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Economic and Social Management of Estuarine Biodiversity in the West Coast of India

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ECONOMIC AND SOCIAL MANAGEMENT OF ESTUARINE BIODIVERSITY IN THE WEST COAST OF INDIA

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CHAPTER 1

Introduction

The Indian sub continent is blessed with a long stretch of coastal zone that delivers a variety of local and global economic benefits. It supplies a variety of living and non-living resources, which offer opportunities for employment, income, amenities and pleasure to the local people. Biological diversity of coastal ecosystems is economically valuable at the global level too. Unfortunately, the Government has not made any systematic efforts to develop its coastal zones, as these ecosystems were believed to be economically insignificant. Coastal zones were never serious targets of national planning in India. These ecosystems were left to the local inhabitants, mostly belonging to the socially and economically deprived sections of the Indian population.

However, the recent global concerns expressed in various national and international conferences and conventions about the irrational use of coastal resources and biodiversity degradation have completely altered the attitude of policy makers and politicians. Biodiversity management is an important global concern now. Yet in India, very few attempts have been made to study them in detail - to value them, to examine the process of degradation, and the related socio-economic issues and management. This study is an attempt to understand the socio-economic significance of estuarine biodiversity along the western coastal belt of the Indian peninsula in a comprehensive manner. It highlights the socio economic importance of Indian estuaries, as a coastal ecosystem and cautions the need for the prudent use of various resources and ecosystem services for the sustainable livelihood of the indigenous and global communities.

More than 200 rivers are seen flowing towards the west coast of India and evolve as estuaries before joining the Arabian Sea **[1]**. These systems are exposed to the tides from the sea on the west and receive fresh waters of about seventy thousand million cubic meters making the water brackish through out the year. Backwater systems in Kerala, **[2]** for instance, have their bed levels at about 1.5 to 1.8 m below the mean sea level and normally remain separated from the sea by a

narrow strip of land of about 0.4 to 12 km wide. Tropical wetlands and estuaries are known for their biological diversity and are considered to be the most productive yet complex ecosystems of the world that support the livelihood of coastal communities. They provide a diversified portfolio of goods and services and are considered to be of immense value. Being the largest common property ecosystems, estuaries play a dominant role in the economy of Kerala, Karnataka, Goa, Maharashtra and Gujarat, although their economic importance has not been properly recognised both in the academic and policy circles. It is unfortunate that these systems were never the primary targets of planning till now.

Estuaries provide an array of natural resource entitlements to rural communities. Mixing of fresh water and seawater provides healthy habitats for a large variety of fish and shellfish. Fishing is one of the major economic activities of the rural coastal communities. Brackish water wetland agriculture is an age-old occupation of the agrarian communities along the western coastal belt of India. Aquaculture of varying intensity has also been carried out on this environment in a significant way. Estuaries of Kerala subsidise the traditional coir making industry as rural communities use brackish water bodies and the nearby wetlands for soaking coconut husks. In fact, this process has helped to subsidies the cost of coir processing and enabled our coir products to compete in the international markets. The north-western coastal zones also supply large quantities of salt for industrial and household consumption. The traditional navigation industry ensured the delivery of essential commodities to the rural areas and was instrumental for maintaining viable trade relations. Sand mining and clamshell fisheries provided the raw materials for the construction industry. The presence of mangroves also enriches various forms of living organisms and ensures smooth delivery of various ecosystem services to humanity at large.

Apart from these direct tangible flows of economic benefits, estuaries also provide a variety of indirect services to local communities and to the rest of the world which also enhance the economic significance of these ecosystems manifold. The capacity of estuaries to regulate various gases, climate, water currents and flow, soil erosion and sedimentation, retention and soil formation, nutrient cycling, waste

treatment, pollination and thereby control the various biological processes is well recognised. A major part of the life cycle of the shellfishes is spent in estuaries. Moreover, estuaries supply various kinds of recreation services and act as the primary pool of genetic resources. In fact, these diverse ecosystem functions along with the direct flow of benefits through the supply of various goods and services make these systems valuable to humanity. These services are enjoyed by human users almost free of cost or at a price much below the cost of acquiring alternate but similar services.

The economic importance of these ecosystems to the local communities and to the world at large has been recognised in the Rio Conference and in the various forums of the Convention of Biological Diversity way back in 1992 **[3].** The Ministry of Environment and Forests has also implemented many programmes for the sustainable development and management of these ecosystems in India partly due to international compulsions. The Government of India and the state Governments have also introduced various legal measures for the prevention of irrational use of estuaries and resources especially mangroves and fisheries. Despite these initiatives these coastal ecosystems continue to deteriorate the world over, due to the inbuilt socio economic and environmental problems associated with their use and misuse.

In India, estuaries, as ecosystems, have not raised much concern over their management or lack of management. Till very recently, it was an environment, left to the socially weaker sections of the society. A number of fishing castes and poor agrarian communities were the major organisers of livelihood activities on this environment. Their technology was labour intensive and primitive and the scale of production small but sufficient to meet the needs of the local rural economy. An important characteristic of their modes of resource use is the active presence and timely intervention of local institutions in the allocation, governance and controls of local resources and environment among various stakeholders. The multiple functions performed by these local institutions allowed a sustainable use of biological diversity for the benefit of various human users. Although the traditional uses appeared to be sustainable and equitable, local communities failed to make

more investments for developing coastal zone activities due to low levels of economic surplus and technical skills. Therefore, whenever there were demands for economic expansion, the local communities could not effectively dominate in the decision-making processes. As we shall explain below this weakness of the system has given birth to the entry of modern stakeholders not necessarily belonging to these traditional user groups.

For the last two decades, estuarine resources and environment in India had been intensively used by modern enterprises subject to the development of international markets. Apart from the state and central government enterprises, a number of new firms started modern industrial activities, using estuarine resources and environment indiscriminately. The process was started in Kerala way back in 1939, with the state sponsored drive towards industrialisation. Today, there are at least 150 small and large industrial establishments located close to the backwaters. Locating industrial units close to backwater bodies has a number of definite advantages. First, market value of wetlands is very low and locating industries on the banks of backwaters would reduce the capital costs of industrial establishments. There are other advantages too. These systems do not have well defined property rights which make it easy for industries to externalize the costs of pollution abatement easily. Moreover, the population staying near these systems is poor and their political and social mobilization inadequate to resist externalities of large-scale industrialization. Inspired by these advantages, the Cochin Port Trust, the Navigation and Transport Industries and the international leisure industries have all entered into this ecosystem. Thus the process of commercialization of estuaries, started during the mid thirties, was an attempt to generate more economic values from these ecosystems.

Commercialisation processes of estuarine ecosystems have accelerated industrialization at many places along the western coastal belt. In fact, today, the Ernakulam district is known as the industrial city of Kerala. Similarly, Nethravadi estuary in Karnataka, Mandovi in Goa, Powai estuary in Maharashtra are also known for their contribution towards rapid industrialisation in these states. Given the huge amount of public and private investments that went into new economic

activities, new economic values were also created. Sustaining these values required the support of legal and social conditions in favour of the new evolving interest groups. Public policies were crafted to provide legal support to the activities of new entrants. Although there were environmental laws preventing activities of modern players, poor enforcement deteriorated the environmental conditions in the backwaters. However, the distributions of these newly created values have been among a smaller number of people and at the expense of traditional stakeholders.

Although the process of industrialisation of different states has been accelerated due to the development of a modern industrial agglomeration around estuaries, it soon started generating external costs to traditional economic activities like fishing, agriculture, aquaculture coir making, clam fishing, lime shell collection traditional ferry and transport services etc **[see chapter 4 for details]**.The evolution of a modern sector consisting of various industrial units, and their activities has produced a number of spill over effects on the kayal ecosystem and on the people living in the nearby villages. Pollutants released into the estuaries by various industries on the banks of the water body have caused severe reduction in the productivity of fishing activities and paddy cultivation. Aquaculture activities were also reduced manifold due to the impact of pollution. Mining along the Goa Maharashtra coastal zone has generated conflicts between mining companies and the local residents. Dredging of the bottom of Cochin estuary by the Port Trust has produced severe ecological imbalances. Sedimentation externalities have reduced the water holding capacity of the ecosystem causing water logging and reduced fishing. Reclamation has also affected economic activities and ecological services of estuaries. **Subramanian (2000)** sites eight specific cases in which a total of more than 680 hectares of kayal land have been reclaimed for development purposes. He also gives details of wetlands and swamps that have been filled up in the recent past for housing projects. In short, commercialisation of these coastal zones of late has drawn limits to their capabilities and degraded the biodiversity of these eco-zones.

The threat imposed by the activities of modern stakeholders to the health of backwater ecosystem is severe and dangerous to the level exceeding the carrying capacity of the system. The destruction of mangroves, the silt and sediment accumulation, the impact of dredging on the living organisms and to the island economies, the impact of brackish water pollution to traditional stakeholders like fishermen, farmers and to the general health of the population are the major concerns raised by the degradation of estuarine biodiversity. Reclamation of estuaries for various development needs is increasing at a rate that would soon lead to the collapse of the major ecosystem services. Traditional resource users have been complaining about the manner in which biodiversity has declined due to the commercialisation of estuarine space in recent years. Many scholars have produced clear evidences to indicate the nature of the evolving resource crisis and environmental degradation. **[Nair, 1992; Gopalan et. al., 1983]**

There are many reasons for the degradation of estuarine biodiversity. Environmental economists pointed out that biodiversity degradation is primarily due to the irrational use of resource by various stakeholders, which results from the wrong choice of development path and the failures of market forces to allocate resources and environmental assets efficiently among different stakeholders across generations (**Swanson, T. M. ed., 1995**). It is also caused by various institutional and government policy failures to regulate such irrational use through modern environmental governance. Apart from the factors listed above, biodiversity degradation in estuarine ecosystems is also related to the nature of weak political and social mobilisations of local communities to tackle their problems. In developing countries like India, people's movements play a crucial role in influencing policy. Unless these issues are reasonably examined, it will be difficult to ensure the sustainable use of resources and environment of backwaters.

Given the level of modern activities, a good number of these traditional people found themselves being gradually marginalized from the mainstreams of the economy. This has created a lot of livelihood insecurities and led to large-scale mobility of people into cities and towns in search of different kinds of jobs.

Traditional coastal zone institutions that guaranteed the necessary social order among different resource users have collapsed while the modern institutions failed miserably to deliver the necessary support services that would protect biological diversity and offer livelihood securities to local communities. The pressing issue is that although livelihoods needs are still being met, it is not on a sufficient scale.

Although, most of these development initiatives and projects appear to benefit the domestic economies in many ways, there is a fear both among the local communities and the policy makers alike that coastal resources and environments have been irrationally used causing environmental damages, biodiversity destruction and marginalized local producers and workers from their traditional occupations. Unfortunately, these processes of destructions are ongoing and have grown even to the extent of directly threatening the livelihood securities of domestic communities.

At the same time, new values created are not on a sustainable basis. The modern stakeholders also experience serious crisis too. It is noticed that most of the large industrial units are among the top ranking firms incurring losses to the Kerala exchequer even without undertaking the required abatement costs. Internalising the costs of externalities will certainly increase their costs of production. Small scale industries also face similar problems .The tourism industry, on the other hand, has already moved to the southern side of the backwaters for want of better water quality. This means that although the system is still capable of generating new economic values from the kayal environment, creation of the new values is at the expense of the biodiversity of backwaters, which in turn would threaten the sustainable existence of the traditional communities of backwater villages. The local population is slowly getting marginalized in the process of development taking place on this environment. Thus the entry of these units into estuarine economy is not an unmixed blessing.

Faced with this crisis of resource degradation and economic exclusion, the traditional communities started responding to the crisis in many ways. First, they have reorganized their economic activities. Fishermen have reduced their mesh

size and resorted to indiscriminate fishing of whatever resources they could catch. They have also increased the number of nets, mostly the Chinese and stake nets, and even reduced the number of workers employed in fishing operations. In fact, there are more illegal nets today than licensed gears. The pokkali farmers have also reorganised their activities to tune to the evolving crisis. Some of them have stopped cultivation, due to lack of profits. A few of them have sold their lands and shifted to other occupations. A large proportion are even willing to sell their properties and waiting for a better opportunity to do so. The construction of the proposed Gusher bridges once completed will intensify the process in the near future. There are also instances in which people approach the legal machinery for conflict resolution where local mechanisms fail to find an effective solution to the problem

The State by means of legislation and acts have taken over the management of these common resources leaving very little incentive to all stakeholders both traditional as well as modern to conserve the resource or manage its use in a sustainable way. However, many of these modern regulations have at the same time come into direct conflict with the traditional stakeholder use of the estuaries. Consequently parallel systems of management have slowly developed among different types of stakeholders. Alongside this, apathy on the part of the state to approach the ecosystem problem from a holistic perspective has led to the emergence of a scenario where there exist a plurality of rules and regulations.

However hydraulic states along the coastal belt of India cannot afford to ignore the slow degradation of these ecosystems. The proportion of population that directly and indirectly depends on it is very huge. Moreover, a large number of modern stakeholders have already intensified their economic activities, which use estuarine resources and environmental assets mostly by excluding traditional communities and by producing externalities to other players. This choice of development path obviously is a wrong path and if allowed to continue will ultimately ruin estuaries and the people who depend on these ecosystems for subsistence. In order to introduce appropriate corrections to this development path a scientific study on the nature of biodiversity degradation and the impacts such

crisis make on the livelihood securities of local communities and on the ecosystems services is essential. This study has therefore concentrated on the following specific objectives.

1.1 OBJECTIVES

1. To characterise the nature of fish and shellfish diversity and to describe the ecological services of major estuaries along the West Coast of India.

2. To estimate the direct, indirect and non-use values of estuarine biodiversity and to compare the economics of degraded and undisturbed areas in the selected estuaries using appropriate methodology in environmental economics.

3. To identify the major causes of biodiversity erosion in these estuaries and to document these processes in detail.

4. To explore how different stakeholders have, enforced their claims on the estuarine environment and to examine the role of various institutions in the development of such rights and economic activities.

5. To suggest appropriate socio-economic strategies for the prudent use of estuarine resources and biodiversity.

This report is organised as follows. **Chapter 2** provides a description of the analytical framework adopted and the methodology followed in the study. **Chapter 3** gives the fish and shellfish diversity found in the study areas. **Chapter 4** introduces the major stakeholders and their activities on estuary. **Chapter 5** deals with the causes of environmental destruction of estuaries and provides some data to highlight the nature of the issue. **Chapter 6** discusses the production potentials, productivities and economic viabilities of these activities in selected locations. **Chapter 7** provides our calculations of direct, indirect and non-use values of estuarine ecosystems. **Chapter 8** details the conclusions and our final remark

NOTES

1. An outstanding feature of the Western coastal zone of the Indian peninsula is the presence of a large number of perennial or temporary estuaries popularly known as backwaters. Major estuaries on the West Coast of India are

Amba	Kali	Netravathu-Gurupur
Astamudi	Korapuzha	Pavenje
Beypore	Mahi	Periyar
Gangolli	Mahim	Purna
Kadinamkulam	Mandovi-Zuari	Vembanad

Source: Estuaries of India, State-of-the art- report

2. List of major estuaries in Kerala.

	Estuary / Backwater	District(s)	Area (Ha.)
1	Anchuthengu	Thiruvananthapuram	521.75
2	Astamude	Kollam	6424.15
3	Azheekode	Thrissur	82.02
4	Beypore	Kozhikode	783.74
5	Chandragiri	Kasargod,	575.81
6	Chettuva	Thrissur	713.87
7	Cheruvattur	Kasargod, Kannur	1153.70
8	Cochin	Ernakulam	7503.80
9	Dharmadam	Kannur	359.06
10	Edava-Nadayara	Thiruvananthapuram	157.65
11	Kadalundi	Malappuram, Kozhikode	407.41
12	Kadinamkulam	Thiruvananthapuram	346.88
13	Kallai	Kozhikode	160.13
14	Kayamkulam	Alappuzha, Kollam	1652.33
15	Kodungalloor	Thrissur	613.81
16	Korapuzha	Kozhikode	1038.08
17	Kottapuzha	Kozhikode	584.12
18	Mahe	Kozhikode, Kannur	180.17
19	Manjeswar	Kasargod	158.41
20	Nileswar	Kasargod	824.69
21	Paravoor	Kollam	662.46
22	Payyoli	Kozhikode	26.70
23	Palakkode	Kannur	598.25
24	Ponnani	Malappuram	757.19
25	Poonthura	Thiruvananthapuram	97.59
26	Poovar	Thiruvananthapuram	30.93
27	Rorapuzha	Kozhikode	1038.08
28	Veli	Thiruvananthapuram	22.48
29	Vembanad	Ernakulam, Kottayam, Alappuzha	15845.89
30	Valapattanam	Kannur	3077.64

Source: ADAK. Kerala Fisheries Brackish Water Resources Survey - 1991 at a glance.

3. Recognizing the importance of marine coastal resources for social and economic development, Agenda 21 dedicated chapter 17 to sustainable management of coasts and oceans. The Agenda recognises that

    - Coastal marine environments form an integral system essential for global life maintenance,

    - Coastal and oceans present economic and social opportunities for sustainable development,

- The United Nations Law of the Sea (1982) establishes rights and obligations of states and provides the international foundation for seeking protection and sustainable development of coast, seas and their resources and

- Given increased loss and environmental degradation, new approaches are needed for management of coastal and marine zones at the sub-regional, regional and global levels.

CHAPTER 2

Estuarine Biodiversity Degradation And Socio Economic Management: A Framework For Analysis

The characteristic feature of tropical estuaries is their biological diversity, which refers to the number, variability and variety of living organisms in a given assemblage. The term is also used to encompass the genetic, species and ecosystem diversities. Ideally, characterizing estuarine biodiversity should begin with detailed inquires to capture the nature of diversities in species composition of fish, shellfish, benthos, mangroves, birds, animals and vegetation supported by the ecosystem and proceed towards documenting ecosystem diversities.

The current study, however, is a humble attempt to document the diversity of various finfish and shell fish species in the selected estuaries along the West coast of India. Since the use of estuarine resources and services has been affected both by natural and socio economic forces, a multidisciplinary approach is essential to understand these processes. This approach should necessarily integrate various biological/ecological and socio economic processes that guide the use and abuse of estuarine resources. This study therefore begins with characterising the fish and shellfish diversity in selected estuaries and proceeds further to valuation of the ecosystem. The task of characterising fish and shellfish diversity has been undertaken in this study using established methodologies with the help of qualified biologists.

Estuarine ecosystems in their diverse forms deliver a variety of direct and indirect benefits to the society. These not only include the direct benefits derived by various sections of the ecosystem communities through fishing, aquaculture, prawn filtration, wetland paddy cultivation, traditional passenger ferry and cargo services etc., but also an array of ecological services that subsidise various activities directly and indirectly. Most of these services accrue to the larger public also (including the world communities) for which payments are seldom made due to failures of markets, institutions and Government policies **(UNEP, 1995; Pearce and Moran, 1997)**.

An important methodological issue therefore, is to understand how valuable these goods and services are so as to derive mechanisms for the prudent use of estuarine resources and environment. In fact, the ability to attribute values on environmental resources is a core problem in sustainable development (**Mitchell & Carson, 1993**). An important follow up therefore, is to value these resources and formulate policies in such a way that individual stakeholders pay the relevant price for using resources and environment. Conducting an environmental economic valuation of biodiversity and then using resource prices to reflect these values normally solve this. **Valuation of the goods and services, including values of the ecosystem functions and non-use values is the second issue undertaken in this study.**

Valuation of the direct, indirect and non-use values of estuaries, generates societal preferences towards the use and abuse of such resources and services of that ecosystem. However, biodiversity of tropical estuaries had been declining over the last few decades due to state interventions and development projects that encouraged intensive use of resources and environment. In Cochin estuary, for instance, large quantities of resources have been used by the modern enterprises like Cochin Port Trust, modern industrial enterprises, modern aquaculture farms, navigation industry and the international leisure industry. Moreover, they also produce negative ecological/environmental externalities, the major cause for the degradation of biological diversity in the economic and social realms of the system.

Economic theory highlights three fundamental causes for the degradation of biological diversity viz. market failures, institutional failures and policy failures **(UNEP, 1995; Pearce and Moran, 1997).** Economists argue that biodiversity being an environmental good, does not get traded in a formal market between buyers and sellers so as to ensure an efficient and optimal allocation of resources and therefore, biodiversity will degrade when markets fail. There are many reasons for this. First, biodiversity degrades when the stakeholders fail to internalise externalities of their activities **(Pigou 1920, Arrow 1970; Dasgupta 1996).** There exist no incentives for the prudent use and conservation of

biodiversity due to the public good features attached to it**.** In such cases, people may over use the asset relative to what is best for the society. Markets fail due to the absence of well-defined property rights. Creation of appropriate structure of property rights with clear delineation of rights and responsibilities and the trading of such permits where possible are necessary for the efficient and sustainable use of resources. Therefore, economists argued that if biodiversity were to be preserved, governments would have to ensure well-behaved markets by taking appropriate measures to overcome market failures.

Governments of developing countries sometimes see the environment as an area to extend the role of the state **(Pearce and Moran, 1995).** After all, this is what one experiences at least in the case of estuaries. These interventions are normally undertaken with the best of intentions for developing these areas and the economic standards of poor stakeholders. They are aimed to correct market and institutional failures and to provide the necessary legal and policy support for better governance of these ecosystems. Despite good intentions, Government interventions fail miserably due to policy failures. For instance, Government interventions could legally create state property, which in turn may contradict with traditional structure of community rights or common property rights. Secondly, state interventions could also produce various externalities in the process of defending state property claims. Dredging externalities, pollution externalities, reclamation externalities are only a few such spillovers generated in the Cochin estuarine ecosystem by the state.

Water pollution is a major externality, which directly influence the traditional activities like fishing, agriculture and aquaculture in the Cochin estuary. There are many methods like productivity differences and dose-response models to study the impact of industrial pollution on the ecosystem and on the population. The Impact of water pollution on the ecosystem especially on the fish yields is analysed in this study by using the productivity difference method. Since our focus is not exclusively on the impact of industrial pollution on the economic activities, we resort to the use of productivity difference method. (See chapter 5 for details)

Another important factor responsible for the degradation of biodiversity refers to the failure of local and global institutions to intervene in the conservation of biodiversity **(Dasgupta, Folke and Mäler 1994; Perrings, 1995**; **Pearce, 1995)**. It is argued that since the uses of ecosystem resources are influenced by local processes, it is best to ensure the participation of local communities in the management of resources. This argument rests on the fact that traditional institutions ensured good governance of local resources especially in pre capitalist societies which were subject to low levels of external market interventions. .Although, traditional communities had their own institutional arrangements to share resources and environment, they were never recognised when estuarine ecosystems were drawn into centralised planned development processes executed by national and state governments. In fact, traditional institutions were viewed as obstacles for modern development and therefore, they were not socially or politically acceptable. This led to the creation of a number of modern institutions designed to replace traditional ones. Traditional institutions also failed in delivering the required services to different stakeholders due to internal conflicts, poverty of stakeholders **(Chopra, 1998)** and the plurality of modern and traditional systems. In spite of drawbacks, traditional institutions had their advantages as they could enforce a social control over resources and the environment.

It is unfortunate that we do not have a comprehensive policy statement, which indicates how to use the estuaries and their environment. Policy failures are highlighted by examining the policies of the government on the alternate use of estuarine space for fisheries, aquaculture, agriculture, tourism, navigation and trade. We have also attempted to highlight these failures at the local level (say at the level of gram panchayat) and global level and argue that all these aspects have cumulatively contributed to the loss of biodiversity in estuaries. **In short, the study will examine the various issues related to the failures of markets, government policies and institutions that cumulatively contribute to environmental degradation of estuaries.**

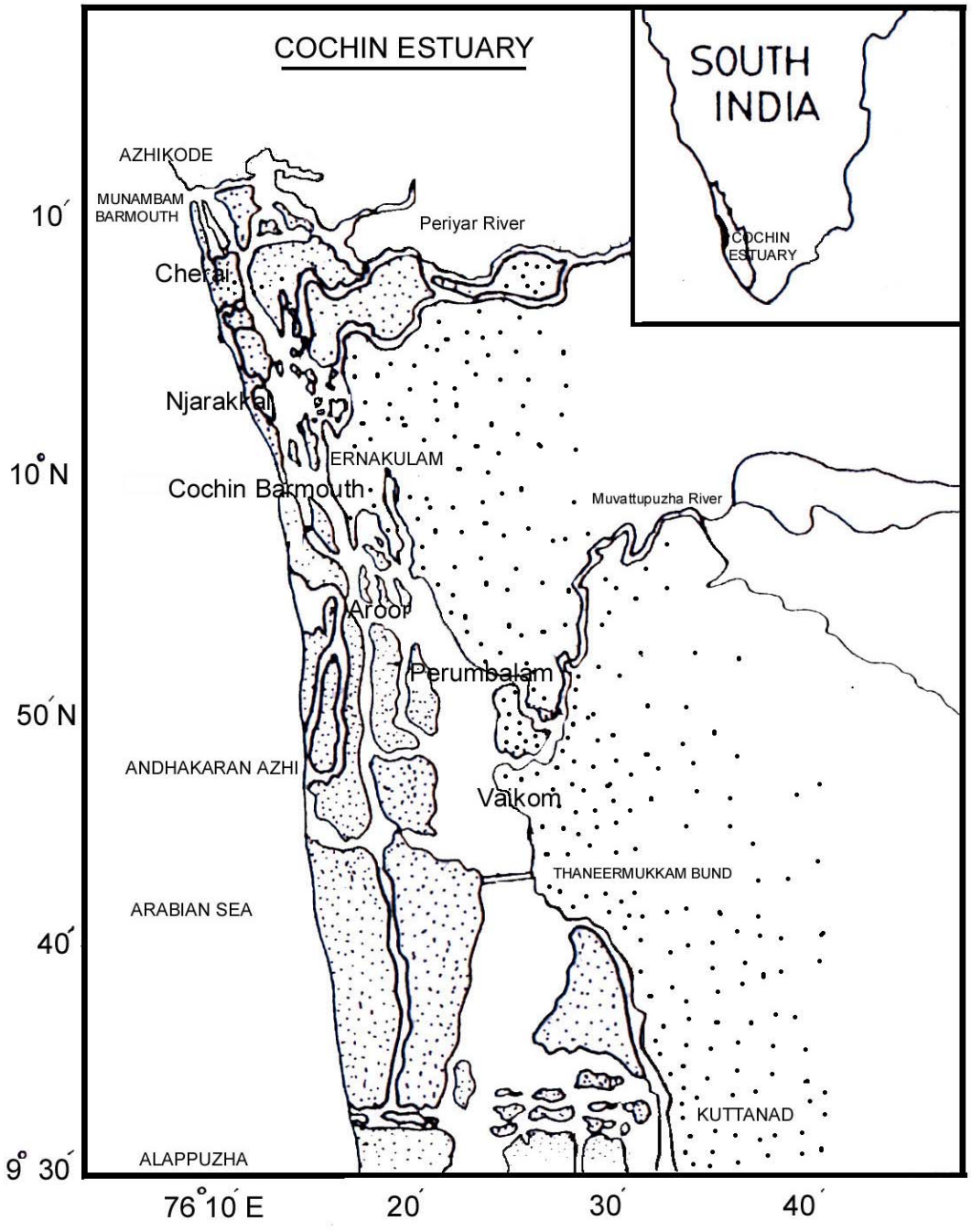
Therefore socio economic management of estuarine biodiversity would require a holistic procedure that not only recognises the economic values of various

resources and the ecosystem/environmental functions, but also the strengths and weaknesses of the institutions to ensure a socially acceptable, and equitable distribution of resources and environment. Policies definitely should support such initiatives at the international, national and local level, which are essential for ensuring these benefits to the present generations without denying them to the future generations also. **Hence, apart from the valuation of various direct, indirect and non-use values of estuarine environment, we have also attempted to analyse the role of formal and informal institutions and organisations in the allocation and governance of estuarine environments.** In order to examine these issues we analysed institutions (formal and informal /customary) that have some role to play in the management of estuaries. Detailed socio-economic surveys are conducted for highlighting major issues involved.

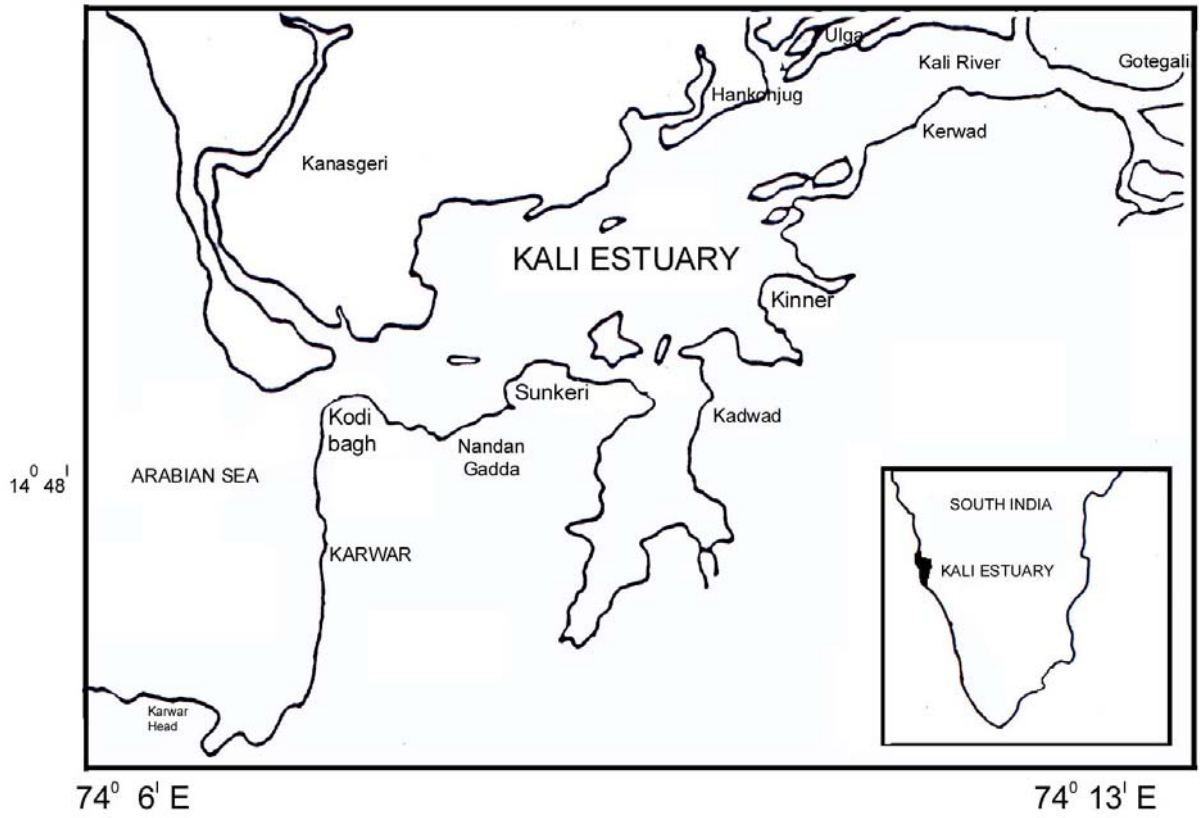
2.1 The study areas

Two estuaries (Cochin estuary in Kerala and Kali estuary in Karnataka) along the southwest coastal zone of India are selected for this study. **Cochin estuary** of Kerala is one of the largest brackish water bodies in India. It stretches to over 24000 ha in area and contributes to about 50 percent of the total area of estuaries in the state. **Kali estuary**, on the other hand, is one of the smallest estuaries in the North Kanara district of Karnataka state situated at 14^{o} 50' 21"N and14 ^{o} 10' 06". (See Maps 2.1 and 2.2). The Cochin estuary has been exposed to the influences of international markets and commercialisation of economic activities from an early date. To appreciate the changes experienced by this system, it is necessary to select an estuary less exposed to such external forces of modernisation. The Kali estuary of Karnataka state is selected mainly to provide this comparative perspective. This estuary has not been commercially exploited until recently. Thus the selection of these two systems offers scope for comparing the nature of social organisation of economic activities and the process of biodiversity degradation at different levels of commercialisation.

Map 2.1 Location map of Cochin estuary



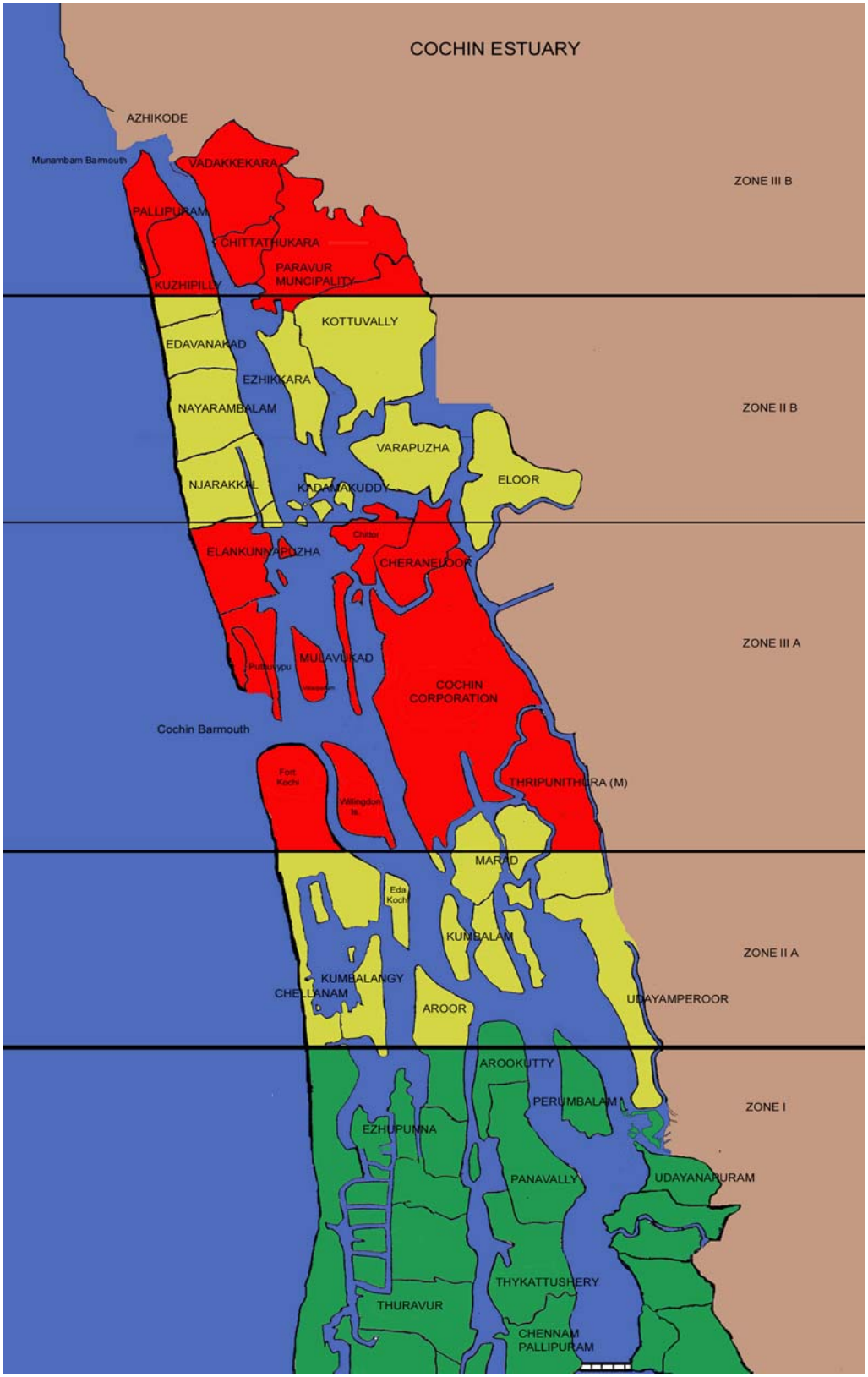
Map 2.2 Location map of Kali estuary



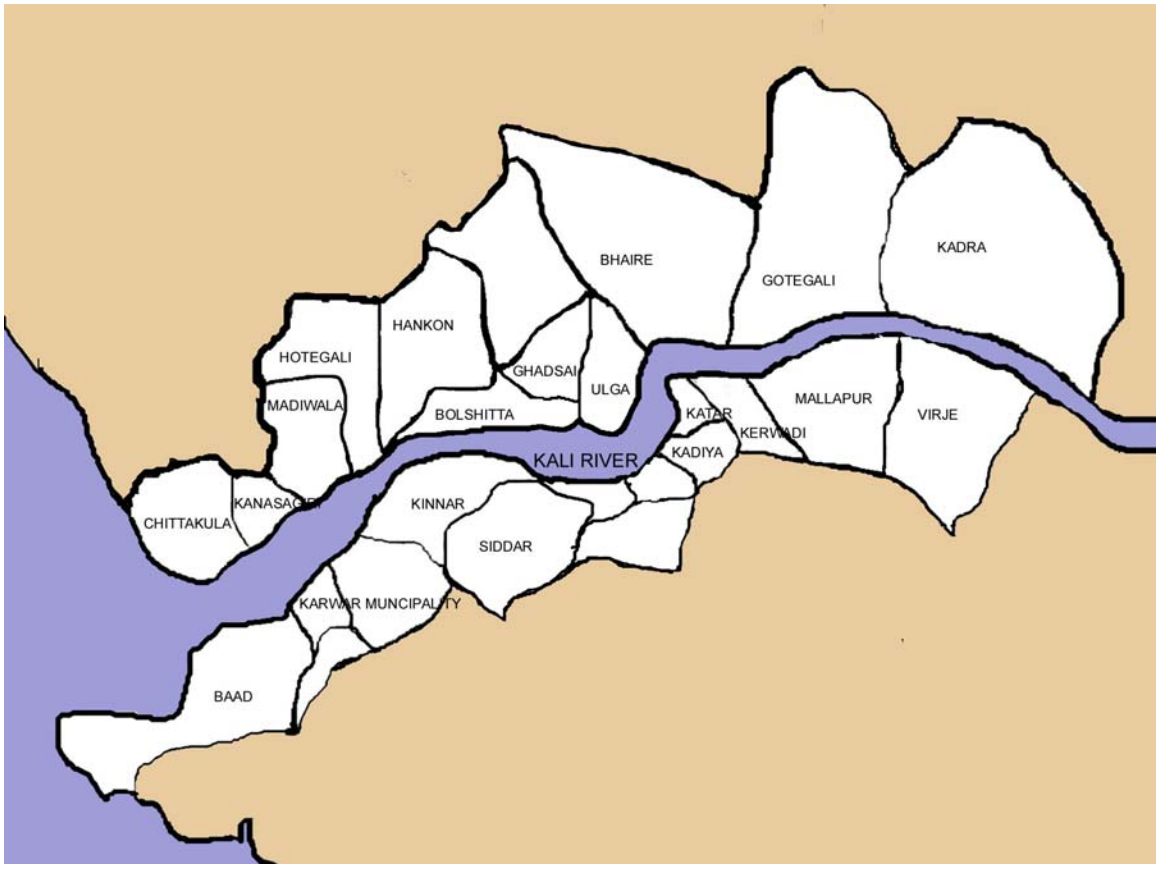
2.2 Locations

The area selected in Cochin estuary extends over a geographical space between Azhikode in the north and Thaneermukkam in the south. It lies within the administrative boundaries of Ernakulam, Alleppy and Kottayam districts. This area is further divided into three zones based on hydrobiological parameters. The first zone (Zone I) has a salinity distribution between 9.5 - 11.5. 15 panchayats and a Municipality lie in this zone. Zone II is the zone whose salinity varies between 17.5 and 19.5 and comprises 14 panchayats and a Municipality. Zone III lies close to the bar mouth where the salinity ranges between 21.5 and 25.0. This zone contains 7 panchayats, one municipality and a corporation. The study area in Kali estuary comprised 23 villages and a municipality. Kali estuary is treated as a single zone. (See maps 2.3 and 2.4)

Map 2.3 Division of Cochin Estuary by Zones



Map 2.4 Division of Kali Estuary by Zone



2.3 Sources of Data and Modes of Data Collection

Two types of database have been used in this enquiry. The first set of data refers to the hydro-biological processes while the second set falls under the economic and social domain. Both primary and secondary sources of data are used to characterise estuarine biodiversity and other related issues. First, we have collected secondary data on the water quality, composition and diversity of living organisms as well as ecological process in these estuaries from the various studies conducted by various research institutes and universities. In fact, the biological/ecological processes of Cochin and Kali estuaries have been deeply examined by local Universities and other research institutes (viz. School of Marine Sciences of the Cochin University of Science and Technology, Centre for Advanced Studies in Marine Biology, Annamalai University, Madras University, National Institute of Oceanography, Mangalore Fisheries College, CMFRI,

Fisheries Biological Stations of Karnataka University located at Karwar etc.) Data gaps have been filled using primary data. Most of the socioeconomic data requirements have been met through primary surveys. In a few instances, secondary data like the Census reports, administrative reports and local level village panchayat reports have also been used.

2.3.1 Data on the hydro-biological processes

As mentioned earlier, since the diversity of finfish and shellfish species in estuaries depends on the health of the ecosystem, the study team first examined the nature of hydrobiological processes in the selected estuaries. Bimonthly sampling was conducted for a period of 12 months. Sampling started in the month of February 2001. Internationally accepted methods **(APHA, AWWA, WEF, 1995 and Vollenweider, 1978)** were consulted to standardise the collection, preservation and analysis of water, sediments and biological samples. From these selected zones, the following sampling stations (Vaikom, Perumbalam, Aroor, Barmouth, Njarrakal, Cherai in the Cochin estuary and Sunkeri, Kodibagh, Kinner in Kali estuary) were fixed for hydro-biological assessments.

Procedure To Standardise Water Quality Parameters

Conductivity, pH and total dissolved solids were measured in the field itself immediately after the collection of the samples using portable ELICO model 118-water quality analyser. Frequent cross checking was done with the Systronics model 335 pH meter and Systronics model 305 conductivity meter. **Turbidity** was measured in NTU units in the laboratory using Systronics model 105 Turbidity meter.

Dissolved oxygen, free carbon dioxide and alkalinity were determined in the field itself with out any delay. The **dissolved oxygen** was determined using Winkler's method in which the Manganous sulphate reacts with sodium hydroxide or potassium hydroxide to form a white precipitate of manganous hydroxide which is then rapidly oxidised by the dissolved oxygen in to brown manganic basic oxide.

In the presence of iodide ions, on the addition of concentrated sulphuric acid, the oxidised manganese reverts to the divalent state liberating iodine proportional to the original dissolved present in the water. The iodine liberated was titrated using sodium thiosulphate with starch as the indicator.

Free carbon dioxide was titrimetrically determined using sodium hydroxide. Sodium hydroxide combined with the free carbon dioxide in the sample to form sodium carbonate and water. The complete removal of carbon dioxide was indicated by a faint pink colour in presence of the phenolphthalein indicator. For the estimation of **alkalinity,** the sample was titrated to convert the carbonates into bicarbonates in presence of phenolphthalein. In the second stage, methyl orange indicator was added and the titration is continued to convert all the bicarbonates (HCO_3) into carbon dioxide and water. The complete neutralisation of alkalinity in the sample was indicated by the change in colour from yellow to orange at the end point.

The **hardness** was determined through the EDTA titrimetric method. The calcium and magnesium ions of the sample were titrated with EDTA disodium salt to form stable Ca EDTA and Mg EDTA. The small quantity of Eriochrome black-T added to the sample and buffered at pH 10 led to a soluble wine-red complex with some of the calcium and magnesium ions. The EDTA during titration first completed all the free calcium and magnesium ions and the solution would turn blue. The Ca_2^+ and Mg_2^+ then dissociated from their complexes with Eriochrome Black-T to form more stable compound with the EDTA. A colour change from wine red to purple blue was at the end point in titration.

The **chloride** ions were quantitatively determined employing the argentometric method using potassium chromate as the indicator. Silver nitrate combined with the chloride ions of water to form a white precipitate of silver chloride. When all the chloride ions were used up, the excess silver combined with the chromate indicator to form a pinkish yellow coloured silver chromate. The end point of the chloride reaction was marked by this colour change, thus enabling the determination of the chloride concentration using standard silver nitrate.

Dissolved organic matter is determined as an index of soluble organic matter in water. Acidified sample is digested with $KMnO_4$ solution and standard ammonium oxalate solution is added. The excess of ammonium oxalate is back titrated with standard $KMnO_4$ solution. The required $KMnO_4$ solution is proportional to the oxygen consumed.

To determine **nitrite nitrogen,** the sulfanilamide was used as an amino compound, which coupled with N-(1-Napthyl) - Ethylene Diamine Dihydrochloride (NEDD), lead to the formation of a pink azo dye. The amount of the azo compound was proportional to the initial concentration of nitrite nitrogen in the sample. The extinction of the dye thus formed was measured at 543nm in a spectrophotometer to determine the concentration of the NO_2-N.

The **nitrate nitrogen** in the sample on the other hand was analyzed by UV spectrophotometric method. Measurement of UV absorption at 220nm enables rapid determination of NO_3^-. Since dissolved organic matter may also absorb rays at 220 nm and NO_3^- does not absorb at 275 nm, a second measurement is made at 275nm to correct the NO_3^- value. Acidification with 1N HCl is done to prevent interference from hydroxide or carbonate concentrations.

The **phosphate phosphorous** is determined by the stannous chloride method. Phosphate combines with ammonium molybdate reagent to form molybdophosohoric acid which, in turn, is reduced by the stannous chloride to the intensely coloured molybdenum blue. The colour developed is proportional to the phosphate concentration in the sample, and is photometrically determined at 690nm.

Silicate silicon of the sample was allowed to react with acidic ammonium molybdate to form an yellow silico-molybdate compound. The complex was then reduced by oxalic acid to generate the molybdate blue colour. This was measured using a UV spectrophotometer (Systronics model 118) at 410 nm.

In order to examine the **texture** of sediments, the samples collected were treated with hydrochloric acid and hydrogen peroxide to remove the carbonates and the

organic matter. These were further treated with sodium hexameta phosphate to get a good dispersion. The dispersed sediment was wet sieved through a 230 mesh and the sand portion retained in the mesh was determined. The mud fraction escaped through the mesh was made into a suspension in 1000 ml Cylinder and the clay and silt fractions were determined after withdrawal using pipettes at specified time and drying the sample. The values were converted into percentages at dry weight.

The **pH** was measured using a Systronics pH meter model 335. Sediment was dried sieved through 60 no. ASTM sieve and 20g was thoroughly mixed with 50 ml distilled water allowed to settle and pH measured.

Organic carbon was estimated according to **Walkley and Black (1934)**. Organic carbon present in organic matter of the sediment is oxidised by chromic acid in presence of concentrated sulphuric acid. Potassium dichromate on reaction with sulphuric acid provides nascent oxygen, which combines with carbon and forms carbon dioxide. The sulphuric acid enables easy digestion of organic matter by rendering heat of dilution. The excess chromic acid left is determined by back titration with Iron (II) ammonium sulphate using diphenylamine indicator**.**

2.3.2 Plankton and Macrobenthos

The samples were collected using a hand-plankton net of blotting silk (aperture size, 56 micron) and preserved in 5 % formalin. Sub-surface samples were collected using a Vandorn sampler. Quantitative and qualitative enumerations of the plankton were carried out in the laboratory at the earliest opportunity.

Multiple samples were collected using an Ekmans grab having 200 cm^2 collection area. The collection was passed through a sieve (ASTM. No.40; mesh size: 0.064 mm) and preserved in formalin. The separation and sorting were done in the laboratory after staining with Rose Bengal.

Qualitative and quantitative enumeration of the plankton was done based on **Davies et al., 1995; Fauvel, 1953; Needham and Needham, 1962; Prescott, 1978; and Ward and Whipple, 1959.** Several other publications were also consulted for the confirmation of identification (**West & West, 1902, Round 1965**).

2.4 Data on other economic activities

In order to collect data on the economic and social parameters and their inter-relations, we divided the communities into traditional and modern stakeholders and monitored their activities through structured questionnaires during the last one year. The major traditional stakeholders monitored are:

1. Fishers (engaged in finfish, shellfish and clam fisheries)
2. Households engaged in wetland agriculture (gazni or pokkali)
3. People involved in traditional prawn filtration
4. People involved in sand mining
5. People involved in traditional ferry services

These economic activities are valued using separate sets of questionnaires.

2.4.1 Fishery

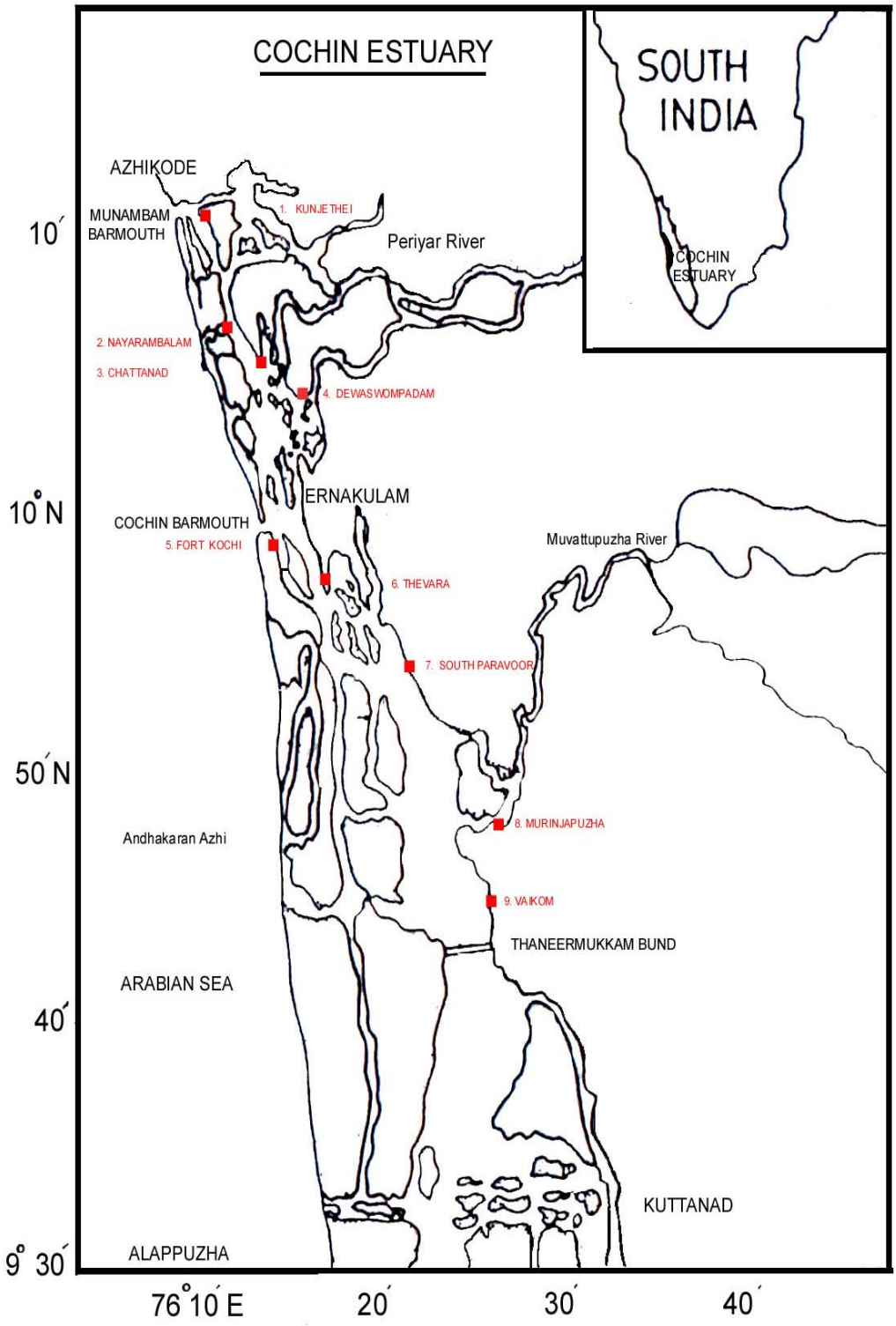
A stratified random sampling procedure was adopted for estimating fish yields. For this, we divided the entire area into different zones and these again into different strata. A representative fishing village/centre was then fixed for each of the strata. Five landing centres towards the southern part of the study area in Cochin estuary (Vaikom, Murinjapuzha, Paravoor, Thevara and Fort Kochi), four landing centres towards the northern side of the estuary (Nayarambalam,

Chathanadu, Devasampadam and Kunjithai) and three landing centres (Sunkeri, Kodibagh, Kinner) in Kali estuary were selected for the collection of fish landings data**.** The distance between sampling stations towards the southern side of Cochin estuary varies between 8t and 12 kilometres while, the distance between any two stations towards the Northern side varies between 3 to 15 kilometres. In Kali, the average distance varied between 5 to 12 kilometres. **(See maps 2.5 and 2.6 for details).**

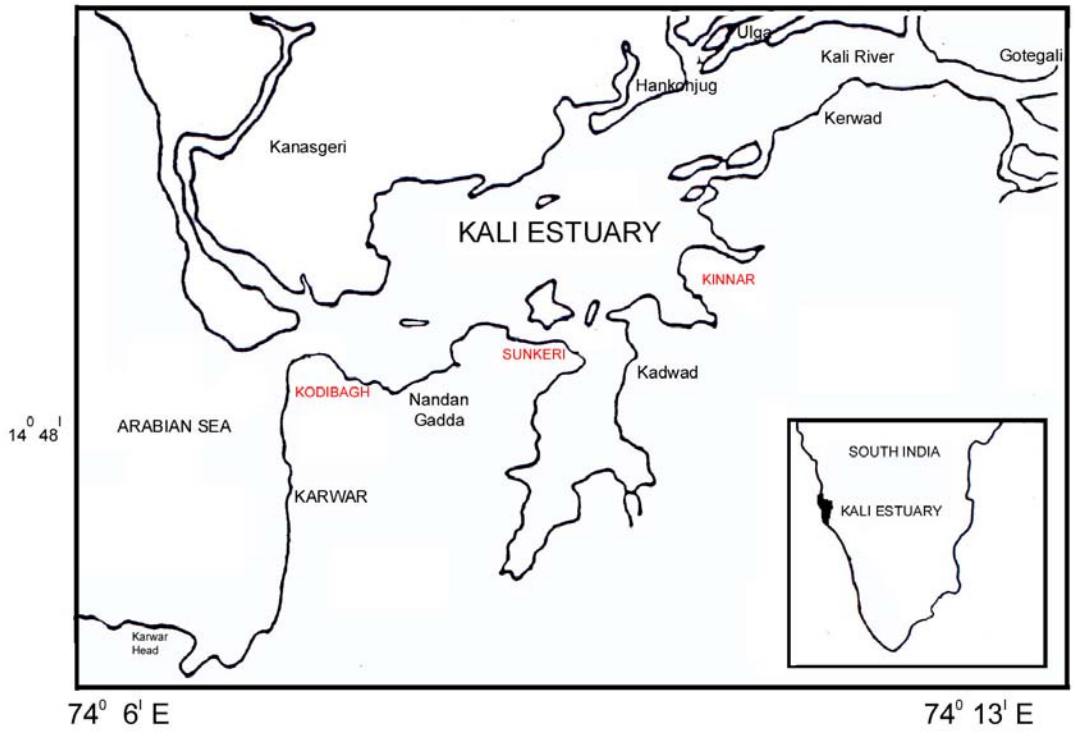
Primary data on fish yields were collected from these landing centres on a monthly basis, which provided estimates of total monthly catches. Sampling days were fixed according to the nature of tides (thakkam and pakkam). Monthly data on catch composition, weight, number and values were collected for 10 major gears in each of these stations for a period of one year from February 2001.This data is used for the calculation of direct economic value from capture fisheries. As the catches from filtration farms also arrive at these landing stations, they are also covered during these landing surveys. Station wise data are compared to unearth the species diversity at different stations within the same ecosystem. This will enable us to identify the ecologically sensitive zones of the selected estuaries.

