Chapter 1

Trade, Environment and Human Well-being in the Sundarbans Region of West Bengal: Summary of the Report

1.1 The Region and Baseline Conditions

West Bengal is located in the eastern region of the country with Bay of Bengal and Orissa on the South, Nepal, Bhutan and Sikkim on the North, Assam and Bangladesh on the East and Bihar on the West. The state is the third largest economy in India with a state domestic product (SDP) of 1,443.89 billion in 2001-2002 (at current prices)(Economic Survey of India, 2004-2005). The state was a relatively closed economy up to 1991,even after the partial opening up of the Indian economy. West Bengal has consistently registered higher growth rates than India in the period 1991-92 to 1998-99, While in the period 1991-92 to 1997-98, average annual growth of West Bengal's SDP at 1993-94 prices was 6.51 percent, the average growth rate of country's GDP over the same period was 5.24 percent. In 1998-99, the growth of SDP, at constant prices, was 7.08 percent, while country's GDP increased at 6.81 percent. In fact, West Bengal registered an SDP growth at constant prices in excess of 7 percent for most of the 1990s. In the period from 1993-94 to 2001-2002, its average annual growth rate was 7.11 percent, the highest among comparable states in the country.

West Bengal has experienced relatively rapid economic growth in the last two decades, which is an improvement from the previous three decades. In the 1990s, these rates are also high when compared with those in other states of India. West Bengal was one of the fastest growing states in India, and showed the second highest rate of aggregate SDP growth among major states, after Karnataka. Indeed, its aggregate rate of growth was faster than that of Gujarat and Tamil Nadu, both of which are more commonly described as dynamic states.

The services sector contributes about 53 percent of the gross SDP while agriculture and industry together contribute approximately 47 percent. The state contributed about 9.8 percent to the total value of industrial output in the country in 1980-81 but this declined to about 5 percent by the year 1997-98. In the agricultural sector, productivity growth of West Bengal for the period 1980-81 to 1998-99 was second among all the major states, next only to Haryana.

The index number of agricultural production in West Bengal depicts a steep rise in the index, which could be the result of economic liberalization policies adopted in the country in 1991 as also the long term effects of land reforms in the state started in 1970s. But the later part of the 1990s display an irregular trend of the agricultural production with reaching to a highest figure of 218 in the year 1999-2000 and again dropping to 210.2 in the next year.

The index number of industrial production in West Bengal shows an improvement of 56 percent over the 1990-1999 period though; mining and quarrying activity shows a bumpy trend by reaching a high of 101.16 in 1992 from an initial figure of 87.83 in 1990. After improving in the mid nineties, it again slipped to 88.22 in 1999, almost the same figure as 1990. Manufacturing and electricity have progressed well with electricity making an impressive jump of 86 percent over the period.

However, the early part of the economic liberalization does not seem to have impacted the growth in per capita income as it grew very marginally during 1990 and 1992 but it shot up to around Rs. 6,500 in 1993. After this, the growth in per capita income has been smooth and positive and has touched around Rs. 9000.

West Bengal has been successful in reducing income poverty in recent decades, with the proportion of people below poverty line falling from 55 percent in 1983 to 36 percent in 1993-94, close to the national average, but leaving 25 million people in poverty. Despite the fast economic growth (compound annual growth rate of 7 percent) over the period 1993-94 to 2000-01 in the state, many parts of the state are relatively backward.

According to the Planning Commission, the proportion of population below the poverty line in 1999-2000 in West Bengal was 31.85 percent (WBHDR, 2004). Some northern and western districts and the Sunderbans area involving North 24 Parganas and South 24 Parganas are the most backward areas of the state. The poor scheduled castes (SCs), scheduled tribes (STs) and minorities predominantly populate these areas. Infant mortality and malnutrition is a major problem, especially in rural areas, with rates of anemia in women and young children higher than the national figure.

The Sunderbans region in West Bengal covers the major portion of the districts of North and South 24 Parganas. Sunderbans is located at the apex of the Bay of Bengal Out of the total 4,263 sq km of mangrove forests in Sunderbans, 1,781 sq km is comprised of water bodies and this waterlogged area is suitable for shrimp farming in the region. Surface water is generally saline giving the Sunderbans a high comparative advantage for various types of brackish water fish production systems including shrimp farming.

The Sunderbans is a region where the biodiversity is rich and valued. The tiger reserve comprising 2,585 square kilometers of the Sunderbans national park and its buffer zone is a part of this region. The national park was declared a UNESCO World Heritage Site in 1989. Two wildlife sanctuaries are also located within the Sunderbans.

1.2 The Trade Event

India embarked upon a programme of liberalization in the early 1990s, in the main due to a balance of payments crisis it was then faced with. The reforms involved opening up the economy, reducing the public sector's role, and liberalizing and strengthening the financial sector. The components of this programme were:

- cutting down fiscal deficit and the rate of growth of money supply so as to keep inflation and balance of payments under control;
- domestic liberalization consisting of relaxing restrictions on production, investment, prices and increasing the role of market in guiding resource allocation; and

- external sector liberalization or relaxing restrictions on international flows of goods, services, technology and capital.

