income specifically from the estuarine and marine capture fisheries, alternatively termed as fishing in Table 2.

Conservation and Economic Sustainability

Mangrove is essential for coastal protection, biodiversity conservation and many other direct and indirect advantages. But, in Bhitarkanika, the conservation strategies of mangrove have led an economic instability of the area. Based on the monthly per capita consumer expenditures estimates by National Sample Survey Organisation (NSSO), India, the poverty line for rural areas of the state of Orissa was Rs 323.92 in 1999-2000 [Deaton 2003]. Our study reveals 68.04 per cent people of region B are living below poverty line, whereas, the figure in region A is as high as 91.8 per cent.

Economic sustainability is defined as the capacity of a renewable resource to provide life support via resource harvest [Glaser and Diele 2004]. Following Kaldor-Hicks compensation rule [Padilla 2002], if gross income is equal to or higher than the sum of operational costs and the costs for the regeneration of human and man-made capital, the activity is economically sustainable [Glaser and Diele 2004]. The impact of conservation efforts are visible throughout the region, but comparative study between the aforesaid regions, helped us in understanding the process more conspicuously. The "region-A" besides facing restrictions in fishery, also faces more stringent ban on mangrove resource extractions. As a result here the opportunity cost for conservation has been found nearly double compared to region B (Table 3).

It is estimated that agricultural practices in region A and B contributes Rs 58.81 and Rs 67.41 respectively to the average monthly per capita income for 96.72 per cent and 84.53 per cent of people's involvement. On the other hand with 91.80 per cent and 77.32 per cent people engaged in miscellaneous professions at region A and B, the respective sectorial per capita monthly income are Rs 105.71 and Rs 100.47 only. No significant improvement in income generation with enhanced people's involvement in these two sectors is noticed. In fact, in case of agricultural activities comparatively lower income is reported with more number of people's involvement in the region "A". In context of carrying capacity, it seems that the maximum per capita income generation potential or the professional carrying capacity for sustained economic returns has been exceeded in the concerned region. Therefore more people are depending on less economic resource base. This situation may otherwise be thought of as a problem of "disguised unemployment".

Similar conditions are noticed in case of miscellaneous professions. The preferences of local people for fishery-related sectors over other miscellaneous professions are reflected in our simple regression exercise.[2] The involvement in miscellaneous professions [y] is regressed on involvement in fishery sector [x] (statistics in Table 4) reveal that the reduced fishery activities lead to higher involvements in miscellaneous professions (Figure 2). The estimated equation is:

$$y = 94.9475 - 0.21838x$$
$$(21.802^*) \quad (-3.4142^*)$$

[* signifies the 99 per cent confidence level]

It has also been noticed that villages with particularly higher involvements in miscellaneous professions tend to have a lower average per capita monthly income.

Comparing human demands on natural capital with the ability of the latter to produce the services that human use is a way of natural capital accounting. This is what can be called "ecological footprint accounting" [Wackernagel et al 2004]. We used this concept for assessing the maximum limit of economic activities the local economy can sustain, or in other words to assess the

Table 2: Per Capita Monthly Income and Backward and Forward Linkages of Fishing

Study Regions	Aquaculture Income Per Capita (Rs/m)	Fishing Income* Per Capita (Rs/m)	Backward Linkage of Fishery (Rs/Rs 100)	Forward Linkage of Fishery (Rs/Rs 100)
Region A	9.14	5.66	1.0	0.0
Region B	53.99	93.61	12.4	2.4
Study area (A and B)	37.01	60.52	11.8	2.2

Note: * Capture fishery (excluding aquaculture and seed collection).

Table 3: Opportunity Cost for Conservation at Bhitarkanika at Present
(Rs Per Capita/Month)

	Potential Mangrove Benefits	Presently Exploited Benefits	Opportunity Cost for Conservation
Region A	58.61	34.79	23.82
Region B	52.77	40.47	12.29
Study area (A and B)	54.97	39.34	15.63

Table 4: Statistical Parameters of Regression Exercise with Involvement in Miscellaneous Professions [y] and Fishery [x]

Parameters	Estimate	T Stat	*p* value	*F* value	*p* value (for *F*)
Constant	94.9475	21.802	0.000		
				11.66	0.0051
Fishery involvements	-0.218381	-3.41418	0.0051		
R-squared (per cent)			49.2743		
Adjusted R^2: (per cent)			45.0472		
Durbin-Watson statistics:			1.97713		

economic carrying capacity. The per capita income in the region without fisheries (region A) has been found to fall short of the minimum monthly per capita household expenditures of Rs 200.82 for the same region. Therefore, at the maxima of existing economic activities the income potential (supply) could not satisfy the demand, indicating a non-sustainability of the local economy. Most surprisingly, even in presence of such fisheries restrictions, withdrawal of the conservation ban over the livelihood supporting mangrove resource exploitation alone may raise the per capita income at a level sufficient to meet the minimum monthly expenditure of the households. But, as the socio-economic metabolism of humans is highly variable and most of its demand is "exosomatic" or external to the human body metabolism [Wackernagel et al 2004], any definite limit of economic sustainability cannot be fixed as yet.

Conclusion

The conflicts between local stakeholders or direct and indirect mangrove users and the administrators now have become a global issue. Experiences in other tropical countries indicate the need of proper resource management to ensure long-term sustainability of the ecosystem. Such strategy not only needs critical mangrove resource valuation, but also should emphasise the biogeophysical and socio-economical linkages. Any fixed deterministic approach is inappropriate for managing a national park. Qualitative or quantitative techniques to describe carrying capacity allow implementation of the concept only through a flexible framework of action [Papageorgiout and Brotherton 1999].

Our findings emphasise on some important socio-economic linkages of the mangrove ecosystem. The restrictions for conservation lead to an economic non-sustainability of the local community. As activity substitution, i e, change in availability of one mangrove component, causes local substitution for other mangrove components [Ruitenbeek 1994] such restrictions may pose a risk of aggravating other mangrove resource exploitation directly for livelihood earning. Our preliminary assessment indicates a tendency of forest resource exploitation at a scale higher than sustenance livelihood requirements, among the people from villages with very low (i e, less than Rs 150) per capita monthly income.

It is thus understood that socio-economic linkages of mangrove ecosystem play a pivotal role in ecosystem management, especially in coastal areas, where major economic activities depend considerably on natural capital. In the present study area the goal of holistic development can only be achieved by the promotion of fishery-related activities and alternative professions around the national park. It is therefore suggested that, prior to imposition of any conservation strategies, the linkages between the nature and the regional socio-economy should be given highest importance, so as to chalk out a better management option. In coastal areas, like Sundarbans or Bhitarkanika, where the scope of alternative income generation is low, such narrow conservation approaches may lead to potential disastrous consequences. Specifically, for Bhitarkanika enhancement in navigability of the Maipura river mouth and appreciation of flexible restrictions in fishing and forest resource harvest strictly maintaining the sustainability conditions, specified for the ecosystem, should be the central theme for the regional development. EPW

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Notes

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1 In this study the word "migrants" refers to the people who immigrated to the area only in post-independent period (after 1947), mostly from the nearby state of West Bengal and a few other areas.

2 In this study, comparative analysis has been done between regions at the village level. Thus, clumping of surveyed household data to represent a village as a whole reduced the effective number of observations (14), which do not appear adequate enough to draw any robust inference. However, the results seem to serve as useful indicator.

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