Landing stations of clam fisheries were selected on the basis of their concentration and seasonal fluctuations. Four stations from Cochin estuary (Kumbalangi, Aroor, Ezhupunna and Perumbalam.) and three stations from Kali estuary (Sunkeri, Nandangadda and Kodibagh) were selected for this purpose.

Map 2.5 Location of fish landings sampling stations in Cochin estuary



Map 2.6 Locations of fish landings sampling stations in Kali estuary



Socioeconomic conditions of fishermen of Cochin and Kali estuaries were studied using structured questionnaires at the panchayats/village level. The sampling frame is given below.

	Chinese net	Stake Net	Gil Net	Cast net	Seine Net	Hook & line	Trap	Scoop Net	Drag Net	Ring Net	Other Nets	Total
Cochin Estuary												
ZONE I	6	22	24	20	10	2	4	6	15	14	8	131
Zone II	21	0	30	14	0	4	0	0	3	5	2	79
Zone III	12	23	29	7	0	2	0	0	7	0	0	80
Grand Total	39	45	83	41	10	8	4	6	25	19	10	290
Kali estuary												
ZONE I	-	11	36	25	7	-	-	-	-	-	10	89

2.4.2 Wetland agriculture

Apart from the secondary data on the distribution of land belonging to the various padashekharams registered with it, a questionnaire was also designed to collect primary data on the area under cultivation, yield and value. The socio economic conditions of these households were also collected during these surveys. Wetland paddy fields (pokkali fields) on the banks of Cochin estuary are spread over 25 panchayats, 3 municipalities and a corporation. In Kali, wetland paddy cultivation (gazani) is concentrated in 17 villages and a municipality. One percent sample was selected at random from each of these areas for detailed examination.

2.4.3 Other traditional activities

Traditional ferry services are engaged in transporting goods to remote islands from the urban markets. These activities are very popular in Cochin estuary. Bi-monthly sampling was conducted in selected cargo loading points to estimate their economic contribution. Sand mining is not undertaken in any significant scale in Cochin estuary while it is one of the major livelihood options of poor people around Kali estuary. Six sand mining centres (Kodibagh, Boribagh, Sidder, Halga, Karwadi, and Kadia) were monitored for a period of one year for collecting data on sand mining in Kali estuary. Questionnaires were also executed in Cochin and Kali estuaries to collect data on lime shell collection and clam fishing.

Modern stakeholders

The modern stakeholders are identified as those involved in modern aquaculture, navigation and tourism activities. The Cochin Port Trust is also considered as a state sponsored enterprise, which uses estuarine environment for providing berthing services to export import business.

2.4.4 Aquaculture

Modern aquaculture is undertaken mainly in the wetland paddy fields both in Kali and Cochin estuary. Although severe legal restrictions prevent undertaking

aquaculture in paddy fields round the year, many people organize these activities using different technologies even today. The data on area under cultivation under different systems is collected from government records while the data on yields, returns and socio economic parameters were collected through structured questionnaires. Two types of aquaculture systems - semi-intensive and extensive - are seen In Kali. The total area under aquaculture was collected through frame surveys while yield and returns are collected through sample surveys.

2.4.5 Navigation

The navigation industry directly makes use of the water transport potential of estuaries. This activity is highly developed in Cochin while it has not developed in Kali even today. Navigation activities along Cochin estuary are undertaken mainly by two state sponsored enterprises (Kerala Shipping and Inland Navigation Corporation, State Water Transport Department). Few private boats also operate passenger services where State transport services are not operated. The data on number of passengers traveled, during the year 2000-01, the value-generated etc is published by the department and is collected for this analysis. Similarly an attempt is also made to calculate the values generated by the private sector.

2.4.6 Port Trust

The Cochin Port Trust publishes annually the data on its operations from which the necessary data on the cargo handled, income and expenditures are collected for this study. Data on the quantity and expenditure incurred on dredging the bottom sediments of the estuary is also collected from these documents.

2.4.7 Tourism

In the case of the operations of tourism industry, there are both private and public sector operators. The government has made a major proportion of investments to promote tourism along the backwaters. These data are collected from the department of tourism and also from the private sector tour operators.

2.5 Economic Valuation

The popular neo-classical environmental economics taxonomy will act as a guiding lamp in evolving a realistic estimate of the economic values of the identified direct, indirect, option, and bequest and existence values of estuarine biodiversity. Accordingly, the total economic value calculated in this study is the summation of direct, recreational and non-use values for the Cochin estuary. Since, the recreational activities in Kali estuary are underdeveloped; such values are not estimated in the present enquiry. The non-use values are also not estimated for Kali due to shortage of time. The major concern in estimating the gross values of direct benefits from the use of living and non-living resources is to highlight the relative importance of these activities to different stakeholders. To simplify the calculations further due to shortage of time, only the important traditional and modern activities are included in the present analysis. For instance, traditional stakeholders like fishers and agrarian communities engaged in fishing and paddy cultivation are included while the traditional households engaged in coir processing are excluded. Similarly, the economic value of mangroves in the estuaries is also not estimated in the study. As far as the measurement of benefits is concerned, we use **market valuation methods** to estimate the values of goods and services having direct markets. Activities like fishing, wetland agriculture, prawn filtration, aquaculture, sand mining, navigation and ferry services, etc. have formal markets and hence their respective values are approximated to the gross revenue produced by the units operating in these activities. Indirect use values of estuaries, especially those related to backwater tourism are estimated using the **travel cost methodology**. The non-use economic values of estuaries are estimated using the **contingent valuation method**.

2.5.1 Calculation of Direct Values

In the case of capture fisheries, we first estimated the total catch of different species for ten major gear groups through a formal systematic biological sampling. Total production for the year 2001-02 and the gross revenue generated through fishing in different zones are then estimated. The gross revenue generated

through fishing is then divided by the total area of the estuaries to calculate the gross value of estuary per hectare of space. Similar procedures of calculations are used for eliciting values of gross revenues generated through wetland agriculture, aquaculture, clam fishing and sand mining.

2.5.2 Estimating Economic Value of Backwater Tourism

The Travel Cost Methodology is used to estimate the value of the recreational and aesthetic services delivered by the estuaries to direct users. The market for backwater tourism is developing very fast in Cochin estuary while it is still underdeveloped in Kali. Therefore the TCM questionnaires were executed only at Cochin.

The study is based on a survey of a random sample of 299 visitors to the Cochin estuary in 2001-02, comprising 195 residents and 104 visitors from outside. As such there is no data on the number of households visiting Cochin backwaters for recreational purposes or on their basic socio economic characteristics. Therefore an onsite survey was conducted during weekdays and holidays at different timings in all the major selected sites along the backwaters to gather information required for estimating recreational value of the estuary.

The population for a TCM research consists of either those who visited the site during a given period or people living expected to visit the site within a stipulated period from a defined region **(Frank and Beal, 2000).** Visitors are broadly defined as those who use the backwaters for various recreational activities. Thus an individual who lives by the backwater is treated as a visitor if he takes a walk or spends some time there deliberately for recreation, exercise or to participate in some cultural events hosted in and around it. However passersby, people who depend on boat service for travel, employees in the navigation industry and those who visit the site for business purposes etc are not counted. The visitors to the Cochin backwater are classified into local tourists, visitors from other districts of the state, those from other states and foreign nationals. A distinction had to be

made between residents and non-resident visitors to account for the fact that non-residents were on multi destination trips.

Only adult visitors¸ who had a definite source of income, were interviewed because they were considered to be more realistic in making personal valuation of their recreational experiences at the park vis-à-vis their budget constraint **(Brown and Henry, 1989).** The visitors were randomly chosen for the interviews and asked to complete the TCM questionnaire. The interview was conducted over a period of two months, at six different sites along the backwaters on working days and holidays between 9 am and 7 pm. Questions were devised taking into consideration the characteristics of visit patterns to the backwaters. A pre testing was also done before the actual survey was conducted. Recreation values were estimated from these data.

Briefly the TCM questionnaire consists of three parts. In the first section, questions were asked to reveal the nature of use of the backwaters, frequency of visits, time spent, alternative use of the time, cost incurred, purpose of visit etc. The second part included questions to reveal the attitudes of the respondents to various aspects. According to standard Travel Costs methodology, important socio economic characteristics like nationality, length of stay and socioeconomic variables like sex, educational qualification and income and travel costs of the visiting group are to be collected. Therefore, the third section was devised to gather information on the demographic features of the respondents. Pre testing was done before the actual survey was conducted.

The backwater environment is used for different purposes such as boating, jogging, recreation, for hosting cultural and religious events (boat races and other festivities) etc. Questions were asked to reveal the purpose of visit, the type of use and the frequency of such uses. The backwater is often visited by tourists from outside the districts, businessmen, people who visit city to meet relatives or friends and people who come for many other purposes such as court visit, hospital, training etc. Therefore, questions were also asked to identify

multipurpose visits. Such respondents were asked additional questions regarding other sites visited or yet to be visited.

According to respondent's place of origin and distance from the backwaters, the tourists are classified to originate from five zones. The region consisting of Ernakulam, Alleppy and Kottayam districts, which the estuary and backwater s are located, was taken as the first zone. The rest of Kerala State was taken as the second zone. Considering the geographic and demographic proximity, the two states of Tamil Nadu and Karnataka were clubbed together to form the third zone. Gujarat, Maharastra, Delhi, Uttar Pradesh jointly formed the fourth zone. Countries of origin of foreign tourists were clubbed to form the fifth zone.

The total travel cost is treated as the sum of the monetary value of round trip travel time and out of pocket expenses, which include expenses for food and beverage, photography, sight seeing and recreating and boarding charges in the case of outstation visitors. The opportunity cost of time is and important factor in travel cost demand models. **Travel cost models may be seriously under specified if pricing of time is ignored. The opportunity cost of time is determined by an exceedingly complex array of institutional, social and economic relationships and yet its value is crucial in the choice of types of and quantities of recreational experience (McConnell and Strand, 1981).**

The travel cost model assumes that site visits are priced by out of pocket expenses and opportunity cost of travel time. Usually the income rates are used as a measure of opportunity cost of time-consuming products. However persons who actually substitute time for money constitute only a small portion of the population. Retirees, students, unemployed persons etc cannot substitute time for income. Work contracts of most employed people do not allow for such a substitution either. People who use the backwaters or estuary during weekends, evenings or early mornings are not foregoing any income. There are many employment categories (carpenters, maisons, laborers, and agricultural laborers) that may use their time for recreation due to lack of continuous employment.

There are employment categories like business people, whose direct involvement is not necessary to ensure their income.

For calculating the cost of travel time individuals were categorized according to their ability and willingness to substitute earned income for time. The sampled individuals are categorized as professionals, service persons, farmers, traders, unemployed, retired and students. No time cost was calculated for students, the retired and unemployed. Others were identified based on employment type and other details for estimating the cost of travel time.

The cost of travel time can be estimated assuming either full hourly wages or 1/3rd of the hourly wages. The estimation of 1/3rd of the hourly wages is more meaningful when the majority of respondents come under taxable income limits. The average hourly wage rate was calculated for each zone. The aggregate household monthly income of respondents was divided by the total working hours in a month assuming an 8 hour duty per day for all.

The total travel cost consists of three components: cost of travel, time cost and other expenses. For respondents from the second zone onwards the boarding charges incurred were also added to other expenses. Multipurpose visitors and tourists who are on their way to different places were accrued 30 percentage of their costs. Time cost for such persons were also treated in similar manner.

Tourists to the backwaters use various modes of transportation. Local people either walk or use bicycles. Others use public transportation system, motorcycles, private cars, taxi etc. These aspects as well as the costs incurred were captured in the survey by asking suitable questions. The questions were further expanded to include other costs such as boarding in the case of visitors from far of places, cost incurred for food and beverage, recreation, photographs, passes etc. incurred for the trip

Since the Cochin backwaters lie close to industries and an urban centre, the quality of water is fast eroding. Respondents were therefore asked to rate and compare the Cochin backwaters with that of Alleppy, which is considered less

polluted. Due to free accessibility and limited number of sites of its kind the sites, especially the ones near the urban limits are drawing huge crowds. Questions were also asked to elicit information on the facilities the visitors would like to enjoy in these sites. Questions were included to get the demographic factors such as sex, age, income, education and profession. To make it convenient for the respondents, age and income were asked in ranges. For education the highest gained qualification was asked. A question on the type of ownership and structure of housing pattern was used to know whether the spending pattern revealed by the respondents match income and other characteristics. (**See annexure 7.1 for the travel cost survey questionnaire used in this study).** Among the 350 questionnaires prepared and executed, 310 were returned, of which only 299 were used, as 11 of them were incomplete.

The visit rate from each zone to Cochin backwaters was calculated by dividing the total visitors to the Cochin estuary from that each zones by the total population of respective zones. The travel cost of sample respondents from the five different zones was multiplied by the respective population that visited the site. This was then aggregated to arrive at a tourism values for Cochin estuary. This calculation mainly relies on a single destination model which assumes that the respondent had undertaken the trip to that sight alone for its aesthetic value. Although these assumptions can be legitimised in the case of domestic travelers, we found that the travel behaviour of foreign tourist dose not correspond to this. Therefore the value that is arrived at is subject to variations. However since they are a negligible proportion of the total visitors, our calculation still remains as a satisfactory estimate of the tourism value of the backwater.

2.5.3 Estimation Of Non-Use Values Of Estuaries: Contingent Valuation Survey

One of the major objectives of this study is to measure the non-use values of the ecosystem services provided by the Cochin estuary to residents and to the rest of the world. Non-use values are estimated in this study using the contingent valuation (CV) method. Contingent valuation is a standardized and widely used

survey method for estimating WTP for use, option, existence, and bequest values **(Mitchell and Carson, 1989).** In order to estimate the consumer's willingness to pay for the non-use values of Cochin estuary, we presented a scenario and a hypothetical market that ensured a better estuarine management programme and improved ecosystem services delivered by estuaries to the respondents. This management programme was to be undertaken by a Consortium consisting of representatives from the state (central, state and local), various estuarine stakeholders, environmental groups and non- governmental organizations.

The hypothetical character of CVM permits it to obtain payment that includes non-use values (**Hoevenagel, 1994).** The CVM questionnaire was structured to value the non-use benefits of estuarine ecosystems and executed in Cochin to direct, indirect and non-users. **(See annexure 7.2 for a detailed questionnaire executed in this study).** Respondents were presented with current levels of management quality and asked the amount of money that they would be WTP to attain a better level of estuary management and environment quality. This would give an indication of the value of the non-use services performed by estuarine ecosystems.

In designing a CV survey, a scenario should offer respondents information about the characteristics of the specific good and the context which meets the requirements of understandability, plausibility, and meaningfulness so that it can enhance the credibility of a survey and make it more likely to produce reliable results **(Yoo, Kwak, and Pyo, 2000).** The questionnaire format consists of :

(1) Respondents' attitude towards various characteristics of estuarine diversity management

(2) Respondents' perception on estuarine ecosystem services

(3) Valuation questions

(4) Payment Vehicle

(5) Description of constructed market and

(6) A personal profile

Interviewers were trained to conduct personal interviews for pre-test on a hundred residents in the district. Questionnaires and visual aids were modified according to the feedbacks received from the pre test. Open-ended value elicitation question were asked in the pre- test to obtain a benchmark value. This value was then used in the closed ended CVM valuation questionnaire as the starting bid. The questionnaire listed a brief explanation of the purpose and contents of the interviews, clarified the context of the study by providing additional background information on the ecosystem services performed by the Cochin estuary. Literature was surveyed for information on attributes of ecosystem services of estuaries and used in the questionnaire and interview. Focal group sessions were arranged with local environmental NGOs, ***ayalkuttams*** and such informal organizations to evaluate participant's perception of the ecosystem services of estuaries and to describe characteristics in ways that would be understandable and realistic to the public. After pre testing, the questionnaire and visual aids were once again modified.

Before the WTP and value elicitation questions were asked, an attempt was made through the questionnaire to construct the scenario by mean of photographs, newspaper clippings and other visual aids. A detailed description of what is known about the likely effects of the hypothetical change in management of estuaries and what is likely to happen if nothing is done was also included. This was expected to create an awareness of the beneficial effects expected to result from the conservation of tidal flats and the time period when those benefits would occur. Examples of non-user benefits included:

- Improved waste disposal functions of estuaries
- Shoreline stabilization and flood control
- Improved water quality
- Fishery rejuvenation function etc.

The elicitation format employed in this study is a dichotomous choice (DC) question according to the “blue-ribbon CV panel” of **Arrow et al. (1993**), which strongly endorsed a DC question rather than an open-ended question. Before the actual valuation questions were asked, the respondent was first asked their WTP to the programme. Those who expressed a negative WTP were excluded from the value elicitation process. Those who expressed a positive WTP were then taken through the bids to arrive at a value figure that would reflect with reasonable accuracy, the value of the indirect functions of the Cochin estuarine ecosystem to the respondent. Each respondent was presented with a bidding card that started at Rs. 25 and went up to Rs.300. The next bid is conditional on the respondent’s response to the first bid. The bid amounts used in this study were : Rs. 25, 50, 100, 200, 300. He was asked to give a yes or no vote depending on whether his WTP equaled or exceeded each bid. Once a value was arrived at, the respondent was once again asked as to whether the arrived at figure was the maximum amount that he was willing to pay. It was observed that, in most cases respondents stuck to the original figure they quoted.

The payment vehicle used for this study included a one time voluntary donation, and a green tax. Despite its high level of familiarity and obvious connection with the good being considered, it (taxes) may encourage respondents to restrict their WTP amounts to the range associated with a fair or customary expenditure **(Mitchell and Carson, 1989, pp. 221–222)**. Therefore, voluntary donation to the conservation fund floated by the consortium formed for the purpose of better estuarine management was also included as an additional payment vehicle.

In order to draw a representative sample of CVM population, a stratified sample of all panchayats, municipalities and Corporations in the districts of Ernakulam Alleppy and Kottayam was taken. Respondent households were randomly selected within each cluster reflecting, with reasonable accuracy, the characteristics of the population of the study area. The survey was conducted by personal interview due to practical reasons. Since this survey was the first of its kind conducted in the study areas, it was assumed that respondents were less likely to supply unprompted values for environmental services if confronted by any

other method. The person-to-person interviews were administered in respondents' home from July to August, 2002. Completed questionnaires were checked. Questionnaires with contradictory or erroneous responses were rejected and new set executed for a different sample.

From the thousand questionnaires collected, the Mean Willingness To Pay for each income group was calculated. The total Willingness to Pay was then generated by multiplying the Mean WTP of each income group with the population belonging to that particular income group. This was summed up to obtain the Total Willingness to pay of the people of the study area for an improved management of the Cochin estuarine system which reflects the value of the ecosystem services of the Cochin estuary.

2.6 Total economic value of the estuary

Total economic value of the estuary is then arrived at by summing up the direct, indirect and non-use values. This value is divided by the total geographical area of the estuary to arrive at the per acre value of the estuary as a natural resource. This estimate, in fact, is an underestimate, as it has to still account for many other implicit values such as mangroves, minerals etc. Still it is expected that these values will reasonably act as a first approximation and will be useful for policy formulations involving the use of estuarine ecosystems.

CHAPTER 3

Species And Ecosystem Diversity Of Estuaries

Introduction

Appropriation of various biological resources in estuaries depends on a number of natural and social processes. In fact, diversity of living organisms is also influenced by the diversity of various ecosystem services. Since these services and resources are subject to various biophysical characteristics of estuarine ecosystems, an examination of these features is an essential pre requisite for an understanding of estuarine biodiversity and its appropriation. This chapter undertakes this task with special reference to the selected estuaries. The chapter is divided into four sections. We begin with an examination of the nature and growth of some crucial physico-chemical parameters that influence the primary productivity of Cochin and Kali estuaries in section 1 and then proceeds to discuss the nature of fish and shellfish diversity in section 2. In section 3 we describe the nature of major ecological services provided by the estuaries. This is followed by a concluding section, which summarises the major findings of this chapter.

3.1 Factors influencing productivity of Cochin and Kali estuaries

As mentioned earlier, this study concentrates on a geographical space between Thanneermukkam in the south and Azhikode in the north, which lies within the administrative boundaries of Kottayam, Alleppy and Ernakulam districts. The area selected in Kali lies between the barmouth and the Kadra dam. The purpose of the analysis below is to highlight the nature and variations in the physical and chemical conditions of these brackish water bodies so as to examine the corresponding fish and shellfish diversities.

3.1.1 Physical conditions of water

Estuaries provide a variety of resources for human livelihood. The ability of these ecosystems to provide such diverse array of resources and services depends crucially on physical parameters like depth, temperature, turbidity and light as well as chemical specificities like salinity, pH, dissolved oxygen, dissolved solids, inorganic compounds, phosphorus and nitrogen related compounds.

3.1.1 [A] Depth

Depth of a water body has an important bearing on the physical and chemical properties of water. A depth of two meters is considered to be congenial. Variation of depth range in different locations of Cochin Estuary during the past 50 years is shown in table 3.1 below. During 1930's, the southern portion of the estuary (Cochin barmouth to Thanneermukkam) had a depth range between 5 to 9 m. This has declined steadily to the range of 3.5 to 4.5 m. The depth of the water body has also declined near the northern bar mouth region. It is seen that the depth around the Cochin barmouth region, is maintained steady at a depth of 7 to 8m [by] the Cochin Port Trust.

Table 3. 1 Variation of depth range in different locations in Cochin Estuary during the past 50 years, 2001-02 (meters)

Stations	Depth range in 1930	Depth range in 1980	Depth ranges in 2001 *
Between Thaneermukkom bund & Vaikom	8-9	3-4	3.5-4
Between Vaikom and South Paravoor	7-9	4-5	3.5-4.0
Between South Paravoor and Aroor	5-6	3-4	3-4.5
Between Aroor and South of Willingdon Is.	7-8	7-8	7-8
Cochin harbour region	7-8	7-8 **	7-8
Between Bolgatti – Cherai	3-4.5	2-2.5	1.5-2
Between Cherai - Munambam	3-6	2.5-4	2.5-4

Source: Gopalan, U.K, (1983) * Primary survey 2001-02

** Cochin ship channel maintained at 15m depth at constant dredging.

The depth of the Kali estuary is shown in table 3.2. This table shows that except in Kerwadi, the depth is much lower at the selected locations.

Table 3.2 Variation of depth range in different location of Kali estuary

Station	Kodibagh	Kinnar	Kerwadi	Mallapur
1978 (m)	3	1.6	7.75	1.5
1987 (m)	3.5	3	7	1.5
2002 (m) *	3.6	3.2	6.5	1.5

Source: Bhat and Neelakantan (1986) * Primary survey 2001-02

3.1.1 [B] Temperature

The selected estuaries, (Cochin and Kali) receive optimum sunlight as received by any representative tropical estuary**.** (See Table 3. 3 and 3.4).

The degree and annual variations in temperature of the water body have a great bearing upon its productivity. All metabolic and physiological activities and life processes such as feeding, reproduction, movement and distribution of aquatic organisms are greatly influenced by water temperature. In the tropics the variation in temperature over the months is minimal and is stable in the entire study area (**Nair, 1983; Ouseph, 1992; Bopaiah and Neelakantan**, **1986; Bhat and Neelakantan, 1985**)

Table 3.3 Distribution of temperature in Cochin estuary

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1966	29.2	30	30.4	30.4	31.6	25	25.1	27	27.3	29	30.2	29
1992	28.2	29	31	31.5	33.3	27	25	27	28	30	31	28

Source: Nair, 1983

Table 3.4 Distribution of temperature in Kali estuary

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct
1979	28	27.8	28.3	29.1	29.7	27.5	28.1	28.6	28.9	29

1982	27.7	28.8	28.01	28.36	28.21	27.93	27.25	26.64	26.09	29.2
2002 *	28.2	28.6	28.4	29.3	29.2	25.9	26.0	25.9	25.8	27.3

Source: Bopaiah and Neelakantan (1986) * Primary survey 2001-02
Bhat and Neelakantan (1985)

3.1.1 [C] Turbidity

The turbidity of a water body is due to the presence of suspended inorganic substances such as clay and silt or due to planktonic organisms. The distribution of turbidity in the study area reveals that in the industrial belt of Eloor where a large number of industries are located, the turbidity is very high compared to areas like Kadamakudi and Mulavukadu **(Ouseph, 1992**). Tables 3.5 and 3.6 show the extent of turbidity in selected locations of Cochin and Kali estuaries.

Table 3.5 Distribution of turbidity (ppm) in Cochin estuary

	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**
Eloor	2237	1765	2000	1768	1298
Kadamakudi	447.2	425	417.3	382	411
Mulavukad	9.5	10	13.8	11	12

Source: Nair (1983)

Table 3.6 Distribution of turbidity (g/litre) in the Kali estuary

Station 1	Station 2	Station 3	Station 4	Station 5
0.174	0.16054	0.1836	0.25	0.174
± 5401.0	± 0550.0	± 3821.0	± 9791.0	± 5401.0

Source: Prasad et. al. (1990)

It can be inferred that the southern zones of Cochin estuary are relatively less turbid compared to the northern zone. Kali estuary is also relatively less turbid.

3.1.2 Chemical conditions of water

We shall now turn to the discussion of some of the major chemical features.

3.1.2 [D] Salinity

Salinity varies from place to place, season to season and surface to bottom. During monsoon, salinity ranges between 0.19 ppm and 3.2 ppm. And from October onwards salinity increases steadily to reach a maximum of 33. ppm in May due to tidal effects (**Nair, 1983; Ouseph, 1992).** An analysis of data on the distribution of salinity in different locations in Cochin and Kali estuaries (see table 3.7 and 3.8) reveals that Kali is more saline than Cochin for most of the months.

Table 3.7 Distribution of salinity in different locations of the Cochin Estuary (ppm), 2001-02

Station	Cherai		Njarakkal		Bar mouth		Aroor		Perumbalam		Vaikom	
	S	B	S	B	S	B	S	B	S	B	S	B
Salinity	25	25	17.37	18.9	21.4	22.9	17.9	24.5	9.6	11.5	9.5	9.5

Source: Primary survey, 2001-02 S = Surface B = Bottom

Table 3.8 Distribution of salinity in different locations in Kali Estuary (ppm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chittakula	29.2	30.1	30.2	32.4	33.0	2.2	2.1	6.8	3.9	19.9	-	-
Kodibag	27.8	27.9	28.2	29.0	31.1	7.1	3.9	1.3	8.0	14.9	19.1	24.6
Kodibag *	-	-	-	-	-	-	-	-	-	-	19.8	25.3

Source: Bopaiah and Neelakantan (1986) * Primary data 2001-02
Kusuma et al. (1988)

3.1.2 [E] Dissolved oxygen

Table 3. 9 shows the distribution of Dissolved oxygen at different locations in Cochin estuary for the month of March 2001.

Table 3.9 Distribution of dissolved oxygen in Cochin estuary, 2001-02

Station	Cherai		Njarakkal		Bar mouth		Aroor		Perumbalam		Vaikom	
	S	B	S	B	S	B	S	B	S	B	S	B
D.O	1.3	1.3	2.09	2.5	4.2	2.2	2.5	2.09	2.5	2.5	2.2	2.6

Source: Primary survey, 2001-02 S = Surface B = Bottom

A comparative analysis of the distribution of dissolved oxygen in 1966 and 1992 shows that, the dissolved oxygen content has been more or less stable over the last three decades in the selected locations of the study areas **(Ouseph,1992).** The distribution of Dissolved Oxygen in Kali estuary is shown in table 3.10 and it reveals higher values compared to the values of Cochin estuary.

Table 3.10 Distribution of Dissolved Oxygen in Kali estuary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Chittakul	5.76	4.1	4	5.4	3.3	5.9	6.0	4	4.1	4.1	-	-
Kodibag	4.81	4.77	4.75	4.78	4.67	5.26	5.34	5	5.29	4.96	4.87	4.73

Source: Bopaiah and Neelakantan (1986) Kusuma et al. (1988)

3.1.2 [F] pH.

It is normally recognised that the optimum level of pH in the water body varies between 7 and 9. **Jhingran (1991)** reported that in 1966 the level of pH in Cochin estuary varied between 7.0 and 8.4. Another enquiry to this aspect at selected locations shows that the pH varies between 6.2 and 7.0 **(Gopalan et. al, 1983).** Table 3.11 below shows the values of pH at different locations of the backwater during 2001-02.

Table 3.11 Distribution of pH in Cochin estuary, 2001-02

	Cherai		Njarakkal		Bar mouth		Aroor		Perumbalam		Vaikom	
Station	S	B	S	B	S	B	S	B	S	B	S	B
pH	7.9	7.9	7.7	7.8	8.2	7.7	7.8	7.6	7.5	7.3	7.2	7.1

Source: Primary survey, 2001-02 S = Surface B = Bottom

This means that, the level of ph has been remaining stable for the last three decades. However in Eloor, the level of pH is recorded at 3.1 showing an acidic pH **(Unnithan, Vijayan, Radhakrishnan & Remani, 1977)**. This is instrumental for a high mortality of the fish population in this area. In Kali estuary, pH varied between 7 and 8.4 during the last three decades (see table 3.12).

Table 3.12 Distribution of pH in Kali estuary

Station	Kodibagh	Sunkeri	Kadwad	Kinner	Botjug	Kerwadi
1978	8.4	8.2	8.4	7.4	7	7.2
1983-85	8.3	7.9	8.2	7.8	8	8.2
2002 *	8.3	8.0	8.1	7.9	8.2	8.2

Source: Kusuma et al. (1988) * Primary data 2001-02

3.1.2 [G] Nutrients

The primary productivity of estuary has also been influenced by the distribution of nutrients, nitrogen and its compounds etc. Table 3.13 gives the distribution of levels of nutrients, apart from other relevant hydrological parameters in Cochin estuary in 2001 and table 3.14 gives the nature of these variables for Kali.

Table 3.13 Distribution of other major hydrological parameters in Cochin estuary (μg /l), 2001-02

Station	Cherai		Njarakkal		Bar mouth		Aroor		Perumbalam		Vaikom	
	S	B	S	B	S	B	S	B	S	B	S	B
PO_4	0.16	0.16	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO_2	0.00	0.00	0.00	0.02	0.03	0.04	0.05	0.01	0.03	0.02	0.01	0.00
NO_3	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlor.	14.18	14.18	9.61	10.50	11.87	12.67	9.92	13.59	5.30	6.40	5.27	5.27
D.S	4385	4385	3136	3950	4760	3604	3659	3413	3164	3402	3080	3585
S.S	30.00	30.00	25.50	29.00	27.50	32.00	29.50	31.50	16.00	19.00	13.50	14.50
Hard.	4100	4100	2500	4700	2700	3300	1900	3800	700	1000	600	500
Alk.	100	100	60	80	60	80	60	100	40	60	40	60

Source: Primary survey, 2001-02 S = Surface B = Bottom

Table 3.14 Distribution of other major hydrological parameters in Kali estuary (μg /l).

Month	Station 1	Station 2	Station 3	Station 4	Station 5
NO_2	2.4	1.8	2.11	2.8	1
PO_4	2.1	1.72	1.89	2.43	1.5
Silicates	278	324	221	236	192

Source: Bhat and Neelakantan (1985)

3.1.2 [H] Organic matter in the sediment

The physical characteristics of the sediment influence the accumulation of organic matter in the sediment. It is seen that silty clay sediments have higher content of organic matter while sediments with higher sand content had lesser organic matter. The high percentage of organic content is related to the land humus associated with the detrimental sediment brought into the estuary by rivers. The organic content in the sediment varies from 0.9 % to 2.2% by weight of dry sediment in Cochin estuary. It is relatively high in the area during pre-monsoon period than in other seasons. Organic carbon of sediment in the Kali estuary on the other hand was found to be moderate with Karwadi having comparatively higher percentage values, which might be attributed to the finer grain size. The range in variation of organic carbon was between 1.21% at Gotegali during September 1982 and 4.06% at Karvadi during December 1981 **(Bhat and Neelakantan, 1985)**. These values have not changed substantially even today.

The data shown above clearly reveal the nature of estuarine ecosystem health at selected locations of the estuaries under examination. It gives an impression that the ecosystem maintains an average health except in areas where anthropogenic influences are higher. We shall demonstrate in section 3.2 below that fish and shell fish diversity is also lower in areas where the water quality is deteriorating.

3.2 Fish and Shellfish diversity In Cochin estuary

Primary monthly surveys conducted during 2001-02 revealed the presence of **73 species of finfishes** and **8 species of shellfishes** in the Cochin estuary and 63 **species of finfish** and **9 species of shell fishes** in Kali estuary. Tables 3.15 and 3.16 give a detailed list of the species recorded during 2001-02 in Cochin and Kali estuaries respectively.

Table 3.15 List of Fin fishes and shellfishes recorded in Cochin estuary during 2001-02

Acanthurus crassipinum, Acathurus bleokeri, Ambasis comersoni, Amblypharygodon mola, Anabus testudineus, Arius platistomus, Caranx nigripinnius, Caranx sexfasiatus, Chaca chaca, Chanda commersoni, Chanos chanos, Chelonodon tauvina, Congresox talabonides, Cynoglossus cynoglossus, Cynoglossus punticeps, Daysiana albida, Drapane penetatus, Dussumieria hasselti, Eleotris carviforms, Eleotris fusca, Epinephalus malabaricus, Esculosa, thoracata, Etroplus maculates, Etroplus suratensis, Euryglossa orientalis, Garra mccalandi, Gerrus filamentosus, Gerrus oyena, Glosigobius guirius, Gobius microlepis, Hemiramphus far, Hemiramphuscaritori, Horabagrus brachysoma, Hyporamphus limbatus, Labeo dussmieri, Latus calcarifer, Leognathus brevirostris, , Leognathus equulus, Leognathus splendens, Liza, acrolepis, Liza parsia, Lobotis surinamensis, Lutianus argentimaculatus, Lutianus fulviflamma, Lutianus jhoni, Lutianus quinquelineeatus, Macrognathus guntheri, Megalops cyprinoids, Mugil cephalus, Mystus malabaricus, Mystuuscembalus armatus, Ompok malabaricus, Ompok pabda, Ophichthys attipinnis, Oreochromis mossambica, Otolithus argentius, Oxyurichthys, ormosanus, Oxyurichthys tentacularis, Pristipoma furcatum, Psseudorhombus javanicus, Puntius dorsalis, Puntius filamentosus, Puntius melanostigma, Seatophagus argus, Silago sihama, Spyraenajello, Stolephorus indicus, Tetradon leopardus, Therpon jarbua, Thryssa malabarica, Tricanthus brevirostris, Tylosurus crocodilus, Wallago attu.
Macrobrachium idella, Macrobrachium rosenbergii, Metapenaeus dobsoni, Metapenaeus monocerus, Penaeus indicus, Penaeus monodon, Scylla serata, Villorita cyprinoides var. cochinensis,

Source: Primary Survey, 2001-02

Table 3.16 List of Finfishes and shellfishes recorded in Kali estuary during 2001-02

Acanthurus crassipinum, Ambasis comersoni,, Amblypharygodon mola, Anabus testudineus, Anadontostoma chacunda, Arius platistomus, Caranx sexfasiatus, Chaca chaca, Chanda commersoni, Chanos chanos, Chelonodon tauvina, Congresox talabonides, Cynoglossus cynoglossus, Cynoglossus punticeps, Daysiana albida, Drapane penetatus, Dussumieria hasselti, Eleotris carviforms, Eleotris fusca, Epinephalus malabaricus, Esculosa thoracata, Etroplus maculates, Etroplus suratensis, Euryglossa orientalis, Garra mccalandi, Gerrus filamentosus, Gerrus oyena, Glosigobius guirius, Gobius microlepis, Hemiramphus far, Hemiramphuscaritori, Horabagrus brachysoma, Hyporamphus limbatus, Labeo dussmieri, Latus calcarifer, Leognathus brevirostris, Leognathus equulus, Leognathus splendens, Liza macrolepis, Liza tada, Lobotis surinamensis, Lutianus fulviflamma, Macrognathus guntheri, Megalops cyprinoids, Mugil cephalus, Mystus malabaricus, Mystuuscembalus armatus, Ompok

malabaricus, Ompok pabda, Oreochromis mossambica, Otolithus argentius, Pristipoma furcatum, Puntius filamentosus, Puntius melanostigma, Silago sihama, Spyraenajello, Stolephorus indicus, Tetradon , leopardus, Therpon jarbua, Thryssa malabarica, Tricanthus brevirostris, Tylosurus crocodilus , Valamughil seheli.
Macrobrachium idella, Macrobrachium rosenbergii, Metapenaeus dobsoni, Metapenaeus monocerus, Metapenaeus affinis, Penaeus indicus, Penaeus monodon, Penaeus merguiensis, Scylla serata.

Source: Primary Survey, 2001-02

Studies on the diversity of fish and shellfish populations of Cochin estuary are very few and limited to certain locations. **Kurup (1982)** reported that there were at least 139 species available during early eighties in the estuary. A study by **Nagaraj and Neelakandan, (1982)** reported about 45 species in Kali estuary.

Although a diverse flow of resources are available both at Cochin and Kali estuaries, their availability is highly uneven across space and time. This unevenness is related to the nature of human interventions and the state of the ecosystem itself. Table 3.17 gives the availability of different species at various locations in Cochin and Kali estuaries respectively.

Table 3.17 Availability of finfish and shellfish during the period 2001-2002 in selected zones of Cochin and Kali estuaries

Species	Cochin					Kali
	I	II A	II B	III A	III B	I
1. *Acanthurus crassipinum*	12	6	8	11	9	1
2. *Acathurus bleokeri*	12	7	12	2	9	0
3. *Ambasis comersoni*	12	7	12	12	12	12
4. *Amblypharygodon mola*	12	7	7	9	11	12
5. *Anabus testudineus*	12	7	12	8	12	11
6. *Anadontostoma chacunda*	0	0	0	0	0	12
7. *Arius platistomus*	12	7	11	12	12	12
8. *Caranx nigripinnius*	12	10	9	6	10	0
9. *Caranx sexfasiatus*	12	7	6	10	12	4
10. *Chaca chaca*	12	7	11	12	12	12
11. *Chanda commersoni*	11	7	8	5	12	11
12. *Chanos chanos*	8	7	11	7	12	1
13. *Chelonodon tauvina*	12	10	5	5	12	1
14. *Congresox talabonides*	12	7	6	11	12	12
15. *Cynoglossus cynoglossus*	12	7	8	6	12	11
16. *Cynoglossus punticeps*	12	7	3	10	11	12
17. *Daysiana albida*	12	7	6	7	12	12
18. *Drapane penetatus*	8	0	9	1	0	1
19. *Dussumieria hasselti*	12	7	1	10	12	1
20. *El eotris carviforms*	12	6	0	7	12	1
21. *Eleotris fusca*	12	10	8	0	12	1

22. Epinephalus malabaricus	12	6	12	7	12	12
23. Esculosa thoracata	12	7	11	5	12	12
24. Etroplus maculatus	12	6	6	12	12	12
25. Etroplus suratensis	12	9	11	9	12	12
26. Euryglossa orientalis	12	6	11	11	12	12
27. Garra mccalandi	8	8	7	0	3	11
28. Gerrus filamentosus	12	6	8	4	12	12
29. Gerrus oyena	12	6	5	12	12	12
30. Glosigobius guirius	12	6	4	3	12	12
31. Gobius microlepis	12	7	3	4	12	12
32. Hemiramphus far	12	7	6	4	12	12
33. Hemiramphuscaritori	12	7	3	5	12	12
34. Horabagrus brachysoma	10	7	3	3	12	12
35. Hyporamphus limbatus	12	7	8	4	11	1
36. Labeo dussmieri	12	16	9	8	12	12
37. Latus calcarifer	12	10	2	12	12	12
38. Leognathus brevirostris	11	7	2	5	11	11
39. Leognathus equulus	12	7	3	10	12	12
40. Leognathus splendens	12	7	3	4	11	1
41. Liza macrolepis	12	7	4	7	12	11
42. Liza parsia	12	7	9	6	12	0
43. Liza tada	0	0	0	0	0	12
44. Lobotis surinamensis	2	0	6	4	1	1
45. Lutianus argentimaculatus	11	7	0	0	11	0
46. Lutianus fulviflamma	12	7	0	7	12	1
47. Lutianus jhoni	1	0	0	0	1	0
48. Lutianus quinquelineeatus	12	7	2	0	11	0
49. Macrognathus guntheri	12	7	2	1	11	1
50. Megalops cyprinoides	12	7	8	4	12	12
51. Mugil cephalus	12	7	11	7	12	11
52. Mystus malabaricus	12	7	8	12	12	12
53. Mystuuscembalus armatus	12	7	1	9	12	12
54. Ompok malabaricus	11	7	1	3	11	12
55. Ompok pabda	2	3	0	1	0	1
56. Ophichthys attipinnis	1	1	0	0	0	0
57. Oreochromis mossambica	12	10	8	6	12	12
58. Otolithus argentius	12	7	3	11	12	12
59. Oxyurichthys formosanus	3	0	3	0	1	0
60. Oxyurichthys tentacularis	12	7	2	0	12	0
61. Psseudorhombus javanicus	12	0	5	0	1	0
62. Puntius dorsalis	0	10	3	2	12	0
63. Pristipoma furcatum	1	0	0	1	0	1
64. Puntius filamentosus	12	7	4	3	12	12
65. Puntius melanostigma	11	7	0	7	11	12
66. Seatophagus argus	12	7	11	7	12	0
67. Silago sihama	11	7	7	12	11	12
68. Spyraenajello	1	0	8	6	1	1
69. Stolephorus indicus	12	7	12	10	12	12
70. Tetradon leopardus	11	7	9	10	11	12
71. Therpon jarbua	12	7	8	8	12	12

72. Thryssa malabarica	12	10	6	9	11	12
73. Tricanthus brevirostris	1	0	5	10	1	1
74. Tylosurus crocodilus	1	3	11	2	1	1
75. Valamughil seheli	0	0	0	0	0	4
76. Wallago attu	11	7	5	1	10	0
Shell Fish						
77. Penaeus monodon	12	7	12	4	12	12
78. Penaeus indicus	12	7	12	12	12	12
79. Penaeus merguiensis	0	0	0	0	0	12
80. Metapenaeus monocerus	12	7	11	12	12	12
81. Metapenaeus dobsoni	12	7	7	12	12	12
82. Metapenaeus affinis	0	0	0	0	0	12
83. Macrobrachium rosenbergii	12	7	4	10	12	12
84. Macrobrachium idella	12	7	3	2	12	12
85. Crab (scylla serrata)	11	10	2	6	11	5
86. V. cyprinoides var. cochinensis	12	12	12	12	12	0

Source: Primary Survey, 2001-02

This table reveals wide variations in the availability of individual species across space during the year 2001-02. In order to bring out this variability and its implications to different sections of fishing communities at different locations, we reclassified the species availability over time and space. Table 3.18 shows distribution of the species availability in Cochin and Kali estuaries.

Table 3.18 Distribution of species availability by months in Cochin and Kali estuaries, 2001-02

	Cochin estuary										Kali estuary	
Months	**I**		**II A**		**II B**		**III A**		**III B**		**I**	
12	58	(72.5%)	9	(12.3%)	8	(11.0%)	12	(16.7)	51	(66.2%)	45	(62.5%)
9-12.	10	(12.5%)	1	(1.4%)	15	(20.5%)	16	(22.2%)	18	(23.4%)	7	(9.7%)
6-9.	3	(3.8%)	51	(69.9%)	15	(20.5%)	18	(25.0%)	0	(0.0%)	3	(4.2%)
3-6.	1	(1.3%)	11	(15.1%)	26	(35.6)	17	(23.6%)	1	(1.3%)	0	(0.0%)
< 3	8	(10.0%)	1	(1.4%)	9	(12.3)	9	(12.5%)	7	(9.1%)	17	(23.6%)
Total sp. available a year	80	**(100%)**	**73**	**(100%)**	**73**	**(100%)**	**72**	**(100%)**	**77**	**(100%)**	**72**	**(100%)**

Source: Primary survey, 200102

The table shows that while 58 species (73%) in zone I and 51 species (66%) in zone III B were available round the year in Cochin estuary, only 9 (12%), 8 (11%) and 12 (8 %) species were available in zone II A, II B and III A respectively round the year. The table clearly reveals that in region II B (where there is a high

concentration of modern industries) the availability of individual species is minimal. 48% of the species were available only for less than six months and another 41 % of species were available between six to eleven months. 85 % species in zone II A and 56% species in zone II B and 49 % species in zone III A are available between three to nine months. In Kali estuary on the other hand, 63 % of the species were available round the year while 24 % were available for less than three months only.

In order to examine the monthly availability of individual species at different locations, we prepared a table showing the distribution of species available in different stations for different months.

Table 3.19 Distribution of monthly availability of species at different locations during 2001-02 in Cochin estuary

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Vaikom	68	67	68	69	69	68	67	68	69	68	67	68
Murinjapuzha	69	70	69	70	69	70	69	70	68	69	69	69
S. Paravoor	71	69	68	70	71	69	68	70	49	69	68	69
Thevara	68	68	68	68	68	69	68	68	68	68	67	68
Fort Cochin	30	30	20	26	20	35	30	20	35	35	30	26
Chattanad	39	41	50	43	37	46	35	53	51	27	31	30
Dewaswompadam	37	37	48	33	34	26	31	29	46	27	31	29
Nayarambalam	47	47	28	30	46	29	33	28	29	29	33	28
Kunjithei	68	68	68	68	68	68	68	68	61	69	69	66
All stations	74	72	76	80	76	76	77	77	79	79	79	80

Source: Primary Survey, 2001-02

Table 3.19 reinforces the fact that the estuarine space lying close to the Eloor industrial agglomeration (landing centres in zone II B like Chattanad, Nayarambalam and Dewaswompadam) experienced a lower diversity compared to other landing stations. This may be due to the influence of physical stress of industrial pollutants in that area. (See chapter 5 for details). In Kali estuary on the other hand, there is a uniform and stable distribution of individual species in selected stations during the survey period (see table 3.20 for details).

Table 3.20 Distribution of monthly availability of species at different locations during 2001-02 in Kali estuary

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Kinner	55	57	56	56	56	57	57	57	57	57	57	57
Sunkeri	43	48	46	46	47	46	45	48	46	46	47	46
Kodibagh	44	47	42	46	46	46	47	47	47	42	43	46
All stations	62	67	64	60	65	64	65	67	66	64	66	65

Source: Primary Survey, 2001-02

The attempt so far was to examine the nature of fish and shellfish diversity in the study area as a whole. Given this diversity as a natural endowment, it is observed that the modes of appropriation depend upon the use of various craft gear combinations. Table 3.21 shows the distribution of species caught by different gears in different seasons at various zones.

Table 3.21 Distribution of species caught by gears in Cochin estuary, 2001-02

Zone		Chinese dipnet	Stake net	Cast net	Gill net	Seine net	Hooks & line	Trap Net	Scoop Net	Drag Net	Ring Net	Other Nets
I	Pre monsoon	24	53	51	49	48	14	11	17	18	12	23
	Monsoon	26	53	41	41	39	24	11	13	13	11	25
	Post monsoon	12	51	46	48	43	20	9	16	20	11	29
II A	Pre monsoon	21	52	49	50	32	14	13	21	18	11	15
	Monsoon	38	51	52	44	24	11	17	21	15	14	11
	Post monsoon	29	38	53	44	31	20	16	18	16	11	14
II B	Pre monsoon	19	0	0	36	0	0	0	15	0	0	25
	Monsoon	17	0	0	34	0	0	0	12	0	0	23
	Post monsoon	14	0	0	26	0	0	0	11	0	0	31
III A	Pre monsoon	17	29	17	36	0	0	0	0	0	17	19
	Monsoon	12	23	10	0	0	0	0	0	0	12	14
	Post monsoon	11	33	23	29	0	0	0	0	0	16	18
III B	Pre monsoon	12	53	49	56	40	17	10	21	21	11	18
	Monsoon	15	53	49	56	40	17	9	21	24	11	12
	Post monsoon	11	41	48	54	39	17	9	20	21	11	15

Source: Primary Survey, 2001-02

Table 3.21 below reveals that the diversity in species caught in Chinese nets is lower in all stations round the year. High species diversity is recorded in stakenets followed by cast net, gill net and seine net. Most of the other gears examined during the survey recorded lower species diversity. In Kali, cast nets and gill nets experienced greater diversity in catch composition while hook and line and other nets recorded lower diversity. (see table 3.22 for details).

Table 3.22 Distribution of species caught by gears in Kali estuary, 2001-02

	Fixed Net	Cast net	Gill net	Hook & line	Other nets	TOTAL
Pre Monsoon	30	36	32	12	15	51
Monsoon	35	37	32	11	24	50
Post Monsoon	32	36	32	12	19	50

Source: Primary Survey, 2001-02

3.3 Diversity of Ecological services and Functions of Cochin estuary

Apart from the free delivery of diverse flow of living organisms to the local population, estuaries provide a variety of useful services to the public at large. These services are also used by various communities mostly free of costs and in turn indulge in activities leading to the destruction of such ecosystem services. In the case of Cochin estuary, at least, introduction of modern economic activities has grown to the extent of seriously affecting the quality of these ecosystem services. This section details the major ecological services of Cochin and Kali estuaries to the coastal communities and to the nation at large.

Ecosystem services of estuaries are valuable supporting services that influence local economic activities in many ways. An important function that adds value to estuaries is its tidal functions. When salt water enters into the estuary and mixes with fresh water during high tides (veliyettam) a healthy habitat is created for various living organisms. It brings a wide variety of juvenile species into the inland water body which is retained in the system until they are matured and harvested. A

large number of traditional farmers have been stocking juveniles of prawns in pokkali paddy fields and earning livelihood.

Similarly, when water recedes during low tide (Veliyirakkam) a variety of pollutants and wastes are taken into the oceans. This function in fact subsidises the cost of cleaning of the local population and local bodies including the Cochin Corporation and Karwar municipality directly.

The backwater tourism values and sport fishing potential are also highly valuable to the domestic and foreign tourists alike. The traditional vallam kali for instance inspires thousands of domestic and foreign tourists.

Estuaries stabilise the coastal shore and prevents soil erosion in many ways. Shore stabilisation functions and sedimentation functions are useful in many ways to the poor people in this area. Mangroves also play a crucial role in the delivery of the estuarine ecosystem services both at Karwar and Cochin area [1].

The table below summarises these functions with special reference to the selected estuaries.

Table 3.23 Major ecosystem services and functions of estuaries

	Ecosystem Service	Ecosystem Functions
1	Pollination	Movement of flagmetes
2	Biological Control	Trophic-dynamic regulations of populations
3	Refugia	Habitat for resident and transient populations
4	Food Production	Primary production extractable as food
5	Raw Materials	Primary production extractable as raw materials
6	Genetic Resources	Sources of unique biological materials and products
7	Erosion Control & Sediment Retention	Retention of soil within an ecosystem
8	Soil Formation	Soil formation processes
9	Nutrient Cycling	Storage, internal cycling, processing and acquisition of nutrients
10	Waste Treatment	Recovery of mobile nutrients and removal or breakdown of excess of xenic nutrients and compounds

11	Climate Regulation	Regulation of global temperature , precipitation and other biological mediated climatic processes at global or local levels
12	Disturbance Regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations
13	Water Regulation	Regulation of hydrological flows
14	Water Supply	Storage and retention of water
15	Recreation	Providing opportunities for recreational activities
16	Cultural	Providing opportunities for non commercial uses

Source: Costanza et. al. (1998)

However, it is doubtful whether the local people and the public at large recognise the free delivery of the ecosystem services of estuaries and care for their sustainability through careful monitoring of economic activities.

As these services are valuable we shall make an attempt to value some of these services in chapter 6 using contingent valuation methodology.

3.4 SUMMARY AND CONCLUSIONS

A large proportion of the population along the Western coastal zone depends on estuaries for their daily bread from time immemorial. These systems were highly diverse and delivered many direct and indirect benefits to the dependant population. In this chapter we made an attempt to characterise the fish and shellfish diversity of two major estuaries along the Indian coast. We have also described the nature of diversity of ecological services of Cochin and Kali estuaries to humanity. The analysis reveals that the Cochin estuary still retains reasonable levels of water quality in many areas except in pockets where industries are heavily concentrated. The shocks imposed by the modern stakeholders through industrial activities are unbearable most of the time, but the system do not show serious signs of collapse due to the free delivery of ecosystem services. The scenario is likely to worsen if proper environmental governance is not undertaken with people's participation.