The aim of the new economic policy was to encourage increased reliance on the market. Focus was given to expansion of export-oriented units Licensing for domestic manufacture was abolished for all but a few industries. The private sector was permitted to enter into areas hitherto reserved for the public sector and the Indian rupee was devalued significantly.

The single most important factor influencing exports was the exchange rate adjustment, which was a first step towards integrating the domestic economy with the global economy. A two-step downward adjustment of 18-19 percent in the exchange rate of the rupee was made on July 1 and 3, 1991. In the 1992-93 Budget, Liberalized Exchange Rate Management System (LERM) was introduced along with the dual exchange rate system implying partial convertibility of rupee. The 1993-94 Budget introduced full convertibility of the rupee on trade account and switched over to a unified exchange rate system. India achieved full convertibility on current account on August 19, 1994.

Further, India became a founder member of the World Trade Organisation (WTO) by ratifying the Uruguay Round GATT Agreement on January 1, 1995. This became a signatory to the various trade agreements.

As a founder member of the WTO, India was under an obligation to strike down all quantitative restrictions on imports and reduce import tariffs so as to 'open up' the economy to world trade. Acting on its commitment to the WTO, the Exim Policy of 2001-02 withdrew quantitative restrictions from all import items. Import tariffs were drastically reduced and more liberal imports of a number of goods whose imports were earlier either totally banned or severely restricted have been allowed.

Focus was given to expansion of export oriented production since the government had taken huge loans from the International Monetary Fund (IMF) with certain conditions of

'Structural Adjustment' of India's economy in order to deal with the Balance of Payment Crisis of the country.

Among other commodities, marine product exports from India increased substantially in the years that followed. Shrimp production in and export from West Bengal too witnessed a substantial increase in the 1990s In addition to the triggering effect of the exchange rate, the following factors can be stated to have encouraged and facilitated this trend:

New Mindset among Decision Makers*:* Prevalence of a new mindset with optimism for 'export led growth' thinking among the decision makers in the state of West Bengal in the wake of liberalization programmes in the country in general. In fact, it was a big change in the policy circle of the left led Government of West Bengal who had hitherto believed in inward looking, import substitution strategy. Shrimp-a premium product in the international market became an ideal choice for the policy makers in the state.

***Favourable International Market Environment*:** Around the same time in early 1990s, the bastion of shrimp export-Thailand and Vietnam got a severe jolt in their supply ability caused by the break out of a disease destroying shrimp production. This was caused by intensive farming using excessive chemical fertilizers and pesticides. This provided a big opportunity to India to fill this supply demand gap and West Bengal tiger shrimp was a good replacement.

Increased Private Investment in Shrimp Processing Units in and around Kolkata. An increase in this investment was a consequence of the new opportunities perceived by entrepreneurs as a consequence of the changed domestic and international situation. A contributing factor could have been that some exporters (for instance of tea) were looking for avenues for diversification due to the difficulties faced in international markets for those commodities. They saw an opportunity in shrimp processing and export.

Initiatives Undertaken by Several Agencies: Along with these factors, other local government agencies especially Department of Fisheries of the state initiated favourable policies which helped the production and export of the shrimp. The state government set up the Brackish Water Fish Farmer's Development Agency (BFFDA). The area covered by it includes some part of Midinipur district along with N24P and S24P districts. During

2000-2001, around 3788.94 hectares of area has been developed by the BFFDA. This produces 41 thousand tonnes of shrimp in the state annual (Economic Review, 2001-2002). Under the World Bank's initiatives, around 451.33 Ha of additional area was brought under shrimp cultivation in Canning and Dighirpur (S24P) and parts of Midinipur district.

Restructuring of Government Departments also contributed to the increased focus on aquaculture. The Directorate of Fisheries was put under the jurisdiction of the Department of Fisheries, Aquaculture, Aquatic Resources and Fishing Harvest (D.F.F.A.R.F.H.). This restructuring gave an added thrust to shrimp farming exclusively for export purposes. Some of the programmes and policies undertaken to facilitate and accelerate the shrimp farming in the state are listed below:

- Distribution of fishing nets and boats
- Extension and demonstration
- Fishermen's group and personal accident insurance scheme
- Savings cum relief schemes
- Training
- Provision of housing
- Brick pavement links and approach roads
- Tank development
- Communication and infrastructure development

Marine products exports are the largest component of India's agricultural and food exports, accounting for approximately 17 percent of the total in 2003–04. The share of marine products exports in agricultural exports varied from 15 to 20 percent from 1990-91 to 2003-04. The growth in exports of fish and fishery products outpaced the overall exports of agricultural and food products from 1990–91 to 2003–04. Over this same period, the contribution of marine products to total merchandise exports remained constant at approximately 3 percent.

Even more rapid expansion occurred in the 1990s; exports of marine products increased more than three times to over 412017 MT from 139419 MT during 1990-91 to 2003-04.

This was much more than the average rate of growth of 10 percent per annum seen from 1960 to 1990. In value terms, growth in exports was equally dramatic from US$ 498 million in 1990–91 to US$1330.76 million in 2003–04.

Frozen shrimp is the major product in the Indian exports of marine products. Over the period 1991–92 to 2003–04, the value of shrimp exports increased by approximately 150 percent from US$395.98 million to US$985 million.

1.2.1 Marine Products Exports from West Bengal

West Bengal accounted for about 11 percent of total frozen shrimp exports from India in terms of volume in 2003-04. The share increased from 9.3 percent in 1991-92 to approximately 11 percent in 2003-04. Whereas percentage share by value remained the same around 13 percent for the same period. In absolute terms, frozen shrimp exports were Rs.126.33 crores in 1991-92 which increased to Rs.508 crores in 2003-04, an increase of 300 percent over 12 years.

Together, the above mentioned trends indicate that frozen shrimp has become a more important component of marine exports from West Bengal in the decade under consideration. Both volume and value from the state have increased during this period but not as fast as from some other parts of India.

In 1995-96 West Bengal exported 52 percent of its total frozen shrimps by volume to Japan. EU was the second largest destination with the share of 29 percent followed by USA (12 percent). In terms of value, Japan's share was 68 percent, EU again the second largest destination with 18 percent followed by USA (7 percent). However, in 2003-04 USA emerged as the largest export destination with 40 percent share by value in total frozen shrimp exports. Japan's share declined to 38 percent followed by EU (11 percent). But in terms of volume of shrimp exported, Japan was leading with 37 percent share followed by the US (35 percent) and EU (17 percent).

In this analysis, UK, Netherlands and Belgium in the EU are focused on based on their share in the total frozen shrimp exports to EU. In 2003-04 these countries together comprised 70 percent of total frozen shrimp exports by volume and 73 percent by value to the European Union. The average share of UK in the total frozen shrimp exports to EU from 1995-96 to 2003-04 was 40 percent and 46 percent by value. Thus making UK the largest export destination within EU. Belgium is the second largest destination with an average export share of 33 percent by volume and 32 percent by value. The average share of the Netherlands over this period is 11 percent in terms of volume and 6 percent by value.

Meanwhile, food safety standards in importing countries were being made more and more stringent and at times, it was felt that these were functioning as non-tariff barriers. These increased environmental compliance costs for exporting units. In the econometric exercise, which attempts to determine the factors determining exports, *it is postulated that the* e*xports of frozen shrimp from West Bengal depend on:*

Exchange rate,

Relative prices in destination markets,

Environment related non-tariff measures imposed by importing countries as measured by an index.

The indefinite nature of the econometric results indicates that the underlying relationships defining the export supply or the import demand equations are not captured well by the linear model. Examining the graph and the data on the index of NTMs and the exports value at the West Bengal level, we find that they move in opposite directions for some years and for some countries. This implies that increasing stringency of NTMs does reduce exports. Then, in the following time periods, the exports increase as the process of adjustment by exporting units continues. There is a continuous process of approximation going on as firms seek to comply by absorbing new knowledge on export requirements and incurring the necessary expenditures in processing, labeling, transport etc. to do so. As long as the international prices are remunerative enough to enable a fair

margin of profit after this compliance cost is internalized, the adjustment process will continue as indeed the increasing exports of shrimp indicate.

In other words, a non-linear adjustment to increasing stringency of non-tariff measures takes place over time. Opening up of world trade through a simultaneous reduction of tariffs in different countries helps in the process by keeping the international prices high. Timely availability of complete information on the nature of import requirements by different countries is an important contributing feature, which enables this adjustment process to proceed without discontinuities marked by events such as rejection of consignments. Such discontinuities disrupt adjustment processes and result in loss of livelihoods all along the chain from processing units to collectors of prawn seed. Policy needs to facilitate the adjustment process.

1.3 Effect on and Responses of Stakeholder Groups

Whatever be the adjustment process which exporting units adopted, increasing exports have led to a number of changes in and around the exporting port and the hinterland.

Between 1995-96 and 2004-05, export of frozen shrimp from Kolkata port increased from Rs. 354.6 crores to Rs. 562 crores[1]. Almost all this was being processed in units in and around Kolkata. While some of these processing units' activities processed other marine products as well, a large number concentrated on shrimp processing and export. Units which process the entire range of marine products are operational for 10 to 12 months in the year while those that concentrate on shrimp operate for 8 months or thereabouts.

Land use has moved from agriculture to aquaculture through leasing or sale. Aquaculture expanded at a rapid rate in West Bengal, in particular in the Sundarbans. All eight blocks registered increases in land under this category. Minakhan registered the largest conversion of land to aquaculture from 1986 onwards up to 2004.

[1] Data from MPEDA office in Kolkata.

Table 1.1: Land Converted to shrimp culture in the Sundarbans 1986 to 2004

Time Period	Land Converted in sq. km.
1986-1989	107.355
1989-1996	143.342
1996-2001	114.891
2001-2004	97.646

Source: NRSA satellite data (See chapter 6)

The categories of stakeholders significant in this context and the issues of significance to them are discussed below.