NOTES

1. Diversity of mangroves in Cochin estuary

Mangroves in and around Cochin estuary are heavily destroyed. The remaining scattered patches of mangroves are now found in Vypeen, Vallarpadam, Malippuram, and Mangalavanam in the north zone and Kumbalam, Panangad, Chellanam and Kumbalangi in the south. The major species recorded in these areas are *Avicennia officinalis, Rhizophora mucronata, Excoecaria agallocha, Acanthus ilicifolius, Bruguiera gymnorrhiza* **(Badaruddin, 1992)**

Panchayat	Extend of Area (ha)	Species
Arookutty	4	*Rhizophora manonata*
Panavally	1	*Rhizophoar apicutala, Avicennia officinalis*
Aroor	4	*Avicennia officinalis*
Thaneermukkom	5	*Avicennia officinalis*
Chellanam	48	*Avicennia acanthus*
Kumbalangi	92	*Rhizophora illibflora, Avicennia officinalis, Avicennia acanthus, Rhizophor micronatzx*
Edavanakaddu	55	*Candalia caudal, Acanthus ilicifolius, Rhizophora micronatzx*
Njarakkal	10	*Candalia caudal*
Nayarambalam	15	*Acanthus ilicifolius, Rhizophor micronatzx, Rhizophoar apicutala*
Mulavukad	96	*Candalia caudal, Rhizophoar apicutala, Rhizophoar apicutala*
Pallipuram	52	*Rhizophora illibflora, Avicennia officinalis, Avicennia acanthus,*
Kumbalam	7	*Avicennia officinalis, Rhizophoar apicutala*
Maradu	30	*Rhizophoar apicutala, Rhizophora illibflora*
Cochin Corporation	36	*Candalia caudal, Rhizophoar apicutala, Rhizophoar apicutala*
Total	455	

Source : Master Panfish Book-1, Dept. of Fisheries, Kerala, 2002

Mangroves expanse of Kali estuary has been estimated to be around 100 ha of the 1000 ha distribution of Uttar Kannada. **(Sivabalan et.al, 1991).** Scattered patches

of mangroves are found in Kodibag, Kadwad, Kinner, Siddar, Mavinhole and Kanesgiri. The major species recorded in these areas are *Rhizophora mucronata, R.apiculate, Bruguiera gymnorrhiza, Ceriops tagad, C.decaandra, Kandelia candel, Avicennia marina, A. alba, A. officinalis, Lumnitera racemora, Sonneratia alba, Acgiceraaas corniculatum, Exeoecaria agallocha, Acanthus illicefolius, S. caseolacis, Clerodendron,Derristrifoliata and D. albergia spinosa.*

CHAPTER 4

Economic Activities On Estuaries And Major Stakeholders

Estuaries had been the major source of livelihood for various rural communities since time immemorial. The vast wealth of fish and shellfish resources was the target of local fishermen while traditional agriculture called ***Pokkali or gazni*** had been the source of livelihood for the agrarian farming communities. They have also been engaged in traditional prawn farming in their paddy fields or even leased out their farms to agents for aquaculture soon after the crop was harvested. Relatively poor people in villages, resorted to ***coconut husk retting, coir making, sand mining, ferrying*** of passengers to other places (***kadathu),*** collection ***of lime shell*** and other minor produces obtained free from the estuarine environment. Poor households also engaged themselves as ***wageworkers*** in a variety of activities organised by owner communities.

As the traditional rural communities were poor, the surplus generated by these stakeholders from economic activities was not sufficient to instigate any major form of investment on modern economic activities. Consequently, it fell on the state to come forward with investments and active participation for the over all development of the region. Hence today, estuaries are used both by the traditional and modern enterprises, increasing the competition for resources and environment.

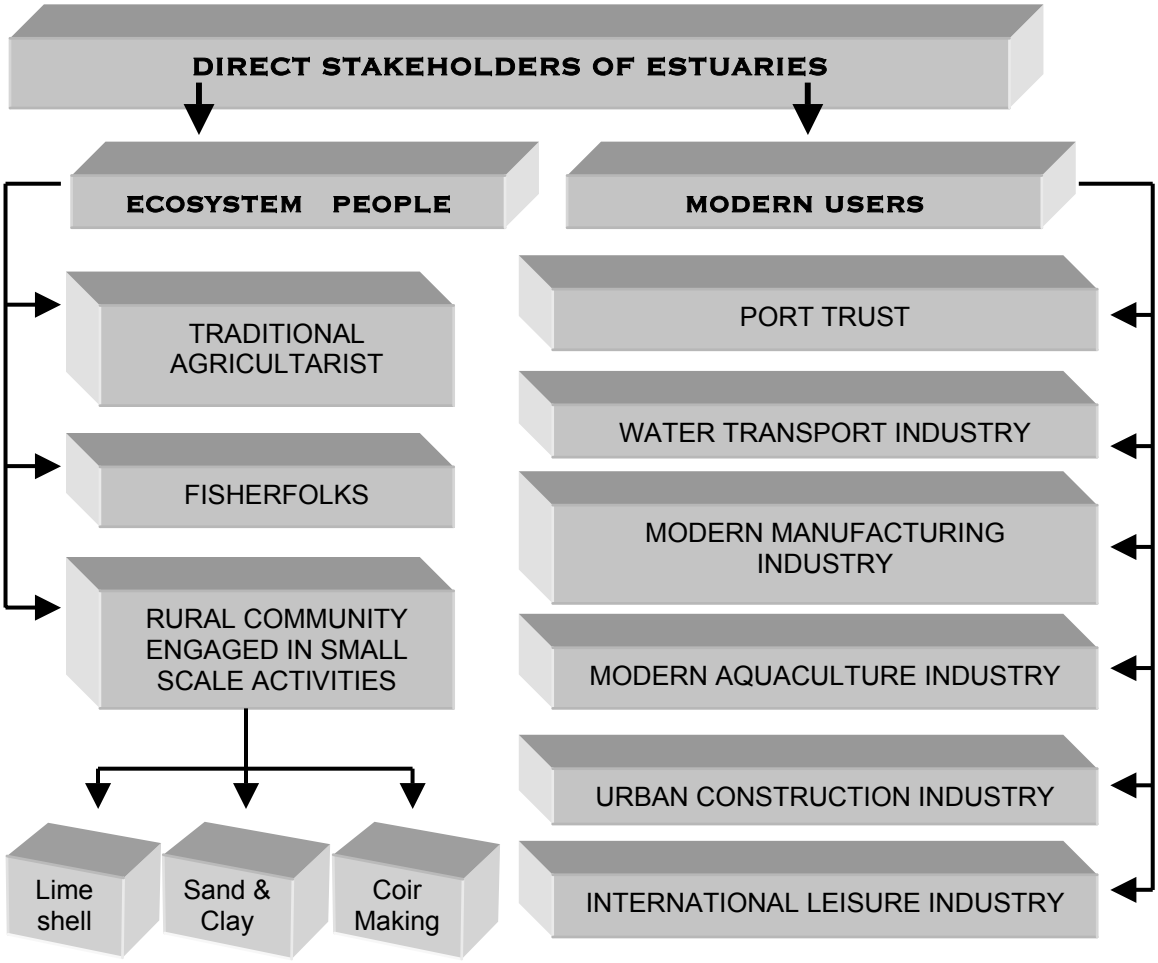
The major users of estuaries are divided into two broad categories: the **ecosystem people** and **modern users.** The ecosystem people are the traditional agriculturists, the fishers, the rural communities engaged in small-scale activities like coir making, lime shell collection and processing, sand and clay mining and the womenfolk. The modern claimants of biodiversity resources are the Cochin Port Trust, modern manufacturing industries, Inland water transport industry, mechanized ferry/ jhankar service industry, modern aquaculture industry, the urban construction industry and the inter national leisure industry. In addition to the above mentioned direct resource users, the national and international communities also use estuarine biodiversity indirectly and in that sense constitute the set of

indirect stakeholders. Finally, state being the custodian and regulatory authority, is also considered as an important stakeholder of this environment. It is the major investor and at the same time, the custodian and manager of the estuarine resource.

The purpose of this chapter is to introduce different stakeholders and to explain how different groups have appropriated resources and the environment of Cochin and Kali estuaries by organising their production activities. We begin with the traditional stakeholders **(section 1)** and then introduce the modern stakeholders one by one in **section 2**. We shall then indicate in **section 3,** how different groups enforced their claims over estuarine resources over the years and the nature of possible conflicts arising from the enforcement of such property rights. This is essential to understand how markets for estuarine resources and environment fail due to the absence of a well-defined structure of rights over resources. A brief summary of this chapter follows.

4.1 Traditional Stakeholders

There is no doubt that estuarine biodiversity is a matter of concern to every Indian citizen and the world community at large as they are also benefited indirectly in many ways by the existence of these ecosystems. Therefore the beneficiaries of biodiversity are divided mainly into direct users, indirect users and non-users. People who directly appropriate estuarine resources and environment are called the direct users. The commonly seen direct resource users are the fisher folk, the agriculturists, the aquaculture farmers, the wage workers related to these sectors including women. Indirect users are those who do not use the resources but benefits from the indirect environmental services provided by the estuary.



The non-users on the other hand, are the national and world community who do not use the services directly but are concerned about their existence and willing to pay for the sustainable use of resources and conservation of environment. Among all these groups, the immediate resource users are to be listed first due to their active involvement in exploiting the resources and environment of these waterbeds.

4.1.1 Distribution of Population

According to 1991 census the total population settled around Cochin estuary was around 1529773 while in Kali, it was 52143. The average density of population was 2211.61 with zone III recording a density of 4163.96. Population density

declines as we move interior from the high saline zone to medium and low saline zones **(See annexure 4.1)**

Wetland agriculture (locally known as pokkali in Kerala and Gazhani in Karnataka) is the major economic activity of the rural communities in the study area, followed by fishing, aquaculture, small-scale industrial activities like clay and sand mining, coir making and lime-shell collection. According to 1991 census abstracts, there were 6463 **cultivators,** 20243 **agricultural labourers and** 41254 **fishermen** around Cochin area while in Kali area there were 4442 **cultivators**, 1466 **agricultural labourers and** 671 **fishers** (**See annexure 4.2 for details)**

4.1.2 Pokkali Agriculture

Records of the nineteenth century (1863) indicate that wetlands constitute about two third of the total geographical area of Alappuzha and Ernakulam districts which is the largest administrative region on the banks of Cochin estuary. Today, the total area of wetland paddy cultivated in Cochin estuary is 6003 hectares, which is organised into 161 Padashekarams having a total of 10308 farmers. (See annexures 4.3 to 4.5) Paddy fields are concentrated in the medium saline zone (67 %) followed by the less saline zone.

A detailed analysis of operational holdings of wetland paddy cultivating area reveals that 77 percent of the holdings lie below one hectare, 21 percent lie between 1-3 hectare range and the remaining ranging between 3-5 hectares (See table 4.1).

In zone I, 92 percent of Padashekarams operate holdings less than 1 ha. 8 percent Padashekarams operate holdings between 1 and 2 ha and none have holdings above 2 ha. 74 percent of Padashekarams in zone II operate holdings less than 1 ha. 17 percent operate holdings between 1 and 2 ha and 9 percent operate holdings above 2 ha. Similarly, 65 percent of Padashekarams operate holdings less than 1 ha. 35 percent Padashekarams operate holdings between 1 and 2 ha and none have holdings above 2 ha in zone III.

Table 4.1 (a) Distribution of average operational holdings of different Padashekarams in Cochin estuary

Zone/Class (ha)	0 - 0 .5	0.5 - 1	1 - 2	2 - 3	3 - 4	> 4	Total
Zone I	28 [75.68 %]	6 [16.22%]	3 [8.11%]	0	0	0	**37 [100 %]**
Zone II	23 [22.12 %]	54 [51.92%]	18 [17.31%]	6 [5.77%]	1 [0.96%]	2 [1.92%]	**104 [100%]**
Zone III	5 [25 %]	8 [40%]	7 [35%]	0	0	0	**20 [100%]**
Grand Total	**56**	**68**	**28**	**6**	**1**	**2**	**161**

Source: Pokkali Land Development Agency Report, 2000

Similarly, it can be seen from table 4.2 that 94 percent of households in zone I operate holdings less than 1 ha. 3 percent operates holdings between 1 and 2 ha while households operating holdings above 2 ha were only 3 percent

Table 4.1 (b) Distribution of operational holdings of households in Cochin Estuary

Zone/Class (ha)	0 - 0 .5	0.5 - 1	1 – 2	2 - 3	3 - 4	> 4	Total
Zone I	1186 [86.6%]	96 [7%]	42	45	0	0	**1369 [100%]**
Zone II	543 [13.5%]	2619 [65.2%]	797	24	10	26	**4019 [100%]**
Zone III	313 [50.9%]	195 [31.7%]	107	0	0	0	**615 [100%]**
Grand Total	**2042**	**2910**	**946**	**69**	**10**	**26**	**6003**

Source: Pokkali Land Development Agency Report, 2000

In zone II, 79 percent households operate holdings less than 1 ha and 20 percent between 1 and 2 ha and only 2 percent operate holdings above 2 ha. The conclusion is that in terms of operational holdings as well holdings less than 1 ha dominate. Comparing the three zones, zone I stands forward.

In Kali estuary, as seen in table 4.2 below, only 9 percent of households operate holdings less than 1 ha, 7.9 percent between 1 and 2 ha, 14.1 percent between 2 and 3 ha, 25 percent between 3 and 4 ha and 44 percent above 4 ha.

Table 4.2 Distribution of operational holdings of households in Kali Estuary

Zone/Class (ha)	0 - 0 .5	0.5 - 1	1 - 2	2 - 3	3 - 4	> 4	Total
Sunkeri	-	6.9	26.2	21.5	33.8	36	**124.4**
Kadwad	-	23.3	7.1	5.6	12.5	1.6	**50.1**
Shirwada	12.4	37.9	29.4	15.9	4.1	15.4	**115.1**
Kinnar	12	17	29	124	157	313	**652**
Wailawada	-	-	-	-	5.0	15	**20**
Karwadi	-	-	-	-	-	9.9	**9.9**
Kodibagh	-	-	4	5	89	118	**216**
Baad	-	-	-	-	-	30	**30**
Total	**24.4 [2.0%]**	**85.1 [7.0 %]**	**95.7 [7.9%]**	**172.0 [14.1%]**	**301.4 [24.8%]**	**538.9 [44.3%]**	**1217.6 [100%]**

Source : Primary data, 2001-02

4.1.3 Estuarine Capture Fisheries and Traditional Fisher Folk

Fishing is an age-old occupation of estuarine fishing communities and is still undertaken by the socially backward communities of Kerala. 18593 households are engaged in active fishing in Cochin estuary today. 38 percent of this is based in zone II, 33 percent in zone III and 29 percent of households are located in zone I. It is reported that during the sixties, fishermen were using as many as 37 different types of gears for fishing in this estuary **[see annexure 4.6],** which has now been reduced to about 15 types. The popular gears used now are the Chinese net, the stake net, the gill nets, caste net, seine net, ring net, trap net, scoop net, the hook and line etc. **Table 4.3** provides the distribution of households using different types of gears in the study area.

The table below reveals clearly that :

- Although fishing households are centered in zone II A, the gears are concentrated in zone I, followed by zone II A (21.62 %) and zone III B (18.07 %).

- Free nets constitute 76.36 percent of the total gears in zone I, 77.11 percent in zone II A and 72.63 percent in zone III B.

- In the case of fixed nets (Chinese nets and stake nets), 33 percent is fishing in zone III, 28 percent in zone II and 22 percent in zone I.

- The survey also revealed high gear diversity in zone I followed by zone II. The bar mouth area experienced the lowest gear diversity.

Table 4.3 Distribution of active fishermen by different Gears used in Cochin estuary, 2001-02

		Fixed Nets		Free Nets										
	Active fishing household s	Chinese net [Cheena	Stake net [Oonni vala]	Cast net [Veeshu vala]	Gill N et [Vysali vala]	Seine net [Kolli vala]	Hooks & line [Choonda]	Trap net	Scoop net	Drag net	Ring net	Others	SubTotal	**Total**
				G 1	G 2	G 3	G 4	G5	G6	G7	G8	G9	G1-G9	
Cochin Estuary														
ZONE I	5314 **[29%]**	510	1594	1310	1766	586	125	869	162	831	850	300	6799 [76.4%]	8903
ZONE II A	**5413 [29%]**	374	1022	1794	1911	98	75	104	162	166	138	255	4703 [77.1%]	6099
ZONE II B	**1728 [9%]**	316	709	529	997	85	95	13	131	244	159	170	2423 [70.3%]	3448
ZONE IIIA	3683 [20**%]**	290	1916	356	1271	6	167	30	79	109	189	253	2460 [52.7%]	4666
ZONE IIIB	**2455 [13%]**	374.0	1022.0	794.0	1911.0	98.0	75.0	104.0	162.0	166.0	138.0	255.0	3703 [72.6%]	5099
Total	18593 **[100%]**	1864 [6.6%]	6263 [22.2 %]	4783 [17%]	7856 [27.8%]	873	537	1120	696	1516	1474	1233	20088 [71.2%]	28215 [100%]
Kali Estuary														
ZONE I	**905**	-	186	1529	294	-	227	-	-	-	-	381	2431	2617

Source: Primary Survey, 2001-02

The best fishing season in Cochin estuary is between December and May. The average number of fishing days ranged between 12 and 20. **(See annexure 4.7 for details)**. In Kali estuary on the other hand, 18593 households are engaged in active fishing in Cochin estuary today. The popular gears used now are the stake net, the gill nets, caste net, scoop net, the hook and line etc. Fishing days range between 8 and 13. The average number of fishing days ranged between 12 and 20. (**See annexure 4.8 for details).**

4.1.4 Other Traditional Occupations

Clam fishery also supports livelihood of about 5000 families in the Cochin study area and 2500 families around the Kali estuary. Traditionally this raw material was used as manure in coconut plantations and for other domestic uses. However, with the development of modern cement manufacturing units in Kerala and nearby states the demand for lime shell has considerably increased in recent years. In addition to these two major ecosystem communities mentioned above a large number of people were also engaged in coir making, traditional ferry services, clay and sand mining, kayal related manual works etc. The exact number of such people is not available at present.

The description above reveals that both agricultural and fishing households (the ecosystem people) were appropriating estuarine resources since time immemorial. Estuaries provided the necessary livelihood for them and they had their own historical systems of sharing resources.

4.2 Modern Stakeholders of the Estuarine Environment

As the traditional rural communities were poor, the surplus generated from economic activities by these stakeholders was not sufficient to instigate any major forms of investments on modern economic activities. Consequently, the state has come forward with investments for the over all development of the region. The Cochin ***Port Trust,*** a number of large and small-scale ***industries*** both in the public and private sectors, firms in the ***navigation, transport and tourism*** sectors have all organised activities around the estuary with government backing. Apart

from promoting the modernisation processes in the estuarine economy, the state has also involved in crafting policies for the governance of estuaries. Being forced to undertake capital-intensive development initiatives, the state started playing a dual role of the custodian and destroyer of biodiversity. In fact, the dynamics of development based on biodiversity management in estuaries is set on such a contradicting base. In Kali, the state started a project for the generation of electricity near Kadra in 1976. The construction of this dam at Kadra has affected fishing activities around the project site.

4.2.1 Cochin Port Trust

We now introduce the modern claimants of the estuarine space. The major players include Cochin Port Trust; modern industries located along the banks of the estuary, modern navigation industry and the national and international leisure industry. **Cochin Port Trust** is a central government public sector company engaged in the export - import business, which started its operations during the early 1930s. The first chart of developing Cochin into a deep-sea port was made way back in 1835 itself. The idea was constantly developed and in 1920, development works of the harbour started. In 1929, the first approach channel of 450 ft. wide was cut and the sediments were used to reclaim Kayal for the activities of the Port trust. This was probably the first organised reclamation of the estuarine ecosystems in the country. In 1930-31, the port trust was thrown open for vessels and in 1936 the government of India took over the administration of this port. **(See annexure 4.9 for details)**

In 1964, the Cochin port trust was formally constituted under the Major Port Trust Act of 1963 with defined boundaries and title deeds. The **Port Trust Act** has assigned a given area to the Port Trust, the jurisdiction of which lies with the Port Trust Authority. Any activity, which takes place within this area, requires the prior permission of the Port Authorities. Hence, the Port Trust emerged as a major stakeholder in the Cochin estuary with exclusive rights over a large estuarine space and legal titles and power to enforce its property rights. **(See annexure 4.10 for details).**

4.2.2 Modern Navigation industry

Inland canals of Kerala have considerable potential for both passenger and goods transport. The state has about 1900 km of navigable waterways. The main canals viz. the West Coast canal has a length of about 555 km, made up of a string of estuary connected together by navigable rivers and artificial canals, in addition to feeder canals. Inland water transport operations in the State are carried out by agencies, which involve Government departments or organizations like the Inland Waterways Authority of India (**IWA),** Kerala Shipping and inland Navigation Corporation (**KSINC),** State Water Transport Department (**SWTD)** and private enterprises

4.2. [A] INLAND WATERWAYS AUTHORITY OF INDIA [IWA]

The IWA of the Government of India had identified 10 important waterways, all passing through the Cochin backwater system in Kerala and declared them as national waterways as of February 1st1993. **[1]** The movement of cargo along this waterway has been entrusted to the Central Inland Water Transport Corporation (CIWTC). With this declaration, the Central Inland Water Transport Corporation has also emerged as a stakeholder in the Cochin backwaters. It may be noted that IWA through CIWTC has carried a cargo of 34,01,872 tonnes through Cochin estuary to different destinations of Kerala.

4.2 [B] KERALA SHIPPING AND INLAND NAVIGATION CORPORATION [KSINCO]

The Kerala Shipping and Inland Navigation Corporation works under the Coastal Shipping and Navigation Department .The state owned Kerala Shipping and Inland Navigation Corporation Limited (KSINCO) set up in December 1975 with a capital of Rs one Crore, acquired vessels and entered into the cargo transport and passenger service business. The company has been in the field of commercial transportation in Cochin estuary since August 1977. The Corporation undertakes ferry services to 2 major destinations in Ernakulam. The present fleet strength of the corporation consist of 4 bulk cargo carriers, 3 petroleum tankers, 2 phosphoric

acid barges, 2 portable water barges, 12 passenger boats, 2 Jhankars and a speed launch. With two barges the corporation is transporting drinking water to the islands of Vypeen and Murukkumpadom.

4.2 [C] STATE WATER TRANSPORT DEPARTMENT [SWTD]

The State Water Transport Corporation was formed in 1968 under the State Water Transport Department with its headquarters at Alleppy **[2]**. This department offers navigation services to tourists, local inhabitants and industries around the Cochin estuary **[see annexure 4.11 for details]**. The table shown in annexure 4.11 gives various aspects related to the operations of the SWTD. The total revenue of SWTD has increased from 135.65 lakhs in 1990-91 to Rs. 408.8 lakhs in 1998-99. How ever, it may be mentioned that, the firm is continuously incurring losses to provide these services to the estuarine communities

4.2.3 National and International leisure industry of Cochin estuary

It was mentioned in the introduction that apart from the direct goods and services to different stakeholders, the estuarine environment also provides rich potential for the development of leisure industry. In fact, modern backwater ecotourism is built on capitalizing this opportunity of the environment. This section briefly introduces the major firms/players of this industry

It is true that the local communities had traditional rituals that recognized environmental values of backwaters. This is what one experiences in the communal sport "vallamkali" **[see annexure 4.12 for details]**. However, commercial ecotourism on estuaries undertaken by modern enterprises is a relatively new experience. Tourism in the Cochin estuary is fast developing as an industry with potential for high levels of profit at low investment. Consequently the number of stakeholders involved in this business is numerous. The major stakeholder is of course the government, which plays an active role in tourism promotion. Along side are the private tour operators, travel agencies and private tourist boat operators.

Government of Kerala has adopted policies that promote backwater tourism. The state tourism department is very active in the sphere of tourism promotion. Each district has a District Tourism Promotion Council which is very active and doing commendable job in the sphere of tourism service. Since this is a new industry tourism promotion activities on the part of the government has resulted in tax exemptions for this industry. Licenses are not required for operation in this field. However, the boat crew is required to have a driver's license from the Port authorities. Local governments, till now do not have any direct dealings with these operators.

Micro enterprises in the private sector of this industry are divided further into private tourist boat operators; travel agencies and speedboat operators. Private tourist boat operators provide boats on hire. They have no fixed destination but a fixed rate per hour. They can be hired to travel to any location in the backwaters. The tour operators on the other hand provide package tours, which not only have fixed charges but fixed timings as well as routes. They offer four types of packages mainly. There is the city tour, the sunset tour, Village backwater canal tour and the houseboat ride. A number of travel agencies also arrange tours in the backwaters. This however comprises a small part of their total business. Speedboat operators also have a stake in this activity. Their boats are hired both for tourism and transportation purposes. They have fixed rates per hour but no fixed routes. **[3]** The tourism industry claims to provide employment opportunities to the local people. Unfortunately, this industry so far has not generated rural employment on any substantial scale.

Thus we note that modern stakeholders who use backwater environment and resources vary widely. The Port Trust uses the brackish water body for its smooth shipping operations. In order to ensure the minimum depth for ship transport, it regularly dredges the water body causing dredging externalities. Modern industries on the other hand emit wastes into the water body causing pollution externalities.

4.3 Property Rights on Estuarine Resources and Environment

In the above two sections, we discussed the nature of economic activities undertaken by various stakeholders on Cochin and Kali estuaries. We noted that estuaries are indivisible common property resources. In addition to a beautiful serene environment and many useful ecological services, Cochin and Kali estuaries supply a variety of biological and non-living resources. The manner in which resources and environment is used by various stakeholders, however, depends on the nature of property rights regimes. Property defines access to the resources and environment. For traditional fishermen, brackish water fisheries are common property resources.

Appropriation of various fishing grounds/territories were subject to localized social norms and customs. Informal institutional arrangements existed for the cultivation of paddy also. Such rules and regulations were influenced by the perceptions of traditional communities on the ecosystem services of estuaries and in that sense these ecosystem functions and services were valuable for them. This section explains the diverse structure of rights enforced by various stakeholders over the selected estuaries. Informal institutional arrangements in the sharing of fisheries and wetland agriculture are explained below. We shall also describe how the local landowners ensured social securities to their labour classes through an institutional arrangement called ***kalakkippidutham***

4.3.1 Evolution of customary fishing rights on estuaries

Evolution of customary fishing rights on estuaries depended on resource specificities and ecosystem services. We have already indicated in chapter 3 that this wealth is highly diverse and seasonal and its availability depended mainly on the ecosystem functions. The tidal functions (locally known as **veliyirakkam and veliyettam**), the inflow of fresh water from river systems and the existence of supporting ecosystems like mangroves, benthos, planktons etc. were therefore important and valuable for the fishermen. Their modes of defining and enforcing an appropriate bundle of rights and the production conditions therefore depended on the above mentioned ecosystem services.

Most of the fishers perceived (and still believe) the half of the brackish water territory between their shore and the neighbor as their village property. Fixed fishing gears (Oonni vala and Cheena vala) are normally fixed within these territories. Although customary rights have evolved from the above notion, fishers did not always defend local boundaries. In fact, when fishing is over, mostly by early morning, other stakeholders were allowed to use these territories for activities like lime shell collection, sand and clay mining, traditional ferry services etc. Other producers organized these activities without disturbing fishing activities.

Having defined and excluded other potential uses from the fishing territories, the defended territories were shared by fishing communities themselves. This sharing depended on the type of gears used by individual gear groups. For instance, the Stake net or **Oonni vala** was traditionally the monopoly of the **Dheevara** caste. Historical evidences indicate that the king had issued royal writs **(Theethorams)** to the **Valans [4]** for the services (supply of fish, organize voyages of the king and soldiers etc.) rendered to him. Certain fishing areas of the estuary were assigned to the **Aravans** (headman of valan community) even free of tax. These rights were later on distributed among other **valans** in return for the payment or a fee. These fishermen were entitled to fix stake nets in such assigned territories and thus **Aravans** got the monopoly of fishing in certain pockets. Although the king issued fishing rights to Aravans, these were redistributed among individual households through Ponambans **[5]** who were the caste leaders of the valan community. Ponambans normally distributed fixing rights to individual households by collecting a fee. He also intervened in fishing disputes and suggested solutions, which were normally obeyed by gear owners. **(Iyer, 1909)**

4.3.1 [A] The evolution of fishing rights around Stake nets

Fishing rights hence granted stayed in the family passing from one generation to the next. A license fee, however, had to be paid in this regard. Water being indivisible, the right to fix an **Ooni-nira** (a row of stake nets) was always allotted in relation to landmarks and varies from place to place depending on the width of the water channel and flow of currents and tides. It is reported that **Oonni niras** were

normally fixed at a minimum distance of 16-18 links from the bank. The fisherman was sole owner of the area allotted to him and no one else could fish there unless royally decreed otherwise.

A row of nets (Oonni padu) may consist of any number of nets varying from a minimum of five nets to one hundred. Depending upon the area where the oonnipadu is located and the nature of water currents, tides and availability of resources, different types of sharing mechanisms prevail among Oonnipadu fishermen. For instance, the system of gear rotation is practiced among the members of oonnipadu near the bar mouth region. Here, the fishermen rotate the position of their nets everyday so that everyone in the team has an equal chance of getting good catches. Similarly earnings of an extra net operated are donated to the common funds of the community. In certain locations like Thevara and Eda Kochi, if a fisherman is not using his Stake nets on a particular day, the **Oonni sangham** puts up a net and the proceeds go to the common fund.

There are also some onnipadu that follow the system of half Oonni or "Ara Oonni". Here the fisherman is allowed to sell or lease out his net to another fisherman for a fee. This normally happens in households, which cannot organize the fishing operations in time due to various internal problems. If rights are leased out, the owner collects lease money either in cash or in kind, spread to mutually agreed period. Sometimes, arrangements are also made to divide the day's catch equally between contracting members.

The discussions made above indicate clearly that various forms of community co-operation and sharing systems exist among the stake net fishermen community. The process of sharing fishing grounds was never a smooth process. Conflicts are observed between two Oonnipadus or between Oonni sangams especially if operations affect catch rates of users.

4.3.1 [B] Evolution of fishing rights around Chinese nets

Chinese nets (Cheena vala) are commonly found along the banks of the backwater. The size of the net varies according to the depth of water channel, the

strength of water currents, and the availability of resources. Dip nets towards the bar mouth are huge in size and require a minimum of six or seven fishermen to haul it in. On the other hand nets seen towards the interior regions of the backwaters are of smaller size, which engage a maximum of two or three labourers. Chinese nets are normally operated after sunset. Lowering and hauling of nets go on usually till the wee hours of the morning. These nets are best for catching ***Chemmeen*** and ***Karimeen*** and hence considered a lucrative gear.

The evolution of fishing rights around Chinese nets, on the other hand, was not very clear in historical records. Although Chinese nets were not allocated to any particular cast, the newly converted Christian communities of fishermen operated the major portion of these nets till recently. Households who owned landed property adjacent to the brackish water body normally fixed Chinese nets in front of their land. No one could install any nets on the water adjoining in front of the property of a land owner without consent or payment of a rent, which generally varied between eight and 18 rupees depending on the ignorance of the net owner **(Iyer, 1909)**. A number of Chinese nets were thus erected on the banks of estuary without affecting the activities of other gear owners and stakeholders.

Efforts were made during the British regime to legalize the operations of stake nets and Chinese nets. The British government levied Rs. three per net as tax for using fixed nets on the backwaters. Rights to fish over backwater territories were enforced by the respective gear groups mainly by excluding other gear groups and other stakeholders. In fact, this was a routine activity performed every day by the respective gear groups lasting a couple of hours depending on the tides and availability of resources. These territories remained open to other stakeholders to organize their activities during the rest of the day. However, the cost of enforcement of individual property rights on the entire water body was obviously unbearable and therefore, accesses to this backwater body had appeared to be free, exhibiting characteristics of a free-access property regime. In fact, this feeling has done more harm to the ecosystem and is primarily responsible for the degradation of estuarine biodiversity

We have argued above that whether the net is fixed or moving, customary rights exist among the fishermen. In normal situations, an individual fisherman does not encroach upon the territory of others. In the case of free nets, definitions of territoriality come from what they have been able to demarcate as their own. But violations occur frequently leading to clashes or police cases. Majority of the conflicts and fishing disputes occur between those owing fixed and free nets. Obviously this means that among fishermen of the same gear type, notions of territoriality are well kept and one does not normally intrude into the activities of the other one.

4.3.2 Evolution of rights on wetlands

The agricultural communities on the other hand, had enforced their rights mainly on the wetland territories adjoining backwater body. These wetlands are subject to saline intrusion through channels and inlets carrying brackish water into the fields. Although this imposes a "natural externality" to the human population, the process of tidal functions delivered a large quantity of prawn and fish seedlings, nutrients and waste dissemination through change of water.

The history of rights on the wetlands adjoining Cochin estuary dates back to the evolution of organised brackish water wetland agriculture, locally called **"pokkali krishi".** Pokkali agriculture in the low-lying belts of Cochin estuary was an occupation that was generally undertaken by the upper classes of the society. Two types of land tenure systems were reported in the low-lying fields around Cochin estuary **(Kumar, 1999)**. The first category was ***Pandaravaka*** (State property). It was either rented to individuals or managed by state officials **(Naduvazhis/ Desavazhies).** The second category was the **Puravaka** (private property) of Jenmies and mostly controlled by the ***Nayars***. Territorial boundaries were well maintained and kept by state officials and no one disputed it. Individual owners strictly maintained the outer boundaries of their paddy fields. During the period of prawn filtration, however, it was difficult to delineate and protect boundaries. But once filtration was over, these boundaries were once again well maintained. As

majority of land was the property of the King, which was leased out on rent, outsiders were careful not to encroach on these rights.

A change in this pattern occurred with the fleeing of the Brahmins from Karnataka to Kerala due to religious persecution in 13 AD. The ideology of land to the temple as atonement for sin, led to large-scale transfer of property to Temples. Jenmi rights were extended to Brahmins and Nampoothiries. Temple Trusts and Devaswoms were constituted for the management of such lands and they were leased out to tenants on rent. Temples became the single largest owners of landed property next to the King.

This pattern of rights changed with the coming of the Land reforms. The first tenure legislation of Cochin was the settlement Proclamation of 1905. Various other Acts, ordinances and laws were passed before the Kerala Land Reform Act, 1963, Kerala Land Reform (Amendment) Act, 1969 and the Kerala Land Reform (Amendment Act,) 1971. " Land to the Tiller" changed the nature of property ownership and rights that were associated with its use. Although many of the Temples lost a good share of their lands, they still managed to retain control over crucial water channels and inlets. This helped them to maintain their control over the resource and its production possibilities to a great extent. In certain regions, panchayats gained control over such resources. In the new scenario, owners of such water channels gained greater power, access and control.

Today, paddy cultivation in Pokkali fields is organised through padashekarams. **Padashekaram were originally a collective *of individual neighbourhood farmers* having fields that vary in size**. The cost for cultivating paddy is borne by individual farmers while the padasekharam undertakes collective investments like construction of bunds, cleaning of inlets and maintenance of sluice gates etc. During the period of prawn filtration, the whole area is leased out to an outside party. In most cases, the Devaswom Trust controls the crucial water channels to these fields and therefore engulfs a major portion of the lease amount. Private individuals also control some channels and hence are eligible for their share of the lease amount. In return, they are responsible for the timely pumping in and out of

water from the fields and the maintenance of the outer bunds. They are permanent owners of the land, which in most cases have been passed on from generation to generation. There are very few instances of people leasing out land for very long periods (that often extend to years) or leases without fixed periods.

4.3.2 [A] Customary rights of agricultural labourers: *Kalakkippidutham*

The description on traditional property rights on brackish water resources will not be complete until we mention the customary rights of the local agricultural labour classes. Pokkali cultivation in fact is a highly labour oriented activity and large numbers of local people were employed at various stages of cultivation. The landlords and the tenants alike expressed this mode of demand for local labour. To reciprocate the services drawn, the owners of land granted fishing rights to the labourers. These customary rights, known locally as ***Kalakkipidutham rights is*** prevalent even today. Kalakkippidutam provides free access to the labour class, especially the local women, to earn an income from fishing in pokkali fields and ensure livelihood securities during the rainy season. Today, kalakkippidutham meets the requirements of the local ***Pulaya and Kanakkan*** women in the study area.

Kalakkippidutham is a social arrangement, an informal institution, by which the land owning classes granted free access to the local working classes for fishing from the pokkali fields for a limited period of the year. It is a reciprocal arrangement of the land owning classes to acknowledge the services offered to them by the agricultural labourers. For laymen, and even to many technocrats and policy makers, ***Kalakkipiditham*** and ***Thappiyedukkal*** are merely traditional fishing methods commonly found in Pokkali fields. It is described in official documents as a tribal activity undertaken by the ***pulaya*** women belonging to the agrarian labour class. They are engaged in agriculture activities during the paddy season and help out in the fields during the period of prawn filtration.

As soon as the Pokkali paddy is harvested by the end of September, prawn filtration starts from November onwards and continues till the first week of April. The lease period between the lessee and the panchayat normally terminates by

the end of March 31st. In the case of private property or ***Padashekarams*** the lease period ends by the third week of April. As soon as this contract terminates, the owners allow free access to the fisher folk and the female workers from the Pulaya caste. Each Pokkali field has a group of agrarian labours belonging to the Pulaya caste who were responsible for all the work associated with dyke preparation, planting, replanting and harvesting. It was the same people who were also given the customary rights over these fishing grounds once the prawn harvesting by the lessee was over.

Kalakkippidutham is an institutional arrangement that reduced uncertainties of crop rotation. First, the arrangement is helpful to the owners because forceful encroachments of the general public and the labour classes to the prawn farms ensure the timely eviction of the leasee so that the land thus regained can be immediately transformed for paddy cultivation. Second, this process reduces a substantial proportion of the transaction costs of the owners in the cultivation of paddy. Thirdly, it ensures timely availability of agricultural workers for the next agricultural season by attaching at least those workers to whom free access was offered. In the past, labour was sufficient to meet the demand for labour for paddy and prawn cultivation. With the passage of time a gradual reduction in the strength of this labour class saw the coming of migrant Pulaya labours **[6].**

To summarize, the major claims of this section, we make the following remarks. First, the analysis has shown that backwater ecosystems were never a free access resource. Various kinds of customary rights existed on the backwaters. Fishermen exercised fishing rights on the brackish water territories while agrarian communities exercised their rights on wetlands along the low-lying fields. The local labour was also granted customary right for extracting fishery resources from prawn filtration farms, which is locally known as kalakkippidutham. As the fishing communities and agrarian communities enforced their claims on different resource endowments and territories, inter community conflicts were rare among traditional stakeholders. In other words the rights defined and enforced by fishing communities and agricultural communities were mutually exclusive.

Fishermen were treated as polluted subaltern classes by the landed gentry and this social distance exists even today.

4.3.3 State interventions and property regimes

Although communities engaged in fishing and agriculture were the traditional owners of backwaters, many activities based on ecological services such as navigation services, were mainly organised by the state by creating suitable bundle of rights for the smooth conduct of such activities. In the past, these services were organised by the King himself which has led to a general feeling among the public that the estuary belonged to the King. Since estuaries and backwaters were the major medium of transport to distant places and to other parts of Kerala (erstwhile Travancore state), both the Travancore and Cochin Monarchies levied taxes from traders and others for using the water channels of Cochin estuary. This has further strengthened the belief that estuaries belong to the King.

Exercising his powers, the king granted fishing rights to various groups who were helping him in fiscal administration, law and order, war and transport services. Wetlands were also given to trustworthy subordinates close to the administration. Hence, excepting places where fishermen and agricultural communities established rights, estuaries were treated as a freely accessible property. Consequently, incentives for conservation or optimal use have never existed. Many of the important function performed by estuaries like shore stabilization, delivery of global services etc have also been ignored.

Once the State government came to power, the confusion in defining and enforcing property rights on estuarine environment continued. First, the state was not quite sure whether to accept and legalize the customary rights of traditional communities. Secondly, the state being the custodian of environment had to decide the nature of management of this resource. The government did not acknowledge the already existing rights and traditional management regimes. It merely continued the policies followed by the British government.

An important factor, which legitimized the active role of the state take over of estuarine environment, was related to the nature of primitive rural surpluses made by the traditional communities and the lack of incentives for bringing up investments in modern activities. Given the low economic surpluses and the local demands for development, the state itself was forced to invest in development projects. The development of the modern stakeholders is to be seen in this context. Having promoted such activities, the government distributed the responsibility of management to various State departments and Government agencies. Thus, the Irrigation department of the State Government is responsible for managing inland waters that include backwaters. The bar mouth and port area has been segregated and given to the Port Trust for management. Land areas bordering the kayal came under the jurisdiction of the Cochin Corporation, Greater Cochin Development Authority, Port Trust or panchayats depending upon their geographic location. The government also came out with a new set of rules and regulations in continuation of old policies that were to be adhered to by different stakeholders regarding use. **(See annexure 4.13 for details)**

4.3.4 Property claims of modern stakeholders

We have pointed out in section I of this chapter that a number of modern stakeholders were actively involved in using Cochin estuary in recent years. The most popular ones being the Port Trust, the navigation industry, the leisure industry and the manufacturing industries. This section explains how these stakeholders define and enforce their rights on the resources and the environments of the backwaters.

4.3.4 [A] Property rights of Cochin Port Trust

The Property rights of Cochin Port Trust were created by an act of Indian parliament. The act claims that the boundaries of the Port shall comprise of all areas contained on land lying within 45.76 meters (50 yards) of high water mark, Kerala estuary and the Sea bounded by straight lines joining the following positions.

> The northern boundary begins from a point on the Ernakulam foreshore (10°00' 44.5") roughly up to the Thevara peninsular region to a point on the eastern shore of Vypeen Island in position latitude…….. and then along the high water mark on the Vypeen shore via Cochin harbour entrance to a point on the western shores of Vypeen island and thereon to a position in the sea 9 nautical miles due west in latitude … …
>
> The southern boundary begins from a point on the southern end of Thevara to a point on the Eda Kochi shore along the high water mark on the Mattancherry shore via Cochin harbour entrance to a point on the western shore near Mundamveli and there to a position in the sea 9 nautical miles due west. The western boundary is a straight line at sea joining the other two lines. The eastern boundary shall lie along the high water mark on the Ernakulam Foreshore between the northern and southern boundaries defined above. In addition to all these areas, the Port Trust shall also have jurisdiction on all land reclaimed or to be reclaimed in future, from the estuary or the sea.

This is the first time, in the history of Cochin estuary that such exclusive property rights were defined to promote industrial activity. It may be recalled that no such declarations were acceptable even in principle for the state in the case of backwater fishing. This declaration affected economic activities of traditional stakeholders. The construction of jetties, the use of a Chinese fishing nets, the operation of fishing and passenger boats within the boundaries of the Port required license.

4.3.4 [B] Property rights of water transport industry

State has also nationalized major waterways in Cochin estuary through appropriate notifications to give a big boost to the state sponsored **national inland water transport industry**. This enabled the industry to accelerate its activities many fold compared to the already existing traditional water transport industry, mostly operated by domestic communities.

Modern industries, on the other hand, treated estuary as a freely accessible territory where their pollutants can be dumped. Creation of any form of rights on the estuary would hence be faced with severe resistance from this powerful industrial lobby, as the creation of such rights will enhance their abatement costs considerably. Hence, they regarded estuary as an **open access** resource. **(See chapter 5 for details on industrial pollution)**

4.5 Decentralised governance and water rights

Recently, the government of Kerala decentralised its modes of public governance and issued clear instructions about the nature of ownership on water bodies. **According to the provisions made in the Kerala Panchayat Raj Act 1994, article 218; estuaries belong to the village panchayat.** The article states the following:

> 218 Vesting of water course, springs, reservoirs, etc in village panchayats
>
> (1)Notwithstanding anything contained in the Kerala Land Conservancy Act 1957 (8 of 1958) or in any other law for the time being in force, **all public water courses** (other than rivers passing through more areas, than the panchayat area which the government may, by notification in the gazette, specify), **the beds and banks of rivers, streams, irrigation and drainage channels, canals, lakes, estuary** and water courses all standing and flowing water, springs, reservoirs, tanks, cisterns, fountains wells, kappus, chals, stand pipes and other water works including those used by the public to such an extent as to give a prescriptive right to their use whether existing at the commencement of this act or afterwards made, laid or erected and whether made, laid or erected at a cost of panchayat or other wise and also any adjacent land, not being private property appearing thereto, **shall stand**

transferred to and vest absolutely in the village panchayat. ……

(2)Subject to the provisions of this act, all rights and liabilities of the government in relation to the water courses, springs, reservoirs, tanks, cisterns, fountains wells, kappus, chals, stand pipes and other water works vested in the village panchayat under sun section (1) shall from the date of such vesting be the rights and liabilities of the village panchayats.

(3) Notwithstanding anything contained in sub section (1) or sub section (2), the government may, by notification in the gazette, assume the administration of any public source of water supply and public land adjacent and appertaining thereto after consulting the village panchayat and giving due regards to its objections, if any.

(4) It shall not be lawful for any person to remove or appropriate for himself, any tree, earth, sand, metal, laterte, lime shell or such other articles of value as may be notified by the village panchayat from any land which is transferred to or vested in the village panchayats … under this aft whether a puramboke or not except under and in accordance with the terms and conditions of a permit issued by the village panchayat in this behalf and on payment of such fees and compensation at the rate determined by the village panchayat. (Kumar, 1997:127-28)

From the above sections it becomes increasingly clear that the estuary and some of its resources are vested with the local village panchayat and individual stakeholders would have to acquire prior permission for using the resources. Nowhere does the formal law recognize the customary rights of local communities especially the fishermen and the pokkali farmers over backwaters.

The analysis on the nature of property rights on estuary reveals the existence of multiplicity and plurality of rights. Traditional common property relations co-exist

with state property. Free access property relations are also quite strong especially among those who want to pollute backwaters. This confusion over rights and responsibilities of different stakeholders has done more harm to the stock of various biological resources, ecological services and is primarily responsible for the evolving economic crisis in backwaters. In the next chapter we shall explain how lack of a well defined structure of property rights has led to the degradation of biodiversity in the selected estuaries.

4.6 Conclusion

The Cochin and Kali estuaries are major sources of livelihood for various rural communities that lived on the banks of these water bodies. The gazni/ pokkali farmers, the fisherfolk, the aquaculturist, clam pickers, the traditional sand miners, the small scale kayal based industry workers etc have eked out a living from these systems for centuries. Agriculturists and fishers (the ecosystem people) have always been the most prominent users of this ecosystem from times immemorial. It was the main source of livelihood for them and they had their own historical informal institutional arrangements for sharing resources.

The process of resource sharing and the organization of various production processes specific to such resources among rural communities had been influenced by their perceptions of ecosystem services too and in that sense these ecosystem functions and services were valuable for traditional communities. Rights over fishing territories were enforced by respective gear groups during the process of fishing mainly by excluding other gear groups and other stakeholders. These territories remained open to all other stakeholders to organize other economic activities as soon as they finish their traditional activities. This has lead to a general perception that the backwater ecosystem did not belong to anyone in particular and was therefore open to all for use. Subsequent State rules and regulations have reiterated this feeling. This however, is a misguided notion. The kayal environment has always belonged to these ecosystem people and no management strategy excluding their customary claims would be effective.

However these users had a subsistence economy with feeble economic surplus, which prevented traditional village communities from undertaking any substantial investment for developing this zone. The state was therefore assumed the responsibility of undertaking development programmes and projects. This brought in new stakeholders like the port, the navigation and tourism industry, modern industries etc and each group had its own modes of appropriating the resources and the environment. Thus, in addition to the traditional and modern stakeholders, the national and international communities as indirect users and the state as a regulator of the environment also form part of this stakeholder group. Opening up of local economies and the decentralized modes of resource governance has added more stress to the ongoing dynamics of this sector.

This is also an indication of how people have adapted to the changed scenario. There has never been a scenario that was conducive for enterprise development among them. It is essentially a low level adaptation of the unskilled estuarine community. Agricultural households have adapted up to an extent by concentrating on prawn filtration. Some have attempted aquaculture farming on their lands as well. It is the fishermen who do not have any real opportunities or skill. Consequently they have shifted to low level unskilled labour. For example, a study conducted in the village of Kumbalangy in Cochin **(Thomson 2001 [a])** reports that 17.09 percent of the population in Cochin estuary is engaged in estuary related activities. In fact this proportion is equivalent to around 59 percent of the working population. Another 28.94 percent of the population depends on service sector activities like government and private sector jobs, construction and trade and around 14 percent in the construction industry. One third of the population is not working. The study points out that in recent years a shift in occupational pattern particularly from traditional to other activities is also seen. It was found that 37 percent of the population still remains in traditional activities while 63 percent have shifted. The shift in occupation is experienced the most in the age group of 20 - 30 years followed by 30-40. This shift can be attributed to many factors. However it would still mean that this traditional resource base is able to support a lesser and lesser number of dependents.

NOTES

[1]. Considering the need to develop Inland Waterways and Inland Water Transport, the Government had identified 10 important waterways for consideration to declare them as National Waterways. This includes the Kollam-Kottapuram stretch of West Coast Canal (168 km) along with Champakara Canal (14 km) and Udyogmandal Canal (22 km) in Kerala with effect from 1 February 1993 have so far been declared as National Waterways and the same are being developed for navigation by Inland Waterways Authority of India.

[2]. The State Water Transport Department is concerned with providing transport services to the public, its activities mainly confined to the 4 Districts of Alleppy, Ernakulam, Kottayam and Quilon as mentioned earlier. The State Water Transport Corporation did not initially operate in the Ernakulam district. It was the Water wing of the Kerala State Road Transport Corporation that operated Ferry services in the Cochin Backwaters. As on 01-07-1994, Ernakulam District, SWTD took over.

Route	No. of Trips	Distance	Total Distance
1. Kumbalm – Arookutty	8	6	48
2. Arookutty – Edacochi	5	4	20
3. Panavally – Panagad - Eda kochi	1	14	14
4. Ernakulam – Mulavukad	22	9.6	211.2
5. Ernakulam – Panavally	6	25	150
6. Ernakulam – Perumalam	4	22	88
7. Ernakulam –Vypeen	26	4	104
8. Panavally – Kumbalam	2	3	6
9. Mulavukad – High Court	14	7	98
10. Ernakulam Alappuzha	2	70	140
Total	90	164.6	879.2
State Total	553	1749.2	7131

Source: Compiled from Administrative Reports, State Water Transport Department

[3]. It is very difficult to obtain an exact number of the total number of tour operators in this region due to the wide scatter and illorganised nature of these activities. However, a rough primary survey of the Cochin estuary gives the

number of boats owned by the KTDC as 2, by private package tour operators as 4, speedboat owner as 15 and by the private tourist boat owners as 35. A single houseboat also operates in the estuary as opposed to a hundred, which operate in the Alappuzha region.

[4]. The Valans have their tribal organization and their headman, ARAVAN or ARAVAR is appointed by the 'Theettoram' or royal writ used by the Raja and the head man appoints other social heads called 'ponambans' who are stationed at each desom (village) or kadavu (landing place) to collect tax. The valans are expert rowers and posses the special privilege of rowing from Tripoonithura the boat of his highness the raja for his installation in the Cochin Palace. When the aravan with sword in hand had to stand in front of him in the boat. Further on the occasion of the journey of his Highness the Raja through the backwater or on the occasion of state functions such as visit of the British Resident, the Governor or other dignitaries, the Head man has to lead the way as an escort in the Snake boat as they are called to supply the requisite number of men for rowing the boats of these high officials and other members of the establishment. He also has to see that during their stay at the Residency, they are furnished with all the necessary fish food for all of which the men are endowed with the privilege of fishing in certain assigned areas of the estuary free of tax. They were later deprived of the privileges and given a wage for the services rendered to the state, which levies a tax on fishing. Arvans thus got the monopoly of fishing in certain pockets. These rights were later on distributed among other valans in return for the payment of a fee.

[5]. The headman (Aravan or Aravar) appointed other social heads (ponambans) who were stationed at each desom (village) or kadavu (landing place) to collect tax. Each ponambans ruled his area of jurisdiction (Muri) with a firm hand. The right to issue Ooru velakku, fire and water vilakku gave him immense power over his people. All matters of dispute were brought to him for settlement. Although the king issued fishing rights, it was the Ponamban who saw to it that all disputes related to it were resolved. Consequently, there rarely arose

any disputes that developed to large-scale conflicts within a clan. But this fishing community showed all the characteristics of a tribal organisation.

[6]. The method of caching fish using kalakkippidutham is very simple. The deliberate movements of fisher women, as they enter the field, create disturbances in the water causing the fish to hide in the detritus on the bottom of the fields. These fishes are them hand picked by the fisherwomen. Gears are also used sometimes by men folk. Aluminum pot, and in certain cases a scoop net forms the total of their gear requirements. In order to assess the potential of this institution we organized a detailed survey aimed to estimate the gross revenue generated from *kalakkippidutham*. In a village called Kumbalangi of Cochin estuary during 2001.The species caught are shown in the table below.