Farm Owner-cum-worker- These are aqua-culturists who own the farm or have taken it on lease for a short period and work on it simultaneously. About 90 percent of the farmers surveyed have leased the land and the rest own the land on which they farm. Further, of those who hold a lease on the land, four-fifths have a three-year lease. Only a small minority of 20 percent has a long-term 20-year lease on the land. However, a large number of the lease holders have been farming the same land for more than 8 to 10 years, some even upto 25 years. It is obvious that the lease is renewed every three years with the option of increasing the area under aquaculture being with the aquaculturists. Aquaculture for these farmers is quite a rewarding and profitable business opportunity. Shrimp production involves substantial capital investment and many risks. The owner bears the cost of production and the risk associated with it. The single most important issue for this set of stakeholders is the technology of shrimp production. The prevalent types of culture systems/technologies for shrimp culture in the Sundarbans are as follows:

- **Traditional System –** In this type of system, large areas of water bodies are naturally inundated with water during high tide and require very little proper management. Water is exchanged infrequently or when required. This system does not require supplementary feed and the production is quite low.
- **Extensive System or Improved Traditional –** This is the most prevalent shrimp culture system in the Indian Sundarbans. Under this system, area of the pond varies between 1 to 5 hectares with low stocking density (approximately 50,000 seeds/ha). The system requires moderate management while the water is exchanged periodically twice a month during the high tide. Occasionally feed and

fertilizers are used for the shrimp growth. This culture system produces reasonable shrimp quantity.

- **Modified Extensive System –** This system employs ponds of 0.5 - 3 hectares in size with quite high stocking density of around 1 lakh seeds/ha. The system needs proper management of water quality, feed and soil characteristics. Water is exchanged quite frequently (6-8 times a month). The pond itself needs suitable preparation before stocking the seeds. Supplementary feed like oil cake etc. are applied whenever required. This system is quite productive and yields about 1.5 tons/ha.
- **Semi-Intensive System –** Under this type of culture system, very small size of ponds are used with high quality of management and care. Ponds are prepared by using Mohua oil cakes, medicinal lime etc. Water is exchanged atleast thrice a week. The stocking density is very high with an average of properly accilimatised 2 lakhs seeds/hectare. The system gives very rich crops with an average production of 4 tons/hectare. But, after the Supreme Court order of 1997, this system is banned from practice due to its harmful effects on the forest and fish biodiversity in particular and agriculture and environment in general.

Farm Workers- The farm level employment includes two types of workers; temporary low-paid construction workers (pond construction workers) and permanent maintenance labourers (handling, pumping, feeding, pond water treatment and harvesting), supervisors, and guards to prevent the theft of shrimp from the grow-out ponds. The aquaculture activity in the region has indeed provided employment and assured income to large numbers.

Prawn Seed Collectors- The supply of hatchery-produced tiger prawn seed (Penaeus monodon) in West Bengal is highly inadequate and as a result the aquaculture farms of this region largely depend on supply from natural resources. Being motivated by a regular cash income, the majority of poor people from the Sundarbans have adopted prawn seed collection as their profession almost throughout the year. The people involved in this activity are from the lowest strata of the society who do not have alternative source of livelihood. At times the entire family is involved in prawn seed collection. These people

go to the river for collecting crabs, prawn seeds, ornamental fish, colour fish and other varieties of fish for sale in the local market.

Aratdars- The aratdars act as intermediaries between prawn seed collectors and shrimp farm producers/owners. The aratdar is the buyer and seller of the commodity (PL in this case). He buys prawn seeds from the PL collectors and sells them to culture farmer. As a financer of last resort, the aratdar provides boat and net to prawn seed collectors on the condition that they will sell their catch to him and also at the same time lends money to an aquaculture farm owner, for meeting his production expenditure. Under this arrangement, the owner agrees to sell his produce to the aratdar.

Input Suppliers- (feed, seed, antibiotics, tractors, pumps, aerators and generators) Shrimp production involves use of inputs such as shrimp feed, organic and inorganic manures, lime, pesticides and veterinary drugs, as well as of technical devices for water treatment and pond preparation. With the increase in the culture activity the demand for inputs has grown over the years. As a result, supplying of inputs to the owners/producers has become a profitable business for the people living in coastal areas.

The Political System- Panchayats have a strong presence in the aquaculture activity. Their existence can be felt right from the allocation of land to a farmer till the harvest is sold. Farmers have to pay a license amount-license for working in the farms to the panchayat and the government. The amount paid to the local panchayat is approximately Rs 1,500/ year and to the government Rs.50/bigha/year. Most of the times panchayat members or their relatives end up receiving assistance and subsidies provided by the government.

Post-Harvest Production Links and Agents- The off-farm post-harvest production links include processors and marketing agents (packaging, transport, export-importers, processing industries, wholesalers, retailers, and restaurants).

1.4 Ecosystem Changes

1.4.1 Caused by Collection

1.4.1.1 Biodiversity Loss Due to Aquaculture

Increase in the practice of aquaculture in the region during the last decade or more together with the absence of hatcheries resulted in the seed input (seed of tiger prawn) being collected from the wild, using labour –intensive drag-nets of different kinds. It has been reported in several studies that during the collection of tiger prawn seeds, juveniles of many species of finfish and shellfish are trapped in the net and these non-target species are thrown away and destroyed, as they are not remunerative. This destructive practice causes a major damage to juvenile finfish community of the area. The juvenile stage of finfish community referred to, as "icthyoplankton" constitutes an important planktonic component of the marine and estuarine ecosystems and forms an integral part of the fresh-cum-brackish-cum-saline water owing to their migratory behaviour. These planktons in a sense are referred to as *ecological crop* of the marine and estuarine systems as they provide nutrition to members of higher trophic level, which includes larger bony fishes, sharks, turtle, dolphin etc.

In the absence of any hatchery, the demand for tiger prawn seeds has risen exponentially and the entrepreneurs have no option but to depend on wild harvest of tiger prawn seeds. Several studies purport to estimate this loss. It is reported, for instance that about 48 species of finfish juveniles are wasted per net per day per haul, which amounts to about 9.834 kg[2]. This constitutes a huge loss of species diversity.

Two kinds of factors have operated in the period since 1991 to change the magnitude of this loss. The steady increase in land under aquaculture would be expected to have increased it. About 33,000 hectares in North 24 Paraganas and 12,000 hectares in South 24 Paraganas are devoted to shrimp farming. Potential area which could be brought under

[2] See Mitra (2005), MOEF, Project Report (1996).

aquaculture is estimated at 1,80, 000 hectares in these two districts[3]. Future expansion could accentuate this ecological crop loss substantially. However, the substitution of improved traditional system of shrimp culture for semi-intensive culture following the Supreme Court of India order of 1996 has reduced stocking density per hectare and consequently the loss in by-catch or ecological crop loss per hectare.

1.4.1.2 Ecological Crop Loss: Estimates and Indices

While one-time estimates of " ecological crop loss exist, it is important to understand changes over time and space underlying this loss. In other words, what was the extent of change in biodiversity indices in the " by- catch" from tiger prawn seed collection during the decade of the nineties?

The expansion of aquaculture in the Sundarbans region has been accompanied by fast market integration and the rapid movement of raw materials and output across the region. We assume therefore that seed collection is spread over the entire region. A representative selection of sites for estimation of biodiversity loss needs therefore to take into account varying salinity levels and dilution factors which vary in different locations of the coastal zone.[4]

Monthly data for ten years on number of species lost in the by-catch from three representative sampling stations was used to estimate the indices of biodiversity loss[5]. The sample size for the computation was a 10gram composite sample of the wasted material obtained by random mixing of the collection of 15 nets. Three sampling stations were selected for their different salinity profiles and distinct identity. These are: Diamond Harbour (station1), Sagar South (Station 2) and Junput (Station 3).

[3] Government of West Bengal (2003)
[4] See Mitra (2000).
[5] This rich data set was made available and analysed as part of the project due to the collaboration of the Department of Marine Science, University of Kolkata. See Mitra (2005).

The results from the analysis of the ten year data can be interpreted thus: biodiversity loss due to prawn seed collection is likely to be far more in regions where it takes place together with other anthropogenic pressure resulting in land conversion away from mangroves. Since rapid transport of prawn seed takes place all over the region, allocating the loss spatially is difficult. The average annual decline (0.03) was taken to arrive at the figure of biodiversity loss over time. To allocate this decline to individual farms, it was assumed that a particular farm's contribution to biodiversity loss was proportional to its demand for seed, which depends on its stocking density and its size. The higher the stocking density, the more its demand. Similarly, even with the same stocking density, larger farms make a larger dent on loss of biodiversity.

1.4.1.3 Internalising Biodiversity Loss in Cost of Aquaculture

The data used for cost of production of aquaculture is derived from the primary survey conducted by the project team during February 2005. Aquaculture farms located in three blocks of the Sundarbans deemed to be representative of the varying conditions under which aquaculture is carried out in the region. Two alternative models are presented - one, which internalizes the social cost of biodiversity loss arising out of the mode of seed collection; and, the other, which does not do so. In the second case, seed is presumably supplied by hatcheries.

The findings based on the use of a translog cost function estimate are important with respect to the social cost of biodiversity loss and its delegation to aquaculture farmers. These results indicate that even if a larger biodiversity cost were to be assigned to aquaculture and seed prices were to rise as a consequence, they would be able to absorb it, given the present structure of costs and the present price levels for their output.

Simultaneously, it is also true that this activity has provided assured incomes to a large segment of the population of the Sundarbans. Further, about 50 percent of the population of 4.1 million (as per 2001 census) survives below the poverty level. A large percentage of these engage in prawn seed collection, which gives them an immediate cash income.

Estimates vary but at least about 1.5 lakhs people including 60,000 children seem to be involved, either part time or full time in this activity as of now. The welfare implications of policy measures suggested for limiting this activity will have to be a part of future policy in this area.