Catch composition in Kalakkippidutham in Kumbalangi village, Cochin estuary

Local Name	**Scientific name**
Naran chemeen (White prawn)	*Penaeus indicus*
Thelly chemeen	*Metapenaeus dobsoni*
Kara chemeen (Tiger prawn)	*Penaeus monodon*
Karimeen (Pearl Spot)	*Etroplus suratensis*
Pallathi	*Ertoplus maculates*
Tilapia	*Tilapia mossambica*
Nandan (Glass pearch)	*Ambasis gymnocephalus*

Source: Thomson (2001 [a])

The table below summarizes our calculations of value produced through ***kalakkippidutham*** in Kumbalangi padashekarams during April -May 2001

Distribution of value generated through kalakkippidutham during April-May 2001

No of days fished	**Quantity caught (Kg)**		**Price (Rs)**		**Value produced (Rs)**		**Total value (Rs)**	**No of workers**
	shrimp	**fish**	**shrimp**	**fish**	**shrimp**	**fish**		
April 1-22	35000	1800	125	30	4375000	54000	4429000	500
April 22-30	48000	2400	110	25	5280000	60000	5340000	1000
May 1-10	24500	2000	75	25	1837500	50000	1887500	700
May 11-31	18000	1500	50	30	900000	45000	945000	450
TOTAL PERCAPITA = 4755							**12601500**	**2650**

Source: Thomson (2001[a])

Total Effort in man days = 35,000
Revenue realised (Rs) = 1,26,01,500
Average revenue/ man-day = 0.04

Annexures

Annexure 4.1 Distribution of population around Cochin and Kali estuaries

Panchayats	Total Area (Sq. km)	No of HH	Total Population			Density of Population
			Total	M	F	
	Cochin Estuary					
Zone I	273.07 **[39.48%]**	65291 **[22.04%]**	330394 **[21.60%]**	163382 [21.54%]	167012 [21.66%]	1210
Zone II	228.13 **[32.98%]**	78039 **[26.34%]**	406145 **[26.55%]**	200116 26.38%]	206029 [26.72%]	1780
Zone III	190.5 **[27.54%]**	152916 **[51.62%]**	793234 **[51.85%]**	395116 [52.08%]	398118 [51.63%]	4164
Grand Total	691.7 **[100%]**	296246 **[100%]**	1529773 **[100%]**	758614 [100%]	771159 [100%]	2212
	Kali Estuary					
Zone I	332.47	8098	52143	33373	47598	157

Source: Primary Census Abstract, Government of India, 1991

Annexure 4.2 Distribution of cultivators, agricultural workers and fishermen in the study area

	Cultivators			Agricultural Labourers			Livestock, Fishing, … and allied activities		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
	Cochin								
Zone I	3008 [47.1%]	2587	421	8555 [40.4%]	5615	2940	8313 [20.2%]	7553	760
Zone II	2050 [32.1%]	1708	342	6191 [29.2%]	4448	1743	18413 [44.7%]	17321	1092
Zone III	1326 [20.8%]	1145	181	5428 [25.6%]	4093	1335	14464 [35.1%]	13601	863
Grand Total	6463 [100%]	5519	1024	20243 [100%]	14227	6095	41254 [100%]	38539	2783
	Kali								
Zone I	4442	2868	1574	1466	713	753	671	653	18

Source: Primary Census abstract, Government of India, 1991

Annexure 4.3 Zone-wise Distribution of Pokkali Padashekaramas in the Study Area

	Panchayats	No. of Padashekarams	Area [Ha.]	No of farmers	Average holdings
	Zone I				
1	Thuravoor	11	518	1239	0.42
2	Kutheathodu	4	220	535	0.14
3	Kodamthuruthu	7	234	531	0.44

4	Pattanakad	5	234	654	0.36
5	Panavally	6	98	208	0.47
6	Thycattusserry	2	47	102	0.46
7	Perumbalam	2	18	60	0.3
	I Total	**37**	**1369**	**3329**	
Zone II A					
8	Chellanam	9	688	808	0.85
9	Kumbalangy	8	434	592	0.73
10	Ezhupunna	3	31	72	0.43
11	Aroor	5	152	490	0.31
12	Kumbalam	7	201	198	1.02
13	Maradu	2	94	110	0.85
14	Udayamperoor	1	100	85	1.18
15	Thripunithura (M)	2	100	120	0.83
	II A Total	**37**	**1800]**	**2475**	
Zone II B					
16	Nayarambalam	3	242	283	0.86
17	Njarakkal	4	312	378	0.83
18	Edavanakad	2	72	132	0.69
19	Ezhikkara	4	586	964	0.61
20	Kottuvally	14	598	715	0.98
21	Varapuzha	29	272	422	0.64
22	Kadamakuddy	11	137	179	0.77
	II B Total	**67**	**2219**	**3073**	
Zone III A					
23	Elankunnapuzha	7	107	116	0.92
24	Mulavukad	2	25	32	0.78
25	Cheranalloor	2	63	47	1.34
26	Cochin (C)	1	18	20	0.9
	III A Total	**12**	**213**	**215**	
Zone III B					
27	Pallipuram	1	12	33	0.36
28	Kuzhippilly	6	347	1151	0.3
29	Parur (M)	1	43	32	1.34
	B Total	**8**	**402**	**1216**	
	Grand Total	**161**	**6003**	**10308**	

Source: Pokkali Land Development Agency, 2000

Annexure 4.4 Distribution of average operational holdings of different Padashekarams

Class	0 to .5	0.5 to 1	1 to 2	2 to 3	3 to 4	> 4	Total
Zone I							
Thuravoor	6	3	2	-	-	-	11
Kutheathodu	4	-	-	-	-	-	4
Kodamthuruthu	5	1	1	-	-	-	7
Pattanakad	5	-	-	-	-	-	5
Panavally	5	1	-	-	-	-	6
Thycattusserry	1	1	-	-	-	-	2
Perumbalam	2	-	-	-	-	-	2

I Total	**28 [75.68 %]**	**6 [16.22%]**	**3 [8.11%]**	**0**	**0**	**0**	**37 [100 %]**
Zone II A							
Chellanam	1	6	2	-	-	-	9
Kumbalangy	2	3	1	2	-	-	8
Ezhupunna	2	1	-	-	-	-	3
Aroor	4	1	-	-	-	-	5
Kumbalam	-	2	4	-	1	-	7
Maradu	-	2	-	-	-	-	2
Udayamperoor	-	-	1	-	-	-	1
Thripunithura Muncipality	-	2	-	-	-	-	2
II A Total	9	17	8	2	1	0	37
Zone II B							
Nayarambalam	-	2	1	-	-	-	3
Njarakkal	1	3	-	-	-	-	4
Edavanakad	-	2	-	-	-	-	2
Ezhikkara	1	3	-	-	-	-	4
Kottuvally	4	6	3	1	-	-	14
Varapuzha	8	19	2	-	-	-	29
Kadamakuddy	-	2	4	3	-	2	11
II B Total	14	37	10	4	0	2	67
Zone III A							
Elankunnapuzha	-	4	3	-	-	-	7
Mulavukad	-	1	1	-	-	-	2
Cheranalloor	-	1	1	-	-	-	2
Cochin Corporation	-	1	-	-	-	-	1
III A Total	0	7	5	0	0	0	12
Zone III B							
Pallipuram	1	-	-	-	-	-	1
Kuzhippilly	4	1	1	-	-	-	6
Parur Muncipality	-	-	1	-	-	-	1
III B Total	5	1	2	0	0	0	8
Grand Total	**56**	**68**	**28**	**6**	**1**	**2**	**161**

Source: Pokkali Land Development Agency, 2000

Annexure 4.5 Distribution of operational holdings of households in the study area

Class	0 to .5	0.5 to 1	1 to 2	2 to 3	3 to 4	> 4	Total
Zone I							
Thuravoor	450	26	42	-	-	-	518
Kutheathodu	220	-	-	-	-	-	220
Kodamthuruthu	160	29	-	45	-	-	234
Pattanakad	234	-	-	-	-	-	234
Panavally	78	20	-	-	-	-	98
Thycattusserry	26	21	-	-	-	-	47
Perumbalam	18	-	-	-	-	-	18
I Total [ha]	**1186**	**96**	**42**	**45**	**0**	**0**	**1369**
Zone II A							

Chellanam	15	532	141	-	-	-	688
Kumbalangy	71	296	50	17	-	-	434
Ezhupunna	19	12	-	-	-	-	31
Aroor	134	18	-	-	-	-	152
Kumbalam	-	145	46	-	10	-	201
Maradu	-	94	-	-	-	-	94
Udayamperoor	-	-	100	-	-	-	100
Thripunithura Muncipality	-	100	-	-	-	-	100
II A Total	**239**	**1197**	**337**	**17**	**10**	**0**	**1800**
Zone II B							
Nayarambalam	0	147	95	-	-	-	242
Njarakkal	4	308	-	-	-	-	312
Edavanakad	-	72	-	-	-	-	72
Ezhikkara	92	494	-	-	-	-	586
Kottuvally	71	191	336	-	-	-	598
Varapuzha	57	194	21	-	-	-	272
Kadamakuddy	80	16	8	7	-	26	137
II B Total	304	1422	460	7	0	26	2219
Zone III A							
Elankunnapuzha	-	53	54	-	-	-	107
Mulavukad	-	18	7	-	-	-	25
Cheranalloor	-	60	3	-	-	-	63
Cochin Corporation	-	18	0	-	-	-	18
III A Total	0	149	64	0	0	0	213
Zone III B							
Pallipuram	12	-	-	-	-	-	12
Kuzhippilly	301	46	-	-	-	-	347
Parur Muncipality	-	-	43	-	-	-	43
III B Total	313	46	43	0	0	0	402
Grand Total	2042	2910	946	69	10	26	6003

Source: Pokkali Land Development Agency Report, 2000

Annexure 4.6 Different types of fishing gears in Cochin backwater

Adakkamkolli	Koru Vala	Nylon Vala	Theruni Vala
Chemmeen Vala	Kozhu Vala	Odak Vala	Thirutha Vala
Choonda	Kuruthola Vala	Oota Vala	Vadi Vala
Dappa Vala	Kuthu Vala	Pattu Vala	Valli Vala
Kaka Vala	Kutti Vala	Pattukanni	Valu Vala
Kamba Vala	Mathi Vala	Payth Vala	Vatta Vala
Karimeen Vala	Meen Vala	Peru Vala	Villu Vala
Kolli Vala	Merug Vala	Scoop Net	
Konchu Vala	Neetuvala	Thappal	
Koori Vala	Noolu Vala	Thelinja Vala	

Annexure 4.7 Distribution of active fishing days per month in Cochin estuary

Distribution of active Fishing days in each month in Cochin Estuary												
	Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Chinese Net	14	15	14	14	12	14	15	16	20	18	18	18
Stake net	18	18	14	14	14	14	15	18	18	18	18	18
Free net	20	20	20	12	12	12	12	22	20	20	20	18

Source: Primary Survey

Annexure 4.8 Distribution of active fishing days per month in Kali estuary.

Distribution of active Fishing days in each month in Kali estuary												
	Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Gillnet	10	12	10	8	9	10	12	12	13	12	13	11
Cast net	10	12	10	8	9	10	12	12	13	12	13	11
Hook & Line	10	12	10	8	9	10	12	12	13	12	13	11
Scare line	8	-	-	-	-	-	10	10	10	10	10	10
Drag net	8	8	-	-	-	-	10	10	10	10	10	10
Scoop net	10	12	10	8	9	10	12	12	13	12	13	11

Source: Primary Survey

Annexure 4.9 Chronology of the development of Cochin Port

Year	Event
1835	The first chart of developing Cochin into a Deep sea Port was made
1920	Execution of Harbor Development work began
1929	Cutting the approach channel 450 feet wide
1930 – 31	Port was thrown open for vessels up to 30 draft
1st Aug, 1936	Cochin was declared a Major port and the harbor administration was taken over by the Government of India
29th Feb, 1964	Cochin port trust was constituted under the major Port Trust Act, 1963. The Port became a trust with effect from 29/02/1964 when the Government of India constituted the first Board of Trustees for the Port under subsection (i) of section 4 of the Major Port Trust Act, 1963.
7th Sep, 1970	The first stage of the Cochin Fisheries harbour was commissioned
22nd Aug, 1980	Cochin Fisheries harbour was commissioned

Source: Compiled from administrative reports, Port Trust

Annexure 4.10 Property rights of Cochin port trust

Definition of Port Limits

It shall comprise of all areas contained on land lying within 45.76 meters (50 yards) of high water mark, Kerala estuary and the Sea bounded by straight lines joining the following positions.

The northern boundary begins from a point on the Ernakulam foreshore (10°00' 44.5") roughly up to the Thevara peninsular region to a point on the eastern shore

of Vypeen Island in position latitude…….. and then along the high water mark on the Vypeen shore via Cochin harbour entrance to a point on the western shores of Vypeen island and thereon to a position in the sea 9 nautical miles due west due west in latitude … …
The southern boundary begins from a point on the southern end of Thevara to a point on the Eda Kochi shore along the high water mark on the Mattencherry shore via. Cochin harbour entrance to a point on the western shore near Mundamveli and there to a position in the sea, 9 nautical miles due west.
The western boundary is a straight line at sea joining the other two lines. The eastern boundary shall lie along the high water mark on the Ernakulam Foreshore between the northern and southern boundaries defined above. In addition to all these areas, the Port Trust shall also have jurisdiction on all land reclaimed or to be reclaimed in future, from the estuary or the sea.

Annexure 4.11 Operational details of SWTD of Kerala

Particulars	1990-91	1991-92	1995-96	1996-97	1997-98	1998-99
No. of boats /jhankars	88	91	77	77	78	81
Boat/ Jhankar in operation	36	36	51	54	55	59
Scheduled trips	44	46	408	400	401	399
Passenger (lakhs)	56	56	243.24	266.2	2201.95	240.8
Gross route	1861.6	1861.60	1527.6	1493.6	1475.6	1549.9
Volume	119.57	116.72	229.47	223.35	-	-
No of employees	189.33	220	-	-	1272	1285

Source: Compiled from Economic Review

Annexure 4.12 The communal sport - Vallamkali.

Apart from the direct and indirect values derived from the estuaries, the local population values the environment is manifest in many ways. One such example is the community sport called “vallamkali” which is a collective initiative. Usually a snake boat is manned by four helmsmen, 25 singers and 100 - 125 oarsmen who row in unison to the fast rhythm of the *vanchipattu* (song of the boatman). Thousands of people crowd the water’s edge to cheer the huge black crafts as they slice through the waters to a spectacular finish. The oldest of these events have curious legends and myths attached to their origin. Myths closely linked to the rustic people and their beliefs. Details of different vallamkali are given below.

A calendar of the snake boat races of Kerala from with four of the oldest and most important events -

1. Champakulam Moolam Boat Race
2. Aranmula Uthrattadi Vallamkali,
3. Payippad Jalotsavam
4. Nehru Trophy Boat Race

Other boat races held during Onam

1. ATDC Boat Race, Alappuzha
2. Rajiv Gandhi Boat Race, Pulinkunnu
3. Neerettupuram Boat Race
4. Kumarakom Boat Race
5. Karuvatta Boat Race
6. Kavanattinkara Boat Race,
7. Kumarakom Arpookara Vanitha Jalamela,
8. Kottayam Mahatma Boat Race, Mannar
9. Thazhathangadi Boat Race,Kottayam
10. Kottapuram Boat Race,
11. Kodungallur and Kumaranasan Smaraka Jalotsavam, Pallana.
12. The Indira Gandhi Boat Race, Ernakulam Lake

From the perspective of our study, this activity shows that the, local inhabitants value their environment although these are not traded in the market. With the introduction of tourism ministry into this activity, this sport is commercially organized for the promotion of eco-tourism on the backwaters.

Annexure .4.13 Chronological Order of Inland Fisheries Regulation That Have Evolved Over the Years

- Regulation To Make Better Provision For The Protection And Preservation Of Game Fish, 1914
- Indian Fisheries (Madras Amendment Act, 1927
- Travancore – Cochin Fisheries Act, 1950
- Travancore – Cochin Fisheries Rule, 1952
- Regulation of Fishing With Fixed Engines (Stake nets, Chinese Nets etc), 1973
- Issue Of Fishing License Rules, 1974
- Regulation Of Prawn Fishing In Private Waters Rules, 1974
- Rules For Management And Control Of Fisheries Of Fisheries In Government Water Rules, 1974

According to the Travancore - Cochin Fisheries Act, 1950 and the Travancore – Cochin Fisheries Rules, 1952, the government stipulates certain regulations to be followed by fishermen using gears that are fixed. The Government prohibits nets

with meshes having a cod end less than 20mm mainly to protect the very young ones but these regulations are neither observed nor enforced. The number of illegal or unauthorized fishing gears in this region itself is an indicator of how ineffective these rules are from the view of the people.

Enforcement of the rules is also reflected here since the fisheries department entrusted with the job of patrolling such a vast area does not have the necessary machinery. In most cases they have to depend on the help from the police department which is already over burdened. The Government clearly states that fishing in Government waters using either a fixed net or a free net requires a license from the government. Licenses are to be issued only to people who are genuine and active fishermen. Fixed nets are not to be planted at the mouth of the river. Transfer of license is not allowed. In cases it is allowed, it transfer requires the sanction from concerned authorities. Unauthorized nets are physically removed. It is returned only after the payment of the penalty fees. It ranges from Rs 50 onwards depending upon the intensity of the crime. All penal cases are registered in the Crime Register.

STAKENETS

- No Person shall posses more than 4 stake nets at a time.
- No stake shall be planted with in a distance of 20 metres from either side of the shore of backwater. In the case of narrow canals the licensing authority shall determine the distance in consultation with the Irrigation department &the water transport authorities.
- No stake net shall be planted with in 40 metres on either side of a landing place or ferry or in the river mouth.
- The distance between two stake lines should not be less than 50 metres and that between two stakes in a stake line should not exceed 4 metres.
- Fishing by any means (free sets etc) in the area between stake lines of with in a distance of 40 metres around a stake net is prohibited.
- Nets should not be tied to stakes during flow- tide (high tide).
- The end post shall be so fixed as to ascertain the exact location of the stake line from any two conventional fixed survey points.
- Upper end of each stake net shall be visible at least 1.5 metres above the surface of the water during high tide.
- Light shall be provided at night at the end post of the lines of stakes and the cost of maintaining such light shall be borne equally by all the owners of stakes in the respective line.

- The use of powerful lights such as Petrol-max or gaslight or electric bulb (60 volts) for fishing with stake is prohibited.

CHINESE NET

- Fishing by any means with in a distance of 40 metres around the net is prohibited.
- The minimum distance between two adjoining Chinese nets shall be 30 metres and the measurement being taken from centre to centre of the nets.
- The end post shall be so fixed as to ascertain the exact location of the Chinese net from any two conventional fixed survey points.
- The use of powerful lights such as petrol-max or gas light or electric bulb (60 Volts) for fishing with Chinese net or other fishing Implements is prohibited.
- No fixed engine is allowed to operate during high tide.
- Chinese nets are not allowed across the channel i.e. against water flow.

FREE NETS

- Gill nets are not to be used in water transport channels and navigation channels. However this does not come under the purview of the State Fisheries Department but the irrigation department and the Water Transport Authority and so, fishermen do not heed this.
- Koruvala Mesh size Due to it destruction of juveniles and spawners, it has been completely banned. Use of lights electric bulbs and Petromax Lighters are not allowed according to government rules.

License fee for single net per annum (Rs.)				
	Average annual net earning	1974*	1980	1990
Stakenets				
Class I	More than Rs.1000	0.75	3.00	25.00
Class II	Between Rs. 750 & 1000	0.40	1.00	20.00
Class III	Less than Rs. 750	0.20	0.75	20.00
Chinese net				
Class I	More than Rs.1000	0.75	5.00	20.00
Class II	Between Rs. 750 & 1000	0.50	3.00	15.00
Class III	Less than Rs. 750	0.25	1.00	15.00

Source: Fisheries Dept.

* During 1974 government of Kerala passed the rule for the issue of licenses

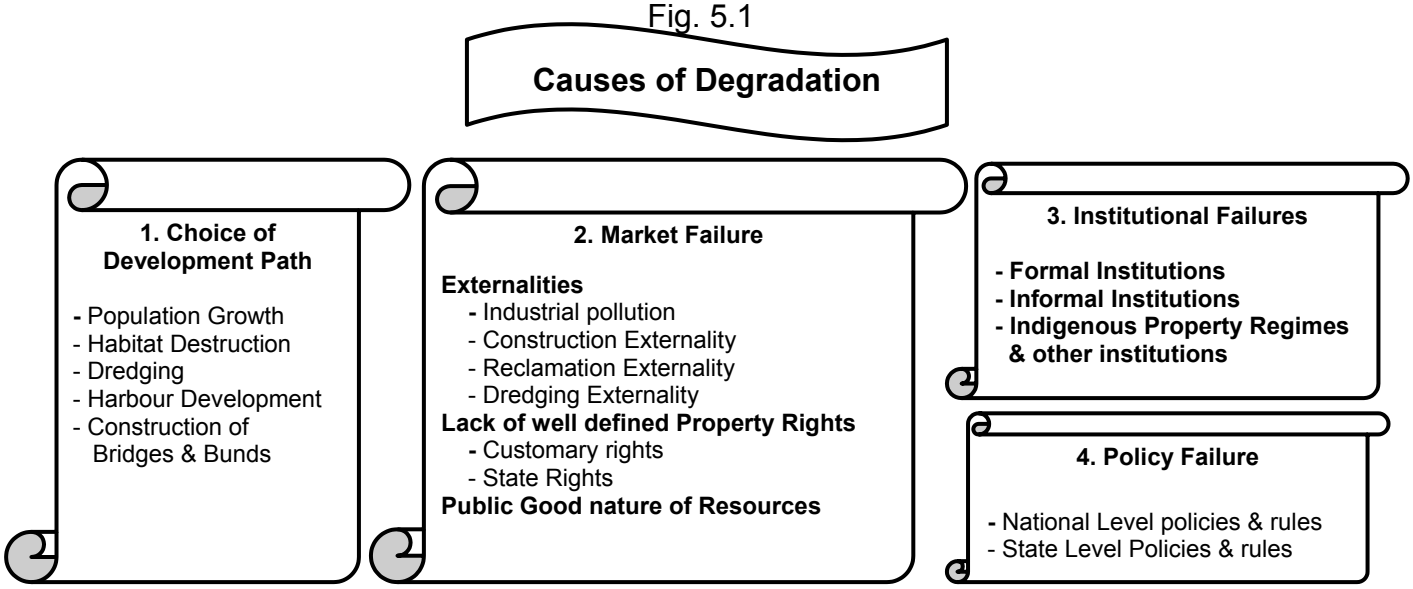
CHAPTER 5

Causes Of Degradation

We have argued in the last chapter that local level initiatives of traditional stakeholders towards economic progress were constrained by the lack of sufficient economic surplus for making investments on modern activities. State sponsored development programs and projects were therefore considered the right **choice of development path** for achieving economic progress and high living standards. The initiatives started as part of the centralized planning of the state and central governments, in the fifties, were strengthened many folds during later decades. An interesting dimension of the state involvement in the whole process of industrial development is the intensive use of biological resources and environment of both Kali and Cochin estuaries. In Cochin estuary for instance, the activities of Cochin Port trust necessitated dredging of the backwaters for providing smooth transportation channels to the incoming ships. The Navigation industry has also introduced a number of structural changes in the spatial allocation of waterways to organize economically profitable navigation activities. The small and large modern industries located on the banks of the backwaters dump their wastes into the waterbed in an attempt to save the costs of pollution abatement. The national and international leisure industry has also introduced many measures to promote tourism related activities on backwaters. The net result of all these external interventions is the intensive use of the resources of kayal and its environment. Traditional communities on the hand have been complaining about the externalities of modern stakeholders on their traditional activities. The objective of this chapter is to explain in detail the causes of biodiversity degradation in Cochin and Kali estuaries.

It was mentioned in chapter 2 that resource degradation is an inevitable outcome of the manner in which **development path** is selected by the nation. Degradation also occurs due to the failures of markets, institutional failures and government (policy) failures. Figure 5.1 below summarizes the major causes for the degradation biological diversity.

Fig. 5.1



The chapter is divided into four sections. **Section 1** deals with the nature of market failures. This is followed by a discussion on institutional failures and government's policy failures in **sections 2** and **3** respectively. A conclusion of this chapter is then followed.

5.1 Market Failures

Market for environmental goods and services fails due to many reasons. First and foremost reason for failure is the occurrence of externalities. In our study area, modern stakeholders produce four kinds of externalities during the process of using estuarine environment. **They are industrial pollution externalities, construction externalities, reclamation externalities and dredging externalities**. In addition to these, degradation could arise due to the **lack of well-defined property rights** on natural resources including environment**.** Finally, degradation can also arise due to the **public good nature of biodiversity.** This section introduces these issues one by one so as to describe the manner in which kayal resources and its environmental qualities are degraded due to the interplay of these factors.

5.1.1 Externalities

Externalities arise in the ecosystem due to sedimentation, reclamation, dredging, construction activities and industrial pollution.

5.1.1 [A] Sedimentation externalities

Sediment accumulation, which badly influences almost all the economic activities in the backwater, is an important form of externality caused both by natural processes and human actions. Siltation occurs due to river discharges, tidal inflows, deforestation and construction of dams, reservoirs and barriers. Available information shows high growth of sediment accumulation in Cochin estuary. Seven major westward flowing rivers (Chalakudi, Periyar, Muvattupuzha, Meenachil, Manimala, Pamba and Achencoil.) discharge their fresh water and dump huge quantities of silt and sediments every year into Cochin estuary at various points. Sedimentation is also cased by soil erosion, reclamation and construction activities and is found to obstruct the tidal functions of the backwaters at various locations. (See annexure 5.1 for details).

It is estimated that the average sediment yield from the catchments of Western Ghats region is of the order of 23 t/ha/year**.** Based on the reservoir sedimentation surveys carried out in the wetland, the average yield of sediments is 26-t/ha/year. Therefore the total annual sediment yield from all the rivers basins draining into the Venmbanad lagoon is estimated to be 32 million tones. The composition of sediments is given in **annexure 5.2.** We do not have enough evidences on the extent of wastes produced by the construction industry and its subsequent sedimentation in backwaters. However, the growth of urban constructions in Cochin City and its suburbs also indicate towards high discharges of such sediments into backwaters. **Sediment accumulation has reduced the mean depth of estuaries in many places affecting fishing activities, water transport and trade.**

The accumulation of sediments in Cochin estuary has produced serious imbalances on the eco system functions of backwaters seriously in recent years especially in selected stations. The comparative data shows that the average depth in different locations of the study area has been declining over the last 50

years. Table 5.1 shows the variation of depth ranges in the study area during the last 50 years.

Table 5.1 Variation of depth range in different sectors of the Vembanad Estuary during the past 50 years (metres)

Stations	Depth range In 1930s	Depth range in 1980s	Depth ranges in 2001*
Between Thanneermukkom bund & Vaikom	8-9	3-4	3.5-4
Between Vaikom & South Paravoor	7-9	4-5	3.5-4.0
Between South Paravoor & Aroor	5-6	3-4	3-4.5
Between Aroor & South of Willington Island	7-8	7-8	7-8
Cochin harbour region	7-8	7-8*	7-8
Between Bolgatti & Cherai	3-4.5	2-2.5	1.5-2
Between Cherai & Munambam	3-6	2.5-4	2.5-4

Source: Gopalan, U.K, 1983 * Primary data 2001

From the available data it can be deduced that in the course of the last fifty years, the average depth of Cochin backwater has reduced from 6.7 meters to 4.4 meters. As a result of the reduction in area and depth the total volume of the brackish water system between Alleppey and Azhikode has been reduced from 2.449 km^3 in the beginning of this century to 0.559 km^3 in 1985.

5.1.1 [B] Dredging Activities

The externalities caused by sedimentation and subsequent dredging away of this sediments and silt are harming the activities of both the traditional and modern stakeholders alike. The local fishermen are the most affected other than the Cochin Port trust and the navigation industry. The Cochin Port Trust has been (and still is) dredging backwaters without considering the ecological and socio economic implications of such unscientific activities. The magnitude of silt in the backwaters of Cochin is reflected in the removal of 2.5 million cubic yards of silt by dredging every year in order to maintain the shipping channel at Cochin harbor, where the rate of silting is 180 cm/year **(Kurup, 1971).**

The Port Trust has been undertaking dredging activities in connection with the maintenance of the shipping channels, annually on a large scale so as to keep it at a depth of 10-13 metres in certain areas and in other areas to a depth of 18m

(Subramanian, 2000). These kinds of operations generally cause wide fluctuations in turbidity and productivity of different forms of life. Table 5.2 summarizes some evidences on the quantity of silt dredged and the expenditure incurred under this head by the port trust. No doubt, huge quantities have dredged by incurring heavy expenditure. (**See annexure 5.3 for details**). **The data clearly reveal an increasing trend.**

Table 5.2 Dredging data of Port Trust for the last 50 years

Year	Sediments dredged lakh m^3
1951-60	23.66
1961-70	39.27
1971-80	28.87
1981-90	14.22
1991-98	24.17

Source: Compiled from Administrative Report, Cochin Port Trust.

5.1.1 [C] Reclamation of estuaries

Human interventions, during the past have resulted in drastic alterations in Cochin estuary. Reclamations of kayal and the adjoining wetlands have been undertaken by various stakeholders for various purposes such as agricultural expansion, aquaculture practices, harbor development, urban development and other public and private uses. Of these, reclamations for agricultural purposes mainly paddy cultivation and paddy-cum-shrimp culture has contributed immensely to the horizontal shrinkage of the backwater **(Gopalan, 1983).**

Due to the non-availability of sufficient data, an accurate documentation on the total area reclaimed both from the Cochin and Kali estuaries is difficult. Different stakeholders have undertaken it at different periods of time for various purposes. Local communities reclaim parts of estuaries and small channels for domestic needs, roads, and for raising commercial crops like coconuts and aquaculture. It has been estimated that the backwaters had an area of nearly 365 km^2 till 1834. The first major large-scale reclamation activity in the estuary was undertaken for the Cochin Port Trust. About 2,226.27 hectares have been reclaimed till the beginning of the century. Thereafter reclamation activities were banned in 1903,

according to a Government notification on the presumption that these activities would adversely affect the Cochin harbour development (**Kurien, 1984)**. However, reclamations activities continued. In 1912, an area of 5,223.15 ha was reclaimed. The large-scale reclamation was of 700 ha in the relatively deeper areas of southern Vembanad region between 1941 and 1950 (**Kurien, 1984)** was confined to the Kuttanad region of the Vembanad Lake under the support of the then state Government. Apart from this, private owners have also reclaimed an area of 1,500.0 ha along the banks of the main channels, connecting canals and islands for agriculture, cottage industries and housing during the present century. Of this, the coconut husk retting ground enclosures alone occupy an estimated area of about 500 ha. **Table 5.3** provides a summary of information on the nature of reclamation undertaken in Cochin estuary.

Table 5.3 Reclamation in the Vembanad estuary for developing agriculture and aquaculture

Period	Area Reclaimed (ha)	% Area Reclaimed	Purpose
1834- 1903	2226.72	6.10	Agricultural
1912- 1931	5253.15	14.39	Agricultural
1941- 1950	1325	3.63	Agricultural
Till 1970s	5100	13.97	Paddy cum shrimp culture
1970- 1984	800	2.19	Paddy cum shrimp culture
1900- 1984	1500	4.11	Housing, agriculture & traditional industries
1975	6900	18.90	Ecologically severed from estuary by Thaneermukkom bund.
Total	**23104.97**	**63.30**	

(Source: Gopalan, U.K, 1983, NIO)

Reclamation has also been undertaken for housing and promoting institutions like the Cochin shipyard, Central Institute of fisheries Technology (CIFT), Central Maine Fisheries Research institute (CMFRI) and also for the Cochin port for additional berth facilities. Plans were made by GCDA to reclaim 640 acres (269.7 ha) of land on the northern foreshore of Ernakulam for urban development in future **(Gopalan, 1983)**. This was subsequently carried out in later years and is

still continuing even today. Large areas of the Kayal are under reclamation along the foreshore of Ernakulam particularly near Tatapuram and Goshree project boundaries.

An area of 69 km^2 of brackish water has been reclaimed for constructing a spillway for flood control at Thottapally in 1955 and at Thaneermukkom for checking the intrusion of saline water in 1974. **(Gopalan, 1983).** A total of 5,100 ha has been converted into paddy cum shrimp culture systems till 1970. The expansion in this field has been faster during the past 15 years and a further area of about 800 ha has been converted to paddy cum shrimp culture fields and for other aquaculture purposes.

The area of 203 acres north of the Rail and Road Bridge and 113.48 acres south of the bridge were levelled and handed over to the Navy. In early 1959-60, reclamation was undertaken south of the Dry Docks up to the Mattancherry Bridge at an estimated cost of Rs 1,30,000/-. 1965-66 saw the Ernakulam channel being widened and the 9.54 lakh cubic yards of material pumped into areas earmarked for reclamation, opposite the Ernakulam Warf. In order to solve the problem of shortage of land on the Willingdon Island, for Port development, large-scale reclamation of the backwaters is still being undertaken. In addition to this a 25-meter strip of land was reclaimed from the backwaters between the south and north Coal berth for laying pipelines for Bharath Petroleum.

5.1.1 [D] Harbor and Urban Development Activities

The project on development of Cochin into a major port on the west coast of India commenced in 1920 under the direction of an eminent harbor engineer Sir Robert Bristow and was completed in 1936. During this period of constant dredging, Wellington Island, the present seat of Cochin port having an area of nearly 365 ha has been reclaimed. Thereafter there was no major reclamation till the 1970's, when the fishery harbor having an area of 10.78 ha had been reclaimed. This was followed by an integrated project for the development of the Cochin port, under which, Vallarpadom - Ramanthuruth - Candle island complex having an area of 141.7 ha had been reclaimed. In addition to this, construction and related dredging

activities also result in large scale sedimentation in parts of the Cochin estuary particularly the northern part of the Cochin bar mouth region where the construction of the Vallarpadom Container Terminal is on going.

Further under the same project a similar area is being reclaimed as a southerly extension to the Willington Island. **Table 5.4** shows the details on reclamation for harbor and other infrastructure development projects.

Table 5.4 Reclamation in the Vembanad estuary for Harbor and Urban Development

Period	Area reclaimed (ha)	% reclaimed	Purpose and location
1920 – 1936	364.37	0.9982	Creation of Willingdon Island for harbour development
1978	10.78	0.0295	Fishing harbour project
1981-1985	141.70	0.3882	Vallarpadam - Ramanthuruthu - Candle Island complex under Integrated Development project
	141.70	0.3882	Southern extension to Willington Island
	23.91	0.0655	Foreshore urban development by GCDA and Cochin Town Planning Trust
	11.73	0.0321	Reclaimed for the use of Cochin Shipyard, CIFT, North Tanker Berth and other berths
Total	**694.19**	**1.9017**	

(Source: Gopalan, U.K, 1983, NIO)

Similarly, an area of 23.61 ha in Cochin estuary was also reclaimed by, the Greater Cochin Development Authority (GCDA) and Cochin Town planning trust for the construction of a marine drive on the foreshore of Ernakulam

Many scholars have reported destruction of mangroves and the reclamation of these areas to other commercial uses. A conservative estimate indicated that the total extent of mangrove areas in the Cochin estuary and Vembanad Lake was around 70,000 ha **(Subramanian, 2000).** This area has progressively reduced as they were converted for coconut plantations, paddy cultivation, traditional pond culture, reclamation and other development activities.

5.1.1 [E] Construction externalities

Traditional settlements of human population in the erstwhile state of Cochin were around the backwaters and the reasons for this are obvious. The water body acted as the medium of transport and exchange among the island village communities. As these economies progressed over time, the demand for speedy transport and communication increased and the government has approved construction of bridges, yielding to local political pressures. The bridges connecting Aroor – Edakochi, Kumbalangy-Perumbadappu, Thevara and Arookutty and the Gosree project connecting Ernakulam and the isolated islands of Mulavukad, Vallarpadam, Vypeen and adjoining areas are examples of strong government interventions in the area of rural infrastructure development, which could influence the ecological balance of estuaries.

Construction of such bridges and related structures are the need of the day. Yet the unscientific mode of construction followed today is another externality on the stakeholder who depends on this natural resource. Often these bridges are constructed after reclaiming land from both sides of the water so that the cost of the bridge is reduced. This however narrows the width, reduces flow of water and affects the current and tidal functions. It affects the distribution of fishery resources that come in with the tide. Catch reduction has affected a number of fishermen and naturally conflicts have occurred. In most cases, these conflicts are observed between the fishermen on opposite banks of the estuary.

From the number of such bridges sanctioned, it is obvious that no one is seriously concerned about the kind of development activity that is taking place. The Goshree plan is depicted as a great leap forward as far as the people of the isolated islands of Mulavukad, Vallarpadam, Vypeen and adjoining areas are concerned. Yet one wonders at the cloak of secrecy that is associated with such a big budgeted investment plan and the absence of an accompanying environmental impacts assessment.

5.1.1 [F] Industrial agglomerations on the banks of Cochin estuary and pollution

Industrial pollution is in fact one of the major causes of biodiversity degradation in Cochin estuary but not very serious in Kali. Cochin is the industrial capital of Kerala and a large number of chemical factories are located on the banks of the river Periyar. The estuary receives effluents from chemical engineering industries, food and drug manufacturing industries and also from paper, rayon, rubber, textiles and plywood industries. It is also polluted due to the flow of sewage from domestic waste from Greater Cochin urban area, organic fertilizers and residues from agricultural lands, Oil spillage and other hydro-carbons from Cochin Refineries and Cochin Port and Caprolactum plant of FACT, chemical wastes from fertilizer plants, effluents from other small industries located on the banks of the backwater, fish spoilage and residues from fish landing centres and fishing Harbour, oil, paints, metal and paint scrapings from Cochin shipyard and port and other boat yards and dock yards, sediments by dredging the Ernakulam Channel for navigational purposes and fish guts, and leftovers from prawn peeling sheds, fish processing plants and canning factories.

We have collected data on the nature and extent of various pollutants in both estuaries from the secondary sources **(See Annexure 5.4 for details).** Although the data is inconclusive in many respects, an examination of the available information reveals clear evidences for high incidence of water pollution in selected areas.

Some evidences

There exist clear evidences to establish that the intensity of different pollutants in the backwater has been increasing over the last three decades. For instance, **Qasim et. al. (1969) and Madhupratap et. al. (1977)** has pointed out that the ever-increasing loads of industrial waste and sewage in the Cochin estuary have created conditions, which are extremely destructive to plants and animals. **Kurian (1972) and Ansari (1977)** have studied benthos of the backwaters. The studies indicated that the density of bivalves, gastropods and isopods in the backwaters have been considerably reduced with time. These have been attributed to the increase in pollution (**Qasim et al, 1969 and Madhupratap et. al. 1977).** Studies

by **Remani (1979)** indicates that in some of the polluted waters the **BOD** (Biological Oxygen Demand) values reach 513.76 mg/ l, Sulphide 4.97 mg/ l and oxygen content less than 0.05 ml/ l. The effects of industrial pollution are seen in the form of depletion of biota, especially benthic organisms, fish mortality and presence of high concentration of ammonia in the water.

Hydrobiological conditions of the estuary are greatly influenced by seawater intrusion and influx of freshwater according to studies on the distribution of salinity and temperature **(Lakshmanan et al, 1982).** It has been shown that the organic carbon in the sediments was higher during monsoon due to the contribution from land run off **(Remani, et al, 1980**). The study with reference to the indicator **bacteria** reveals that the principal source of faecal pollution is of the non-human type originating from land drainage, sewage and organic discharge **(Gore et al 1979).** The higher **COD** (Chemical Oxygen Demand) values observed are probably due to the domestic sewage and water discharged into the harbor area **(Sarala Devi et al 1979).** Studies have further shown that there is appreciable degree of organic pollution in the harbor area **(Unnithan et al, 1975). [1]**

5.1.2 Nature and Growth of Pollutants in Cochin estuary

It was observed that pollutants like Copper, Zinc, Cadmium, Lead, Nickel and Iron (dissolved metals) were highest at the effluent discharge point and gradually decreasing towards the bar mouth, it was lowest in the upstream of the river Periyar. Seasonal data shows that the pollutants were greater during the pre-monsoon season and lowest during the monsoon season due to freshwater influx.

Incidence of **mortality of fish** (*Ambassis gymnocephalus)* due to industrial pollution is reported from the upper reaches of Cochin estuary (**Unnithan et al, 1977).** The effluents carrying a heavy load of ammonia at the rate of 432-560 ppm which is far above the accepted lethal limit of 2-5 ppm pouring into the incidence area together with many other pollutants such as acids and suspended solids in varying quantities, have changed the hydrographic conditions to extreme toxic proportions so as to cause heavy mortality of the animals in the area. Fish shoal entering the polluted zone is unable to tolerate the cumulative effect of pollution,

resulting in their sudden death due to asphyxiation. It is suggested that treatment of waste be adopted to recycle and recover the ammonia and other pollutants from the effluent before it is let out into the estuary.

Studies conducted by **Rajendran et al (1986)** showed that **concentration of mercury** in the oyster Crassostrea madrasensis collected from the Cochin estuary showed levels of mercury, which ranged from 15 to 48ppb for small size oyster and 7.0 to 37.0 ppb for larger size group. The concentration of mercury in the sediment samples ranged from 31 to 144 ppb. Mercury is discharged into the estuary by a paper mill and other factories engaged in chemical manufacturing. The levels of mercury in backwaters of Cochin are also high.

Organic pollution exists to a considerable extent in the Cochin estuary especially in areas like Padiyathukulam canal, Mullasherry canal and Market canal. **High amounts of hydrogen sulphide were observed in the areas of discharge of organic waste into the estuary. Highest values obtained were 3041 and 2.25 mg/litre. Lower oxygen values showed higher values of BOD and hydrogen sulphide**. The extent of pollution in these areas is well above the tolerance level of estuarine fauna. Continued discharge of effluents at the present rate will influence the ecosystem and estuarine life of the harbour and harmful effects may extend to the inshore waters also.

Retting of coconut husk is another major source of organic pollution in the backwaters of Cochin. Retting is brought about by the pectinolytic activity of micro organisms, which liberates large amounts of organic matter into the medium. Higher temperatures and salinity accelerates the process with consequent increase in organic load of the medium. Sediments are the indicators of quality of water overlying the sediments. A study was conducted by **Remani (1983**) at Vaduthala located about 5 km upstream from the bar mouth, in the northern region of the Cochin estuary which showed that **Organic carbon** and organic matter showed enrichment in the retting ground sediments (av. 46.8 and 92.3 mg/g respectively) compared to the reference station (20.6 and 48.9 mg/g). Annual average of **bacterial biomass** was higher in the reference station (25.7 mg/g) as

against 22.8 mg/g in the retting yard. Bacterial contribution to total organics was higher at the reference station (av. 72.55%) compared to the retting yard (av. 32.59%). Average energy content calculated for the retting ground was 1819 J/g dry weight, twice that for the reference station and higher than the average for sediment detritus in the Cochin estuary (1497.9 J/g).

To summarize, the analysis made above, the level of many pollutants in Cochin estuary is very high even to the extent of causing serious threat to its biodiversity. Industrial pollution has already caused fish mortality in the regions of Chitrapuzha and Periyar, which is an indication towards taking necessary steps to prevent such practices. Many scientists have hence suggested the need for implementing compulsory regimes to treat the effluents before discharging into the backwaters.

5.1.3 Pollution in Kali Estuary

The incidence of industrial pollution in Kali estuary is negligible. However, organic pollution from household discharges exists.

5.2 Institutional Failures

Institutional economists have pointed out that sustainable use of biological resources and their environment is conditional on the strengths and weaknesses of institutions which are social constraints governing socio economic behaviours of resource use and users. This section reports the results of our primary studies on the role of institutions in estuarine ecosystems in the study area**.**

Institutional economics distinguishes two kinds of organisations that stabilise and legitimise economic activities. **Following North, (1990) and Johnson (1995), estuarine institutions are broadly classified as formal and informal organisations.** One is surprised at the number of such organisations in this sector of activities.

An important characteristic of the present estuarine ecosystem economies is the coexistence of traditional and modern institutions and organisations aiming towards better resource governance. The government does not recognize the

capabilities and limitations of indigenous institutions. At the same time biodiversity degradation arises due to the failure of various human institutions to attribute proper values to estuarine biodiversity. Although, institutional failures could arise due to national/regional or global failures, most of the institutional failure are characterised as local since ecosystems are localised ones **(Pearce & Moran 1997).** There is no single window for disbursement of funds or subsidies. Sometimes it may be the panchayat, sometimes any of the fisheries institutions and sometimes the Krishi Bhavan.

As mentioned in the previous section, government does not have a holistic vision in crafting policies for ecosystem governance and the situation in Cochin and Kali estuaries is no exception. In fact, government adopts an opportunistic behaviour to collect revenue by issuing permits and licenses to various stakeholders (including its own share from the profits of public sector enterprises) which use backwaters. In this process, the state has established a number of institutions.

A close look at the structure and function of these institutions and organisations reveals that their activities overlap. When a number of parallel and sometimes overlapping policies and policy objectives exist, a lot of confusion arises. Sometimes disagreements on policies are carried on for a long period. This section describes in detail the nature of institutions in Cochin backwater.

5.2.1 Formal organisations

State has created many formal institutions for the smooth introduction of development projects in the isolated villages around backwaters.

Fig. 5.2 Formal Government Departments and Organisations

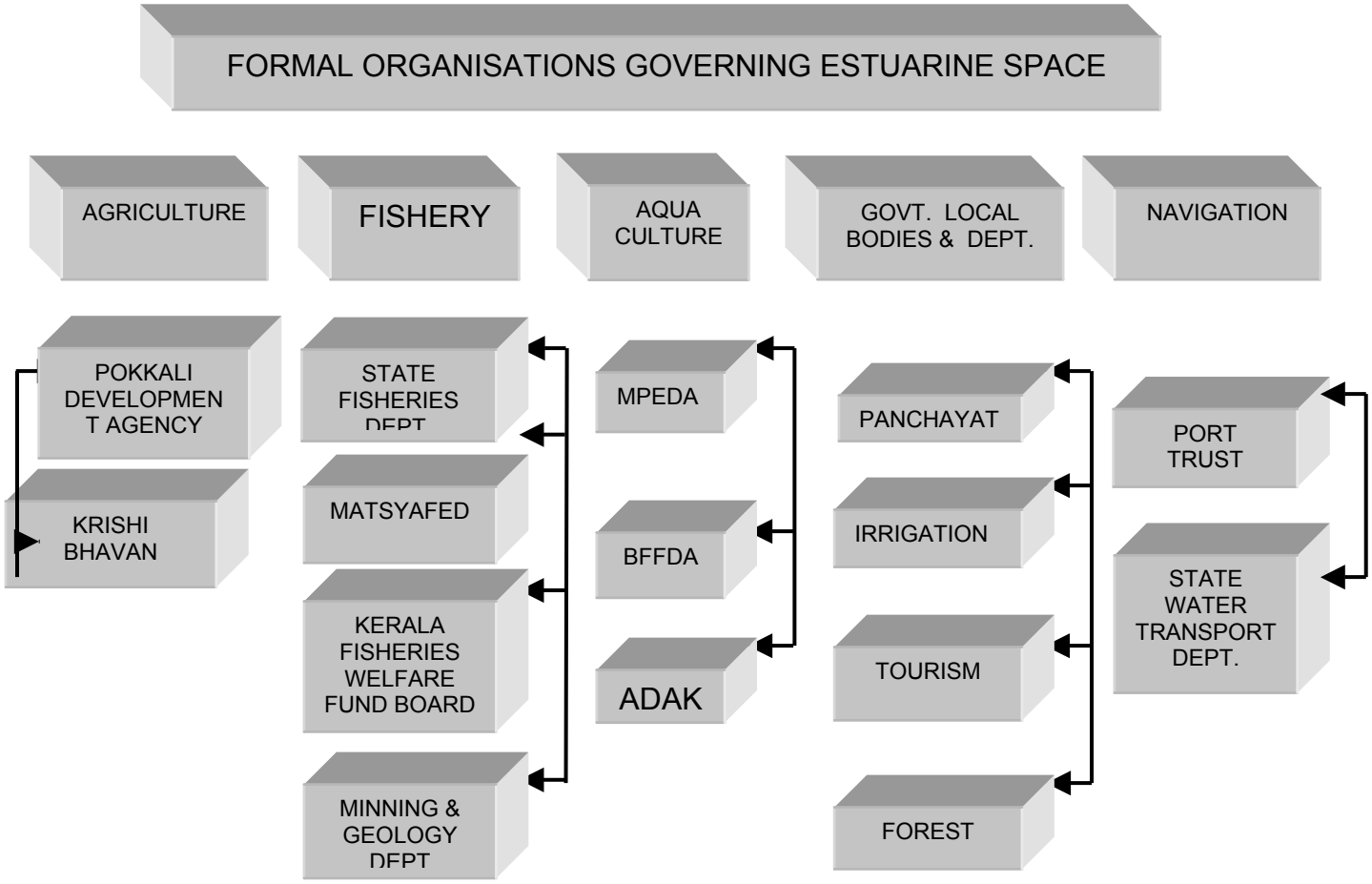


Figure 5.2 above depicts these institutions in different sectors. The list of various formal national and regional bodies is given below. Most of the formal institutions are either the departments of the state or central governments, which are created either for implementing various programmes of the government or with the sole intention of management and governance. Autonomous institutions with specified tasks of resource management and development are also seen. For instance, in the Cochin estuary area, a number of government departments (State Fisheries Department, agriculture department, the local administration department, Mining and Geology Department, Irrigation Department, Industries department, Tourism Department, Forest Department, Water transport department, the Revenue department.) are involved for the development of economic activities. Specialised agencies like the Pokkali Land Development Agency, Krishi Bhavan, MATSYAFED, Kerala Fisheries Welfare Fund Board, Marine Products Export

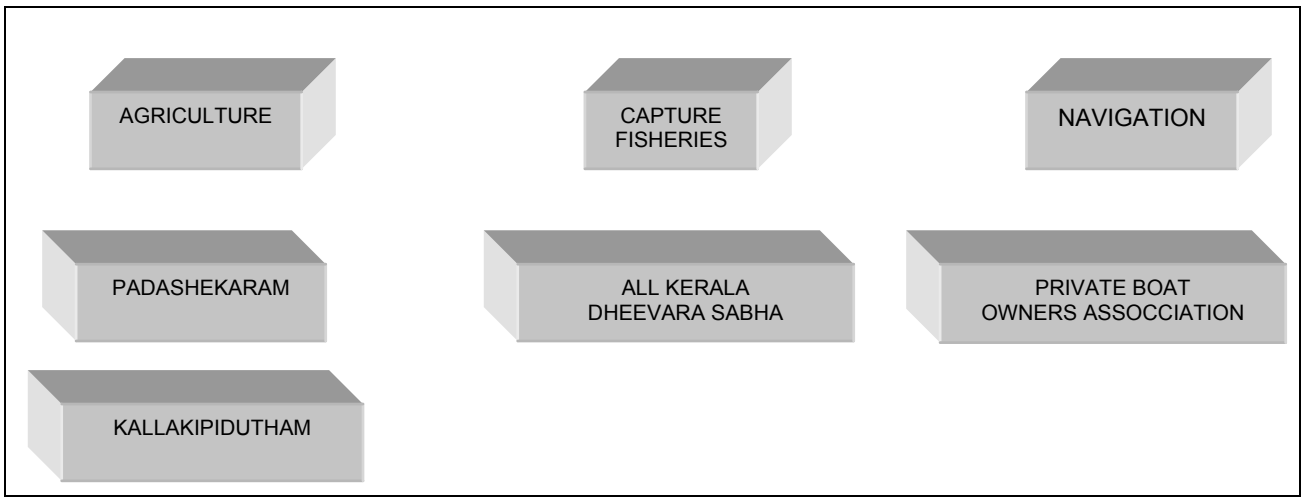
Development Agency, Coir Board, Agency for Development of Aquaculture (Kerala), Brackish Water Fish Farmer's Agency, local Panchayats, are also operating here.

The Government of Kerala constituted the Pokkali Land Development Agency (PLDA) in 1996 for the development of pokkali rice cultivation in the wetlands of the state. PLDA's jurisdiction is spread across 33 panchayats, 2 municipalities and one corporation. Till then all matters related to paddy culture were dealt with directly through the **Krishi bhavan**. Even with the coming of PLDA, all schemes like production bonus, subsidies etc are still implemented through the Krishi bhavan since it has a wider network.

The fisheries sector has a multiplicity of organisation for a multiplicity of function. The Brackish water Fish Farmer's Development Agency (**BFFDA**) are district level organisations and the Agency for Development of Aquaculture, Kerala (**ADAK)** is a single unit, nevertheless, they disperse similar functions and aim at the development of aquaculture in the state. The Marine Products Export Development Authority **(MPEDA)** aims primarily at export development but it gives equal importance to aquaculture development as well. A look at the amount dispensed as subsidies by these institutions combined is enormous. However, the total numbers of recipients are small in number. Besides these institutions do not have any foolproof mechanism to ensure that farmers do not get subsidies from more than one agency at a time.

5.2.2 Informal Institutions, on the other hand, are indigenously evolved sets of customs and societal practices. The following figure 5.3 shows the major informal organisations in our study area. These institutions had performed many functions that sustained traditional activities in the brackish water body **[2].**

Fig. 5.3 Informal organisations of Cochin estuary



For instance, the institution of common property seen in backwater ecosystems had performed the allocation and distribution functions efficiently for centuries. Similarly, the padashekhara committees, in the agricultural sector, the dheevara sabha in fisheries and the institution of Kalakkippidutham had also been performing similar functions in the traditional economy. It may be mentioned here that, these organisations are still active in many places even today.

Resource sharing under old forms of institutions was never a smooth process either. Property rights of traditional users, the state and new users overlapped causing uncertainties in production processes. Decline in traditional institutions has also led to the erosion of resources and biodiversity. This suggests the need for strengthening traditional institutions and evolving appropriate bundle of rights that support the new economic uses. New institutions developed for this purpose could not address the real issues. As a result, people have developed their own sets of rules for management that rationalised their resource use, causing further degradation and economic crisis.

5.2.3 Indigenous Property Regimes and other institutions

Property regimes can be of different types namely open access, **traditional commons, individual private rights, state regimes, limited access regimes etc. Open access** is a situation where there are no rules or controls regarding

resource use or access. Estuaries were never an open access ecosystem. Traditionally, many rural communities settled along the banks of estuaries have been using this environment for fishing, agriculture, coir retting, and established various informal rules, which governed access to the ecosystem. These bundles of rights are known as the local **community rights or customary rights.** Many resource users respect these rights even today. Of late, the state has undertaken a number of developments oriented projects on the estuaries by establishing **state rights**. Private property claims are normally seen in the case wetland agriculture called pokkali lands in Kerala and Gasani lands in Uttara Kannada. **The study team has collected the nature of rights existing in the study areas**

The analysis of data collected so far revealed the following.

- Whatever community rights remain, they have existed for generations despite state efforts to undermine it.

- State being the new entrant into this ecosystem, has established its own **State rights** for undertaking new activities like navigation infrastructure developments, port Trust etc.

- These rights coexist with other forms of property rights regimes.

- The nationalisation of waterways and enforcement of state property rights has led to the forced eviction of fishermen and other agrarian communities from productive areas of the estuaries.

- Under state rights, a plurality of rights co- exists for the same resource.

- Since state rights are legal, it makes decisions for the management of estuaries ignoring traditional regimes that existed and managed estuarine resources till now.

- When state sponsored management of resources threatens rural livelihood patterns, conflicts are bound to arise. There are many instances

where conflicts occur frequently due to contradictions and plurality in public policies.

- Estuarine ecosystems were never part of planning, in Kerala. Local panchayats, municipalities or corporations do not seem to be worried about the sustainability and viability of activities organized on the estuaries and its economic significance.

- Even specialised agencies with mandate for urban development follow a similar laziness in these matters.

5.3 Government Intervention (Policy) Failure and Degradation of Biodiversity in Cochin Estuary

In the previous sections, we have argued that biodiversity degradation is caused by the failures of the government at various levels to manage the resources and environment through crafting appropriate policy **(Pearce and Moran, 1994; UNEP, 1995).** We shall now turn to the discussion of these issues and the progress made in each of the modules in the sections to follow.

Policies are guidelines designed by the policy-making authorities to facilitate the best and efficient use of resources and environment. Policies in general, are formulated at the national, regional and local levels depending on the nature and magnitude of the problems of different stakeholders. **The study team made an attempt to collect information on these issues**.

5.3.1 [A] National Level policies and Rules

The major national level policies that were designed to influence coastal and marine biodiversity are listed below.