There is also evidence of strong scale economies in the aquaculture production, as can be seen from the result above. A coefficient for economies of scale of 1.8501 indicates that a 1 percent change in the inputs would lead to more than proportionate change (1.85 percent) in the output. Large farms are more profitable than small ones.

1.4.2 Caused by Aquaculture (Shrimp Production)

Two types of land use change occurred in the region of Indian Sunderbans (North and South 24, Paraganas) as a consequence of expansion of shrimp farming. The first is the annual cumulative conversion of paddy land in the region to aquaculture land. The second case of conversion is of annual cumulative mangrove land to aquaculture farm.

A block wise trend in land use transformation from various land use classifications to aquaculture during 1986 to 2004 is constructed from NRSA data. Blocks Sandeshkhali I&II and Minakhan experienced conversion of more than 100 sq. km. of land for aquaculture during the study period while Canning observed about 54 sq. km. of land being converted to aquaculture. The biggest chunk of land converted to aquaculture under each block has come from paddy. Very little conversion took place from mangrove forest.

Namkhana and Kultali blocks exhibit conversion of dense forest to aquaculture to the tune of about 25 sq. km. and 11 sq. km. each during the study period whereas Minakhan block, with highest land being converted to aquaculture, does not have any conversions from dense forest. The study period also witnesses conversion of aquaculture land mainly for settlement purposes. This reflects partly the conversion to brick kilns.

In the model set up, conversion of paddy to aquaculture farm is explained by:

- the labour productivity in paddy field;
- population density; and
- the return to paddy land relative to aquaculture land use; relative land productivity is used as a proxy for the opportunity costs of land conversion.

In the second kind of conversion from mangrove forest to aquaculture, the relative factor productivity (labour) and sectoral productivity ratio explain the conversion process. In case of both conversions, we assume that the private opportunity cost of converting the paddy field and mangrove areas is far lower than maintaining them as they are (paddy land or mangrove forest). Also, in case of paddy to aquaculture conversion, the differential return of two land uses is of the critical factor.

Results of the model attempting to explain paddy to aquaculture conversion show a statistically significant impact of net relative land productivity and population density on the conversion of paddy land to aquaculture. The sign of the coefficient of net relative land productivity (of paddy relative to aquaculture) is negative, which is a reliable estimate and it tells us that if the yield from the paddy goes down, there will be more incentive for that land to be converted to aquaculture otherwise not. Moreover the magnitude on the variable tells us that, on an average, there will be conversion of 0.47 percent of land from paddy to aquaculture as a result of 1 percent decrease in the relative yield ratio. The coefficient of the population density shows positive sign implying that as the over all population pressure on the blocks increases, land under paddy is converted to aquaculture. This can be explained through the higher labour productivity and greater employment opportunities available in the aquaculture activity. For every 1 percent increase in population per sq. km., there will be a corresponding conversion of 0.40 percent of land from paddy to aquaculture.

In case of mangrove to aquaculture conversion, population density, net relative land productivity, and relative labour productivity (productivity of paddy labour relative to aquaculture labour) variables illustrate statistically significant relationship with the land

conversion. Here too, the sign of the coefficient of net relative land productivity is negative tells us that there will be conversion of mangrove land to aquaculture land if the yield from paddy relative to aquaculture decreases. This variable also highlights an interesting finding that the land under mangrove can be directly converted to aquaculture uses. The magnitude of this variable is -0.11, which says that, if the yield from paddy relative to aquaculture drops by 1 percent, there will be conversion of 0.11 percent of land from mangrove to aquaculture.

The variable relative labour productivity presents a negative relationship with land use change entailing that if paddy labour productivity is lower relative to aquaculture labour productivity, there is greater incentive to convert mangrove land to aquaculture activities. Mangrove areas may be more pressed for conversion to reap higher profits on account of relative lower labour productivity in paddy. The size of this variable is -0.40 meaning that for every 1 percent fall in relative labor productivity ratio; there will be 0.40 percent of land conversion from mangrove to aquaculture. Population density is an important variable in this kind of land use change. The variable shows a positive relationship with mangrove land conversion. On an average, 0.55 percent of mangrove land goes to aquaculture in response to 1 percent increase in population density in the blocks.

In sum, conversion from paddy to aquaculture is far higher in magnitude than that from mangrove to aquaculture. Population density has driven both kinds of conversion. A block-wise analysis reveals that the first kind of conversion from paddy to aquaculture takes place in the northern blocks where population density increases had earlier led to introduction of paddy in a large way. The limited conversion from mangrove to aquaculture is in the southern bocks. Can it be that we are observing a sequential change spread over space and time in this region, the sequence being as follows: from mangroves to agriculture from agriculture to aquaculture and then onwards to settlement, which is the land use category including brick kilns in this region?

The implications of this land use change for the services provided by the ecologically rich region need to be studied in depth. Aquaculture and settled land with brick kilns provides

higher levels of material well-being at the cost of ecosystem services such as regulation of storms and biodiversity based tourism. What is the impact on human well-being of the stakeholders of different kinds? This is what we next investigate.

1.5 Consequences for Human Well-being in the Sundarbans

Shrimp export has definitely earned foreign exchange. More importantly, the entire process from prawn seed collection to farming, processing and transport to the final destination creates employment and generates income. It also provides opportunities to a large number of people by creating source of livelihood. However, as seen in earlier chapters it has also impacted the use of land and water and influenced the biodiversity of the region.

Poverty is defined as " the pronounced deprivation of well-being" in the World Development Report (2001) This definition of poverty leads to the question: What then is well-being? The literature on well-being accepts its multi-dimensional characteristics and the World Development Report takes this multi-dimensionality as its reference point. Empirical work in a large number of countries has been of use in assisting to see what values humans hold dear and in therefore identifying what may alternately be called " basic capabilities to be striven for " or " constituents and determinants of well being".[6] The dimensions cluster around the following themes: material well-being; physical well-being, social well-being, security and freedom of choice or action. Communities scattered across different countries also included a sense of " responsible well being" in their understanding of what constituted the good life.[7]

Taking into account both the state of theoretical developments and empirical evidence documented, the Millennium Ecosystem Assessment (MA) identified the constituents and determinants of human well-being as follows:

[6] See Dasgupta (2001) in this context.
[7] This led Chambers (1997) to consider "responsible well-being as the main agenda for development.

- Basic material for a good life (adequate livelihoods, sufficient food, shelter, access to goods)
- Health (Strength, feeling well, access to fresh air and water)
- Social relations (social cohesion, mutual respect, ability to help others)
- Security (Personal safety, secure resource access, security from disasters)
- Freedom and Choice (opportunity to be able to achieve what an individual values doing and being)

Table 1.2: Income and Employment from Shrimp Production and Processing for Export in Indian Sundarbans (Annual)

	Number ('000)	Income (Rs. Crores)	Attributable to Export Activity (Rs. Crores)
Shrimp Farmers	8,100	568.36 (779.26)*	397.85
PL Collectors	150	75	52.5
Shrimp Farm Workers	72.14	129.6	90.3
Processing Unit value added		24.3	24.3
Transporters and Agents	-	90.55	90.55
TOTAL		887.81	655.5

Note: 1. All figures are annual for the year 2004-05.
2. No shrimp farm worker reported from Gosaba in the survey
*Figures in brackets under category shrimp farmers are estimated on the basis of land use data from NRSA

A shrimp farm owner gets the maximum per capita income as compared to prawn seed collectors, farm workers and workers in the processing units. This is true for all the blocks- Minakhan, Gosaba and Canning. On average, an agricultural farm household has an income of Rs. 17,324 compared to Rs. 32,853 obtained by a shrimp farming household. It is therefore easy to understand the motivation for land use conversion from agriculture to aquaculture.

PL collectors also have a household income of Rs. 24, 282, with very little investment of capital. Given the very good market linkages and the minimal investment, which too is made, by the "aratdar " or agent, it would seem that they are getting this income almost entirely due to the effort or labour and the abundance of the natural resource region in

which they live. In fact, they have a higher income than agriculture farm households and shrimp farm workers in the same region. Are they better off by other indices of well-being as well? Would they choose this occupation if they had other options open to them? The next section tries to answer some of these questions using an array of well-being indices.

Human well-being indices have been estimated in as many dimensions as possible for major stakeholders and for three different blocks. To recapitulate the significance of the spatial differences, Canning and Minakhan are the blocks with a greater concentration of shrimp farms, where different technologies for shrimp farming have been tried and a move towards polyculture with improved traditional techniques found to be the best. These are also the blocks where land conversion has been from agriculture to aquaculture and then to brick kilns. Gosaba is the area with larger concentration of fishermen, PL collectors and where alternative livelihood experiments have also emerged. It includes the relatively distant and less accessible region as well.

For a comparative study across regions and stakeholders, we have selected the following:
Shrimp farmers and agricultural farmers in Canning and Minakhan: this comparison is significant in view of the land-use change from agriculture to aquaculture in the region in the period 1986 to 2004. In other words, the query addressed is: what have been the human well-being impacts of this change.

Shrimp farmers and mixed income households in Canning and Minakhan: this comparison assumes significance in view of the fact that it represents the option that might have existed for upwardly mobile agricultural farmers in case the export based expansion of aquaculture had not taken place.

PL collectors and fisherman in Gosaba. PL collection has emerged as a major livelihood source in recent years and it is mainly fisherfolk who have digressed into this. The consequence is a change in the manner of use of the natural resource base, at a cost of

biodiversity loss. How has this made the PL collectors better off in comparison with fishermen?

PL collectors and salary-wage earners in Gosaba. Salary and Wage earners represent the options available to households as a consequence of better educational levels in comparison to PL collectors. They also illustrate the possible alternative livelihood strategies in the region, if PL collection is to be banned. It is worthwhile to see how this comparison performs.