- Environment Protection Act, Bills and Environmental Laws

- Indian Fisheries (inland) Act

- Coastal Regulation Zone Act
- Port Trust Act
- National Biodiversity Bill

5.3.1 [B] State Level Policies and Rules

Similarly, policies were also crafted at the state level for the rational use of estuarine resources. The guidelines that influence allocation of estuarine space, its resources and environment at the state level are scattered mainly in the following policy statements.

- Agricultural policies
- Inland fisheries policies
- Aquaculture policies
- Industrial policies
- Environmental laws
- Panchayat Raj Act
- CRZ Act
- Kerala Land Reforms Acts
- State level Fisheries Regulations
- Aquaculture Authority bill
- The Kerala Minor Mineral Concession Rules
- Environment and national biodiversity Act
- Coastal zone management plans
- Port development policies

Similar policies are also crafted by Karnataka state as well for the protection of its own coastal zones. We shall demonstrate below some of the relevant policies and argue how such policies fail to protect biodiversity of estuaries in India.

When market as an institution fails to conserve biodiversity due to externalities, public good characteristics or lack of well-defined property rights, governments have a habit of intervening in markets to remove the main elements of externality caused by market behaviour. This is normally undertaken by adopting a series of

penal and incentive structures, crafting policies and institutions and also by enforcing these structures efficiently so as to conserve biodiversity (**EPW, 1998)**

Unfortunately a great many of these interventions are contrary to the interest of the environment, even when those interventions appear to serve some social purpose **(Pearce & Moran, 1994).** Besides, since the values of ecosystem services are not fully captured in commercial markets, or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions **(Constanza et al 1998).**

Often Government policy for each sector is made with a short-sighted view usually ignoring the long-term perspectives. In addition, a lot of policy regulations exist on paper that is never really implemented either due to political reasons or shortage of manpower in the associated enforcing agencies. In many developing countries, governments may indeed intervene; just as much environmental damage is done by government interventions. This inability to act efficiently often accelerates natural resource exploitation and degradation. Subsidies, taxes are all examples of government intervention that alter the market. Misdirected subsidies are most common and usually seen wherever markets are heavily administered. However in practice government fails to provide a socially desirable level of biodiversity protection **[3].**

5.3.2 Government policies related to the use of estuaries

It may be mentioned at the outset that government has not enacted laws exclusively for regulating degradation of biodiversity in Cochin backwater ecosystem. Instead, the government has adopted a sectarian approach towards the management of different resources and environment. Hence, policies influencing allocation of backwater territories, resources and environment are scattered in various documents and laws relating to fisheries, minerals, agriculture, Industries, navigation and the Port development, coastal environment and tourism. We shall now turn to the discussions of some of these policies and examine how different stakeholders organize their activities on backwater environment subject to these regulations.

5.3.2 [A] Inland Fisheries Policies

Formal inland fisheries laws and legislations date back to the Indian Fisheries Act of 1897 passed by the British Parliament. Since then a series of laws were introduced both by the Indian and Kerala governments for the development of inland fisheries. A careful reading of these regulations reveals that these rulings are mostly advices discouraging fishermen from fishing. **One wonders how fisher folks can honestly follow all the rules and directions listed in these**. As a result, inland fishermen do not take these instructions and legal decrees seriously. Table 5.5 below lists the major inland fisheries policies of the government

Table 5.5 Major Inland Fisheries Regulations in India

Year	Description of the law
1914	Regulation to Make Better Provision for The Protection and Preservation of Game Fish,
1927	Indian Fisheries (Madras Amendment Act
1950	Travancore – Cochin Fisheries Act,
1952	Travancore – Cochin Fisheries Rule,
1973	Regulation of Fishing With Fixed Engines (Stakenets, Chinese Nets etc)
1974	Issue Of Fishing License Rules, Regulation Of Prawn Fishing In Private Waters Rules and Rules For Management And Control Of Fisheries Of Fisheries In Government Water Rules.
1994	The new fisheries policy accorded fish production the status of agriculture to make it eligible for all assistance /subsidies recommended for agriculture. The policy had also envisaged the formulation of an "**Aquarian"** reform with the objective of ensuring ownership rights of fishing implements exclusively to real fishermen

Although a number of guidelines were issued for the good governance of inland fisheries, fishermen do not follow them leading to the failure of policies and resource degradation. Some commonly found violations are given below.

- According to the Travancore-Cochin Fisheries Act of 1950, the Government prohibits nets with meshes having a cod end less than 20mm mainly to protect the very young ones **but these regulations are neither**

observed nor enforced. The mesh size reported today is as low as 4mm to 6 mm

- According to the Fisheries department rules, operations of fixed nets like Chinese nets and stake nets would require license from government which is a renewable contract between he government and the fishermen But s per the data published by the department itself, in 1989, of a total of 4823 Chinese nets, 1692 were licensed and 3131 were unlicensed **(Pauly, 1991).** In 1995 – 96, there were a total of 211930 nets, a substantial number being illegal **(Department of Fisheries, 1989**).

- Fishing by means of fixed nets (especially Chinese nets and Stake nets) is prohibited during high tide to enable the seedlings and fishery to enter the smaller channels in the backwaters**. But most of the nets in the bar mouth and Thevara, Aroor area operate during high tide as well affecting movement of fishery resources into the estuary.**

- The minimum distance between two adjoining Chinese nets should be 30 meters and that between two poles of a Stake net 4 meters. **However, today, the Chinese nets are fixed so closely leading to clashes between gear owners. Stake net owners, on the other hand, fix their nets leaving a little waterway in between for boats to move.** Often boats have to deviate from their path to avoid these nets when they are put across the backwater in a row. These nets strain the water and the resources that pass through it.

These violations reveal that fishermen do not follow government regulations. The mediations of the government are also not efficient either. Disputed parties' sometime approach the formal courts to redress grievances. As this mode of redressal is time consuming and expensive very few people have faith in the legal machinery. Instead, they look forward for speedy and cost effective grievance redressal mechanisms. A look at the conflict redressal mechanism shows that in most cases attempts are made to redress it at the grass root level itself with the help of local leaders. It is curious to observe that very rarely do political leaders

have any say in this matter. People approach courts only in cases where other kinds of settlements impossible.

5.3.2 [B] Brackish Water Aquaculture Policies

Aquaculture development policies are also loaded with axioms that discourage sustainable entrepreneurship. The following rules and violations are noteworthy.

- According to the 1974 prawn regulation act, no kind of prawn fishing should be undertaken in any private waters or fields without a special license from the concerned authority. The Inspector of Fisheries is supposed to grant the license after he is satisfied that the farming if undertaken will not be harmful to the prawn filtration in adjoining farms**. Very few aquaculture farms obtain such clearances.** A comparison between the number of licensed aquaculture farms and a field survey of the actual number of farms in the study area is greatly mismatched.

- According to the Punja Act **[4]**, low lying brackish water wetlands are to be used for prawn culture only for a period of six months. However, many farms do not comply with the stipulations of the Punja Act. They are engaged in the culture activities round the year without considering the ecological consequences of monoculture and socio economic significance of integrated farming. Although the Pokkali Land Development Agency is responsible for the monitoring of crop rotation, it is neither authorized nor does it have the machinery to take appropriate penal actions against offenders. It can only negotiate with these farms and use the incentive of subsidies to lure these farms to undertake rotation of paddy and prawn culture.

5.3.2 [C] Policies for Wetland Paddy Cultivation

- Recognizing the importance of wetland paddy cultivation, the government has enacted many laws to boost production. Introduction of radical land reforms brought in a number of structural changes in the nature of ownership and control of agricultural land in the study area. Most of the

Paattakkars and ***varikkars*** became owners of soil. **At the same time, the synergies produced through collective action in traditional agriculture were lost and pokkali paddy cultivation became highly unattractive for the farmers**.

- As per the Punja Act, paddy cultivation has to be undertaken compulsorily for 6 months every year. The Rural Development Officer (RDO) who is also the Punja special officer of Ernakulam, Alappuzha and Trichur, is vested with special powers to take action against farmers who violate this rule. **Despite these rules and incentives offered, the wetland agriculture has not revived from stagnation**.

5.3.2 [D] Policies for Regulating Industrial Activities

Localization of industries along the water bodies that discharge water into the Cochin estuary is not an accident. It is the product of the national industrialization policies, which encouraged clustering of industries to provide economies of scale and efficiency. No doubt, this search ended in coastal zones, areas that were undervalued. Soon, these industrial clusters emerged as the major sources of kayal pollution affecting thousands of people who directly depend on this water body for livelihood.

The responsibility of maintaining environmental quality is vested with the Central and State Pollution control Boards. The Ministry of Environment and Forests also lay down broad policy perspectives and guidelines for the better management of coastal zone environment. The mining and geology department is responsible for granting permission for sand and clam mining from backwaters. The perspectives of these departments and agencies are contradictory and therefore fail miserably in bringing up the required quality of environment and resources use. For instance, most of the policies of the state and central government departments of industries are production oriented with built in incentives such as subsidies and other concessions, which accelerated use of estuarine resources and environment.

The Ministry of Environment and Forests and the state and central pollution control boards have brought out a number of guidelines and laws for the better management of backwater resources. The Coastal zone regulation act introduced in 1992 was aimed to provide a formal control over the entire coastal zones within 500 metres high tide line on the landward side including backwaters. **[5].** Despite these controls and formal laws the biodiversity of backwaters of the country eroded. Thus most of the government policies failed to generate optimum and efficient allocation of kayal resources and environment.

5.3.2 [E] Policies for Developing Navigation and Shipping Industries

They do not raise any hopes for the conservation of biodiversity and livelihood securities for the rural communities either. During the periods of the princes in Travancore and Cochin, backwaters were the major means of transport. Consequently there had been a well-developed and monitored system of water navigation. All boats had licenses and they were required to register at the office of the 'Chokki' or tax collectors who were stationed in certain allotted regions. Even after the merger of these princely states, this system of navigation continued.

Today, navigation in Cochin estuary does not come strictly under the mandate of a single government department. The operation of boats in any backwater of Kerala require license from the irrigation department. The over all maintenance of navigation system on backwaters is the responsibility of the irrigation department. However it has been years since any serious investment has been made. Consequently the government is hesitant to raise the taxes levied on boats, services etc. For years now it has being leaving Rs. 4 per a tonne capacity boat. Maintenance or introduction of new technology has not been forthcoming to this economical and convenient means of transport for the marginalized and isolated islands of this region. Consequently, a number of departments have overlapping authority over this water giving way to policy failures.

For instance, the Port Trust crafts rules and regulations related to shipping and major navigation. According to the powers vested with the Port Trust, access to the backwaters was redefined at least in the areas that came under port’s

jurisdiction. The central authority of the Port overrules the authority of irrigation department. All economic activities that occur in its territory require the prior permission or license from the Port. Only licensed fishermen are allowed to operate in the port area. Penal and prompt action is taken on those violating this rule. The license fee levied by the Port trust is higher than that collected by the irrigation department. Similarly, harbor crafts or vessels cannot be operated without a license from the Trust. Licenses vary between Rs. 75 to Rs. 350 varying according to the tonnage of the vessel.

The fisheries department too collects Rs.15 and Rs.10 for II grade and I grade nets respectively in the case of Chinese and Stake nets. Free net license fee varies between Rs.5 and Rs. 10 depending on type and mesh size. In the case of the Port Trust, only Chinese fishing nets are allowed and they require a license fee of Rs.168 including inspection charges. The Port Trust also imposes regulations on the construction of Jetties irrespective of whether it is for private or public requirements. They levy Rs.515/ annum for Jetties and Piers, Rs.453 for slipways and Rs. 215 for boat pens excluding Rs250 as inspection fees. Even the State Water Transport Department has to pay a fee for use of the Port Jetty.

Despite these broad spectrum of polices for governing economic activities on backwaters, the resources continued to decline over the years causing severe threats to the local traditional stakeholders. Agencies responsible for ensuring the optimum use of resources were not enforcing these rules either due to the lack of clarity or due to the costs of enforcement. Traditional stakeholders objected rules that threatened their livelihood directly leading to the total failure of government policies. **[6]**

The analysis of these policies revealed that the state has crafted various policies and guidelines to ensure a rational resource use. Its approach is pragmatic and is aimed to fuse the conflicting interests of various groups that use estuarine resources and environment. When a number of parallel and sometimes overlapping policies exist, a lot of confusion arises, which persists for a long time

leading to degradation of resources and reduction in the livelihoods of rural communities.

5.4 Summary

This chapter discussed in details the major causes for the loss of biological diversity of Cochin estuary. We argued that the degradation of biodiversity is due to market, institutional and government failures. Major externalities produced by modern stakeholders were explained in detail. We have mentioned that one of the major reasons for loss of estuarine biodiversity is related to the large amounts of industrial pollutants/effluents emitted by the industries located around the banks of Cochin estuary. Available evidences indicate that such emissions are increasing and no efforts have been undertaken by the law enforcing agencies to adopt modern management measures to control industrial pollution in this part of the industrial agglomeration. Similarly, the activities of Cochin Port Trust, ever since its inception, have also been leading to biodiversity loss in this area. The land reclaimed by the Port has already led to permanent changes in the flow of water body and ecologists allege that the seashore erosion in the nearby fishing villages is also caused by the creation of Cochin Port. Being an enterprise controlled directly by the state, the Port is not found to internalize its externalities even today. At the same time, groups of people use this estuary for making quick profits by dumping industrial and agricultural wastes into its environment mainly by producing externalities. The zone close to the barmouth and the Ernakulam city is strategically important as a space of high economic value and a variety of development initiatives (bridges, parks, reclaimed urban property for commercial purposes, container terminals with foreign participation etc.) are now being planned for the development of this area. Although these initiatives are not unwelcome, the project proposals seldom speak about the means and ways of mitigating the negative externalities of these projects. We expect that these development initiatives are bound to worsen the quality of environment and would soon lead to loss in estuarine biodiversity.

The descriptions revealed that unless externalities are internalized, the problem of degradation would worsen in future. Lack of a well defined and enforceable bundle of backwater property rights and the public good nature of estuarine diversity are all responsible for this sad state of affairs. The analysis of institutional failure revealed that modern institutions often lack the flexibility, adaptability and accountability that would regulate access to resources and environment. Multiplicity of institutions with overlapping delivery systems also caused problems. Each institution is designed to look after the commercial organization of an activity for which it is designed and do not care for other stakeholders of the ecosystem. This failure adds to the pace of biodiversity degradation. Finally, the government does not treat the backwaters as an integrated system and craft policies for the conservation of biodiversity. Instead, its policies of governance are issued under the banner of different departments and specialized agencies and do not therefore produce the synergies and collective efforts needed to conserve resources and biodiversity. Thus the aquatic ecosystem has failed miserably to provide decent means of survival to many indigenous agrarian and fishing communities. Large scale economic activities on the estuarine environment, different forms of externalities and the increasing amounts of wastes and pollution, if unregulated, will deplete biodiversity and ultimately ruin the environment and the people who depend on it for their livelihood. It may be noted that environmental depletion such as loss of estuarine biodiversity accelerates rural poverty, especially among the marginalized and weaker sections of the population.

NOTES

[1] The survey of studies on the biological processes of Cochin estuary reveals clearly that biodiversity of Cochin backwater has been declining. **Unnithan (1975)** reported that high levels of organic pollution exists in the backwater, which is well above the tolerance levels of the estuarine fauna. The **bottom fauna** of polychaetes, crustaceans, and molluscs shows considerable decrease in their number in the polluted areas. (**Unnithan et al.1975).** In the polluted and marginal zones bivalves are lesser in number. Molluscs being mostly filter feeding in habit, concentrate more pollutants than other animals. Hence they are not able to tolerate the increase of pollutants beyond a level.

Maximum **BOD value** high hydrogen sulphide and minimum oxygen values of certain zones in the Cochin backwater are the indication of pollution. High values of BOD indicates an increase in the organic content and bacterial activity and consequent decrease of oxygen content and hence decrease in the number of animals including zooplankton and benthic macro invertebrates and there by fishes. The **polychaetes** being the tolerant group of macro invertebrates exist in good number in all the zones including the polluted zones. Crustaceans and molluscs are few or absent in the polluted zones than the healthy zones. The density of **benthic fauna** becomes reduced and fish mortality due to ammonia content was reported by **Unnithan et al (1975)**. **Saraladevi (1986)** found that benthic organisms were totally absent in the polluted areas of Cochin backwater. **Jayapalan (1976)** reported deleterious effect of effluents on plankton productivity of Cochin backwater due to pollution. **Kurup (1995)** raises doubts about the decline in fish catches and loss of certain species due to biodiversity degradation in Cochin estuary. Incidence of mortality of fish *Ambasis gymnocephalus* due to industrial pollution is reported from the upper reaches of Cochin estuary. **Unnithan et. al. (1977).** The effluents carrying a heavy load of ammonia at the rate of 432-160 ppm, pouring into the incidence area together with many other pollutants such as acids and suspended solids in varying quantities have changed the hydrographic conditions to extreme toxic proportions so as to cause heavy mortality of the animals in the area. Due to the influence of high temperature of the

effluent, temperature of surface and bottom waters of the mortality zone which extends to an area of 500 m^2 is considerably increased, enhancing the chemical and biochemical processes of the environment which indirectly accelerates the pollution effect of the mortality zone.

[2] The estuaries have a unique physical trait of being water dominated, which directly affects their uses and the institutional setups that dominate them. This means that many of the uses of the wetlands are cyclical with the time scale of the cycles depending on the water regime. This adds complexity to the property rights structure of the wetlands as they include aspects of the management of the aquatic resources in addition to the systems for land resources.

[3] Two broad approaches are available for analysing Policy failures. The former approach looks at the issue from the point of view of the State and examines how effective the rules of governance have been in attaining the goals. The second view on the other, approaches the problem from that of the stakeholders and examine how people abide by the rules and regulations imposed on them. Whether these rules take into account the customary rights of the people. Whether or not they were followed or broken according to convenience.

The study team made an attempt to collect information on the various stakeholders using the resources and environment of selected estuaries. National and state policies towards the use and control of estuarine resources and environment have also been looked at. A list was made of all the different Acts, rules and regulations that have been passed by the State regarding the governance of the backwaters and what rules and regulations people have to keep while using these resources for their livelihood activities.

The following were identified for critical evaluation: The Panchayat Raj Act, Kerala Land Reforms Acts, the Fisheries Act, The Coastal Regulation Zone and Aquaculture Authority bill, the navigation bill, Port Trust Act, The Minor Resources Use Act, and the biodiversity act.

Documentation is made of the various Acts, rules and regulations that have been passed by the Government and its various departments so as to regulate the use and misuse of the estuaries over a period of time. Instances of significant conflicts in the backwaters have been identified and case studies documented.

[4] According to the Punja Act passed by the State of Kerala, low lying brackish water wetlands are to be compulsorily used for prawn culture only for a period of six months. The remaining six months are to be used for Paddy cultivation. To monitor this, a Punja Special Officer was to be appointed in each district to monitor this.

[5] Some of the pertinent norms regulating activities are the following.

CATEGORY I (CRZ – I)

> Areas that are ecologically sensitive and important such as national parks, …… mangroves, ….. Areas close to the heeding and spawning grounds of fish and other marine life, may be declared b the Central authority or the concerned authority at the State level from time to time.

Category I (CRZ – I)

> Areas between the low Tide line and the high Tide Line. No new constructions shall be permitted within 500 metres of the High Tide Line.

CATEGORY II (CRZ – II)

> The areas that have already been developed up to or close to the shore line. …….. within municipal limits or in other legally designated urban areas……. Buildings permitted on the landward side ….. shall be subject to the existing local Town and Country Planning Regulation including the existing norms or FSI/FAR.

CATEGORY III (CRZ – III)

> Areas that are relatively undisturbed and those which do not belong to either Category I or II. This area has been earmarked as 'No Development Zone'. No constructions shall be permitted here except repairs of existing authorised structures……. Development of vacant plots between 200 and 500 metres of High Tide Line in designate areas of CRZ – III with prior approval of the Ministry of Environment and Forest …….. subject to the conditions as stipulated in the guidelines at Annexure – II.

Annexure – II

> The project shall not undertake any construction within 200 metres in the landward side from the High Tide Line and within the area between the Low Tide Line and High Tide Line.

[6] Many examples of government failures can be cited. A major failure that was highlighted was when the question of allotting part of the estuary for the new National Waterways III came up. Licensed stake net fishermen refused to move unless paid a huge compensation. Their argument was that those fishermen along the main channels of the Cochin estuary are required to pay a tax of Rs.25 per net, at a time when the tax levied for landed property was only 50 paise per acre. The total compensation for shifting these fishermen would then have run into lakhs in that case.

Yet another government failure that is obvious is the one observant during bridge construction. Often these bridges are constructed after reclaiming land from both sides of the water so that the cost of the bridge is reduced. This however narrows down the channel gap, reduces the flow of water, the current and tide affecting resources. In Kumbalangy, parts of the estuary are rising up as a result of sedimentation and changes in the flow of the water. The movement of fishes is also affected. With a large number of fishing gears and too little area to operate, one finds a lot of Chinese fishing gear in the middle of the estuary there.

ANNEXURES

Annexure 5.1

Examinations of bore-hole data from various stations at Cochin and Azhikode shows the presence of lumps of degraded wood at depths of about 30-50 metres which might have deposited at a time when the river bed was at this level. Dating of wood sample from 30m depth at Azhikode indicated that it is about 1500 years old (P. S. N. Murthy). This shows a high sedimentation rate of 20 mm/year. Azhikode was an important port on the west coast of India from the pre-Christian era and has later become practically extinct due to sand bar formation and siltation, presumably after the deluge in 1341 A.D., when the river Periyar took a diversion and opened up the Cochin gut.

Bore hole data from Cochin harbour area also reveals that shell deposits of estuarine oyster *Crassostrea madrasensis*, extend up to a depth of over 5m below the present bed level. The bottom level of these reef shells indicates the bed level of the backwaters at the time of their early settlement. In the southern Vembanad region, the shell deposits are known to occupy a depth of 2-5m below the present bed level. Such shell deposits are available from almost all over the backwater system. These indicate that the backwater was deeper in the past than it was today. It is presumed that the settlement of estuarine oyster commenced only after the deluge of 1341 A.D from which time a typically estuarine condition began to prevail in the environment. From the available data it has been deduced that in the course of fifty years, the average depth of Vembanad estuary has been reduced from 6.7 meters to 4.4 meters. As a result of the reduction in area and depth the total volume of the brackish water system between Alleppey and Azhikode has been reduced from 2.449 km^3 in the beginning of this century to 0.559 km^3 in 1985.

Annexure 5.2

The trends of sediment distribution in the Vembanad wetland are given as follows based on the grain size analysis of the substrata of the five sampling stations in Cochin backwater- their percentage composition.

Station no.	Gravel 2mm	Very coarse sand 2-1 mm	Coarse sand 1-0.5 mm	Medium sand 0.5-0.25 mm	Fine sand 0.25-0.0625 mm	Silt	Clay	Remarks
Bar mouth	16.31	2.52	8.50	46.88	25.76	--	--	Medium and fine sand with shell gravel and coarse sand
Off port Trust	--	--	0.22	1.41	67.51	11.92	18.88	Fine sand with clay and silt
Bolghatty	--	--	--	--	2.38	62.15	35.46	Silty clay
Thevara	--	--	4.54	34.57	22.62	12.53	25.73	Medium and fine sand with clay
Aroor	--	--	10.59	36.16	34.40	9.89	8.96	Fine medium and coarse sand. Small amount of silt and clay.

Source : Dept. of Agriculture, 1978

Annexure 5.3 **Distribution of quantity silt dredged and expenditure incurred by the Port Trust: 1952-1998**

Year	Quantity dredged (lakh m3)	Expenditure (Rs.)	Year	Quantity dredged (lakh m3)	Expenditure (Rs.)
51-52	15.81	-	75-76	34.64	142.29
52-53	25.84	-	76-77	37.29	156.81
53-54	23.93	-	77-78	21.85	154.29
54-55	20.65	-	78-79	13.62	174.31
55-56	19.9	-	79-80	20.13	288.10
56-57	31.59	-	80-81	17.76	232.37
57-58	22.38	-	81-82	22.8	437.99
58-59	29.49	-	82-83	18.48	726.47
59-60	25.71	-	83-84	21.25	339.01
60-61	22.12	-	84-85	16.23	796.39
61-62	65.06	-	85-86	12.71	1070.00
62-63	68.01	-	86-87	15.43	942.29
63-64	28.26	-	87-88	12.85	629.70
64-65	28.79	-	88-89	3.13	916.51
65-66	32.96	-	89-90	1.57	982.52
66-67	26.61	30.94	90-91	-	-
67-68	42.56	46.19	91-92	-	-
68-69	34.08	-	92-93	-	-
69-70	44.22	57.24	93-94	-	-
70-71	26.77	58.95	94-95	-	-
71-72	33.12	62.43	95-96	-	-
72-73	32.13	71.91	96-97	126.52	-
73-74	38.12	99.22	97-98	115.19	-
74-75	31.07	130.39			

Source: Administrative reports of Port Trust.

Annexure 5.4 **Concentration of Some Heavy Metals & Organic Carbon in the Sediments**

LOCATION	No. of Samples		Hg (ppm)	Pb (ppm)	Zn (ppm)	Cr (ppm)	Cd (ppm)	T/Org. carbon (%)
Fresh water zone (unpolluted)	4	A	.04-.06	10-65	40-60	7-20	ND	.2-.6
		B	-	2-15	10-24	2-8	-	-
		C	-	(20-25%)	(25-40%)	(28-40%)	ND	-
Effluent Discharge Point	**5**	**A**	**5.5-11.5**	**160-190**	**420-780**	**85-120**	**6-8.4**	**0.8-3.5**
		B	-	15-40	350-700	15-42	5-8	-
		C	-	(9-21%)	(83-89%)	(17-35%)	(83-95%)	-
Cochin Harbour Area	3 4	A	0.12-1.1	30-165	35-380	20-130	0.5-4.5	.2-3.4
		B	-	1.5-17	2-230	6.5-20	0.05-3.6	-
		C	-	(5-10%)	(5-60%)	(2-15%)	(10-80%)	-

A = Total Attack B = Acetic Acid Attack
C = % of bioavailability elements ND = Not Detected)

CHAPTER 6

Traditional estuarine Production Systems: An examination of production potentials and productivities

In the previous chapters we indicated that estuaries have provided a variety of livelihood opportunities for centuries to local inhabitants and that these opportunities are gradually eroding due to the commercialization of estuarine resources and environment. Despite the growing degradation, the ecosystem is still valuable to the traditional stakeholders like fishers and the agrarian communities, to the whole nation and to the world communities. It is therefore necessary that we examine how Indian estuaries provision these opportunities to the local population, to the national economy and to the larger world communities. The next two chapters are designed mainly to report the finding of these inquires. This chapter deals with the level of production and productivity of different traditional production systems of Cochin and Kali estuaries while the next chapter will discuss the valuation of direct, indirect and non-use values of the estuaries.

Social features of the traditional stakeholders of estuarine settlements

Primary surveys conducted in the Cochin area, on a selected sample of estuarine communities revealed that most of them (ninety five percent) have been settled in these villages for more than 25 year. In the Kali area, around 92 percent of the households are reported to be early settlers for more than 25 years. **[See annexure 6.1 for details]** Around 65 percent of respondents in Cochin belong to the age group between 15 and 65 while the proportion in Kali is around 82 percent. This leaves 35 percent of the population as non working in Cochin and 15 percent in Kali area. **[See annexure 6.2 for details].** Average literacy rates are relatively high in Cochin estuarine settlements than around the Kali settlements**. [Annexure 6.3]** In both the settlements, the male population dominates their female counterpart **[Annexure 6.4]**. The marriage rate is however higher in Cochin settlements than in Kali **[See annexure 6.5]**

A detailed analysis of the distribution of respondents by their major occupations in the selected areas revealed wide variations. The data, however, confirmed the fact that a large proportion of traditional communities (33 percent in Kali and 35 percent in Cochin) still use estuaries for various income generating activities. Table 6.1 provides a distribution of sample population by occupation around the Cochin and Kali settlements during the year 2001-02.

The major occupations centred on estuarine resources and environment in the selected stations are agriculture, capture fisheries, aquaculture, sand mining, clam fishing, tourism and ferry services.

Table 6.1 Percentage distribution of respondents by occupation Cochin and Kali estuarine settlements: 2001- 02

Major occupations	Cochin %	Kali %
Estuary related		
1 Fishery	18.5	22.6
2 Clam fishery and related works	0.4	1.7
3 Agriculture	12.2	6.4
4 Coir Making	3.5	0.7
5. Sand & clay mining	0.2	1.1
6. Tourism	0.2	0.0
7. Ferry	0.2	0.5
Sub total	**35.4**	**33**
Other occupations		
8. Govt. services	1.4	1.5
9. Private sector	11.5	5.0
10. Business	3.2	2.0
11. Coolie	5.6	2.3
12. Fish Trade	3.5	6.4
13. Students & Unemployed	39.4	49.8
Total	**100**	**100**

Source : Primary survey, 2001-02

We shall now introduce the production potentials and productivities of these activities in the following sections. This chapter is divided into five sections. **Section one** deals with the level of production and productivity of different traditional pokkali/gazani paddy production systems around the Cochin and Kali estuaries. This section will also discuss the relative profitability of farms in the study area. **Section two** provides estimates of fish landings, productivity and

profitability in the capture fisheries. In **section three**, we discuss the levels of aquaculture activities. In **section four**, we discuss clam fisheries. A section summarizing the major conclusions of this chapter follows.

6.1 Distribution of production and productivity of wetland agriculture around Cochin and Kali estuaries

Wetland paddy fields around estuaries are subject to salinity intrusion and the agrarian communities since centuries have been using a variety of seeds that could withstand high degree of variation in salinity. In the low lying catchments of Cochin and Kali estuaries, the farmers use a variety called pokkali and in Kali another similar variety is being cultivated. As these basins are rich in nutrients and minerals, paddy cultivation does not require application of fertilizers. Similarly the costs of pesticide applications are also subsidized by the tidal functions of estuaries.

Pokkali cultivation in the low lying fields of Cochin and Kali estuaries begins in the first week of June before the monsoon starts, and lasts for six months ending November **[1]**. After the harvest, these lands are converted for prawn filtration. These activities normally begin in November itself and terminate by mid April **[2]**. Before the introduction of land reforms in Kerala, each landlord from Cochin brackish watershed had a certain number of tenant families attached to his household. Both the men and women of the tenant's household provided the necessary labor for paddy cultivation and harvesting. Today, wetlands are cultivated either by the landowner himself with the help of family members and hired laborers or through tenants. In the case of tenancy, a good portion of the produce or value equivalent to the agreed amount is paid to the owner as rent. If the landlord cultivates the field himself a portion of the produce was given to laborers as kind transfers/payments.

Owners offer a variety of economic benefits to their labor classes who attach themselves to their fields. For instance, local laborers are preferred for field related activities and they were ensured regular employment in the activities related to prawn filtration that follows immediately after the paddy harvest. Similarly, in many

places around Cochin brackish watershed, the labor class was given free access to fish in the landlord's fields during the last two weeks of the season. The fish caught during this period can be retained or/and sold by the labor. This amount was sufficient to meet the subsistence needs of the labor households in the rainy season that follows. The institution of kalakkippidutham also ensured survival securities to the labor and women alike **[see chapter 4 for details of this institutional arrangement]**.

The social organization of paddy cultivation in the gazni lands of Kali estuary shows similar pattern. With the onset of monsoon, the agriculture fields in Kali are flooded making it difficult to enforce legal boundaries. So the farmers come together in informal groups to jointly cultivate the next crop. Under the leadership of the headman, members contribute labor and other inputs to the collective farming effort **(Bhatta & Bhat, 1998).** Today, however, large areas of gazani farms are leased out to private contractors. Landowners around Kali also allow access to a traditional fishing caste called Ambiga to the fishing grounds once the period of prawn filtration is over.

6.1.1 Production and productivity of wetland paddy cultivation (pokkali) around Cochin estuarine settlements

It was mentioned in chapter two that primary surveys were undertaken in the settlements around Kali and Cochin estuaries to estimate total production from pokkali agriculture during the year 2001-02. The results of these surveys are presented in table 6.2

Table 6.2 Distribution of production of Pokkali paddy in Cochin and Kali estuarine settlements

Zone	Area cultivated [ha]		Production [tonnes]		No. of households		Production per hector [Kg]
Cochin Estuary							
I	1369	**[22.8%]**	2094.73	**[25.1%]**	3329	**[28.4%]**	1530.1
II A	1800	**[29.9%]**	1773.04	**[21.2%]**	2475	**[21.1%]**	985.0

II B	2219	**[37.0%]**	3689.23	**[44.1%]**	3073 **[26.2%]**	1662.6
III A	213	**[03.5%]**	326.40	**[3.9%]**	1431 **[12.2%]**	1532.4
III B	402	**[06.7%]**	473.38	**[5.7%]**	1431 **[12.2%]**	1177.6
TOTAL	**6003**	**[100%]**	**8356.78**	**[100%]**	**11739** **[100%]**	**1392.1**
Kali Estuary						
I	1217.6		2036.2		469	**1672.3**

Source: primary data 2001-02

The table shows that:

- The annual production of pokkali paddy from Cochin settlements is 8356.8 tonnes.

- In the Cochin brackish watershed, farming is mainly concentrated in the medium - saline zone II. In fact, 67 percent of the area and 47 percent of the farming households are concentrated in this belt.

- 65 percent of the total output (5462.3 tonnes) in Cochin area is contributed by zone II followed by zone I with 2094.7 tonnes (25.1%) 799.8 (9.6%) tonnes of paddy is produced in zone III.

- The average level of pokkali paddy production per hectare of wetland in the Cochin brackish watershed is estimated as 1392.1 kg.

- Zone II B recorded the highest yield of 1662.6 kg per hectare, followed by zone III A with 1532.4kg per hectare, zone I with 1530.1 kg per hectare and zone III B with 1177.6 kg. Zone II A recorded the lowest productivity 985.0 kg per hectare.

- Total output in Kali brackish watershed is estimated to be 2036.2 tonnes for the year 2001-02. The highest yield (1672.3 kg/ha) is recorded in Kali watershed.

6.1.2 Cost and earnings of pokkali cultivation in Cochin estuary

The following table presents the cost and earnings of paddy cultivation in the wetlands around Cochin estuary. As the table shows, in all zones of the Cochin estuary, pokkali farmers find it economically unprofitable to undertake pokkali paddy cultivation. The average loss ranges between Rs. 716 to Rs. 2697 per ha. It is very doubtful whether this is due to the degradation of estuarine biodiversity alone as many other factors also contribute to this sad state of affairs. However, despite losses, paddy cultivation is still undertaken due to two major reasons.

First of all, the Government of Kerala through its Punja Act, has made it compulsory for pokkali cultivators to cultivate both crops (paddy and prawn filtration) during a year. Failure to comply is often means the form of suspension of subsidy or such other forms of assistance from the government. Secondly, prawn cultivation as is shown in the chapter is an immensely profitable enterprise and any profit made is more than enough to compensate for losses made during pokkali cultivation. Thirdly, pokkali cultivation subsidizes the cost of production of prawn filtration particularly that of feeds to a great extent. Due to a combination of all these reasons, pokkali cultivation despite losses is still undertaken in the study area.

Table 6.3 Cost and Earnings of pokkali paddy in different zones around Cochin estuary, 2001- 02

Zones	Revenue/ha (Rs.)	Cost of cultivation/ha (Rs.)	Profit/Loss/ha (Rs.)
I	4643.3	5334.1	-715.7
II A	3267.6	4857.4	-1560.1
II B	3942.0	5187.5	-1226.6
III A	4271.4	6986.2	-2697.0
III B	3380.9	5543.9	-1810.5

Source: Primary survey, 2001-02

6.2 Production and productivity of capture fisheries in Cochin and Kali estuaries

As mentioned earlier in chapter 4, fishing in Cochin estuary is undertaken by fishing communities using a variety of craft gear combinations. More than 80

percent of the fishing households were staying in these villages for more than 25 years**. [See annexure 6.6]. The proportion of active working population ranges between 74 to 88 percent in the study area while the aged and children below 15 years ranges from 12 to 26 percent. [See annexure 6.7]. Similarly, compared with the sea going fishermen the average level of literacy of inland fishermen especially in the study area is very high. [See annexure 6.8]**

In order to estimate the levels of fish landings we organised a survey in Cochin and Kali estuaries during the year 2001-02. Table 6.4 shows the distribution of fish landings in Cochin and Kali estuaries by gears for the year 2001-02.

Table 6.4 Distribution of fish landings in Cochin and Kali estuaries by gears for the year, 2001- 02

ZONE	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total
Cochin Estuary												
I	283.7	1215.5	721.6	1115.8	400.9	44.7	170.7	24.1	373.5	155.4	53.3	4559.2
II A	121.4	872.3	1215.2	1054.0	69.1	20.1	34.3	20.2	33.9	17.2	20.5	3478.0
II B	113.4	0.0	0.0	444.8	0.0	0.0	0.0	53.6	0.0	0.0	5.4	617.3
III A	268.5	0.0	214.4	641.1	0.0	0.0	0.0	0.0	0.0	0.0	8.2	1132.3
III B	250.5	780.0	540.8	1076.3	70.5	24.5	27.2	17.2	33.4	22.2	13.9	2856.5
Total	1037.5 **[8.2%]**	2867.8 **[22.7]**	2692.0 **[21.3]**	4332.0 **[34.3]**	540.5	89.3	232.2	115.2	440.8	194.8	101.3	12643.2 **[100 %]**
Kali Estuary												
I	-	13.2	767.0	146.3	-	31.0	-	-	-	-	54.2	1128.7

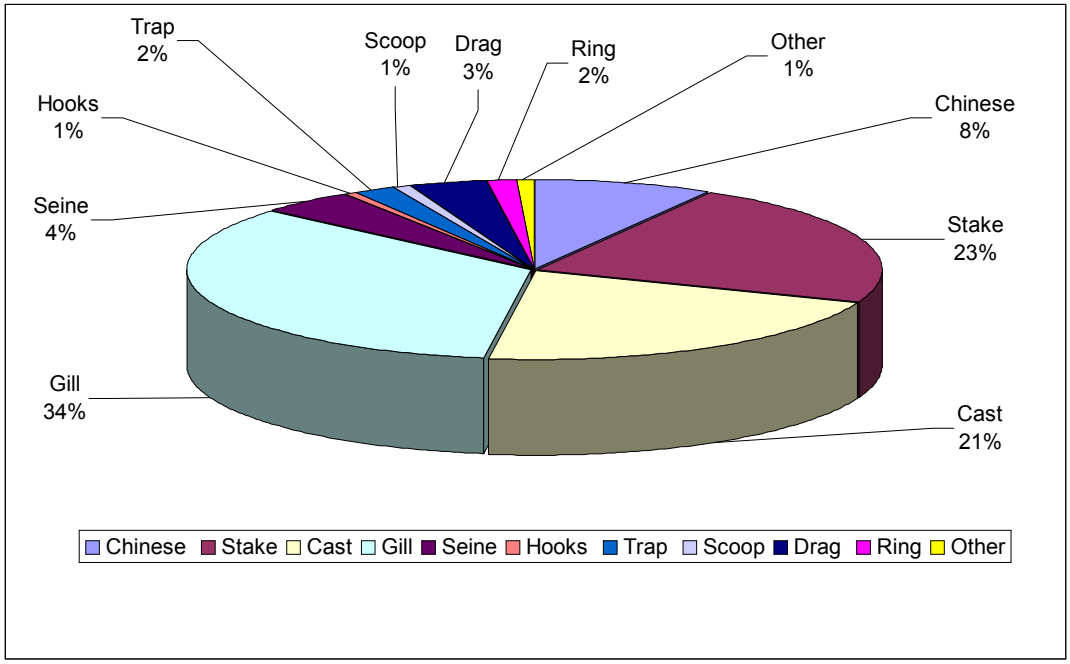
Source: Primary survey

This table reveals that

- Total fish production in Cochin estuary during the year 2001-02 was 12643 tonnes and that of Kali estuary was 1129 tonnes.

- 34 percent of landings of Cochin estuary were contributed by gill nets, 23 percent by stake nets and 21 percent by cast nets. All the other gears contributed marginally to the total output.

Figure 6.1 Distribution of fish landings in Cochin estuary by gears, 2001- 02



The results of Cochin estuary are presented through tables 6.5 to 6.9. Table 6.5 shows the distribution of monthly fish landings by gears in Zone I. Table 6.6 shows the distribution of monthly fish landings by gears in Zone II A. Table 6.7 shows the distribution of monthly fish landings by gears in Zone II B. Table 6.8 shows the distribution of monthly fish landings by gears in Zone III A and Table 6.9 shows the distribution of monthly fish landings by gears in Zone III B. Table 6.10 shows the distribution of monthly fish landings by gears in Kali estuary.

Fish Production in zone I

Table 6.5 Distribution of monthly fish landings by gears in Zone I of Cochin Estuary, 2001- 02. in ('000)

Zone I	Chinese Dipnet	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Tonnes
Feb	32.6	125.5	77.3	84.5	35.6	1.6	9.6	1.1	25.9	10.0	2.9	406.6
Mar	33.5	82.6	51.8	82.1	34.8	0.9	17.1	1.4	37.6	10.9	3.6	356.4
Apr	17.8	105.9	58.3	93.8	39.5	3.3	11.4	2.9	33.0	10.1	4.6	380.6
May	17.9	74.2	54.7	105.6	27.2	4.8	12.2	3.0	33.0	10.0	5.0	347.5
Jun	7.0	100.1	54.5	95.1	23.9	4.8	12.7	2.8	28.5	8.7	4.7	342.7
Jul	34.7	102.3	52.8	79.8	34.6	4.0	23.8	2.0	33.8	10.8	4.8	383.3
Aug	17.1	101.7	63.4	82.6	31.9	4.0	10.7	1.7	29.3	9.1	3.9	355.4

Sep	18.5	100.7	59.4	94.2	34.5	3.5	11.7	2.1	34.1	9.9	4.3	372.9
Oct	35.0	102.4	42.9	98.4	35.1	4.8	23.2	2.8	40.2	29.1	6.8	420.7
Nov	17.7	101.3	60.5	125.9	39.0	5.0	13.2	0.6	20.6	29.3	4.6	417.6
Dec	31.7	126.9	64.1	76.9	30.9	3.8	13.7	2.0	21.9	8.3	3.8	383.9
Jan	20.1	92.0	82.2	96.9	34.0	4.2	11.6	1.7	35.6	9.3	4.2	391.7
Total	283.7 [6.2%]	1215.5 [26.7%]	721.6 [15.8%]	1115.8 [24.5%]	400.9 [8.8%]	44.7 [1.0%]	170.7 [3.7%]	24.1 [0.5%]	373.5 [8.2%]	155.4 [3.4%]	53.3 [1.2%]	4559.2 [100%]

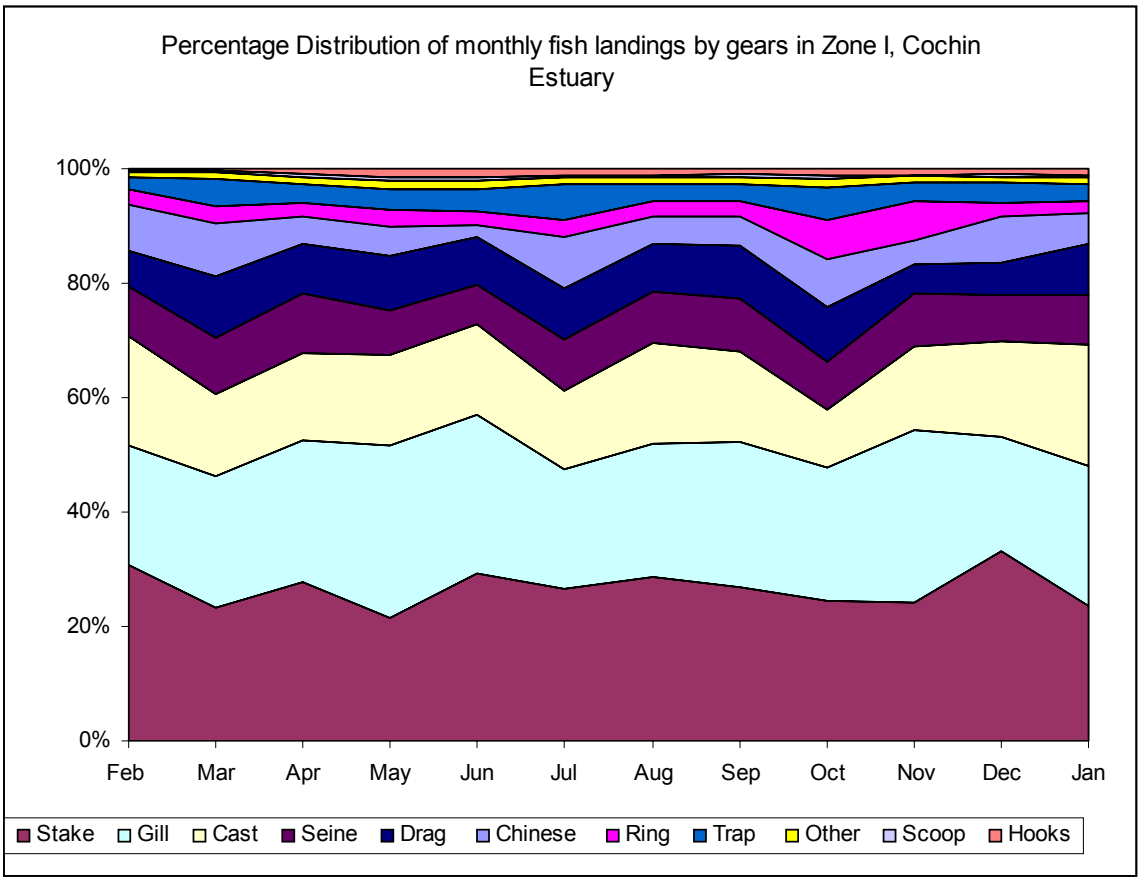
Source: Primary Survey, 2001-02

This table shows that:

- 4559.2 tonnes of fin fishes and fishes were landed in zone 1 during 2001-02. Stake nets landed 27 percent of this quantity while 25 percent was by various gill nets. Chinese nets contributed only 6.2 percent while the other nets contributed the remaining (43 %). See figure 6.1 for details.

- The pre monsoon (march-may) average landings were 361.5 tonnes while the monsoon average was 360.5 tonnes and the post monsoon average worked out as 336.8 tonnes.

Figure 6.2 Distribution of monthly fish landings by gears in Zone I of Cochin Estuary, 2001- 02



Fish Production in zone II A

Table 6.6 Distribution of monthly fish landings by gears in Zone II A of Cochin Estuary, 2001- 02. in ('000)

Zone II A	Chinese Dipnet	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Tonnes
Feb	10.9	78.4	98.2	99.4	5.9	0.8	1.8	1.2	2.9	1.5	1.5	302.5
Mar	9.3	72.9	101.6	89.5	5.9	1.0	1.1	0.9	3.0	1.4	1.3	287.7
Apr	9.1	67.1	117.9	95.3	5.4	2.0	2.8	2.1	2.7	1.6	2.1	308.1
May	9.9	70.7	96.8	85.3	5.9	2.0	2.4	1.7	2.8	1.7	2.0	281.1
Jun	6.7	76.5	93.5	99.2	5.9	1.8	4.1	1.9	2.9	1.6	2.2	296.3
Jul	8.2	72.9	95.5	65.0	5.9	1.8	2.2	1.6	3.0	1.4	1.8	259.2
Aug	9.1	66.3	100.2	81.0	6.0	1.9	2.8	1.9	2.7	1.5	1.6	274.9
Sep	12.1	73.4	112.5	69.5	5.6	1.7	2.8	1.5	2.7	1.1	1.4	284.4
Oct	8.8	78.6	96.9	100.1	5.9	1.6	4.3	1.6	3.1	1.5	1.7	304.1
Nov	8.2	73.0	105.3	89.9	5.8	1.8	2.2	2.1	3.0	1.5	1.6	294.3
Dec	8.2	78.4	95.7	90.3	5.9	1.8	4.3	2.1	2.9	1.6	1.8	292.9
Jan	21.0	64.2	101.1	89.5	5.0	1.9	3.3	1.8	2.5	0.8	1.5	292.5
Total	121.4	872.3	1215.2	1054.0	69.1	20.1	34.3	20.2	33.9	17.2	20.5	3478.0
	[3.5%]	[25.1%]	[34.9%]	[30.3%]	[2.0%]	[0.6%]	[1.0%]	[0.6%]	[1.0%]	[0.5%]	[0.6%]	[100%]

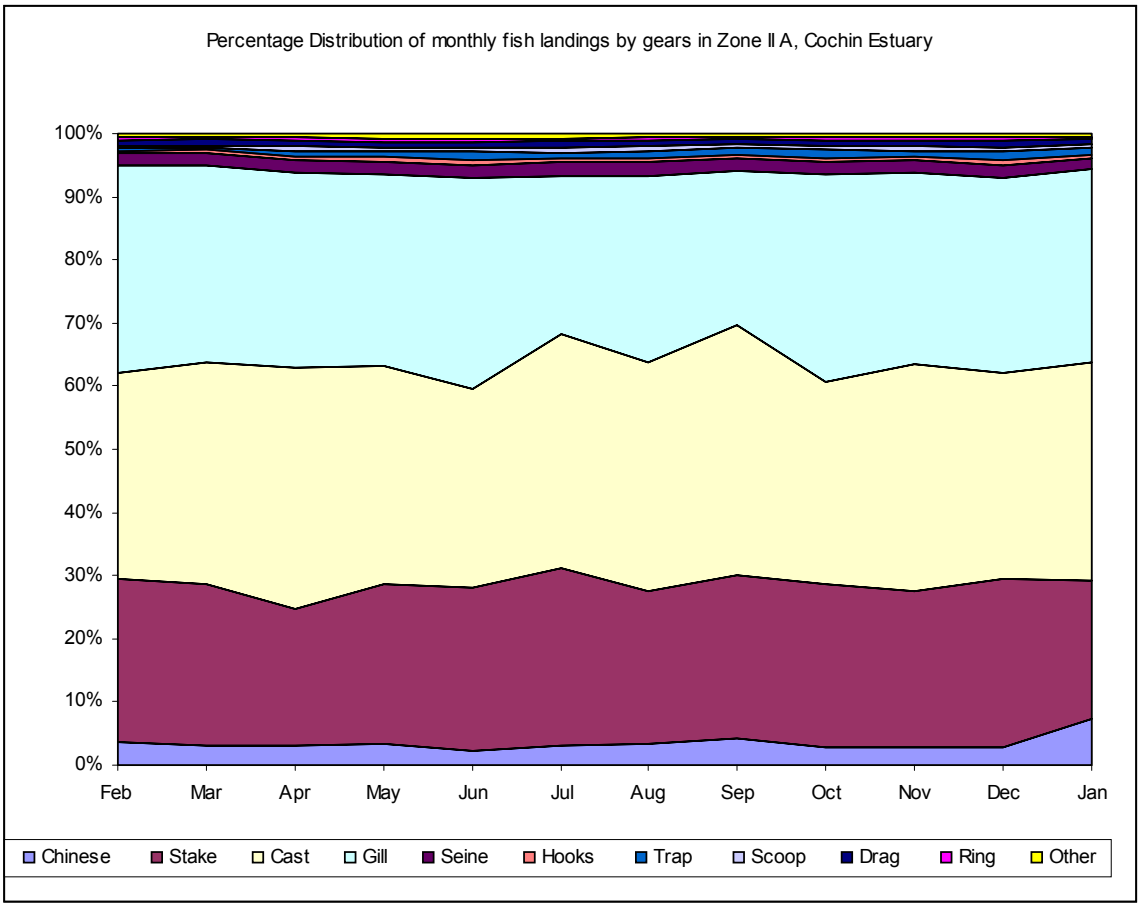
Source: Primary Survey, 2001-02

This table reveals that

- Total fish landed in zone II is 3478 tonnes. Cast nets catch 35 percent of this catch; 30 percent in various gill nets and 25 percent in stake nets. Other nets contributed the remaining 10 percent. See figure 6.2 for details.

- The pre monsoon (march-may) average landing was 292.3 tonnes while the monsoon average was 285.5 tonnes and the post monsoon average worked out as 296.0 tonnes.

Figure 6.3 Distribution of monthly fish landings by gears in Zone II A of Cochin Estuary, 2001- 02



Fish Production in zone II B

Table 6.7 Distribution of monthly fish landings by gears in Zone II B, Cochin Estuary, 2001- 02. in ('000)

Zone II B	Chinese Dipnet	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop Net	Drag Net	Ring net	Other Gears	Total Tonnes
Feb	15.4	0.0	0.0	39.7	0.0	0.0	0.0	5.7	0.0	0.0	0.6	61.4
Mar	13.4	0.0	0.0	36.3	0.0	0.0	0.0	2.0	0.0	0.0	0.2	51.9
Apr	10.3	0.0	0.0	37.2	0.0	0.0	0.0	5.0	0.0	0.0	0.5	53.1
May	9.7	0.0	0.0	39.7	0.0	0.0	0.0	4.3	0.0	0.0	0.4	54.1
Jun	6.5	0.0	0.0	35.8	0.0	0.0	0.0	4.9	0.0	0.0	0.5	47.8
Jul	4.3	0.0	0.0	40.3	0.0	0.0	0.0	5.3	0.0	0.0	0.5	50.5
Aug	5.8	0.0	0.0	37.7	0.0	0.0	0.0	6.1	0.0	0.0	0.6	50.3
Sep	3.9	0.0	0.0	31.3	0.0	0.0	0.0	4.0	0.0	0.0	0.4	39.6
Oct	5.3	0.0	0.0	34.5	0.0	0.0	0.0	2.5	0.0	0.0	0.2	42.4
Nov	7.2	0.0	0.0	39.0	0.0	0.0	0.0	4.1	0.0	0.0	0.4	50.8
Dec	11.4	0.0	0.0	35.8	0.0	0.0	0.0	3.6	0.0	0.0	0.4	51.2
Jan	20.2	0.0	0.0	37.4	0.0	0.0	0.0	6.0	0.0	0.0	0.6	64.2
Total	113.4	0.0	0.0	444.8	0.0	0.0	0.0	53.6	0.0	0.0	5.4	617.3
	[18.38%]	-	-	[72.1%]	-	-	-	[8.69%]	-	-	[0.88%]	[100%]

Source: Primary Survey, 2001-02

This table reveals that

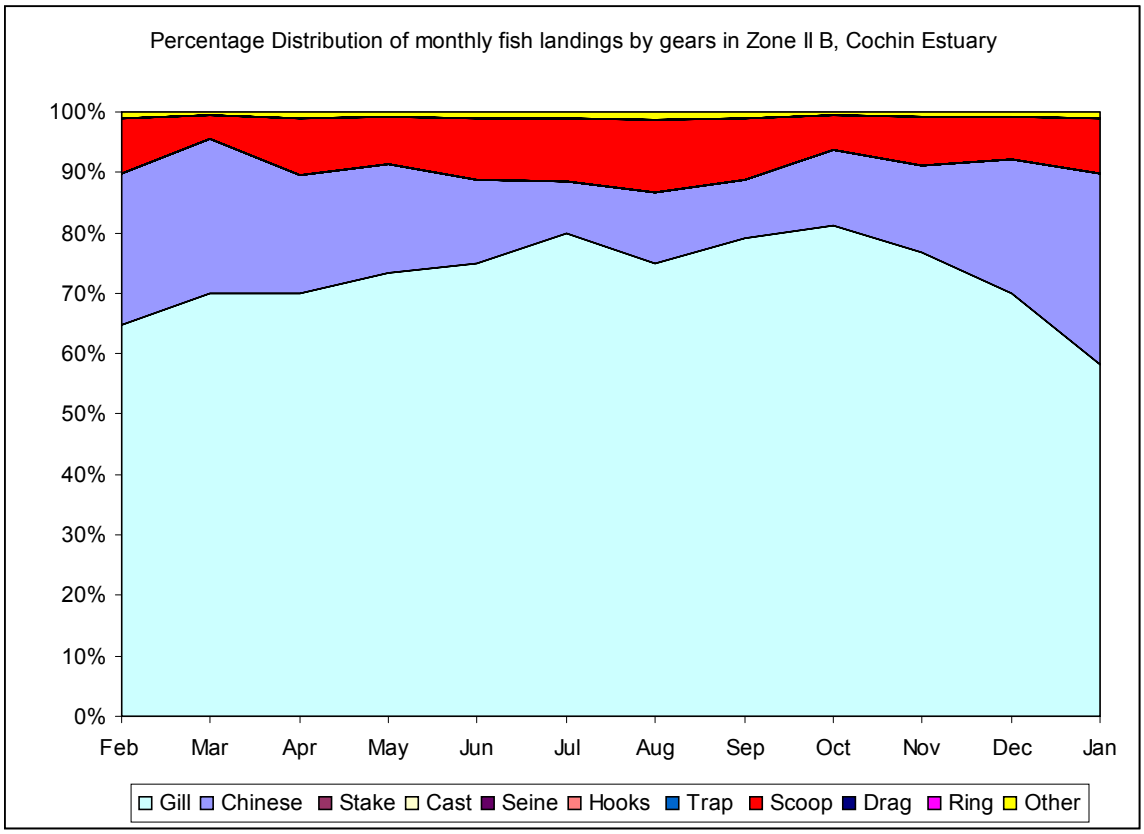
- The lowest quantity of fish landings was recorded in zone II B, the region which is affected by industrial externalities

- Total fish landed in this zone was only 617.3 tonnes. 72 percent of this biomass was caught in gill nets. 18 percent in Chinese nets and 9 percent in scoop nets. See figure 6.3 for details.

- The pre monsoon (march-may) average landing was 53 tonnes while the monsoon average was 46.9 tonnes and the post monsoon average worked out as 58.9 tonnes.

- Most of the other sample nets especially stake nets, cast nets, seine nets, hook and line, trap net, drag net and ring net recorded no catch, showing a low diversity in gear applications.

Figure 6.4 Distribution of monthly fish landings by gears in Zone II B, Cochin Estuary, 2001- 02.



Fish Production in zone III A

Table 6.8 Distribution of monthly fish landings by gears in Zone III A of Cochin Estuary, 2001- 02. in ('000)

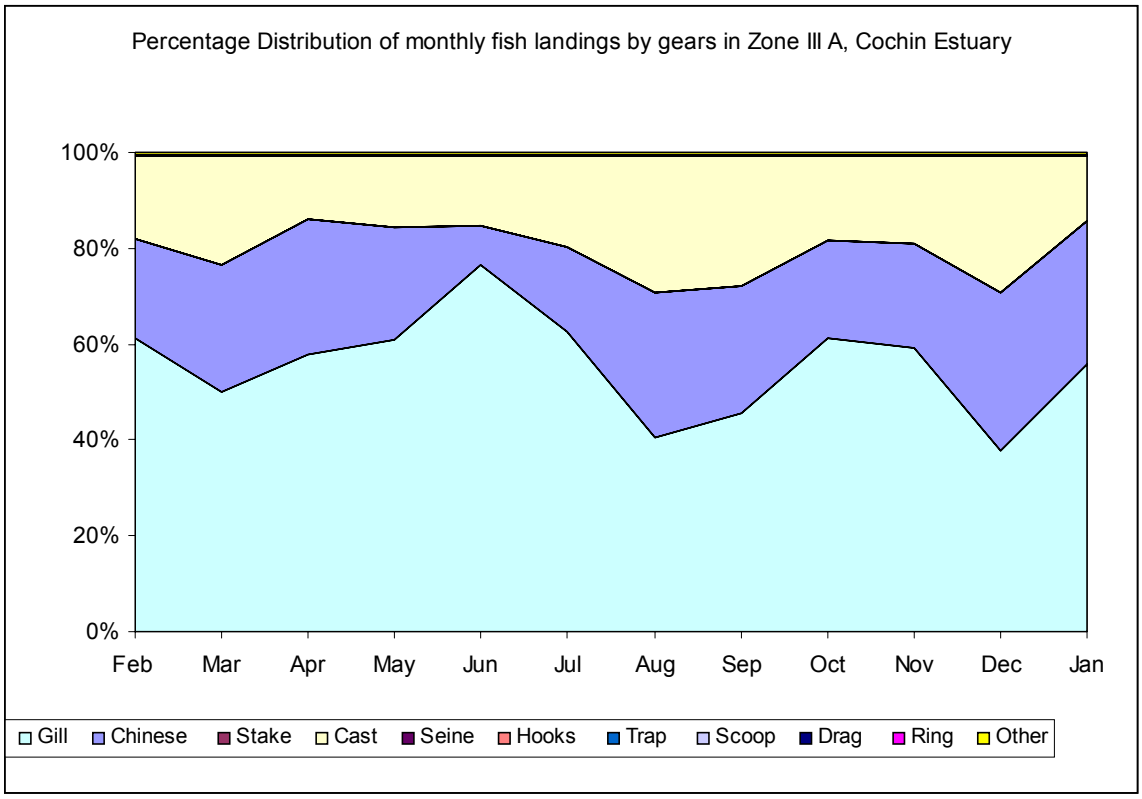
Zone III A	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap Net	Scoop Net	Drag Net	Ring net	Other Gears	Total Tonnes
Feb	23.3	0.0	19.5	68.3	0.0	0.0	0.0	0.0	0.0	0.0	0.8	111.9
Mar	24.3	0.0	20.5	45.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	90.7
Apr	28.0	0.0	13.0	57.5	0.0	0.0	0.0	0.0	0.0	0.0	0.7	99.2
May	27.5	0.0	17.5	71.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	117.0
Jun	6.5	0.0	11.7	60.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5	79.3
Jul	17.8	0.0	18.9	62.5	0.0	0.0	0.0	0.0	0.0	0.0	0.7	99.8
Aug	21.3	0.0	20.0	28.4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	70.3
Sep	20.5	0.0	21.0	35.4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	77.5
Oct	22.0	0.0	19.0	66.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	107.8
Nov	23.0	0.0	19.3	62.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	105.8
Dec	24.4	0.0	20.7	27.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	73.3
Jan	29.9	0.0	13.4	55.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	99.6
Total	268.5 [23.7%]	0.0 -	214.4 [18.9%]	641.1 [56.6%]	0.0 -	0.0 -	0.0 -	0.0 -	0.0 -	0.0 -	8.2 [0.7%]	1132.3 [100%]

Source: Primary Survey, 2001-02

This table reveals that :

- Total fish landed in zone III A was 1132.3 tonnes.
- 57 percent of this catch was landed by gill nets, 24 percent by Chinese nets and 19 percent by cast nets.
- The pre monsoon (march-may) average landing was 102.3 tonnes while the monsoon average was 90.1 tonnes and the post monsoon average worked out as 94.9 tonnes.

Figure 6.5 Distribution of monthly fish landings by gears in Zone III A of Cochin Estuary, 2001- 02



Fish Production in zone III B

Table 6.9 Distribution of monthly fish landings by gears in Zone III B, Cochin Estuary, 2001- 02. in ('000)

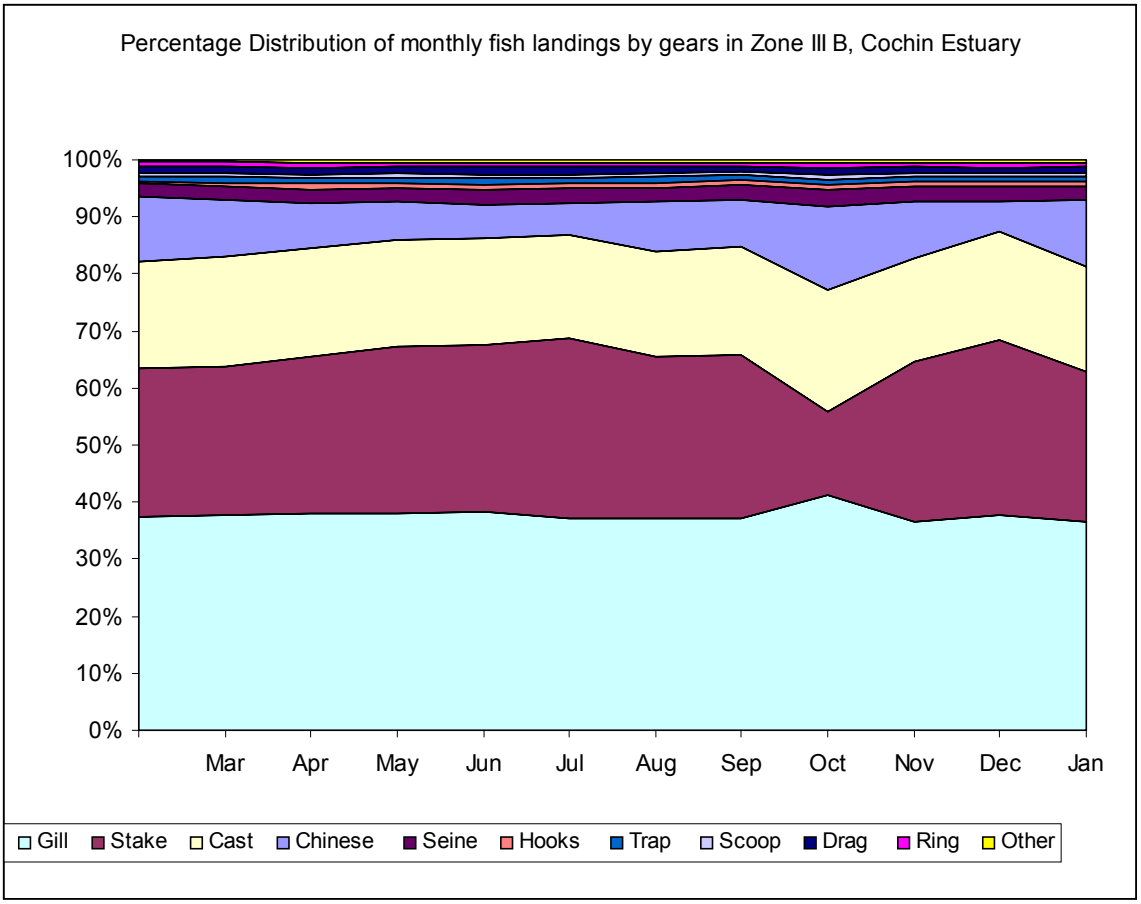
Zone III B	Chinese Dipnet	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Tonnes
Feb	28.2	65.2	46.2	93.0	5.9	0.9	2.4	1.2	2.8	2.0	1.0	248.8
Mar	24.3	64.4	48.0	92.8	6.0	0.7	3.3	1.4	2.9	1.8	1.0	246.7
Apr	19.2	67.1	46.9	93.3	6.0	2.6	2.3	1.5	3.0	2.0	1.3	245.2
May	15.6	70.0	45.0	90.7	5.8	2.2	2.3	1.5	3.0	1.7	1.2	239.1
Jun	12.9	64.9	41.9	85.6	5.8	2.3	2.4	1.4	2.8	1.7	1.2	223.0
Jul	13.1	73.5	42.6	86.5	5.8	2.3	2.1	1.4	3.0	1.7	1.2	233.3
Aug	20.1	66.3	43.7	87.3	5.6	2.3	2.3	1.4	2.9	1.6	1.2	234.6
Sep	19.9	67.9	45.2	88.9	5.9	2.0	2.2	1.3	2.4	1.6	1.1	238.5
Oct	29.3	29.9	42.9	82.9	5.8	2.2	1.8	1.5	2.2	2.0	1.1	201.7
Nov	24.5	69.4	45.0	90.4	5.9	2.4	2.1	1.4	2.8	2.0	1.2	247.1
Dec	13.2	73.6	45.9	91.1	5.9	2.3	1.8	1.4	2.8	2.0	1.2	241.1
Jan	30.2	67.7	47.5	93.9	6.0	2.3	2.1	1.6	2.8	2.0	1.2	257.4
Total	250.5 [8.8%]	780.0 [27.3%]	540.8 [18.9%]	1076.3 [37.7%]	70.5 [2.5%]	24.5 [0.9%]	27.2	17.2	33.4	22.2	13.9 [0.5%]	2856.5 [100%]

Source: Primary Survey, 2001-02

This table reveals that :

- Zone III B on the other hand recorded 2856.5 tonnes of biomass landings.
- 38 percent of these landings were caught in gill nets, 27 percent in stake nets, 19 percent in cast nets and 9 percent in Chinese nets.
- The pre monsoon (march-may) average landing was 243.7 tonnes while the monsoon average was 229.7 tonnes and the post monsoon average worked out as 249.1 tonnes.

Figure 6.6 Distribution of monthly fish landings by gears in Zone III B, Cochin Estuary, 2001 - 02



Fish Production in Kali estuary

Table 6.10 Distribution of monthly fish landings by gears in Kali Estuary, 2001- 02. in ('000)

Zone I	Fixed Net	Cast Net	Gill Net	Hooks & line	Other Gears	Total Tonnes
Feb	8.3	59.6	12.2	2.4	2.9	85.5
Mar	11.0	60.9	12.4	0.9	3.7	88.9
Apr	11.2	74.9	12.0	2.4	4.7	105.1
May	11.2	64.2	11.9	1.2	5.1	93.7
Jun	10.6	51.9	12.2	1.0	4.8	80.6
Jul	10.5	68.2	11.1	2.2	4.9	96.8
Aug	11.1	63.2	12.5	2.4	4.0	93.2
Sep	11.0	69.8	12.4	2.4	4.3	100.0
Oct	11.4	70.8	12.1	8.6	6.9	109.8
Nov	11.5	57.2	12.3	2.4	4.6	88.1
Dec	11.2	60.9	12.5	2.4	3.9	90.9
Jan	11.2	65.5	12.7	2.4	4.3	96.0
Total	130.2 **[11.5 %]**	767.0 **[68.0%]**	146.3 **[13.0%]**	31.0 **[2.7%]**	54.2 **[4.8%]**	1128.7 **[100%]**

Source: Primary Survey, 2001-02

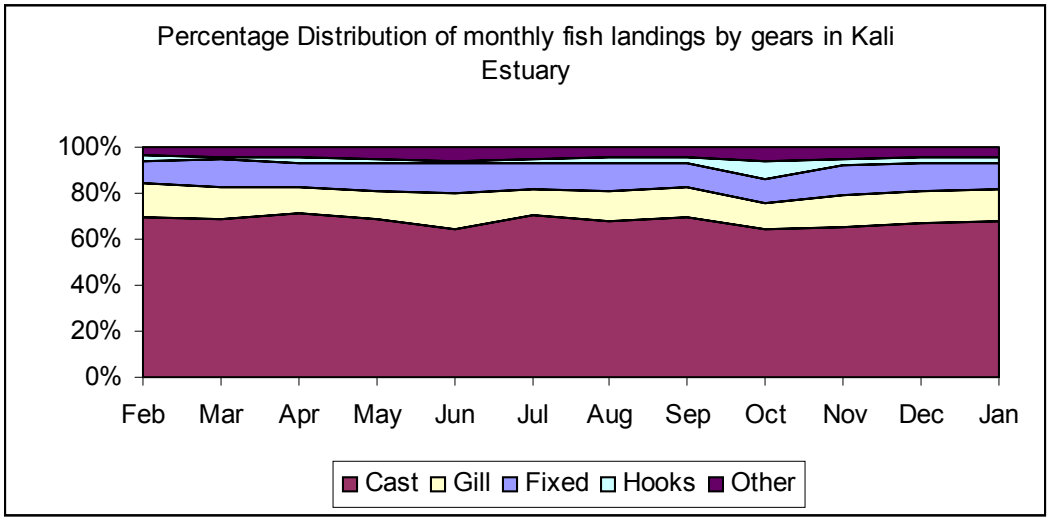
This table reveals that:

- Total fish landings of Kali during 2001-02 were 1128.7 tonnes.

- Sixty eight percent of these landings is caught in cast nets followed by fixed nets (12 percent) and gill nets (13 percent).

- The pre monsoon (march-may) average landings were 95.7 tonnes while the monsoon average was 94.75 tonnes and the post monsoon average worked out as 90.8 tonnes.

Figure 6.7 Distribution of monthly fish landings by gears in Kali Estuary, 2001- 02



6.2.1 Productivity of Fishing in Selected Estuaries

Two simple benchmarks are used to measure productivity of fisheries production. First we calculated the yield per net per day for the selected zones of Cochin estuary. Average yield per hectare of the brackish water body is also estimated as a second measure of productivity. These are calculated mainly to understand whether there is any significant reduction in the levels of yields in the respective areas due to degradation of biodiversity. The results are summarized in the tables below. Table 6.11 shows the average catch per net per day used in the different locations in Cochin area.

Table 6.11 Distribution of average catches per day by different gears in different zones of Cochin and Kali Estuaries, 2001- 02

		Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total (Tonnes)
Cochin Estuary													
ZONE 1	Production	283.7	1215.5	721.6	1115.8	400.9	44.7	170.7	24.1	373.5	155.4	53.3	4559.2
	Productivity	4.0	5.4	3.9	4.5	4.9	3.6	2.0	1.5	4.5	1.3	1.8	
Zone II A	Production	121.4	872.3	1215.2	1054.0	69.1	20.1	34.3	20.2	33.9	17.2	20.5	3478.0
	Productivity	2.3	6.1	4.8	3.9	5.0	2.7	3.3	1.2	2.0	0.9	0.8	
Zone II B	Production	113.4	0.0	0.0	444.8	0.0	0.0	0.0	53.6	0.0	0.0	5.4	617.3
	Productivity	2.6	0.0	0.0	3.2	0.0	0.0	0.0	4.1	0.0	0.0	0.3	
ZONE III A	Production	268.5	0.0	214.4	641.1	0.0	0.0	0.0	0.0	0.0	0.0	8.2	1132.3
	Productivity	6.6	0.0	4.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Zone III B	Production	250.5	780.0	540.8	1076.3	70.5	24.5	27.2	17.2	33.4	22.2	13.9	2856.5
	Productivity	4.8	5.5	4.9	4.0	5.1	3.3	2.6	1.1	2.0	1.1	0.5	
Kali Estuary													
ZONE I	Production	-	130.2	767.0	146.3	-	31.0	-	-	-	-	54.2	1128.7
	Productivity		4.2	3.0	3.0		1.2					1.2	

The table shows that in Cochin estuary :

- The average catch per day in zone II B is significantly lower than the yield per day per net in other zones. It may be mentioned that this zone receives the largest quantity of industrial effluents.

- The lowest productivity of Chinese nets was recorded in zone II A and the highest in zone IIIA.

- Stake nets performed much better than the Chinese nets in all the stations.

- Cast net catch varied between 3.9 and 4.9 kilograms per net per day.

- Gill net catch rates varied between 3.6 and 4.5 in Cochin estuary while it was 3.0kilograms in Kali estuary.

Table 6.12 shows the production per hectare in Cochin estuary.

Table 6.12 Fish productivity distribution in Cochin estuary, 2001- 02

	Production (kg)		Area (ha)	Production/ha (Kg)
Cochin Estuary				
ZONE I	4559240.6	(36.1 %)	10899.02	418.3
Zone II A	3477964.2	(27.5 %)	3560.9	976.7
Zone II B	617286.1	(04.9 %)	4980.7	123.9
ZONE III A	1132250.8	(09.0 %)	6104.6	185.5
Zone III B	2856487.6	(22.6 %)	1740.58	1641.1
Total	12643229.3	(100 %)	27285.8	463.4
Kali Estuary				
ZONE I	1623571.2		3240	501.1

Source: Primary survey 2001-02

The lowest productivity is recorded in Zone II B which again reinforces our earlier findings that fishing has been affected directly by the activities of

industries that pollute the brackish water body. The highest productivity 1641 kg per hectare is recorded in Zone III B, followed by 977 kg in zone II A.

6.2.2 Cost and earnings of estuarine fisheries in Cochin estuary

The average investment to organise a Chinese net fishery ranges from Rs. 17829 to Rs. 25929 depending on the size and location of operation. Similarly, Investment for stakenet fishery varies between Rs. 4983 and Rs. 8045. Investment for seine net fishery ranges between Rs. 3811 and Rs. 4183 while for cast nets, the investment ranges between Rs. 1778 and Rs.2554. The hook and line fishery requires the lowest investment which ranges between Rs 100 and Rs.175. (See table 6.13 for details)

Table 6.13 Investment on gears in different zones of Cochin estuary, 2001-02

	Investment				
	I	II A	II B	III A	III B
Chinese net	22750	25929	17829	25000	23250
Stake net	5677	8045	4983	7340	6780
Gill net	1944	2150	2164	2025	1900
Cast net	1778	2554	2422	2200	2433
Seine net	4183	3811	3997	3904	4090
Hook & Line	125	175	100	142	128
Trap	675	540	720	689	641
Scoop net	400	650	450	655	458
Drag net	2358	3067	3500	2500	0
Ring net	1534	0	1600	936	1800
Others	1200	1090	1236	958	1285

Source: Primary survey 2001-02

Tables 6.14, 6.15 and 6.16 show the cost, earnings and levels of net profits of 10 major estuarine gears. The major gears operated in zone II B, where there is a high incidence of industrial pollution, recorded losses compared to other regions. It may be recalled that the level of fishery production is also lower in this zone. (See table 6.12).

Table 6.14 Cost and earnings of fixed nets by zones in Cochin estuary, 2001-02

	I	II A	II B	III A	III B
Chinese net					
Fixed Cost	9100.0	10371.8	11131.8	10000.0	9300.0
Variable Cost	11083.3	6600.0	22778.0	12133.3	4900.0
Total Cost	**20183.3**	**16971.8**	**33909.8**	**22133.3**	**14200.0**
Total Revenue Rs.	**40760.0**	**36197.1**	**29536.4**	**41101.4**	**68593.3**
Profit	**20576.7**	**19225.3**	**-4373.4**	**18968.0**	**54393.3**
Stake net					
Fixed Cost	1419.2	2011.4	1245.7	1835.0	1695.0
Variable Cost	5023.7	3476.7	4521.3	3166.7	2310.0
Total Cost	**6442.9**	**5488.0**	**5767.0**	**5001.7**	**4005.0**
Total Revenue Rs.	**34304.9**	**52395.3**	**0.0**	**0.0**	**34168.9**
Profit	**27862.0**	**46907.2**			**30163.9**

Source: Primary survey 2001-02

Table 6.15 Cost and earnings of free nets by zones in Cochin estuary, 2001-02

	I	II A	II B	III A	III B
Gill Net					
Fixed Cost	3888.4	4300.0	4327.3	4050.0	3800.0
Variable Cost	4968.1	3388.0	7938.0	7231.0	2870.0
Total Cost	**8856.5**	**7688.0**	**12265.3**	**11281.0**	**6670.0**
Total Revenue Rs.	**20859.7**	**21819.3**	**18713.4**	**20356.8**	**18639.3**
Profit	**12003.2**	**14131.3**	**6448.1**	**9075.8**	**11969.3**
Cast Net					
Fixed Cost	889.1	1276.9	1211.1	1100.0	1216.7
Variable Cost	5211.5	3480.0	4256.0	7875.0	2520.0
Total Cost	**6100.6**	**4756.9**	**5467.1**	**8975.0**	**3736.7**
Total Revenue Rs.	**17150.6**	**23394.4**	**0.0**	**18096.7**	**23025.7**
Profit	**11050.1**	**18637.5**		**9121.7**	**19289.0**
Seine Net					
Fixed Cost	2091.7	1905.6	1998.6	1952.1	2045.1
Variable Cost	2682.1	2413.9	3266.7	2312.5	2100.1
Total Cost	**4773.8**	**4319.5**	**5265.3**	**4264.6**	**4145.3**
Total Revenue Rs.	**23768.6**	**42152.6**	**0.0**	**0.0**	**29353.2**
Profit	**18994.8**	**37833.1**			**25207.9**

Source: Primary survey 2001-02

Table 6.16 Cost and earnings of Other nets by zones in Cochin estuary, 2001-02

	I	II A	II B	III A	III B
Hook & Line					
Fixed Cost	31.3	43.8	25.0	35.4	32.0
Variable Cost	812.8	731.5	989.9	700.8	636.4
Total Cost	**844.0**	**775.2**	**1014.9**	**736.2**	**668.4**
Total Revenue Rs.	**8011.8**	**12770.4**	**0.0**	**0.0**	**16129.2**
Profit	**7167.7**	**11995.1**			**15460.8**
Traps					
Fixed Cost	1350.0	1080.0	1440.0	1378.0	1282.0
Variable Cost	2275.0	2047.5	250.3	1979.3	1781.3
Total Cost	**3625.0**	**3127.5**	**1690.3**	**3357.3**	**3063.3**
Total Revenue Rs.	**9273.9**	**22953.4**	**0.0**	**0.0**	**11667.1**
Profit	**5648.9**	**19825.9**			**8603.8**
Scoop net					
Fixed Cost	400.0	650.0	450.0	655.0	458.0
Variable Cost	2981.1	1716.7	2300.0	2593.6	1493.5
Total Cost	**3381.1**	**2366.7**	**2750.0**	**3248.6**	**1951.5**
Total Revenue Rs.	**7518.2**	**7434.1**	**27587.4**	**0.0**	**4929.3**
Profit	**4137.1**	**5067.5**	**24837.4**		**2977.8**
Drag net					
Fixed Cost	589.4	766.7	875.0	625.0	530.5
Variable Cost	2900.0	2610.0	2000.0	2523.0	2270.7
Total Cost	**3489.4**	**3376.7**	**2875.0**	**3148.0**	**2801.2**
Total Revenue Rs.	**17074.2**	**7260.2**	**0.0**	**0.0**	**5328.9**
Profit	**13584.7**	**3883.6**			**2527.8**
Ring net					
Fixed Cost	1394.7	1255.3	1454.5	850.6	1636.4
Variable Cost	3289.6	2712.0	2644.2	2861.9	2949.3
Total Cost	**4684.3**	**3967.3**	**4098.7**	**3712.6**	**4585.7**
Total Revenue Rs.	**5763.9**	**4357.3**	**0.0**	**0.0**	**5222.6**
Profit	**1079.5**	**390.0**			**636.9**
Other nets					
Fixed Cost	400.0	363.3	412.0	319.3	428.3
Variable Cost	2861.4	2441.0	1798.6	995.8	849.5
Total Cost	**3261.4**	**2804.3**	**2210.6**	**1315.1**	**1277.8**
Total Revenue Rs.	**7132.4**	**4188.7**	**2155.3**	**1805.9**	**2299.5**
Profit	**3871.0**	**1384.4**	**-55.3**	**490.8**	**1021.7**

Source: Primary survey 2001-02

6.3 Productions And Productivity Of Culture Fisheries In Cochin Estuary

The levels of aquaculture production in and around Cochin estuary are shown in table 6.17.

Table 6.17 Distribution of culture production in Cochin estuary, 2001-02

Zone	Area under culture [ha]	Ave. yield / ha [Kg]	Production [Tonnes]
Traditional prawn filtration farms			
I	229.5	365.1	83.8 [08.8%]
II A	582.1	375.4	218.3 [22.9%]
II B	433.9	424.9	184.4 [19.4%]
III A	645.6	400.1	258.2 [27.1%]
III B	455.1	455.3	207.1 [21.8%]
Total	**2346.2**	**0.41 [tonnes]**	**951.8 [100%]**
Modified/improved Traditional prawn filtration farms			
I	255.1	809.9	206.6 [02.4%]
II A	2368.3	874.8	2309.1 [26.7%]
II B	1765.4	950.4	1677.1 [19.4%]
III A	2626.6	986.9	2592.5 [30.0%]
III B	1851.5	1005.1	1860.8 [21.5%]
Total	**8866.9**	**0.98 [tonnes]**	**8646.0 [100%]**
Grand Total	**11213.1**	**0.86 [tonnes]**	**9597.8**
Production/ha			**856**

Source: Master Panfish book I, Dept. of Fisheries, Kerala, 2002
@ Calculations based on primary survey, 2001-02

The table shows that:

- The total aquaculture production from all farms around Cochin estuary during the survey period was 9597.8 tonnes.
- 90 percent of this total production is generated in modified/improved traditional prawn filtration farms and only around 10 percent was the contribution of traditional prawn filtration farms.
- The average yield per ha for a modified improved traditional prawn filteration farm was 0.98 tonnes and that of traditional farms is 0.41 tonnes.

- 49 percent of traditional filtration activities is concentrated around the bar mouth (III A and III B) region.

- 52 percent of the modified farms are centered in zone III and 46 percent in zone II.

Table 6.18 shows the distribution of culture production around Kali estuary.

Table 6.18 Distribution of culture production around Kali estuary, 2001-02

Zone	Area under culture [ha]	Ave. yield / ha [Kg]	Production [Tonnes]		Production per hector [Tonnes]
Traditional prawn filtration farms					
I	51.0	368.9	18.8	**[9.5 %]**	
Modified/improved Traditional prawn filtration farms					
I	204.0	877.9	179.1	[90.5 %]	
Grand Total	**255.1**		**198.0**	**[100 %]**	**0.8**

Source: Primary survey 2001-02

This table shows that :

- The total aquaculture production around Kali estuary is estimated as 198 tonnes of which 179 tonnes is from modified/improved prawn filtration farms while 19 tonnes is from traditional farms.

- The average yield per ha for traditional farms is 0.37 tonnes and for modified /traditional prawn filtration farm, 0.88 tonnes.

6.4 Clam Fisheries

Clam fishery is not a dominant activity in Cochin estuary. However, it is a gear specialisation in certain regions of the estuary. The following table shows the clam production in Cochin estuary during the year 2001-02.

Table 6.19 Distribution of clam production in Cochin estuary, 2001-02

	Qty Landed (Tonnes)

Pre Monsoon	762.5
Monsoon	865.9
Post Monsoon	1325.9
Grand Total	**2954.4**

Source: Primary survey 2001-02

The table reveals that :

- The total clam landings for the survey year is 2954.4 tonnes of which 44.9 percent is landed during the post monsoon period, 13 percent during monsoon and the remaining during the pre monsoon period.

6.5 Summary and Conclusion

In this chapter, we discussed how various traditional stakeholders organized their economic activities, with special reference to the levels of production, productivity and profitability. We argued that despite constraints, due to the degradation of estuarine biodiversity, agricultural households still cultivate paddy in the low lying wetlands around Cochin and Kali. However there is no strong evidence to assert that degradation of environment water quality in the estuaries and pollution is the only factor responsible for this agrarian crisis. In fact the average productivity per hector in a relatively degraded zone (II B) is higher than the level of productivity in areas where the water quality is better. This may be attributed to the presence of strong traditional agrarian institutions in the region. We have seen that the padashekara committees undertake various steps to control degradation of water quality around their territories by constructing or strengthening bunds, cleaning canals etc.

In the case of estuarine fisheries, there are clear evidences to show that the level of productivity is lower in a degraded environment (II B) compared to other zones.

There is also clear indication that farmers are adopting improved or modified traditional aquaculture practices, leaving traditional filtration techniques. The study indicated, despite risks, that the levels of productivity and profitability are high in modern aquaculture systems compared to the traditional systems. It may be

mentioned that this economic rationality is responsible for the recent large scale reclamation of estuaries and wetlands and consequent estuarine biodiversity degradation of Cochin estuary.

Most of the traditional communities have been settled on the banks of estuaries long ago and a large proportion of the population is engaged in productive economic activities. [65% in Cochin and 82 % in Kali.]. This leaves 35 percent of the population as non-working in Cochin and 15 percent in Kali area. Although the average literacy rates are relatively high in Cochin estuarine settlements than Kali settlements, it is unfortunate that most of the active working population did not possess technical skills and education to undertake modern sets of activities or employ themselves in other productive activities organized by modern stakeholders. Moreover, they themselves had not accumulated enough economic surpluses that would enhance their economic standards. The data, however, confirmed the fact that around one-third of traditional communities still use estuaries for various income generating activities. Around one-third of the sample respondents seek employment mainly in the private sector like construction activities, petty trade and other domestic works. Very few get government jobs and other permanent jobs. The new activities which use estuarine resources directly and indirectly do not require the services of unskilled traditional communities of the local area. Thus the process of modern developments of estuaries marginalizes local population due to their non involvement in modern sets of activities. Similar findings are reported by other scholars also. **Thomson (2001[a])** reported that in a typical estuarine village called Kumbalangi, around 14 percent of the sample population is employed in the construction industry. It was found that 37 percent of the population still remains in traditional activities while 63 percent have shifted. The shift in occupation is experienced the most in the age group of 20 - 30 years followed by 30-40. It can be seen that 30% are now engaged in the construction industry due to the shortage of estuarine related jobs.

In other words local communities do adapt to the forces of modernization and try to enhance their economic conditions by involving in new economic activities not necessarily based on estuarine resources. However, only a few of them could

stabilize their activities and enhance their economic conditions. Majority of them- particularly the fishers and agricultural communities- are still unable to cope up with the challenges posed by the process of modernization as their activities are not making enough profits due to the externalities and reduced stakes in the modern sets of activities. However, these estuaries still provide lots of livelihood opportunities for the marginalized rural communities even today.

NOTES

1. Pokkali paddy cultivation is an organic farming system that is common to around 20,000 hectares of land in the low-lying areas of Trissur, Ernakulam and Alleppy districts of Kerala state. In the Monsoon season, from May to September, a single crop of the saline tolerant variety locally known as Pokkali is cultivated. The soils of the Pokkali tract are rich in organic carbon, phosphorous and medium to high in Potassium content.

During most of the year, these areas are saline in nature however, just before the rainy season, they are kept fallow and free of water for a short period. During which, Mounds of soil, about half a centimetre high and one meter width are made and allowed to dry up. Soon after, Monsoon follows and with it the saline content of the soil is washed away. Once the topsoil is cleared of salts, germinated paddy seeds are sown on the mounts. The mounds serve as nursery. After 30-40 days, stage transplantation is done by a system known as "Vettieru" whereby, the mounds are cut along with a few seedlings and thrown into the main fields evenly spreading them. Other than the transplanting method, the sowing method can also be employed a lot though this practice is not commonly followed except for a few particular areas. Chemical fertilizers and pesticides are not used.

Filtration is a suitable aquaculture traditionally practised by the people of estuarine waters and Cochin estuary is not an exception. Commercially important prawn varieties such as *Penaeus monodon, P. indicus, Metapenaeus monocerus, M. dobsoni* etc enter the estuary at their early life stage and these predating prawns with the tidal waters are allowed into already prepared fields. The periodical harvesting of seeds with the help of sluice nets are known as filtration.

The usual practice is to auction the fields to contractors after the paddy harvest. The contractor who bids the highest and pays a whole lease amount before the commencement of the operation is awarded the lease. Lease is generally only for a period of 4 months, in order to enable preparing the field for rice cultivation. The lease amount varies according to the location and nearness of the fields to the bar mouth, depth, productivity of the fields etc. The lessee has to take a license on a nominal fee of Rs. 15/- per acre, which is levied by the State Department of Fisheries. In areas where there is no paddy cultivation but only filtration, the lease is awarded for a whole

year. The lease amount varies from Rs. 4000 to Rs. 6000/- per hector depending on various factors. Kalakkipidutham marks the end of the prawn filtration season.

With cultivation of paddy in low lying wetlands around the backwaters facing a lot of difficulties, the majority of agriculturists are turning their lands to prawn culture all round the year. Many people keep land barren due to externalities and lack of incentives for collective farming. In order to resolve this crisis, the government passed the Punja Act according to which paddy cultivation had to be undertaken compulsorily for 6 months every year. The Rural Development Officer (RDO) who is also the Punja special officer of Ernakulam, Allapuzha and Trichur is vested with special powers to take action against farmers who violate this rule. Despite these rules and incentives offered, wetland agriculture has not revived from agricultural stagnation.

ANNEXURES

Annexure 6.1 Distribution of households by duration of settlement in Cochin and Kali estuarine settlements

YEARS	< 5	5 - 10	10 - 15	15 - 20	20 -25	> 25	Any other type	Total
COCHIN ESTUARY								
%	0.68	0	0	2.05	95.26	5.0	0	100
KALI ESTUARY								
	0	8.3	0	0	91.7	0	0	100

Source: Primary survey, 2001

Annexure 6.2 Percentage distribution of pokkali agriculture respondents by age in Cochin and Kali estuarine settlements

Age group	0-5	5-15.	15-25.	25-35.	35-45.	45-55.	55-65.	> 65	Total
COCHIN									
%	8.8	14.4	20.2	17.2	12.8	11.4	3.8	11.4	100
KALI									
%	4.3	12.6	29.5	19	14	10.2	8.8	1.7	100

Source: Primary survey, 2001

Annexure 6.3 Percentage distribution of pokkali agriculture respondents by education in Cochin and Kali estuarine settlements

Qualification	Cochin area %	Kali area %
Infants & no schooling	7.1	18.7
LP	12.8	22.3
UP	15.2	29.3
SSLC	33.9	19.1
PDC	9.5	5.3
Degree	9.2	4.4
Post graduate	5.7	0.8
Professional	6.6	
	100	100

Source: Primary survey, 2001

Annexure 6.4 **Percentage distribution of pokkali agriculture respondents by sex in Cochin and Kali estuarine settlements**

Sex	male	female	Total
Cochin			
%	54.9	45.1	100
Kali			
	52	48	100

Source : Primary survey, 2001

Annexure 6.5 **Percentage distribution of pokkali agriculture respondents by marital status in Cochin and Kali estuarine settlements**

marital status	Cochin %	Kali %
Married	60	53
Unmarried	40	47
Total	100	100

Source : Primary survey, 2001

Annexure 6.6 **Percentage distribution of Fishery respondents by years of settlement in Cochin Estuary, 2001-02**

	I	**II A**	**II B**	**III A**	**III B**
1. Les than 5 years	0.0	0.0	0.0	0.0	0.0
2. 5-10 year	7.9	10.7	20.0	2.4	8.3
3. 10-15 years	3.9	7.1	0.0	4.8	0.0
4. 15-20 years	2.4	3.6	0.0	1.2	0.0
5. 20-25 years	77.11	74.82	75.22	89.71	89.58
6. > 25 years	2.89	3.78	4.78	1.89	2.12
7. Any other types	0.8	0.0	0.0	0.0	0.0
	100	100	100	100	100

Source : Primary survey, 2001

Annexure 6.7 **Percentage distribution of fishery respondents by age in Cochin Estuary**

Age class	I	II A	II B	III A	III B
0-5	8.2	7.5	7.4	8.8	7.7
5-15.	12.9	7.9	18.5	13.3	21.5
15-25.	21.6	23.2	18.5	19.5	10.8
25-35.	20.7	18.5	11.1	19.9	24.6
35-45.	13.1	15.7	18.5	17.3	18.5
45-55.	11.6	16.9	11.1	11.7	9.2
55-65.	5.8	5.1	7.4	6.6	6.2
> 65	6.1	5.1	7.4	2.9	1.5
Total	100	100	100	100	100

Source : Primary survey, 2001-02

Annexure 6.8 **Percentage distribution of Fishery respondents by Educational qualification in Cochin Estuary**

Level of education	I	II A	II B	III A	III B
0. Infants & No schooling	6.3	6.3	11.1	10.6	9.2
1. LP	24.8	24.0	37.0	21.2	21.5
2. UP	43.4	40.9	35.2	38.5	46.2
3. SSLC	19.2	18.1	11.1	19.5	15.4
4. PDC	4.1	7.9	3.7	6.9	7.7
5. Degree	1.9	2.4	1.9	3.3	0.0
6. PG / Professional	0.3	0.4	0.0	0.0	0.0
Total	100	100	100	100	100

Source: Primary survey, 2001

CHAPTER 7

Economic value of Estuaries

We have argued in chapters 4 and 5 that estuaries provided immense economic opportunities to the traditional communities along the Indian costal zone and the activities of modern stakeholders have grown to the extent of directly threatening the sustainable use of natural resources and environment. One of the major reasons for biodiversity degradation is that the economic worth of these ecosystems is not properly understood and hence underestimated. The natural follow up therefore is to estimate the true economic worth of estuaries, which include the direct, indirect, and non-use values accruing to various stakeholders. This chapter aims to provide estimates of these values for both Cochin and Kali estuaries. We begin by estimating the direct gross revenues (values) of traditional activities in **section 1**. Economic values of modern activities are estimated in **section 2**. **Section 3** deals with the estimations of indirect values, while section 4 deals with the estimation of non-use values. A brief summary of the results of this chapter follows.

7.1 Estimates of Direct Values of Traditional Estuarine Activities

In order to estimate the direct values from traditional economic activities, we have included all the major activities undertaken in the rural areas of the estuaries. These include pokkali / gazani paddy crop, estuarine capture fisheries which includes traditional filtration, estuarine culture activities, kadathu (traditional ferry services), sand mining and clam fisheries.

7.1.1 Economic value Generated by Pokkali Paddy Production

As mentioned earlier, the farmers of this region have been undertaking pokkali cultivation mainly for livelihood. In order to assess the economic importance of this activity, we made an attempt to value the revenue generated from this activity in the study area. The results are produced in tables 7.1 through 7.5 below.

Table 7.1 below reveals that in zone I:

- The gross revenue from paddy cultivation in zone I is Rs.14612000.
- 3329 households generate this value by cultivating 1369 hectares of wetland.
- The value per hectare is Rs. 10,673.

Table 7.1 Distribution of revenue by different class holdings from Pokkali paddy in the Zone I, 2001-02

Size of holdings [ha]	Area under cultivation [ha]	Ave. yield [kg]	Price [Rs.]	Gross revenue Generated ('000 Rs.)		No. of house holds	Value per hector (Rs.)
0 to .5	1186	1471.0	7.00	12211.9	**[83.6%]**	3074	
0.5 to 1	96	1840.0	7.00	1236.5	**[08.5%]**	225	
1 to 2	42	1679.3	7.00	493.6	**[03.4%]**	30	
2 to 3	45	2288.9	6.50	669.5	**[04.6%]**	0	
3 to 4	0	0.0		0.0	**-**	0	
> 4	0	0.0		0.0	**-**	0	
Total	**1369**			**14611.5**	**[100%]**	**3329**	**10673.2**

Source: primary data 2001-02

Table 7.2 below shows the distribution of revenue generated by different class holdings of Pokkali paddy in zone II A.

Table 7.2 Distribution of revenue by different class holdings from Pokkali paddy in the Zone II A, 2001-02

Size of holdings 7ha]	Area under cultivation [ha]	Ave. yield [kg]	Price [Rs.]	Gross revenue Generated ('000Rs.)		No. of house holds	Value per hector (Rs.)
0 to .5	239	1450.9	7.00	2427.4	**[20.0%]**	768	
0.5 to 1	1197	935.2	7.00	7835.7	**[64.5%]**	1440	
1 to 2		787.7	7.50	0.0	**-**	257	
2 to 3	337	834.0	6.00	1686.3	**[13.9%]**	7	
3 to 4	17	850.9	8.00	115.7	**[01.0%]**	3	
> 4	10	1136.7	7.00	79.6	**[0.7%]**	0	
Total	**1800**			**12144.7**	**[100%]**	**2475**	**6747.1**

Source: primary data 2001-02

The table reveals that in zone II A :

- The gross revenue from paddy cultivation in zone II A is Rs.12145000
- This value is generated by 2475 households by cultivating 1800 hectors of wetland
- The value per hectare is Rs. 6747.1.

Table 7.3 shows the distribution of revenue in Zone II B.

Table 7.3 Distribution of revenue by different class holdings from Pokkali paddy in the Zone II B, 2001-02

Size of holdings [ha]	Area under cultivation [ha]	Ave. yield [kg]	Price [Rs.]	Gross revenue Generated ('000 Rs.)		No. of house holds	Value per hector (Rs.)
0 to .5	304	1851.5	7.00	3940.0	**[15.1%]**	544	
0.5 to 1	1422	1698.4	7.00	16905.9	**[64.7%]**	2126	
1 to 2	460.00	1435.3	7.50	4952.8	**[18.9%]**	395	
2 to 3	7.0	1316.7	6.00	55.3	**[0.2%]**	3	
3 to 4	0.0	-	-	0.0	**-**	0	
> 4	26	1607.9	7.00	292.6	**[01.1%]**	5	
Total	**2219.0**			**26145.6**	**[100%]**	**3073**	**11782.6**

Source: primary data 2001-02

The table shows that in zone II B :

- The gross revenue from paddy cultivation in zone II B is Rs. 26145600
- 3073 households generate this value by cultivating 2219 hectares of wetland.
- The value per hectare is Rs. 11782.6.

Table 7.4 shows the distribution of revenue generated by different class holdings of Pokkali paddy in zone III A. This table reveals that in zone III A :

Table 7.4 Distribution of revenue by different class holdings from Pokkali paddy in the Zone III A, 2001-02

Size of holdings [ha]	Area under cultivation [ha]	Ave. yield [kg]	Price [Rs.]	Gross revenue Generated (Rs.)	No. of house holds	Value per hector (Rs.)
0 to .5	0	1295.3	6.50	0.0	0	
0.5 to 1	149	1383.0	6.50	1339467.7 **[61.4%]**	120	
1 to 2	64	1880.1	7.00	842296.9 **[38.6%]**	95	
2 to 3	0	0.0	6.50	0.0	0	
3 to 4	0	0.0	7.00	0.0	0	
> 4	0	0.0	7.00	0.0	0	
Total	213			2181764.6 **[100%]**	**215**	10243.0

Source: primary data 2001-02

This table reveals that in zone III A :

- The gross revenue from paddy cultivation in zone III A is Rs. 2181764.6.
- The value per hectare is Rs. 10243.
- 215 households generate this value by cultivating 213 hectares of wetland.
- Value per hectare is RS.10243

Table 7.5 Distribution of revenue by different class holdings from Pokkali fields in the Zone III B, 2001-02

Size of holdings [ha]	Area under cultivation [ha]	Ave. yield [kg]	Price [Rs.]	Gross revenue Generated (000 Rs.)	No. of house holds	Value per hector (Rs.)
0 to .5	313	1156.4	7.00	2533.7 **[76.5%]**	1164	
0.5 to 1	46	1572.1	7.00	506.2 **[15.3%]**	0	
1 to 2	43	909.5	7.00	273.8 **[08.3%]**	52	
2 to 3	0	0	6.50	0.0	0	
3 to 4	0	0	7.00	0.0	0	
> 4	0	0	7.00	0.0	0	
Total	**402**			**3313.7 [100%]**	**1216**	**8242.9**

Source: primary data, 2001-02

Table 7.5 shows the distribution of revenue generated by different class holdings of Pokkali paddy in zone III B.

This table reveals above that in zone III B:

- The gross revenue from paddy cultivation in zone III B is Rs. 3313648.1.
- The value per hectare is Rs. 8242.9.
- 1216 households generate this value by cultivating 402 hectares of wetland.
- Value per hectare is Rs. 8243

Table 7.6 below shows the distribution of revenue generated by different class holdings of Gazani paddy in Kali estuary.

This table below reveals that in Kali estuary :

- The gross revenue from gazani cultivation in Kali is Rs. 12216491.
- 469 households generate this value by cultivating 1217.6 hectares of wetland.
- The value per hectare is Rs. 10033.6.

Table 7.6 Distribution of revenue by different class holdings from Gazani in the Kali estuary, 2001-02.

Size of holdings [ha]	Area under cultivation [ha]	Ave. yield [kg]	Price (Rs.)	Gross revenue Generated (Rs.)		No. of house holds	Value per hector (Rs.)
0 – 0.5	24.4	1924.4	6	281732.16	**[02.3 %]**	61	
0.5 – 1	85.1	1694.2	6	865363.476	**[07.1 %]**	106	
1 – 2	95.7	2204.2	6	1265674.608	**[10.4 %]**	53	
2 – 3	172.0	2166.7	6	2236034.4	**[18.3 %]**	61	
3 – 4	301.4	1587.9	6	2871558.36	**[23.5 %]**	79	

> 4	538.9	1452.3	6	4696128.234	**[38.4 %]**	108	
Total	**1217.6**			**12216491.2**	**[100 %]**	**469**	**10033.6**

Source: primary data, 2001- 02

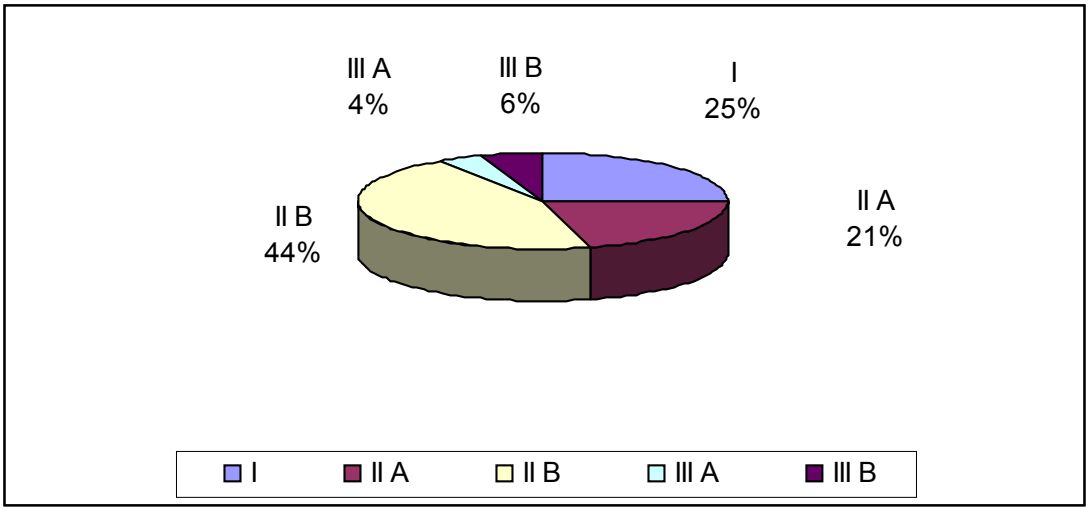
Table 7.7 provides value generated through paddy cultivation in the study areas.

Table 7.7 Distribution of value of paddy generated by different class holdings in Cochin and Kali estuaries, 2001-02

Total Value Generated [Rs. Lakhs]							
Size of Holdings [ha]	**Cochin Estuary**						**Kali Estuary**
	I	**II A**	**II B**	**III A**	**III B**	**Total Rs.**	**I**
0 to .5	122.12	24.27	39.40	0.00	25.34	211.13	2.8
0.5 to 1	12.36	78.36	169.06	13.39	5.06	278.24	8.7
1 to 2	4.94	0.00	49.52	8.42	2.74	65.62	12.7
2 to 3	6.70	16.86	0.55	0.00	0.00	24.11	22.4
3 to 4	0.00	1.16	0.00	0.00	0.00	1.16	28.7
> 4	0.00	0.80	2.93	0.00	0.00	3.72	47.0
Total	**146.12 (25.0)**	**121.45 (20.8)**	**261.46 (44.8)**	**21.82 (3.7)**	**33.14 (5.7)**	**583.97 (100)**	**122.2**
Value per ha. (Rs.)	**10673.2**	**6747.1**	**11782.6**	**10243.0**	**8242.9**	**9728.0**	**10033.6**

Source: primary data, 2001- 02

Figure 7.1 Distribution of value from Pokkali paddy generated by different zones in Cochin estuary, 2001-02.



This table reveals that:

- The total value from pokkali cultivation during the year 2001-02 from the low lying wetlands around Cochin estuary is Rs 5,83,97,238.
- 25 percent of this value is the contribution of zone I. Zone II contributed around 65 percent. Zone III, contributed only ten percent.
- The average value of pokkali paddy production in the Cochin brackish water area is estimated as Rs.7635.7 per hectare. Zone I recorded the highest value of Rs.10673.2 kg per hectare, followed by zone II with Rs. 6842.6 per hectare and zone III with Rs. 6057.3 per hectare.
- 11739 households from an area of 6003 hectares contribute this value.
- In Kali on the other hand, the total value generated is Rs. 12216491.
- The average value per hectare is Rs. 10033.6.

7.1.2 Economic Value Generated From Fishery Resources

As mentioned in chapter 2, we organized a detailed survey from February 2001 to January 2002 to estimate the gross value of fisheries in Cochin and Kali estuaries. Table 7.8 gives a summary of the value of estuarine capture fisheries of Cochin and Kali estuaries during the survey year.