We find that shrimp farmers in Canning and Minakhan are better off than agriculturists in terms of per capita incomes. However, the security of these incomes is much lower in terms of frequency of normal harvests. Also, while agricultural farmers are not exposed to any conflict, shrimp farmers have a relatively lower level of social cohesion due to constant conflicts. Aquaculture farmers too had to face higher conflict situations and more income insecurity than agricultural farmers.

PL collectors have increased incomes and reduced life insecurity, when compared to fishermen. They do not enjoy the level of income security, health security and conflict free livelihoods as salary and wage earning households in the same area have. Given an option, almost all PL collectors would like to move to the category of salary and wage earners. Alternative livelihoods based on the latter are a viable option. However, this requires creation of additional skills and infrastructure.

1.6 Policy Responses and Interventions: Local/National/External

This section analyses policy responses emerging from an analysis of the inter relation of trade in shrimp, the producers' response to it and subsequent impact on ecosystems and rural poverty. Responses of different actors as they emerged in the decade of the nineties are discussed and possible directions, which could be outlined for the future, are indicated below:

1. **Processing Units can internalize compliance costs arising out of food safety regulations in importing countries provided appropriate and timely information is provided.** The adaptive capacity of the exporting units to the international environment has exhibited itself and needs to be strengthened. *The national government and industry associations* have an important role to play in this. Fast transmission of accurate information on prevailing food safety standards and other requirements to exporters is essential to sustain incomes accruing in the region from this activity. Such action will constitute a good example of private-public partnership in accessing international markets.
2. **Disease related with intensive stocking in aquaculture and subsequent income vulnerability has resulted in choice of appropriate technology.** A combination of economic rationale and legal action resulted in the emergence of an appropriate technology. The continued adoption of such sustainable aquaculture practices needs to be supported through appropriate provision of credit and market access.
3. **Multiple drivers of ecosystem change have been addressed through targeted responses, sometimes not well integrated.** In the region, there has been a lack of integrated policies addressing different benefits of mangrove ecosystems and constituents of human well-being but as is evidently clear from the discussion in different chapters, narrowly focused policy has clearly impacted the relevant target.
4. **The effectiveness of response options related to natural resources can be improved with coherence among different types of policies and the degree of collaboration among stakeholders.** While the forest department is entrusted with the protection of forests, the effect of economic factors on this mandate is not taken into account. Such neglect has expected results. The effect of the aquaculture lobby or big shrimp farmer and processing unit owner in the city is also ignored in the process. This lack of understanding of differential interest and priority of the stakeholders is the recipe for disaster as far as management and sustainable use of the mangrove of Sundarbans is concerned.

5. **Biodiversity loss from livelihood creation for the poor can be mitigated through innovative policies.** It is well documented that subsequent to aquaculture expansion and in the absence of hatcheries, prawn seed collection is an important livelihood for large numbers of the poor. The following policy options exist and may be considered:
    - **(i)** Internalize the cost of biodiversity loss in the aquaculture farming cost and set up a manner of spending amounts collected in a "designated fund" on mangrove generation and more generally on biodiversity conservation. This is economically feasible but administratively difficult to implement.
    - **(ii)** Provide prawn seed through the " hatcheries technology" and provide alternative livelihoods to prawn seed collectors. Such an option also requires extensive preparation by way of setting up of enabling social and legal frameworks.
6. **Collaboration among actors in identifying livelihood options is often facilitated by "bridging organizations"** In some cases, focused efforts of civil society and NGOs have brought the desirable change in the livelihood options for the people. Provision of livelihood options and non conventional source of energy supply especially in areas like Chhotamullakhali has helped people in income generation with less impact on the stress of the ecosystems there. Development of small-scale tourism by involving local people (like in Bali Island) by Wildlife Protection Society of India (WPSI) and WWF has supplemented the effort of the state government. Such efforts need to be extended on a much wider scale.
7. **When people with different interests, experiences, and knowledge cooperate, the potential diversity of response options is enhanced.** Society in the Sundarbans region as in many places is driven by diverse interests and goals. Marginal people like prawn seed collectors try to maximize the daily catch of tiger prawn and in the process cause harm to biodiversity. Processing units want the continuous supply of the raw material (shrimp) for business where this supply constitutes more than 92 percent of the total inputs. But the base of the supply is vulnerable as this demand by the processor cannot be met without adopting the

intensive farming (causing pollution and biodiversity loss) and may be running the risk of white disease as well. Poor people in search of prawn seed collection encroach the forest. People also try to penetrate the forest for temporary / permanent stay causing the threat of forest clearing. Here diverse interests drive people.

Often, the well-being of one set of stakeholders depends on diverse determinants and constituents. Faced with limited options, they are forced to make choices between these constituents in their best interest. If these stakeholders receive facilitative help from civil society and the government with inputs from diverse experiences and knowledge systems (especially of local people in dealing with protection of precious wildlife and forest etc), response strategy would far prove far more effective in managing the ecosystems and its impact on the people's well being. Such facilitative and enabling environments result in development, essentially an enhancement of peoples' ability to fulfill their aspirations in diverse ways.