Table 7.8 Distribution of value from fish landings in Cochin and Kali estuaries by gears, 2001-02 (in lakhs)

Zone III B	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine Net	Hooks & line	Trap Net	Scoop Net	Drag Net	Ring Net	Other Gears	Total Rs.
Cochin Estuary												
Zone I	249.5	656.2	269.6	442.1	167.1	8.6	69.1	10.4	121.6	58.8	18.3	2071.3 (32.6%)
Zone II A	162.5	642.6	503.6	500.4	49.6	8.2	20.5	10.3	10.3	7.2	9.2	1924.3 (30.3%)
Zone II B	112.0	0.0	0.0	223.9	0.0	0.0	0.0	31.0	0.0	0.0	3.1	370.0 (5.8%)
Zone III A	143.0	0.0	77.3	310.5	0.0	0.0	0.0	0.0	0.0	0.0	3.9	534.7 (8.4%)
Zone III B	307.8	419.0	219.4	427.4	34.5	10.4	10.4	6.8	7.6	8.6	5.0	1457.1 (22.9%)
Total	974.8 (15.3)	1717.8 (27.0)	1069.9 (16.8)	1904.3 (30.0)	251.2 (4.0)	27.2	100	58.5	139.5	74.6	39.5	6357.4 (100)
Kali Estuary												
Zone I	-	52.85	158.56	35.52	-	12.47	-	-	-	-	12.42	271.81

Source: Primary Survey 2001-02

This table reveals that :

- The total value of fish landings is 6357.4 lakhs of which 33 percent, 30 percent, 23 percent are contributed by zone I, zone II A and zone III B respectively. Other two zones together contributed the remaining.
- 30 percent of the value is generated by gillnets, 27 percent by stake nets, 17 percent by cast nets, 15 percent by Chinese nets and the remaining 11 percent by all the other gears . See the figure 7.2

Figure 7.2 Value from fish landings in Cochin estuary by gears, 2001-02

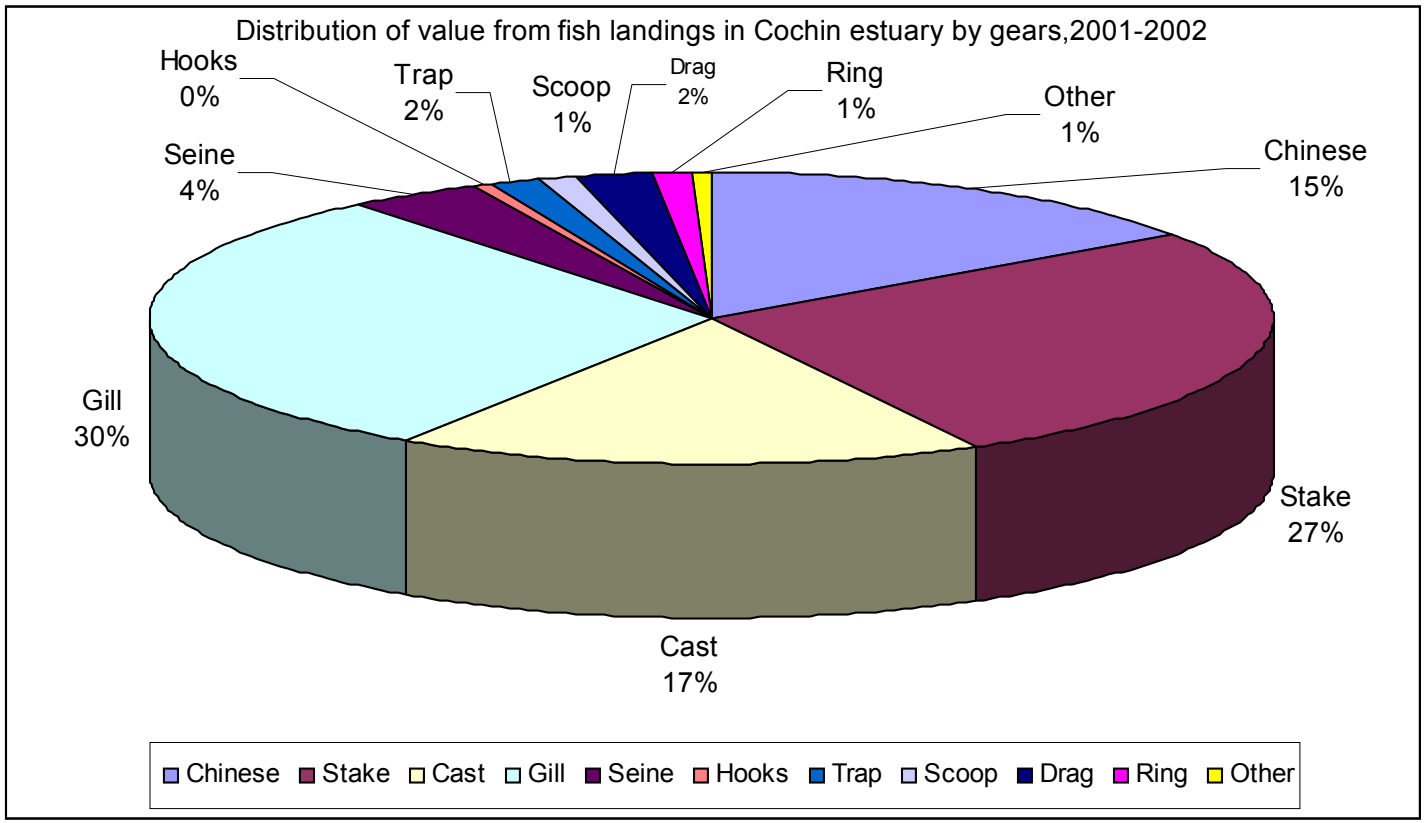
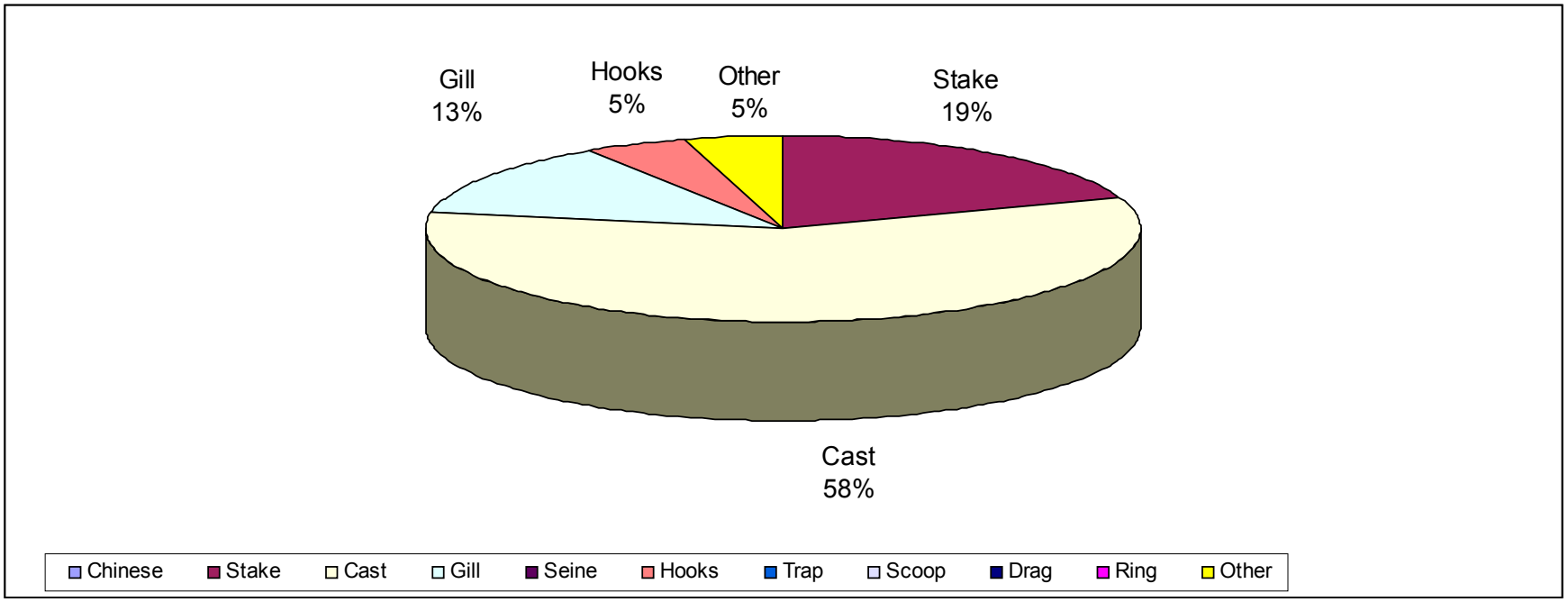


Figure 7.3 shows the value generated from fish landings in Kali estuary by different gears in 2001-02.

Figure 7.3 Value from fish landings in Kali estuary by gears, 2001-02



Similarly figures 7.4 to 7.8 depict the value of fish landings of different zones in Cochin estuary.

Figure 7.4 Value from fish landings in zone I, Cochin estuary by gears, 2001-02

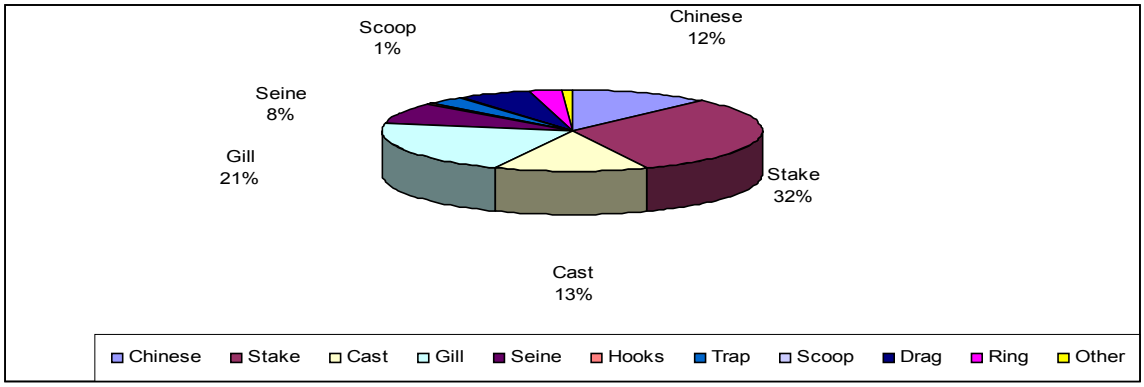


Figure 7.5 Value from fish landings in zone II A, Cochin estuary by gears, 2001-02

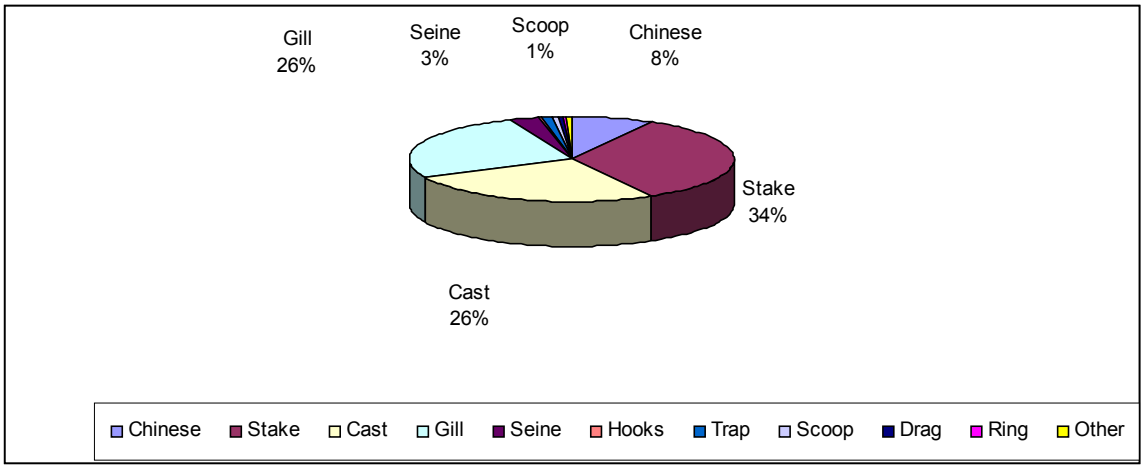


Figure 7.6 Value from fish landings in zone II B, Cochin estuary by gears, 2001-02

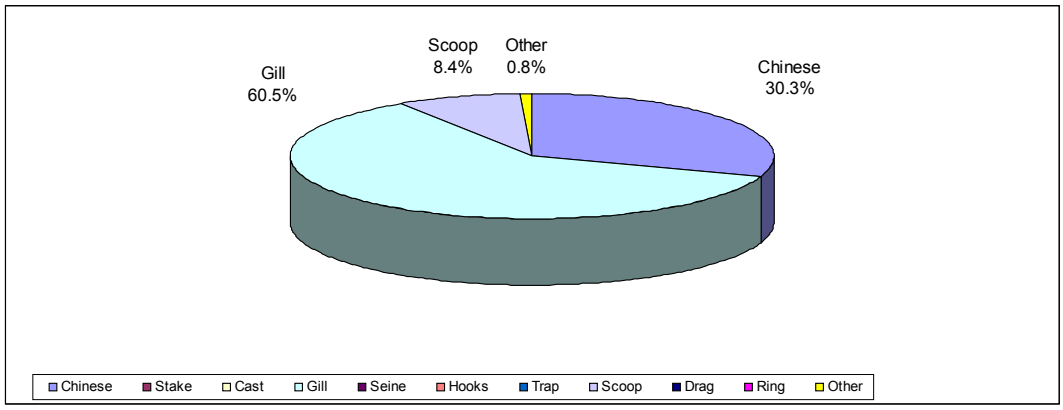


Figure 7.7 Value from fish landings in zone III A, Cochin estuary by gears, 2001-02

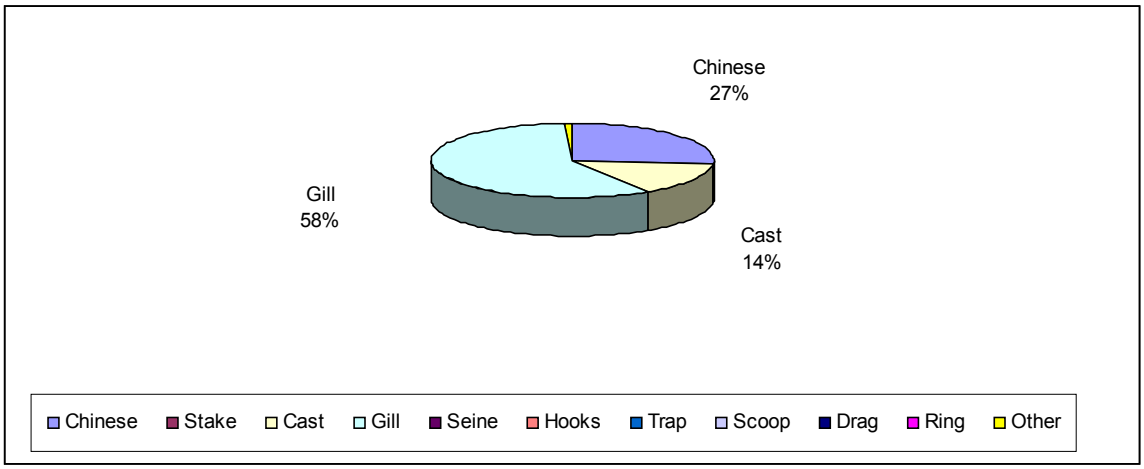
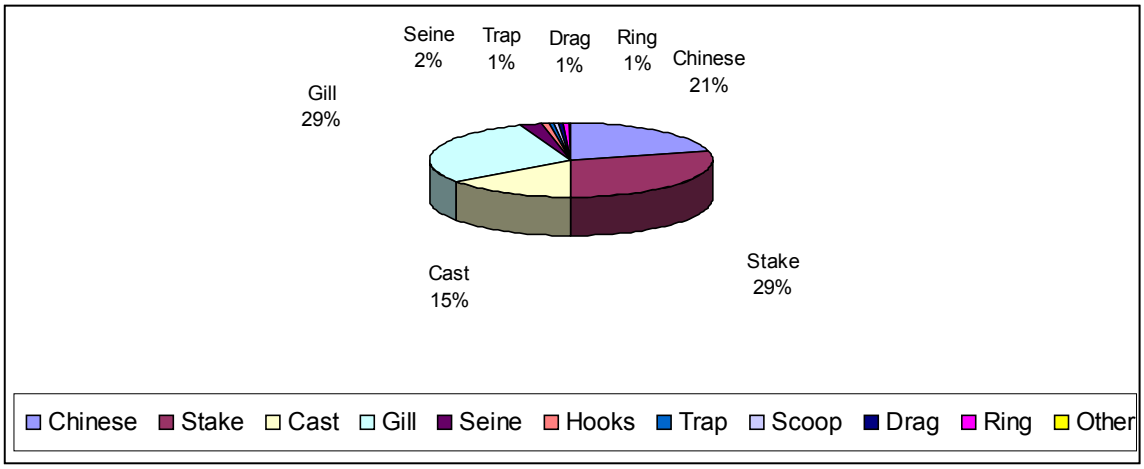


Figure 7.8 Value from fish landings in zone III B, Cochin estuary by gears, 2001-02



Tables 7.9 to 7.13 present details of the monthly value generated by various nets in the selected zones of the estuaries.

Table 7.9 Values of monthly fish landings by gears in Zone I of Cochin Estuary, 2001-02 (in lakhs).

Zone I	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Rs
Feb	28.8	64.8	32.1	34.2	17.5	0.3	2.8	0.4	5.1	3.5	0.8	190.5
Mar	28.3	40.0	19.2	33.9	17.0	0.2	4.5	0.6	10.3	5.3	1.2	160.4
Apr	10.5	51.2	24.3	42.6	18.7	0.7	5.1	1.1	9.2	4.2	1.5	169.2
May	10.5	32.4	21.2	50.0	11.4	0.9	5.2	1.2	9.2	4.2	1.6	147.8
Jun	4.3	54.2	22.7	43.7	11.2	0.9	5.7	1.0	7.7	3.2	1.4	156.0
Jul	28.6	51.6	19.3	33.2	17.0	0.9	9.8	0.9	9.9	5.3	1.8	178.2
Aug	12.5	50.5	24.2	34.9	14.6	0.9	4.1	0.6	8.2	4.2	1.3	156.1
Sep	10.4	49.1	24.3	42.1	17.2	0.8	5.4	1.1	9.3	4.2	1.6	165.5
Oct	66.1	71.9	12.0	40.7	3.0	0.9	4.9	1.1	17.5	8.8	2.2	228.9
Nov	12.7	76.9	11.7	14.0	7.7	0.3	9.4	1.0	19.3	8.4	2.2	163.6
Dec	25.5	66.8	24.8	31.7	15.8	0.8	7.0	0.9	5.6	2.8	1.3	182.9
Jan	11.2	46.9	33.9	41.0	16.0	0.9	5.3	0.6	10.3	4.7	1.4	172.2
Total	249.5 [12%]	656.2 [31.7%]	269.6 [13%]	442.1 [21.3%]	167.1 [8.1%]	8.6 [0.4%]	69.1 [3.3%]	10.4 [0.5%]	121.6 [5.9%]	58.8 [2.8%]	18.3 [0.9%]	2071.3 [100%]

Source: Primary Survey 2001-02

Major findings :

- Total value of landings in zone 1 is Rs.2071.3 lakhs.
- 32 percent of this value is the contribution of stake nets 21 percent gill nets, 13 percent cast nets and 12 percent Chinese nets. See figure 7.9 for details.

Fig 7.9 Values of monthly fish landings by gears in Zone I of Cochin Estuary, 2001-02

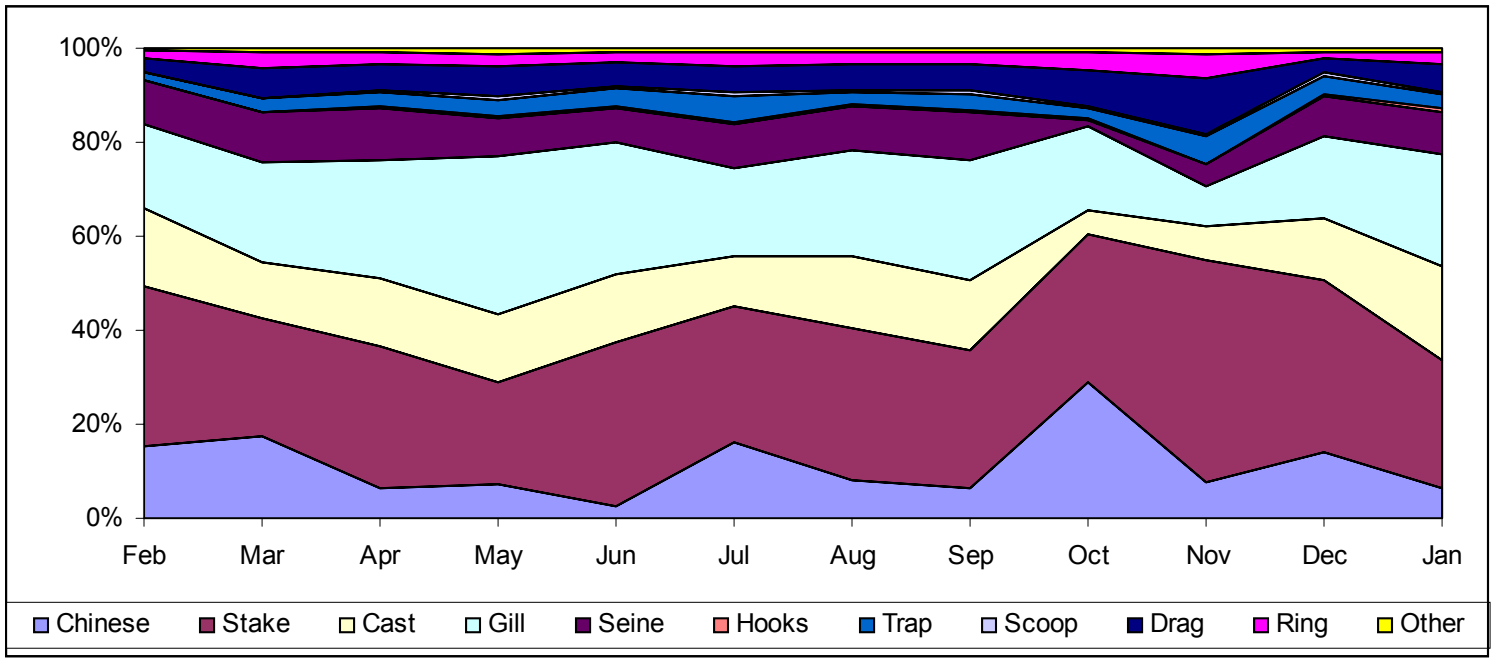


Table 7.10 **Distribution of value of monthly fish landings by gears in Zone II A of Cochin Estuary, 2001-02 (in lakhs).**

Zone II A	Chinese Dipnet	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Rs
Feb	14.9	56.3	36.0	42.8	4.1	0.3	0.6	0.6	0.8	0.6	0.6	157.6
Mar	14.9	55.7	41.8	39.3	4.1	0.2	0.4	0.6	0.8	0.5	0.5	158.7
Apr	15.7	47.2	42.8	45.6	3.9	0.7	1.7	1.0	0.7	0.6	0.9	160.8
May	14.3	49.2	39.8	41.1	4.1	0.8	1.4	0.9	0.8	0.7	0.9	153.9
Jun	7.9	61.9	33.6	45.6	4.7	0.9	2.4	1.2	0.9	0.7	1.1	160.9
Jul	13.4	55.7	42.0	39.9	4.1	0.7	1.2	0.8	0.8	0.6	0.8	160.0
Aug	15.2	47.1	49.3	49.9	4.3	0.8	2.1	0.8	0.8	0.7	0.7	171.8
Sep	16.2	52.0	56.0	42.9	4.2	0.8	2.0	0.6	1.3	0.4	0.7	177.2
Oct	11.8	56.3	37.6	44.1	4.1	0.7	2.7	0.9	0.8	0.7	0.8	160.6
Nov	12.0	56.2	44.3	40.9	4.1	0.8	1.3	1.0	0.8	0.6	0.7	162.6
Dec	9.5	56.6	37.5	36.0	4.1	0.7	2.7	1.0	0.8	0.7	0.8	150.5
Jan	16.7	48.2	43.0	32.3	3.8	0.7	2.1	1.0	1.0	0.3	0.7	149.7
Total	162.5 [8.4 %]	642.6 [33.4 %]	503.6 [26.2 %]	500.4 [26.0 %]	49.6 [2.6 %]	8.2 [0.4 %]	20.5 [1.1 %]	10.3 [0.5 %]	10.3 [0.5 %]	7.2 [0.4 %]	9.2 [0.5 %]	1924.3 [100 %]

Source: Primary Survey 2001-02

Major findings :

- Total value of landings in zone 2 A is Rs.1924.3 lakhs.
- 33 percent of this value is the contribution of stake nets 26 percent gill nets, 26 percent cast nets and 8 percent Chinese nets. (See figure 7.10 for details).

Fig 7.10 Values of monthly fish landings by gears in Zone II A of Cochin Estuary, 2001-02

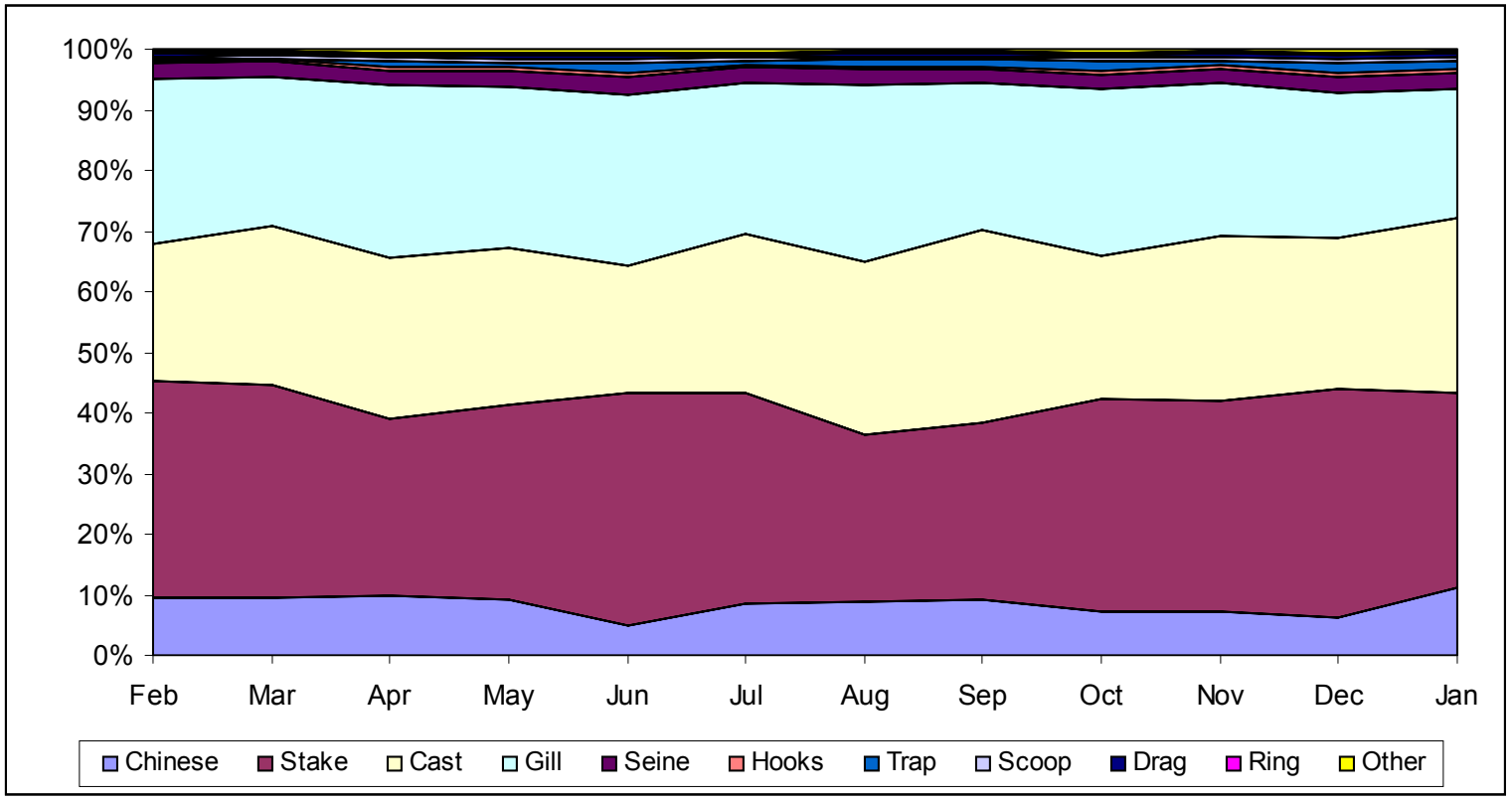


Table7.11 Distribution of value of monthly fish landings by gears in Zone II B of Cochin Estuary, 2001-02 (in lakhs).

Zone II B	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Rs.
Feb	16.9	0.0	0.0	21.1	0.0	0.0	0.0	3.5	0.0	0.0	0.4	41.8
Mar	14.6	0.0	0.0	20.5	0.0	0.0	0.0	1.8	0.0	0.0	0.2	37.0
Apr	11.3	0.0	0.0	17.5	0.0	0.0	0.0	2.9	0.0	0.0	0.3	31.9
May	9.3	0.0	0.0	20.2	0.0	0.0	0.0	2.6	0.0	0.0	0.3	32.4
Jun	3.4	0.0	0.0	21.5	0.0	0.0	0.0	2.9	0.0	0.0	0.3	28.0
Jul	3.9	0.0	0.0	18.8	0.0	0.0	0.0	2.2	0.0	0.0	0.2	25.1
Aug	4.7	0.0	0.0	22.6	0.0	0.0	0.0	3.9	0.0	0.0	0.4	31.6
Sep	2.5	0.0	0.0	17.7	0.0	0.0	0.0	3.0	0.0	0.0	0.3	23.6
Oct	4.5	0.0	0.0	13.6	0.0	0.0	0.0	1.9	0.0	0.0	0.2	20.2
Nov	4.0	0.0	0.0	16.0	0.0	0.0	0.0	1.9	0.0	0.0	0.2	22.1
Dec	17.9	0.0	0.0	18.3	0.0	0.0	0.0	1.7	0.0	0.0	0.2	38.1
Jan	19.0	0.0	0.0	16.0	0.0	0.0	0.0	2.7	0.0	0.0	0.3	38.0
Total	112.0 [30.3 **%]**	0.0	0.0	223.9 [[60.5 **%]**	0.0	0.0	0.0	31.0	0.0	0.0	3.1	370.0 [100 **%]**

Source: Primary Survey 2001-02

As mentioned earlier this zone is the highly degraded area of the Cochin estuary due to industrial pollution. This has caused a low value realization in this area.

Major findings :

- Total value of landings in zone 2B is only Rs.2071.3 lakhs.
- 61 percent of this value is the contribution of gill nets, 30 percent Chinese nets and nine percent by scoop nets.
- All the other gears recorded zero value. This means that biodiversity degradation could also lead to reduction in gear diversity an important feature of the fishing practices in Cochin estuary. See figure 7.11 for details.

Fig 7.11 Values of monthly fish landings by gears in Zone II B of Cochin Estuary, 2001-02

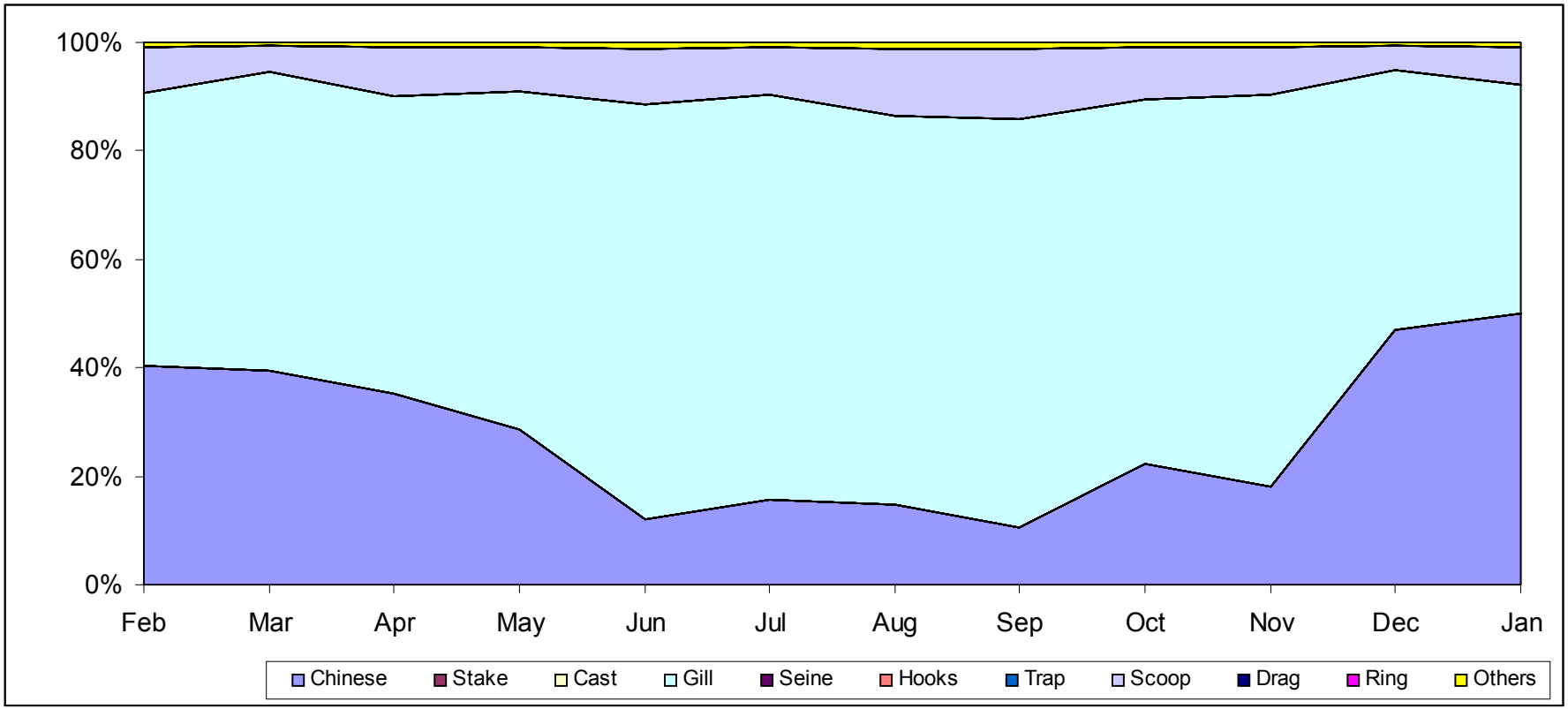


Table 7.12 Distribution of value of monthly fish landings by gears in Zone III A of Cochin Estuary, 2001-02 [in lakhs]

Zone III A	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Rs.
Feb	11.5	0.0	7.1	33.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	52.6
Mar	11.4	0.0	6.9	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	36.6
Apr	16.5	0.0	4.6	30.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	52.3
May	14.7	0.0	6.6	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	61.3
Jun	5.1	0.0	4.0	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	44.6
Jul	7.6	0.0	6.6	29.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	44.1
Aug	9.7	0.0	6.9	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	28.2
Sep	12.5	0.0	10.2	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	34.5
Oct	10.8	0.0	6.4	31.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	48.7
Nov	13.2	0.0	6.6	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.4	49.0
Dec	13.3	0.0	6.9	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	32.0
Jan	16.7	0.0	4.7	29.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	51.0
Total	143.0 **[26.7 %]**	0.0	77.3 **[14.5 %]**	310.5 **[58.1 %]**	0.0	0.0	0.0	0.0	0.0	0.0	3.9 **[0.7 %]**	534.7 **[100 %]**

Source: Primary Survey 2001-02

Major findings:

- **Total value of landings in zone 3 A is Rs.534.7 lakhs.**
- **58 percent of this value is the contribution of gill nets 27 percent Chinese nets and 15.**
- **As this is a bar mouth region gear diversity is very low. See figure 7.12 for details**

Fig 7.12 Values of monthly fish landings by gears in Zone III A of Cochin Estuary, 2001-02

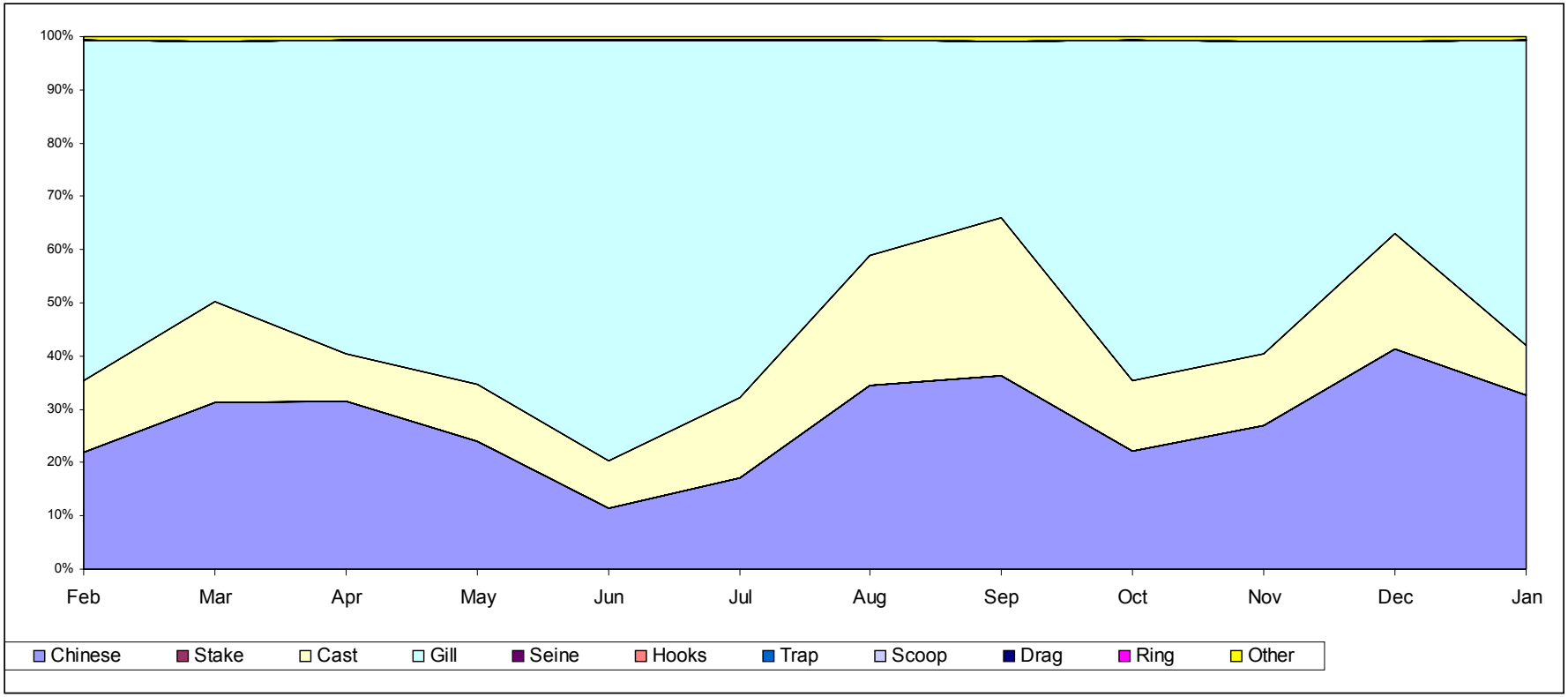


Table 7.13 Distribution of value of monthly fish landings by gears in Zone III B of Cochin Estuary, 2001-02 (Rs)

Zone III B	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine net	Hooks & line	Trap net	Scoop net	Drag Net	Ring net	Other Gears	Total Rs.
Feb	29.4	33.3	19.2	37.5	2.9	0.4	1.1	0.4	0.6	0.9	0.3	126.1
Mar	26.9	31.9	19.4	37.5	2.9	0.2	1.7	0.8	0.6	0.7	0.4	123.1
Apr	15.7	34.8	19.3	37.3	2.9	1.2	0.9	0.6	0.7	0.9	0.5	114.8
May	22.4	37.5	19.1	37.1	2.9	1.0	0.9	0.6	0.7	0.6	0.4	123.1
Jun	8.8	32.4	17.0	33.2	2.9	1.0	0.9	0.5	0.7	0.6	0.4	98.3
Jul	13.2	40.1	16.3	32.8	2.8	0.9	0.8	0.5	0.8	0.6	0.4	109.2
Aug	23.4	32.1	16.9	32.5	2.6	0.9	0.9	0.6	0.7	0.5	0.4	111.5
Sep	26.8	37.1	17.6	34.7	2.9	0.8	0.8	0.5	0.6	0.6	0.4	122.8
Oct	47.2	29.3	17.5	34.7	2.9	1.0	0.5	0.6	0.5	0.9	0.4	135.6
Nov	33.9	35.3	18.3	35.9	2.9	1.0	0.7	0.5	0.6	0.9	0.4	130.4
Dec	22.9	40.9	18.8	35.9	2.9	0.9	0.5	0.5	0.6	0.9	0.4	125.2
Jan	37.2	34.5	19.9	38.4	3.0	0.9	0.7	0.6	0.6	0.9	0.5	137.2
Total	307.8 **[21.1 %]**	419.0 **[28.8 %]**	219.4 **%] [15.1**	427.4 **[29.3 %]**	34.5 **[2.4 %]**	10.4	10.4	6.8	7.6	8.6	5.0	1457.1 **[100 %]**

Source: Primary Survey 2001-02

Major findings:

- **Total value of landings in zone 3 B is Rs1457 lakhs.**
- **29 percent each of this value are the contributions of gill nets and stake nets, 21 percent Chinese nets and 15 percent cast nets.**
- **The remaining gears contributed hardly five percent of the value. See figure 7.13 for details.**

Zone III B is also a bar mouth region but it shows a different pattern of landings

Fig 7.13 Values of monthly fish landings by gears in Zone III B of Cochin Estuary, 2001-02

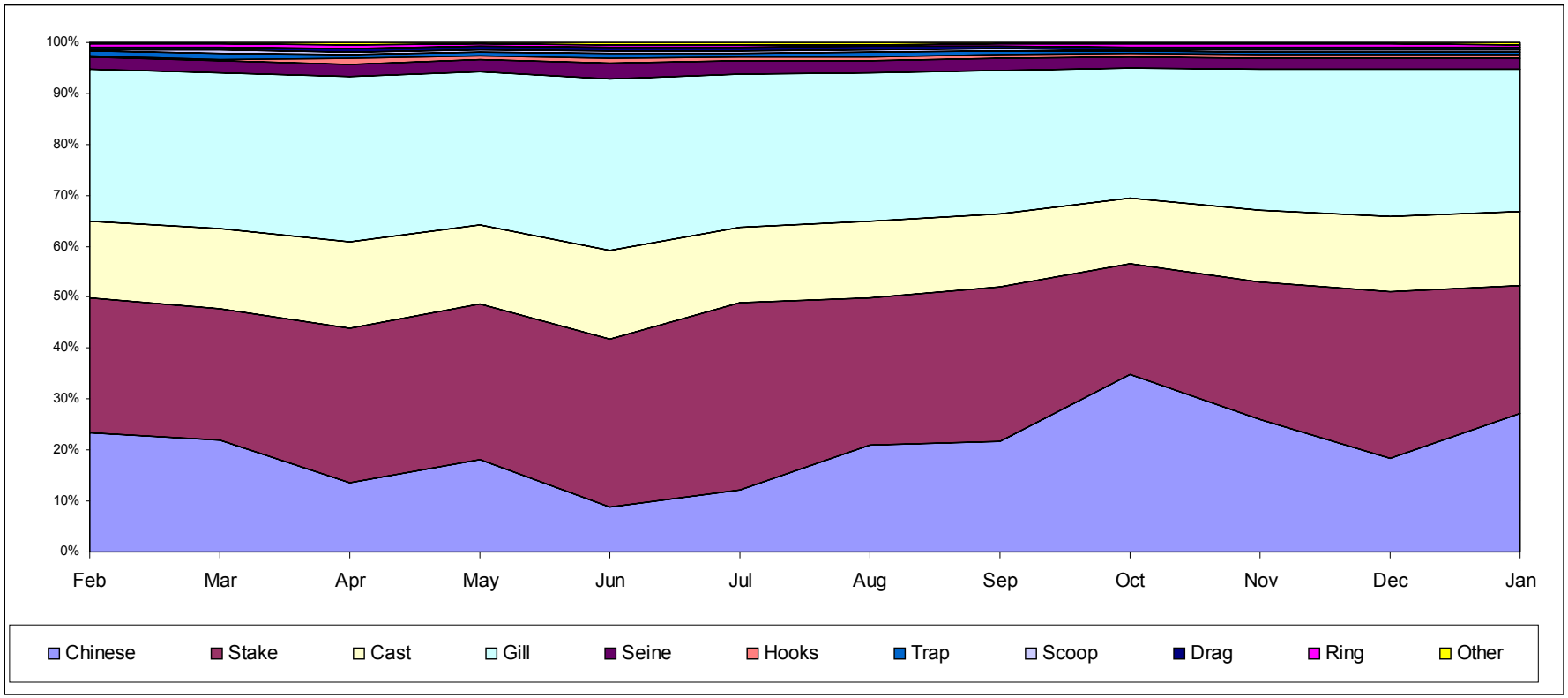


Table 7.14 Distribution of value of monthly fish landings by gears in Kali Estuary, 2001-02 (in lakhs)

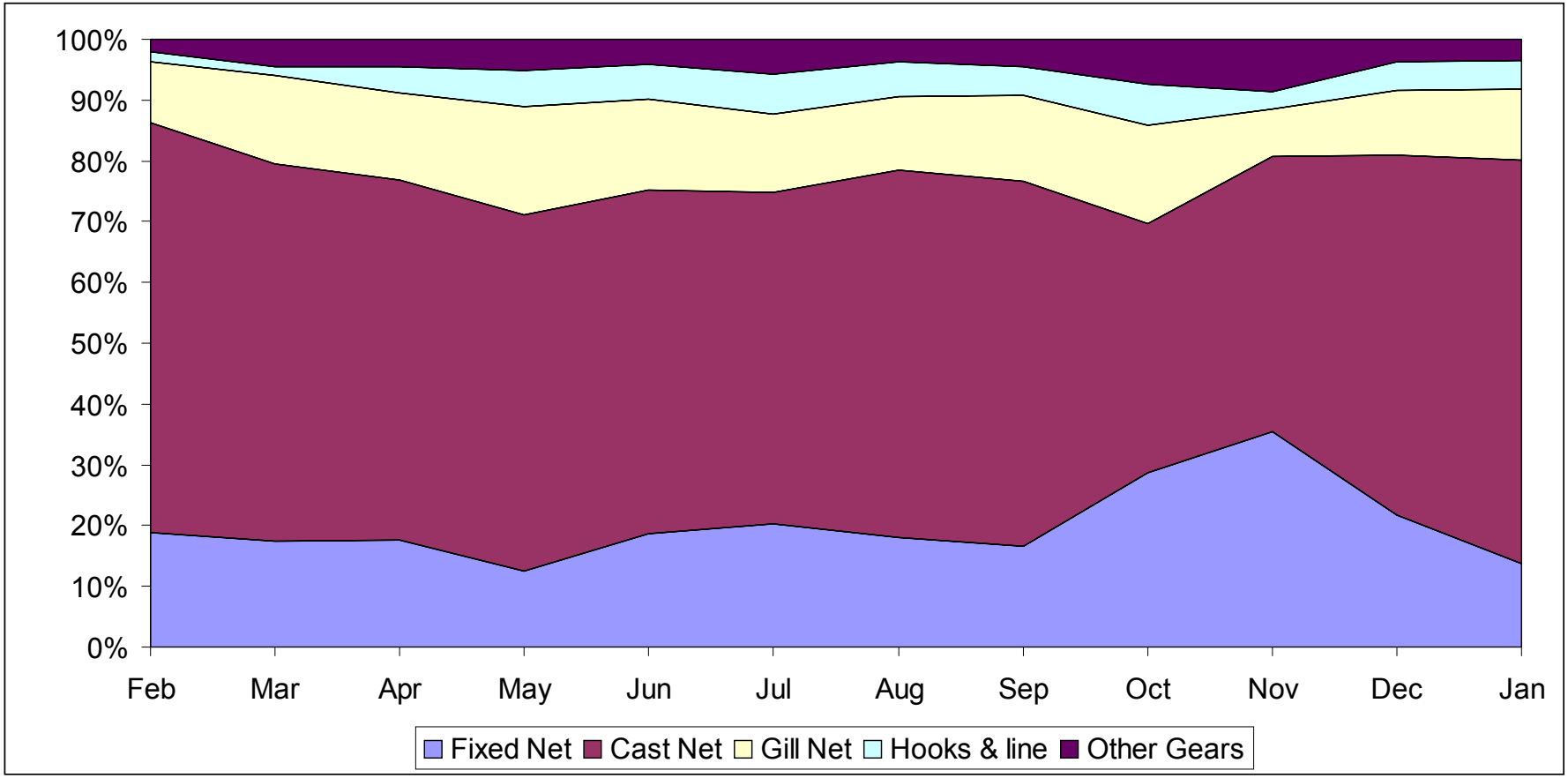
Zone I	Fixed Net	Cast Net	Gill Net	Hooks & line	Other Gears	Total kg
Feb	5.14	18.26	2.74	0.44	0.55	27.13
Mar	3.28	11.64	2.75	0.27	0.84	18.79
Apr	4.12	13.93	3.38	1.00	1.05	23.48
May	2.77	12.88	3.90	1.32	1.11	21.97
Jun	4.34	13.09	3.44	1.32	0.97	23.15
Jul	4.18	11.26	2.70	1.34	1.19	20.66
Aug	4.21	14.21	2.83	1.34	0.86	23.45
Sep	3.93	14.28	3.35	1.14	1.07	23.76
Oct	5.68	8.09	3.24	1.32	1.46	19.79
Nov	6.07	7.75	1.34	0.47	1.48	17.11
Dec	5.33	14.63	2.59	1.19	0.89	24.62
Jan	3.81	18.55	3.24	1.33	0.96	27.89
Total	52.85 **[19.4 %]**	158.56 **[58.3 %]**	35.52 **[13.1 %]**	12.47 **[4.6 %]**	12.42 **[4.6 %]**	271.81 **[100 %]**

Source: Primary Survey 2001-02

In the case of Kali estuary,

- Total value of landings is Rs.271.8 lakhs.
- 58 percent of this value is the contribution of cast nets 19 percent fixed nets and 13 percent gill nets.
- Gear diversity is lower in kali than in Cochin estuary. **See figure 7.14 for details.**

Fig 7.14 Values of monthly fish landings by gears in Kali Estuary, 2001-02



In order to compare different stations relative contributions we estimated the value of landings of various gears at the different stations of Cochin estuary and the reference station Kali. The results are summarised in table 7.15 which provides estimates of daily catch value by gears in different zones in Cochin and Kali estuaries

Table 7.15 Distribution of value of catch per day per net in different zones of Cochin and Kali Estuaries, 2001-02 (Rs)

	Chinese Dip net	Stake Net	Cast Net	Gill Net	Seine Net	Hooks & Line	Trap Net	Scoop Net	Drag Net	Ring Net	Other Gears
Cochin estuary											
Zone I	349.4	294.0	147.0	178.8	203.7	68.7	79.5	64.4	146.4	49.4	61.1
Zone II A	310.3	449.1	200.5	187.0	361.3	109.5	196.7	63.7	62.2	37.3	35.9
Zone II B	253.2	0.0	0.0	160.4	0.0	0.0	0.0	236.5	0.0	0.0	18.5
Zone III A	352.3	0.0	155.1	174.5	0.0	0.0	0.0	0.0	0.0	0.0	15.5
Zone III B	587.9	292.9	197.4	159.8	251.6	138.3	100.0	42.3	45.7	44.8	19.7
Kali estuary											
Zone I	-	169.2	62.9	72.2	-	49.1	-	-	-	-	28.4

This table reveals that :

- **The Chinese dip nets generated the highest value per net per day followed by Stakenets, gill nets and cast nets.**

Table 7.16 below gives some summary statistics on sales value per hectares area in different zones of Cochin and Kali estuaries.

Table 7.16 Distribution of Gross Sales Value generated in Cochin estuary, 2001-02

	Revenue [Lakhs Rs]		Area (ha)	Value/ha/year [Rs.]
Cochin Estuary				
ZONE I	2071.3	(32.6 %)	10899.02	19004.4
Zone II A	1924.2	(30.3 %)	3560.9	54039.4
Zone II B	370.1	(05.8 %)	4980.7	7428.8
ZONE III A	534.7	(08.4 %)	6104.6	8759.6
Zone III B	1457.1	(22.9 %)	1740.58	83714.0
Total	6357.4	(100 %)	27285.8	23299.4
Kali Estuary				
ZONE I	271.8		3240	8388.8

Source: Primary survey 2001-02 *** to be calculated**

This table reveals that :

- Estuarine fishery of zone I of Cochin estuary generated Rs. 19004 during the year 2001-02.
- Zone II generated Rs. 54039.
- The highest value of Rs. 83714 is generated in the northern bar mouth region zone III B.
- The lowest value Rs. 7428.8 is realized in the highly degraded area Zone II B as expected.

In the following table 7.17 we provide some summary statistics to make a comparative analysis of the activities of different fishing zones.

Table 7.17 Productivity and performance indices of different fishing zones in Cochin and kali estuaries 2001-02.

Zone	Value/net	Active fishermen	Fishing days	Fishing Area (ha)	Value/net/ Day [Rs.]	Value/ ha/year [Rs.]	Value/ ha/day [Rs.]
Cochin Estuary							
I	23265.10	5314	126.4	10899.02	184.1	19004.4	150.4
II A	31550.89	4697	127.8	3560.9	246.8	54039.4	422.8
II B	10731.03	2444	130.0	4980.7	82.5	7428.8	57.1
III A	11460.35	3958	127.3	6104.6	90.0	8759.6	68.8

III B	28576.37	2180	124.5	1740.58	229.4	83714.0	672.2
Total	22532.11	18593	127.2	27285.8	177.1	23299.4	183.2
Kali Estuary							
I	10386	905	124.0	-	83.8	-	-

Source : Primary Survey 2001-02

The table revels that:

- The value per net per day for the whole region is estimated as Rs. 177.
- The lowest value Rs. 83 is recorded in zone II B which is the area experiencing highest level of fish and shellfish diversity degradation.
- The highest value (Rs. 229) is recorded at the northern bar mouth region.
- Similarly the average value/ha/ day for the whole region is Rs. 183. However, higher values are realized in zone III B (672) and in zone II A (Rs. 423).
- Zone II B a recorded the lowest value/ha/day (Rs. 57.1).

The analysis reveals very clearly that the degradation of fish and shellfish diversity experienced in zone II B is largely responsible for the low value realization in the area and hence low income for the local fishermen.

7.1.3 Economic Value Generated By Traditional Ferry Services In Cochin Estuary

Ferry services provide direct employment and useful services to the local population. The value generated in traditional ferry services is given in table 7 18.

Table 7.18 Distribution of value generated by traditional goods ferry Services in Cochin estuary, 2001-02

	No. of Boats	Total Revenue			
		Pre monsoon [Rs.]	Monsoon [Rs.]	Post Monsoon [Rs.]	Grand Total [Rs. lakhs]
Type I Ferry	7	1077057	664645.3	1417677	31.59
Type II Ferry	5	916735	917640	1296050	31.30
Type III Ferry	2	384000	336000	384000	11.04
Motor Dingy	5	243000	252000	311625	8.07
					82.00

Source: Primary Survey 2001-02

This table shows that

- **The value generated in this activity for the year 2001-01 is Rs. 82.00 lakhs.**

Table 7.19 gives the value generated by traditional passenger ferry services in Kali estuary.

Table 7.19 Distribution of value generated by traditional passenger ferry services in Kali estuary, 2001-02

Month	Total boats	No. of passengers/day	Revenue / day	No. of Days	Total Revenue lakhs
Pre Monson	50	150	300	106	15.90
Monsoon	50	100	220	76	8.36
Post Monsoon	50	168	150	112	8.40
Total	50			294	**32.66**

Source: Primary Survey 2001-02

This table shows that the value generated in this activity is Rs. 32.66 lakhs

7.1.4 Economic Value Generated By Sand Mining In Kali Estuary

Sand and clay mining are the other two major traditional activities in the estuaries. Sand mining is not very popular in Cochin estuary but it is one of the leading activities in Kali especially due to the modern construction boom in nearby areas. Therefore we have monitored the activities of Kali and we assume nil values for Cochin estuary. **The economic value generated by sand mining in Kali estuary is estimated as Rs. 276.37 lakhs. [See table 7.20 for details]**

Table 7.20 Distribution of value generated by sand mining in Kali Estuary, 2001-02

Village	Quantity mined (m^3)				Total		
	Pre Monsoon	Monsoon	Post Monsoon	Total	No. of days	Price [Rs.]	Total Revenue [Rs lakhs]
Karwar municipality	600.0	300.0	420.0	1320.0	118.0	100	155.76
Boribag	48.0	48.0	48.0	144.0	120.0	100	17.28
Siddar	72.0	24.0	50.0	146.0	124.0	100	18.10
Halga	75.0	28.0	52.0	155.0	100.0	100	15.50
Karwadi	120.0	72.0	96.0	288.0	120.0	100	34.56
Kadia	125.0	75.0	98.0	298.0	118.0	100	35.16
Total	**[1040.0 %]**	**[547.0 %]**	**[764.0 %]**	**[2351.0 %]**			**276.37**

Source : Primary Survey 2001-02

7.1.5 Economic Value Generated By Clam Fishery And Lime Shell Collection

Clam fishery is very live both in Cochin and Kali estuaries. This fishery also supports an active lime industry in Karwar. Traditional lime making practices are also popular in the villages around Cochin estuary also.

Table 7.21 provides the estimates of value generated in lime clam fishery and lime shell collection in Cochin area and table 7.22 gives the corresponding figures for Kali estuary.

Table 7.21 Distribution of value generated by clam fishery and lime shell Collection in Cochin estuary, 2001-02

	Qty of Meat Sold (Tonnes)	Prize/ Kg	Revenue Received [Rs lakhs]	Qty. of Shell Sold (Tonnes)	prize/ Kg (Rs.)	Revenue [Rs. Lakhs]
Pre Monsoon	190.63	9.5	18.1	9.0	4.9	44.2
Monsoon	131.74	7.5	9.9	12.9	4.2	54.1
Post Monsoon	255.24	7.9	20.2	16.9	4.6	77.6
Grand Total	2954.4	577.6	48.2	4815.4		**175.9**

Source : Primary Survey 2001-02

Table 7.22 Distribution of value generated by clam fishery and lime shell Collection in Kali estuary, 2001-02 ([Rs. Lakhs]

Pre Monsoon	Monsoon	Post Monsoon	Total	Grand Total [Rs. lakhs]
Revenue from Clam meat [Rs. Lakhs]				
4.4	16.04	12.93	33.37	
Revenue from Lime shell sold [Rs. Lakhs]				
1.4	3.5	1.6	6.5	**39.87**

Source: Primary Survey 2001-02

These tables reveal that:

- Clam fishery and shell fish collection generated a value of Rs. 176 lakhs in Cochin estuary and Rs. 39.87 lakhs in Kali estuary.

Table 7.23 summarises the value generated by the traditional stakeholders of Cochin and Kali estuaries.

Table 7.23 Value generated by the traditional stakeholders of Cochin and Kali estuaries, 2001-02

Agriculture	Fishery	Ferry services	Clam fishery	Sand Mining	Total Rs. Lakhs
Cochin estuary					
583.97	6357.4	82.00	175.9	-	**7199.27**
Kali estuary					
27.89	271.81	32.66	39.87	276.37	**648.6**

Source : Primary Survey 2001-02

So far we explained the activities of the traditional stakeholders in the selected estuaries and calculated the gross livelihood potentials of these groups using simple calculations of the economic value realized by these groups by selling their products in the already existing markets. Despite the limitations of this methodology, the results are revealing on many grounds. As table 7.24 above revealed, these activities are still valuable to traditional communities and the tendencies towards degradation have to be regulated immediately. We shall now

discuss how the modern stakeholders make their values using resources and environment of the estuaries.

7.2 Economic Values Generated By The Modern Stakeholders

In this section we will introduce the nature of economic activities carried out by the modern stakeholders in Cochin estuary and present estimates of gross revenue generated. The major stakeholders who use estuarine environment are modern aquaculture, the Cochin Port Trust; Kerala Shipping and Inland Navigation Corporation, State Water Transport Department and the Tourism Industry.

7.2.1 Economic Values Generated From Fish Farming and Aquaculture

Aquaculture is the second largest livelihood supplier to the traditional agrarian communities around Cochin backwaters. In the study area, the traditional prawn filtration (Chemmeen Kettu and Varshakettu), practices coexist with Modified/improved Traditional prawn filtration and semi intensive and the modified semi intensive prawn culture. Prawn filtration, the most popular culture of prawn, is organised by collecting seedlings entering the estuary during high tides in the Pokkali fields. Such traditional prawn filtration ensures high rates of utilisation coastal wetlands in the area. The crop is harvested within 150 days. What makes the prawn culture attractive is its organic character. Prawns in pokkali fields subsist on organic matter from decayed stubble, drying waterweeds etc and are not fed with chemical feed. In turn pokkali fields are enriched in manure and the excreta of organic wastes from fish and prawns.

Table 7.24 shows the distribution of brackish water area under different aquaculture systems in the Cochin area.

Table 7.24 Distribution of revenue generated under different aquaculture systems in Cochin estuary, 2001-02

Zone	Area under culture [ha]	Avg. yield / ha	Revenue [lakhs Rs]	Value per hector (Rs.)
Traditional prawn filtration farms				
I	229.5	365.1	178.03 [08.7 %]	77,562.5
II A	582.1	375.4	463.86 [22.8 %]	79,687.5

II B	433.9	424.9	405.70 [19.9 %]	93,500.0
III A	645.6	400.1	548.76 [26.9 %]	85,000.0
III B	455.1	455.3	440.02 [21.6 %]	96,687.5
Total	**2346.2**		**2036.37 [100** %]	**86,793.3**
Modified/improved Traditional prawn filtration farms				
I	255.1	809.9	439.02 [02.9 %]	172,125.0
II A	2368.3	874.8	1836.91 [12.0 %]	77,562.5
II B	1765.4	950.4	356.390 [23.3 %]	201,875.0
III A	2626.6	986.9	550.89 [36.0 %]	209,737.5
III B	1851.5	1005.1	3954.10 [25.8 %]	213,562.5
Total	**8866.9**		**15302.91 [100** %]	**172,585.5**
Grand Total	**11213.1**		**17339.28**	**154634.3**

Source: Master Panfish book I, Dept. of Fisheries, Kerala, 2002
@ Calculations based on primary survey, 2001-02

The table reveals that:

- The total value generated from aquaculture is Rs. 17339.281 lakhs.
- Contribution of traditional prawn filtration farms is Rs.2036.37 (11.74%) lakhs while modified/improved Traditional prawn filtration farms generated a value of Rs. 15303 lakhs (82.26 %).
- The average value per hectare of the traditional filtration farms is Rs. 86,793.3.
- The average value per hectare of the modified/improved Traditional prawn filtration farms is Rs. 172,585.5 around twice that of the traditional farms.

Table 7.25 shows the distribution of brackish water area under different aquaculture systems in the Kali estuary.

Table 7.25 Distribution of revenue generated by aquaculture activities in Kali estuary, 2001-02

Zone	Area under culture [ha]	Ave. yield / ha [Kg]	Revenue [Rs lakhs]	Value per hector (Rs.)
Traditional prawn filtration farms				

I	51.0	368.9	39.9	[9.5 %]	78,391.25
Modified/improved Traditional prawn filtration farms					
I	204	877.9	380.66	[90.5 %]	1,86,553.75
Grand Total	255.1		**420.65**	[100 %]	164921.3

Source: Primary survey 2001-02

The table shows that :

- The total value generated from aquaculture activities is Rs. 420.65 lakhs, 91 percent of which is the contribution of modified/improved prawn filtration farms.

- The value per hectare from aquaculture activities in kali is Rs. 164921.The traditional prawn filtration generated Rs. 78391 while the modified/improved prawn filtration farms generated more than double the value of traditional prawn filtration farms.

7.2.2 Economic Values Generated by The Cochin Port Trust

The Cochin Port Trust is a central government public sector company engaged in the export import business. Table 7.26 gives the gross revenue generated by port trust.

Table 7.26 Gross revenue generated by Cochin Port Trust [Rs. Lakhs]

Cochin Port Trust	1996-97	1997-98	1998-99
Cargo handling & Storage Charges (Rs)	945.61	10489.60	10735.47
Port & Dock charges (Rs)	3456.50	4034.48	438.62
Estate rentals (Rs)	863.66	1020.90	1168.83
Total revenue income (Rs lakhs)	**5265.77**	**15544.98**	**12342.92**

Source: calculated from annual reports

It is noted that during the year1998-99, port trust generated Rupees 12343 lakh from the export import business which uses the backwater environment.

7.2.3 Economic Values Generated by the Navigation Industry

As indicated earlier, the modern navigation industry in Cochin backwaters is a mixture of public and private participation. The State has nationalized certain

routes and provides services to these regions. The State Water Transport Department provides the passenger services and the Kerala State Inland Navigation Corporation provides ferry, Jhankar and barge services. Private boats also provide ferry and Jhankar services in the interior regions like Varapuzha, Kadamakuddy, Chitoor and Cheranalloor. **The gross revenue generated by the modern navigation industry** is the sum of the revenues of KSINC and the State Water Transport Department. Table 7.27 shows the distribution of gross revenue generated by Kerala shipping and inland navigation corporation and table 7.28 shows the distribution of values by the state water transport department

Table 7.27 Gross revenue generated by Kerala Shipping and Inland Navigation Corporation

Particulars	**1999-00**	**2000-01**
Total No of boats/ Jhankars in operation	9+2	10+2
No of trips	45840	50698
No. of passengers carried	63.79	66.87
Gross route distance (Km)	470679	378294
Total revenue received (Rs Lakhs)	**695.01**	**730.87**
Total Revenue Expenditure (Rs Lakhs)	636.64	658.35
Net loss	65.06	50.39

Source: Economic Review, 2001

Table 7.28 Gross revenue generated by the State Water Transport Department

Particulars	1999-00	2000-01
No. of boats /jhankars in operation	56	56
Passengers carried (lakhs)	241.09	242.4
Total Revenue Receipts (lakhs)	**420.98**	**464.63**
Total Revenue Expenditure (lakhs)	1106.21	1267.85
Profit/ Loss (lakhs)	(-) 685.23	(-) 803.22

Source: Economic Review, 2001

It can be seen that:

- The KSINC generates Rs. 730.87 lakhs while the State Water Transport Department generates Rs. 464.63 lakhs.
- Therefore the total value generated by the navigation industry from Cochin estuary is Rs.1195.5 lakhs in 2000-01.

7.2.4 TOTAL DIRECT VALUES OF COCHIN ESTUARY FOR THE YEAR 2001-02

Table 7.29 below summarizes our calculations of the direct values of Cochin estuaries.

Table 7.29 Direct Economic Values generated from Estuarine based activities by traditional and modern stakeholders, 2001-02. (Rs. lakhs)

Traditional Stakeholders						**Modern Stakeholders**				
Agriculture	Fishery	Clam & Lime shell collection	Traditional Ferry	Sand mining	**Sub Total**	Culture	Port Trust	Navigation	**Sub total**	**Grand Total**
COCHIN										
583.97	6357.4	**175.9**	**82**	**-**	**7199.27 [18.9 %]**	17339.28	12343.0	1195.51	**30877.79 [81.1 %]**	**38077.06**
KALI										
122.2	271.81	**39.87**	**32.66**	**276.37**	**742.91 [63.84 %]**	420.65	-	-	**420.65 [36.15 %]**	**1163.56**

Source: Primary survey 2001-02

The major inferences of calculations of direct economic value are the following:

- Total gross direct value generated both by the traditional and modern stakeholders from Cochin estuary for the year 2001-202 is Rs. 38077 lakhs.
- Around 81 percent of this is the contribution of modern stakeholders and 19 percent by traditional stakeholders.
- Estuarine capture fisheries contributed around 16.7 percent and agriculture contributed only 1.5 percent.

The Kali, which has experienced low levels of commercialization, exhibits a different pattern. Here out of the total value generated, (Rs. 742.91), 64 percent is the contribution of traditional stakeholders even today. Only 36 percent is the contribution from modern activities.

These calculations reveal that the traditional sector is slowly loosing its economic importance as new modern enterprises encroach into the backwater environment. This mad rush to commercialize the ecosystem hence works against the economic interests of the millions of poor people who depend on this ecosystem for livelihood and hence require immediate and careful coastal zone management with people's participation.

So far we have estimated the direct values related to the economic activities of both traditional and modern stakeholders in the selected estuaries. We shall now proceed to the estimation of recreational and the non-use values in the following sections.

7.3 Estimation Of Recreational Value Of Estuaries: TCM

In tourism parlance, Kerala is known as god's own country. Being an important recreational site, estuaries contribute a large portion of this value. Cochin estuary attracts a large number of domestic and international tourists. For local population also, a visit to the backwaters is refreshing to the mind and the body. Its cool

gentle breeze and its aesthetic beauty make it a preferred venue for recreation seekers. A journey along the backwaters presents everlasting memories to the foreign and domestic travelers who come in large numbers. The backwater can attract more and more people if facilities are provided and options for recreation are widened. Considering the economic significance of this environment, we organized a travel cost survey to elicit its recreational value.

7.3.1 Socio Economic Features of visitors

A look at the socio - economic features of the respondents show that most of the visitors were from lower to middle income groups with an average income of Rs 8085. **[see Table 7.30].**

Table7.30 Distribution of backwater tourists by levels of income, 2001-02

Income	Number	%
< 5000	98	32.78
5000 - 10000	112	37.46
10000 - 15000	45	15.05
> 150000	44	14.72
Total	**299**	**100**

Source: TCM survey, 2001-02

This may be due to the fact that estuaries and backwaters are accessible free of cost to everyone. A look at the occupational distribution of the population further cements this. The professionals, traders and those in service sector constituted about 57% of the sample. Students constituted 14% of the sample. **(Table 7.31).**

Table 7.31 Distribution of tourist's occupations, 2001-02

Occupation	Number	%
Professional Employees	55	18.39
Service Sector	76	25.42
Traders	39	13.04
Farmers	3	1.00
Laborers	20	6.69
Others	48	16.05
Students	43	14.38
Idle	1	0.33
Unemployed	6	2.01
Retired	2	0.67

NRI	6	2.01
Total	**299**	**100.00**

Source : TCM survey, 2001-02

More than 50 percent of the samples are graduates or highly qualified people [Table7.32].

Table 7.32 Distribution of tourists' educational levels, 2001-02

Qualification	Number	%
Primary	10	3.34
High school	70	23.41
Secondary	52	17.39
Graduation	89	29.77
Post graduation	26	8.70
Professional	37	12.37
Others	15	5.02
Total	**299**	**100.00**

Source : TCM survey, 2001-02

The age composition of the sample reveals that majority of them are in the working category. Also a sizeable 70% of the sample comes under the age group of 15 - 35, which clearly reveals that young people are more involved in travel and recreational activities.

Table 7.33 Distribution of tourists by age, 2001- 02

Age	Number	%
< 15	0	0
15 - 25	98	32.78
25 - 35	113	37.79
35 - 45	45	15.05
45 - 55	28	9.36
55 - 65	12	4.01
> 65	3	1.00
Total	**299**	**100**

Source : TCM survey, 2001-02

An analysis of the housing facilities of the sample reveals that 90 percent of them live in own houses and 85 percent of them had independent houses **[Tables 7.34 and 7.35]**. The sample population living in flat was 14 percent. The most common

housing structure of the sample is 2 bedrooms, one kitchen and one hall with other facilities. Average family size of the sample was 5.

Table 7.34 Distribution of respondents housing, 2001-02

Type	Number	%
Independent	257	85.95
Flat	14	4.68
Joint family	22	7.36
Housing Colony	4	1.34
Other	2	0.67
Total	**299**	**100.00**

Source : TCM survey, 2001-02

Table 7.35 Distribution of respondents by ownership on housing, 2001-02

Type	Number	%
Own	271	90.64
Rented	28	9.36
Total	**299**	**100**

Source : TCM survey, 2001-02

The survey reveals that water quality, congestion, lack of public utility services, infrastructure, security, cleanliness etc are the major problems facing the recreation seekers.

Table7.36 Responses of respondents on the quality of backwater, 2001-02

Features	Number	percent
Extremely Congested	49	16.39
Quite Congested	70	23.41
Slightly congested	63	21.07
Water Quality		
Extremely Good	12	4.01
Extremely Bad	55	18.39
Quite Good	45	15.05
Quite Bad	40	13.38
Fairly Good	42	14.05
Fairly Bad	23	7.69
Good nor Bad	82	27.42
Kochi Comparison		
Extremely Good	8	8.99
Extremely Bad	8	8.99

Quite Good	27	30.34
Quite Bad	7	7.87
Fairly Good	21	23.60
Fairly Bad	4	4.49
Good nor Bad	14	15.73

Source : TCM survey, 2001-02

About 60 percent of the sample population feels the sites are congested. Respondent's reflections on various aspects of the site are given in table 7.36.

49 percent of the sampled population rated water quality in backwaters as bad. This is important as the backwaters and estuaries, which have close proximity to urban centres, are being made a dump-yard for wastes. The increasing congestion along the backwaters also accounts for polluting the water with plastics, papers and other waste materials.

The total travel cost consists of three components: cost of travel, time cost and other expenses. Table 7.37 provides the travel costs of respondents by zones for visiting Cochin backwaters.

Table 7.37 Total Travel Cost# for visiting Cochin Backwaters, Kerala, India 2001-02

Zone	Travel costs	Other costs	1/3 Time cost	Total cost Rs.
1	25.26	27.57	11.4	64.23
2	85.07	148.77	44.34	278.18
3	354.05	305.45	59.96	719.46
4	1551.125	623.75	227.34	2402.215
5	9000	1134.29	450.78	10585.07

Source: Primary survey, 2002 # using 1/3 time cost

7.3.2 Visit Rate and Recreational value

The visit rate of each zone to Cochin backwaters is calculated by dividing the total visitors to the site by the population. Table 7.38 provides our calculations of visit rates by zones.

Table 7.38 Visit rates of tourists visiting Cochin backwaters by zones, 2001-02.

Zone	Population	Visit rate
1	7436000	0.096920
2	21663000	0.001916
3	64000000	0.000100
4	120000000	0.000010
5	204937000	0.000008

Source : TCM survey, 2001-02

Table 7.39 gives our estimation of recreational value of Cochin backwaters based on the above travel cost model

Table 7.39 Recreational value of Cochin backwaters, 2001-02

Zone	Actual pop visited	Travel cost [Rs]	Value [Rs Lakhs]
1	720700	64.23	46.29
2	41500	278.18	115.45
3	6400	719.36	46.04
4	1200	2402.215	28.83
5	1700	10585.07	179.95
Total	**7,71,500**		**833.16**

Source: TCM survey, 2001-02

This table shows that:

- The recreational value of Cochin estuary is Rs. 833 lakhs. It may be noted that this value approximates, the environmental value corresponding to the recreational services offered by estuaries. Since there is no tourism in Kali, we have not estimated its recreational values.

7.4 ESTIMATION OF NON - USE VALUES OF ESTUARIES: CONTINGENT VALUATION SURVEYS

One of the major objectives of this study is to measure the non-use values of the ecosystem services provided by the Cochin estuary to residents and to the rest of the world. Non use values are estimated in this study using the contingent valuation (CV) method.

Contingent valuation is a standardized and widely used survey method for estimating WTP for use, option, existence, and bequest values **(Mitchell and Carson, 1989). In order to estimate the consumer's willingness to pay for the non-use values of Cochin estuary, we presented a scenario and a hypothetical market that ensures a better estuarine management programme and improved ecosystem services delivered by estuaries to the respondents. This management programme was to be undertaken by a Consortium consisting of representatives from the state (central, state and local), various estuarine stakeholders, environmental groups and non- governmental organizations.** The results of this exercise are given in this section. The survey was executed on earning head of households or housewives whose age ranges from 25 to 70.

According to the blue ribbon panel's testing protocol, a total sample size of at least 1,000 respondents is required for a DC method. Trained interviewers administered a total of 1415 personal interviews in respondents' home during July and August, 2002. The survey yielded 1100 usable interviews of which 80 were of poor quality. 20 were found to be self contradictory when examined in detail. Reasons for rejection were observed as follows:

1. Bid amounts quoted were too low as to be taken seriously.

2. Gave salary figures that were too low as to be credible when related with their occupation

3. Attitude, perception and valuation questions were answered in contradictory manners making it clear that the respondent had not really understood the scenario or hypothetical market.

Therefore, the findings from the survey are based on the analysis of 1000 interviews. Of this 21.5 percent of respondents stated a negative WTP while the remaining 78.5 percent were Willing To Pay for a better management of the Cochin estuarine system.

Table 7.40 presents the distribution of responses to the valuation question, indicating the total number of respondents who stated that they would be willing to pay for the management program at each bid level, ranging from Rs. 25 to Rs.300.

Table 7.40 Distribution of willingness to pay responses by levels of income, 2001-02

WTP BIDS (Rs)	< 500	500 - 1000	1000-2500	2500 - 5000	5000 -10000	> 10000	Total
0	31	30	58	63	30	3	215
25	13	53	92	60	11	0	229
50	10	19	84	103	33	6	255
100	5	17	47	74	46	14	203
200	2	1	9	10	7	2	31
300	1	4	8	13	3	2	31
> 300	1	7	11	10	4	3	36
Total	63	131	309	333	134	30	1000

Source : CVM field survey, 2001-02

Focusing on the column of YES responses, we see that 78.5 percent of the 1000 sample said 'yes' to the first question, implying that their WTP was Rs. 25. 55.6 percent had a WTP of Rs. 50. 30.1 percent had a WTP of Rs.100. 9.8 percent had a WTP of Rs. 200. 6.7 percent had a WTP of Rs. 300/-. Exceptions were seen in the case of respondents whose bid amount equaled Rs.300. In this case 3.5 percent of the total respondents changed the original amount and quoted WTP greater than Rs.300. Thus, 3.5 percent had a WTP of more than Rs. 300.

Table 7.41 gives the percentage distribution of WTP of respondents classified on the basis of their educational qualification. It was observed that the maximum number of people (54.8 %) WTP for a better management of Cochin estuary were those who had done only their primary education. 20.7 percent of graduates also showed a higher WTP.

Table 7.41 Distribution of willingness to pay responses by educational level, 2001-02

Education / WTP (Rs.)	0	25	50	100	200	300	> 300	Total
Post Graduation	6.5	0.9	5.9	6.9	9.7	3.1	17.1	**5.5**
Graduation	24.2	9.2	17.6	31.0	22.6	34.4	22.9	**20.7**
Technical Course	7.0	4.8	6.3	6.9	6.5	9.4	8.6	**6.4**

Pre Degree	8.8	10.9	16.1	13.8	22.6	9.4	8.6	**12.6**
X Standard	29.3	41.0	28.6	26.6	22.6	21.9	22.9	**30.6**
Primary Education	24.2	33.2	25.5	14.8	16.1	21.9	20.0	**24.2**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: CVM survey, 2001-02

As mentioned above, 21.5 percent of the total 1000 samples were unwilling to pay anything towards Cochin estuarine management although they (95.7%) agreed that wetland functions were of value to mankind. The reasons stated and the percentage responses for those not willing to pay are given in the following table.

Table 7.42 Distribution of reasons stated for negative WTP and the percentage responses, 2001- 02

Reason	%
(a) I don't believe my payment will help in stopping the degradation of the Kayal.	17.2%
(b) It is not worth anything to me	3.3 %
(c) I can't put a rupee value on improved water quality	5.6 %
(d) It is the Government's duty to pay for such expenses	51.6 %
(e) Such expenses are to be undertaken by those who use the estuary.	16.3 %
(f) Other reasons	6.0 %

Source: CVM survey, 2001-02

Table 7.43 provides our estimation of the consumer's total willingness to pay for the delivery of ecosystems services of Cochin estuary.

Table 7.43 Total willingness to pay for the non-use values of Cochin estuary, 2001- 02

	Population *	Total WTP (lakhs)
< 500	4.77	191.1
500 - 1000	9.91	671.68
1000 - 2500	23.39	1581.76
2500 - 5000	25.2	1888.27
5000 -10000	10.14	819.26
> 10000	2.27	317.87
Total (lakhs)	**75.68**	**5469.94**

Source : CVM survey, 2001-02

*** 2000 census of Ernakulam, Kottayam and Alappuzha districts,**

Thus the total willingness to pay for the non-use values of the estuarine services are estimated as Rs. **5469.94 lakhs.**

7.5 VALUE FROM DIRECT, INDIRECT AND NON-USE VALUES OF COCHIN ESTUARY, 2001-02

The following table consolidates the direct, indirect and non-use values of Cochin and Kali estuaries.

Table 7.44 Direct, indirect and non-use values of Cochin and Kali estuaries, 2001- 02

	Cochin Estuary	Kali Estuary
A. Direct Values		
Traditional Stakeholders		
1. Agriculture	583.97	122.2
2. Fishery	6357.4	271.81
3. Clam & Lime shell Collection	175.9	39.87
4. Traditional Ferry Services	82	32.66
5. Sand Mining	-	276.37
Sub Total	**7199.27**	**742.91**
	[16.2 %]	**[63.9 %]**
Modern Stakeholders		
1. Culture	17339.28	420.65
2. Port Activities	12343	-
3. Navigation	1195.51	-
Sub Total	**30877.79**	**420.65**
	[69.6 %]	**[36.2 %]**
B. Indirect Values		
1. Recreational Values	**833.16**	**zero**
	[1.9 %]	
C. Non use Values		
1. Ecosystem Services	**5469.94**	*
	[12.3 %]	
D. Grand Total	**44380.16**	**1163.56**
	[100 %]	**[100 %]**

Source: Primary survey, 20021-02 and secondary data. Not estimated

The summary table reveals that:

- The aggregate value of Cochin estuary from the traditional, modern, recreational and non-use values is Rs. 44380 lakhs.
- The value per hectare of brackish water is estimated as Rs.99, 726.
- The aggregate value of Kali estuary from the traditional and modern activities is Rs. 1163.56 lakhs.
- The value per hectare of brackish water in Kali estuary is estimated as Rs. 35913.

This overall estimate in fact is an underestimate, as it did not cover all the activities both in the traditional and modern sectors of the estuarine economy. Similarly, the contributions of mangroves to the ecosystem and resource rejuvenation have also not been accounted for in this study. However, this empirical exercise to estimate the worth of the Indian estuaries is a novel attempt undertaken to attribute economic values and to guide policies for the optimum use of estuarine resources and environment. For instance, the study will guide pricing of estuarine resources used in long-term development projects undertaken by private and public sector enterprises alike. Similarly, it will enable jurisprudence in settling issues related to compensation and pollution abatement.

7.6 A Comparison of the Total Economic Value generated in Kali and Cochin Estuary

As mentioned in chapters 2 and 7, Kali estuary is an ecosystem least affected by the forces of modernization compared to Cochin estuary. As shown in table 7.45 below, Kali estuary supports 905 fishing households and 469 agricultural households while Cochin, being a larger ecosystem supports18593 fishing households and 10308 agricultural households. The recent boom of prawn exports has of late led to a limited development of commercial aquaculture, while tourism industry has not even developed here so far. Cochin estuary on the other hand

has also been supporting navigation and transport of men and cargo and an active international tourism industry than Kali.

Comparing the activities of Kali and Cochin, we note the following distinct variations clearly. Traditional activities contribute 64 % of the total direct and indirect use values, in Kali while the contribution of the traditional sector is only 18.5 percent. Among the modern activities, 44.6 percent is the contribution of commercial aquaculture, 31.7 percent is that of port trust, 3 percent is that of navigation industry and 2.1 percent by the tourism industry.

Comparing the productivities of fishing, agriculture and aquaculture, we note that Kali estuary is superior to Cochin estuary. For instance, agriculture production per hectare in Cochin is 1392 kg while that of Kali is 1672 kg. In the case of fishing, average production per hectare is found to be lower (463 kg) than Kali (501kg). Comparing value, we note that, the average value per hectare in agriculture in Kali is higher (Rs. 10034) than Cochin (Rs.9728). The value generated by fishery per hectare in Kali, however, was little lower than that of Cochin mainly due to the high unit values of exportable fishes recorded at Cochin than in Kali. In short, the economic activities of an ecosystem affected least by forces of modernization recorded higher values than a commercialised system.

Table 7.45 A Comparison of Cochin and Kali estuary

	Cochin	**Kali**
Population (1991)	1529773	52143
Agriculture area	6003	1218
Agriculture Households	10308	469
Agriculture production (Tones)	8357	2036
Agriculture gross value (lakhs)	584	122
Agriculture production/ha	1392	1672
Agriculture value/ha (Rs)	9728	10034
Area (ha)	27286	3240
Fishermen Households	18593	905
Fish Production (tones)	12643	1129
Fish Production gross value (lakhs)	635	272
Fish Production/ha (Kg)	463	501
Fish Production value/ha (Rs)	23300	8389
Aquaculture area	11213	255
Aquaculture Production (tones)	9598	8646

Aquaculture Production/ha (Kg)	856	800
Aquaculture gross value (lakhs)	17339	421
Aquaculture value per hector (Rs.)	154634	164921
Values		
Traditional Stakeholders (lakhs)	7199	743
Modern Stakeholders (lakhs)	30877.79	420.65
Recreational Values (lakhs)	833	-
Non use Values (lakhs)	5470	-
Total economic value (lakhs)	**44380**	**1164**

Source: Primary survey 2001-02

In order to examine the issue of development of ecosystem in areas generating environmental externalities (negative - positive), we formulated two hypothetical scenarios: The first one discusses the changes in the total fisheries production and value in the highly polluted, less polluted and least polluted areas in Cochin estuary. The results are summarized in table 7.46. The table shows that the total fish production and its value in the area subject to a high degree of negative externalities (Zone II B and III A) are 155159 kilograms and Rs. 8114585 respectively which are lower than the respective production and value levels of less polluted (289830 kg, Rs.16035740) and least polluted (379937 kg, Rs.17260771) areas.

If the externalities are internalized and the environmental quality of the estuary is maintained, the production and value increase many fold. Replacing the values of the polluted area by the values recorded at less polluted and least polluted areas clearly indicates towards an economic benefit to the local communities. For instance, when yield levels of highly polluted area are replaced by values of less polluted area, the production and value increase respectively to 384284 kilograms and Rs. 24232160 and when yield levels of less polluted area are replaced by values of highly polluted area, the production and value of the polluted area increase to 396030 kilograms and Rs 19077984.

Table 7.46 Potential benefits/costs due to the regulation of externalities in Cochin estuary. A hypothetical exercise.

	Highly Polluted Area	Less Polluted Area	Least Polluted Area
EXISTING SCENARIO			
Total production (Kg)	155159	289830	379937
Total value (Rs.)	8114585	16035740	17260771
When yield levels of highly polluted area replaced by values of less polluted area			
Total production (Kg)	384284		
Total value (Rs.)	24232160		
When yield levels of highly polluted area replaced by values of least polluted area			
Total production (Kg)	396030		
Total value (Rs.)	19077984		
When yield levels of less polluted area replaced by values of highly polluted area			
Total production (Kg)	152991		
Total value (Rs.)	7547213		
When yield levels of least polluted area replaced by values of highly polluted area			
Total production (Kg)	178487		
Total value (Rs.)	8285815		

Source: Primary survey, 2001-02

Similarly, when yield levels of less polluted area are replaced by the values of highly polluted area, the production and values **reduce to** 152991 kilograms and Rs. 7547213 respectively. On the other hand if the yield levels of least polluted area are replaced by the values of highly polluted area, the production and values reduce to178487 kilograms and Rs.8285815 respectively. **[See annexure 7.3 for details].** This exercise reminds that it is possible to improve economic benefits to traditional communities if externalities are regulated.

The exercises undertaken above indicate that there exist economic benefits if measures for conserving estuarine biodiversity are enforced through the control of various externalities produced by the modern and traditional stakeholders. At the same time, the calculation of non use values indicates that various

stakeholders/consumers are also willing to pay for conservation programmes, if such activities are executed properly and the environmental quality is delivered in time, including the ecological services (see the WTP questionnaire for the nature of services included in the survey). The process of conservation (the reversibility of ecosystem health) would hence benefit the traditional fishermen, the agrarian communities and those traditional communities likely to undertake modern activities like aquaculture, tourism and even private transport services. This means that, the process of modernization to be adopted for the prudent use of resources and ecological services is one which includes local communities rather than processes that exclude the majority of them as is presently carried out. For instance, since the local agricultural households express propensities towards modern aquaculture, they should be allowed to carry on their activities with proper institutional support subject to locally enforceable norms of conservation. This is important especially in the context of policy and institutional failures of the government. In other words a new sustainable development initiative involving various stakeholders (various local/traditional communities, the modern industrialists, Government agencies, local bodies etc.) that ensures a just distribution of benefits of modernization, alone, can deliver the required processes for estuarine biodiversity conservation. This arrangement of co-management is an essential element of estuarine biodiversity conservation in India.

7.7 Summary and Conclusions

Estimation of the economic worth of estuaries is useful for environmental planning and governance. Unfortunately, this exercise is not very popular in developing countries. This study undertakes such a task for advising the resource governors and various resource users on the need for a rational use of estuaries for making a sustainable living from estuarine ecosystem .In this chapter, we have made an attempt to estimate the different components of the total economic value of the selected estuaries along the western coastal zone of India using neo-classical environmental economic methodology. Direct, indirect and non-use values are

estimated using various established procedures. However, due to scarcity of time, difficulties in organizing the surveys in remote estuarine villages and islands and the poor understanding of the local people about environmental valuation we could not include all the traditional activities in this valuation programme. Nevertheless, this exercise has given an opportunity to judge the perceptions of local communities about the values they attach to their ecosystems.

Market valuation is used to estimate the gross sales proceeds of traditional activities like fishing, clam fishing, meat processing, lime shell sales, paddy production, aquaculture, traditional ferry services. Modern stakeholders use backwaters for various activities mostly by over using living and non-living resources and environment. They also generate externalities affecting the traditional activities in significant ways. Valuation could therefore provide useful insights and simple prescriptions for the better use of estuarine resources and environment.

Annexure 7.1

Cochin University of Science and Technology
School of Industrial Fisheries

Questionnaire for Estimating Recreational Value of Cochin Backwaters

Cochin backwaters are one of the most valuable coastal environments in this part of the world, which provide a variety of recreational potentials to visitors and tourists. The School of Industrial Fisheries of the Cochin University has recently launched a study to understand the environmental value of Cochin backwaters. The objective of this survey is to estimate the recreational value of the backwaters. We request you to co-operate with us by filling up this questionnaire.

1. **How many trips have you made to Cochin Backwaters within the last 12 months for the purpose of**

   (a) Sight seeing and recreation ----------
   (b) Boating ----------
   (c) Cultural Events ----------
   (d) Exercising ----------
   (e) others(specify) ----------

2. **Where do you live?**

   Panchayat :
   District :
   State :
   Country:

3. **If you were not on this trip today, what would you most likely be doing?**

   (a) Working
   (b) Watching TV
   (c) Housework or shopping
   (d) Others

4. **How many hours did you spent in the backwaters today?**

   ( ) hours.

5. **Please estimate the time and distance it takes you to get to the backwater from your home?**

   Hours ( ) kilometers ( )

6. **Please state the cost incurred for undertaking a travel to the Cochin Backwaters**

Items	Rs
(a) Travel from hometown to Cochin Private car(fuel cost) Motorcycle Train Bus Taxi Other (specify)	
(b) Boarding and lodging(no; of days) (c) Food and Beverage (d) Sight seeing and recreating (e) Photographs (f) Others	

7. If you are not from Kochi you came to Kochi for

(a) Conference attendance
(b) Business
(c) Visiting friends or relatives
(d) Tour and travel
(e) Other

8. Have you visited any other site/s before coming to Cochin

· YES · NO

(specify the site/s)

9. Name the sites you visited and planning to visit in Kochi during this tour?

Visited	Planning to visit
1. **2.** **3.**	**1.** **2.** **3.**

10. Which are the other sites you plan to visit during this tour?

(a)
(b)
(c)

11. Are you willing to extend your stay in Kochi to visit the backwaters again

· YES · NO

B

12. Have you visited the backwaters of Alappuzha

· YES · NO

If yes ,

13. How do you rate the Cochin Backwaters with that of Alappuzha

(a) Extremely Good
© Quite Good
(e) Fairly Good
(b) Extremely Bad
(d) Quite Bad
(f) Fairly Bad
(g) Neither Good nor Bad

14. How do you rate the water quality in Cochin Backwaters?

(a) Extremely Good
(c) Quite Good
(e) Fairly Good
(b) Extremely Bad
(d) Quite Bad
(f) Fairly Bad
(g) Neither Good nor Bad

15. From your experience in visiting various sites in Cochin Backwaters how do you feel the congestion in those sites

(a) Extremely Congested (b) Quite Congested (c) Slightly Congested (d) Not Congested

16. What are the other recreational facilities you like to enjoy in the Backwaters?

C

To help us analyse the results, we would like to have the following information.

17. Sex: · Male · Female
18. Age:

< 15	15-25	25-35	35-45	45-55	55-65	>65

19. Education

Primary	High School	Secondary	Graduate	Post Graduate	Professional	Others

20. Occupation and Length of Vacation

Professional	Service	Traders	Farmers	Laborers	Others

21. What is the status of ownership of your house?

· Own · Rented

22. What type of housing do you live in?

		Bedroom	**H all**	**Kitchen**
(a)	Independent house			
(b)	Flat			
(c)	Joint family			
(d)	Housing colony			
(e)	others			

23. what is the size of your family

24. What is the approximate monthly income of your household?

(a) Less than Rs5000
(b) Between Rs5000 and Rs10000
(c) Between Rs10000 and Rs150000
(d) 15000 and above

ANNEXURE 7.2

ECONOMIC AND SOCIAL MANAGEMENT OF ESTUARINE BIODIVERSITY IN COCHIN ESTUARY

CVM QUESTIONNAIRE FOR THE VALUATION OF ECOSYSTEM FUNCTIONS OF COCHIN ESTUARY

Panchayat : Date :
Time of interview : Interviewer :

I. ATTITUDINAL QUESTIONS

1. The environmental services that the Kayals perform for us are invaluable and cannot be replaced if destroyed.
   (a) Strongly agree (b) Agree (c) Neutral
   (d) Disagree (e) Strongly disagree

2. The government should not pursue developmental programmes that damage the Cochin Estuary.
   (a) Strongly agree (b) Agree (c) Neutral
   (d) Disagree (e) Strongly disagree

3. It is the duty of the people to protect their environment. Hence they should take the initiative.
   (a) Strongly agree (b) Agree (c) Neutral
   (d) Disagree (e) Strongly disagree

4. The Cochin Estuary supports 150 species of fish and shellfish, different species of phytoplankton and prawn filtration. It does not matter if a few of these species are lost.
   (a) Strongly agree (b) Agree (c) Neutral
   (d) Disagree (e) Strongly disagree

5. It does not matter if 1000 ha of the backwater is reclaimed for development activities.
   (a) Strongly agree (b) Agree (c) Neutral
   (d) Disagree (e) Strongly disagree

6. What according to you is the best agency to conserve biodiversity in the Cochin Estuary
   (a) State Government (b) Fisheries Department
   (c) Pokkali Land Development Agency (d) Village Panchayat
   (e) A coalition of State agencies, ayalkuttams and other stakeholders who use the Kayal.

II. RESPONDENT'S PERCEPTIONS

7. Environmental quality degradation in Kerala will become more widespread in times to come.

Likely I----------I----------I----------I----------I----------I----------I----------I Unlikely
Extremely quite slightly neither slightly quite extremely

8. To you, how serious is the current state of environment in Kayals/Estuary?

Serious I----------I----------I----------I----------I----------I----------I----------I Not serious
Extremely quite slightly neither slightly quite extremely

9. Deterioration in the quality and services provided by the Kayal ecosystem will affect indirect users of this resource.

Likely I----------I----------I----------I----------I----------I----------I----------I Unlikely
Extremely quite slightly neither slightly quite extremely

10. In the absence of any concrete bids or initiatives to conserve biodiversity, the people will take up the initiative.

Likely I----------I----------I----------I----------I----------I----------I----------I Unlikely
Extremely quite slightly neither slightly quite extremely

11. I will donate money to conserve biodiversity of the Kayal ecosystem.
Likely I----------I----------I----------I----------I----------I----------I----------I Unlikely
Extremely quite slightly neither slightly quite extremely

State of the Kayal ecosystem and its delivery of services in 2015 if current environment management remains the same.	State of the Kayal ecosystem and its delivery of services in 2015 if managed by a Kayal Protection Consortium.
1.A Household/Industrial Waste dissemination function ▪ Congested water channel ▪ Accumulated waste ▪ Contamination of water ▪ Spread of communicative diseases via. Mosquitoes, etc ▪ Non degradable plastic and industrial pollutants ▪ Increased pollution	1.B Household / Industrial Waste dissemination function ▪ Cleaner water channels & canals ▪ Prompt disposal of wastes ▪ Good water quality ▪ Free from communicative diseases. The people of Cochin will be safe from attacks of mosquitoes and such insects. ▪
2.A Shore stabilisation function and flood control ▪ Increase in land reclamation ▪ Increased sedimentation and flooding	2.B Shore stabilisation function and flood control ▪ Dredging undertaken on a small scale to clean up clogged channels and canals ▪ Conserving mangroves to preserve banks
3.A Tidal Functions (Veliettam & Velierrakam) ▪ Reclamation and sedimentation causes salinity intrusion ▪ Reduced inflow of fresh water from river bodies	3.B Tidal Functions (Veliettam & Velierrakam) ▪ Monitor and discourage kayal reclamation and other activities that affect tidal functions
4.A Source of Seedlings and fishery resources ▪ Destruction of mangroves and pollution affecting juvenile seedlings. ▪ Weak tidal functions and destructive levels of seed collection for commercial aqua culture	4.B Source of Seedlings and fishery resources ▪ Conserve mangrove forest in the Cochin Estuary ▪ Organise methods to reduce pollution in the region
5.A Recreational value ▪ Influx of tourism at the expense of the environment	5.B Recreational value ▪ Encourage eco-friendly tourism activities

12. Please rate the consequences of the two scenarios

Situation A
Situation B

III. Valuation Questionnaire

13. If by 2015, we are to achieve the desired environmental quality explained in section B, we will have to start taking many additional environmental measures now both in and around the Cochin backwater territories and in the State and National level. The additional environmental measures that we will have to take in the country to achieve this environment are going to cost money. We will all have to bear this expense?

Yes **No**

14. Assume that a body, reputed for doing efficient and honest work undertakes the task of protecting the Cochin Estuary from further degrading activities like Pollution, large scalar Kayal land reclamation, waste dumping and such other external activities so that we can at least maintain the current Scenario A from further degradation will you be willing to support such a move?
    Yes No

15. If no, proceed to question 17
16. If yes, please go to question 18

17. If you are not willing to contribute, which of the following reasons best describes why you would not be willing to pay anything?
    (a) I don't believe my payment will help in stopping the degradation of the Kayal.
    (b) It is not worth anything to me
    (c) I can't put a rupee value on improved water quality
    (d) It is the Government's duty to pay for such expenses
    (e) I oppose this type of question
    (f) Other, please specify_____

IV. DESCRIPTION OF THE METHOD OF PAYMENT

18. If yes, suppose that the additional environmental measures would mean that your household would have to contribute a one time payment of Rs. 25/- to achieve the environment which can be expected as a result of a more stringent environment policy by the year 2015, would you be willing to contribute this amount?
    Yes No

19. If yes, suppose that the additional environmental measures would mean that your household would have to contribute a one time payment of Rs. 40/-, given your budget constrain, would you be willing to contribute this amount?
    Yes No

20. If no, would you be willing to pay Rs.10/- to achieve the environment, which can be expected as a result of a more stringent environment policy by the year 2015?
    Yes No

21. Suppose that the additional environmental measures would mean that your household would have to contribute a one time payment of Rs.60/- to achieve the environment which can be expected as a result of a more stringent environment policy by the year 2015, given your budget constrain would you be willing to contribute this amount?
    Yes No

22. Suppose that the additional environmental measures would mean that your household would have to contribute a one time payment of Rs. 80/- to achieve the environment which can be expected as a result of a more stringent environment policy by the year 2015, would you be willing to contribute this amount?
    Yes No

23. Suppose that the additional environmental measures would mean that your household would have to contribute a one time payment of Rs. 100/- to achieve the environment which can be expected as a result of a more stringent environment policy by the year 2015, given your budget constrain would you be willing to contribute this amount?
    Yes No
24. What is the maximum amount of money that your household would be willing to contribute to achieve the environment which can be expected as a result of a more stringent environment policy initiated by the environment Protection consortium by 2015?
    The MAXIMUM amount is Rs.

25. Please explain the main reason, which played an important role in determining your maximum amount.

26. Are you willing to pay anything at all?
    Yes No

30. Suppose the situation B can be achieved by the year 2008 rather than 2015, would that affect the maximum amount that you have just mentioned?
 Yes **No**
31. If yes, to specify to what extend? _____

V. DESCRIPTION OF THE CONSTRUCTED MARKET

32. In order to construct and monitor this, the consortium will begin functioning next year. Which of the following methods would you prefer as a mode of payment of this amount to the consortium?
 - A one time green tax
 - Voluntary donations
 - Voluntary donation to the conservation fund floated by the consortium.

VI. PERSONAL PROFILE

33. Have you journeyed along the Cochin Estuary?
 (a) Not yet
 (b) Just once or twice
 (c) Very often
 (d) Will be visiting in the near future

34. Age :
35. Gender :
36. Occupation :
 1. Agriculturist 2. Fisherman 3. Prawn Filteration
 4. Aquaculturist 5. Entrepreneur 6. Government Job
 7. Private Sector 8. Housewife 9. Business 10. Other Jobs

37. Educational Qualification
 1. Masters or higher 2. Bachelor's degree 3. Vocational degree
 4. Pre Degree 5. SSLC 6. _____ Years of schooling

38. Number of members in your family :
39. What is your family's net monthly income?
 (a). Rs. 500 and below (b). Rs. 500 - Rs. 1000
 (c). Rs. 1000 – Rs. 5000 (d). Rs. 5000 – Rs. 10000
 (e). Rs. 10000 and above

40. Are you a member of an environmental organisation?
 Yes **No**

If yes, please explain in detail

DO YOU HAVE ANY COMMENTS TO MAKE ABOUT THIS SURVEY OR THE ENVIRONMENT IN THE COCHIN ESTUARY? IF SO, PLEASE USE THIS SPACE.

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS SURVEY. IT IS GREATLY APPRECIATED.

ANNEXURE 7.3

Existing scenario												
	Chinese dipnet	**Stake net**	**Cast net**	**Gill net**	**Seine net**	**Hooks & line**	**Trap net**	**Scoop net**	**Drag net**	**Ring net**	**Other nets**	**Total**
Highly Polluted												
Avg. yield	2.1	0.0	3.6	2.7	0.0	0.0	0.0	3.4	0.0	0.0	0.3	
Avg. value	211.0	0.0	129.3	133.7	0.0	0.0	0.0	197.1	0.0	0.0	15.4	
Gear	606.0	2625.0	885.0	2268.0	91.0	262.0	43.0	210.0	353.0	348.0	423.0	8114.0
Avg. days op.	14.0	14.0	14.0	14.0	14.0	10.0	10.0	10.0	10.0	14.0	10.0	
Total production	18126.5	0.0	44421.2	84320.1	0.0	0.0	0.0	7163.6	0.0	0.0	1127.3	155158.7
Total value	1789905	0	1601558	4244191	0	0	0	413811	0	0	65120	8114585
Less Polluted												
Avg. yield	1.9	5.1	4.0	3.3	4.2	2.2	2.7	1.0	1.7	0.7	0.7	
Avg. value	258.6	374.3	167.1	155.9	301.1	91.2	164.0	53.1	51.9	31.1	29.9	
Gear	374	1022	1794	1911	98	75	104	162	166	138	255	6099
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	
Total production	10115	72689	101266	87830	5755	1674	2855	1687	2824	1431	1706	289830
Total value	1353770	5354797	4196956	4169662	413095	68413	170511	86024	86086	60130	76295	16035740
Least Polluted												
Avg. yield	3.3	4.5	3.3	3.8	4.1	3.0	1.6	1.2	3.7	1.1	1.5	
Avg. value	291.1	245.0	122.5	149.0	169.8	57.2	66.2	53.7	122.0	41.2	50.9	
Gear	510	1594	1310	1766	586	125	869	162	831	850	300	8903
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	
Total production	23638	101295	60131	92982	33410	3725	14227	2011	31125	12950	4442	379937
Total value	2078762	5468203	2246735	3683817	1392841	71534	575644	86996	1013474	489929	152837	17260771
Scenario when biodiversity is conserved - Applying highly polluted area with values of less polluted area												
Avg. yield	1.9	5.1	4.0	3.3	4.2	2.2	2.7	1.0	1.7	0.7	0.7	
Avg. value	258.6	374.3	167.1	155.9	301.1	91.2	164.0	53.1	51.9	31.1	29.9	
Gear	606	2625	885	2268	91	262	43	210	353	348	423	8114
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	
Total production	16389	186701	49956	104238	5344	5847	1180	2187	6005	3608	2829	**384284**
Total value	2193542	13753759	2070405	4948610	383589	238988	70500	111512	183061	151633	126560	**24232160**

Scenario when biodiversity is conserved - Applying highly polluted area with values of least polluted area												
Avg. yield	3.3	4.5	3.3	3.8	4.1	3.0	1.6	1.2	3.7	1.1	1.5	0.0
Avg. value	291.1	245.0	122.5	149.0	169.8	57.2	66.2	53.7	122.0	41.2	50.9	0.0
Gear	606	2625	885	2268	91	262	43	210	353	348	423	8114
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	0
Total production	28088	166813	40623	119413	5188	7807	704	2607	13222	5302	6264	**396030**
Total value	2470058	9005039	1517832	4730972	216294	149934	28484	112773	430513	200583	215501	**19077984**
Scenario when biodiversity degrades - Applying less polluted area with values of highly polluted area												
Avg. yield	2.1	0.0	3.6	2.7	0.0	0.0	0.0	3.4	0.0	0.0	0.3	
Avg. value	211.0	0.0	129.3	133.7	0.0	0.0	0.0	197.1	0.0	0.0	15.4	
Gear	374	1022	1794	1911	98	75	104	162	166	138	255	6099
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	
Total production	11187	0	90047	71047	0	0	0	5526	0	0	680	178487
Total value	1104661	0	3246547	3576124	0	0	0	319226	0	0	39257	8285815
Scenario when biodiversity is conserved - Applying least polluted area with values of highly polluted area												
Avg. yield	2.1	0.0	3.6	2.7	0.0	0.0	0.0	3.4	0.0	0.0	0.3	
Avg. value	211.0	0.0	129.3	133.7	0.0	0.0	0.0	197.1	0.0	0.0	15.4	
Gear	510	1594	1310	1766	586	125	869	162	831	850	300	8903
Avg. days op.	14	14	14	14	14	10	10	10	10	14	10	
Total production	15255	0	65753	65657	0	0	0	5526	0	0	800	152991
Total value	1506356	0	2370667	3304781	0	0	0	319226	0	0	46184	7547213

CHAPTER 8

Summary, Conclusions and Recommendations

Estuaries are coastal ecosystems that sustain human life in many ways. They provide a variety of livelihood opportunities for rural communities. Fishing, paddy cultivation, traditional prawn filtration, clam fishing and lime shell collection, salt making, coir fibre making, traditional ferry services, clay and sand mining etc. were the major occupations of rural communities. Since these activities were undertaken by them using traditional technologies for their own subsistence needs, local communities could not accumulate wealth to make fresh investments on modern economic activities. The process of economic development hence was the main responsibility of the government.

Of late, these systems have been intensively exploited by modern industrial enterprises due to the influence of globalisation. Many local activities are now organised according to the demands of a growing international market. This process of incorporation of local ecosystems and the subsequent over use of resources and environment intensified the process of degradation. The capacity of these systems to provide food security to the millions of poor people who traditionally depended on such systems has also eroded considerably. These concerns were discussed in many national and international forums and the need for the sustainable use of biological resources and environment was emphasised many times. However, the role played by coastal zones, particularly, the tropical estuaries to sustain global biodiversity have not been properly recognised for want of sufficient empirical studies on the use and abuses of these ecosystems. In India, very few attempts **(Thomson, 2000)** have been made to study them in detail - to value them, look into the causes and consequences of degradation particularly the socioeconomic issues and management. We wish to overcome these lacunae by making an attempt to understand an estuarine system, which is intensively used by various stakeholders along the western coastal belt of the Indian peninsula.

In chapters two through seven, we have discussed the details of various aspects of estuarine biodiversity. We mentioned in chapter 2 that characterizing estuarine biodiversity should ideally capture the nature of diversities in genetic and species composition of the fish, shellfish, benthos, mangroves, birds, animals, trees and vegetation, diversity of ecosystem functions and link these natural processes to the diverse manner in which various communities make their livelihood The current study, however, documented only the fish and shellfish diversity of estuaries and linked these relations with the social and economic forces that influence such uses, relying on a multidisciplinary approach.

An important feature of this inter disciplinary framework is the use of environmental economic concepts and tools for understanding the environmental and socio economic problems of Indian estuaries. We hypothesized that the environmental and socio economic issues related to the use of estuaries arise due to failures of markets, institutions and government policies (UNEP, 1995; Pearce and Moran, 1997). Since different stakeholders use estuaries as a public good and generate various externalities in such uses, it is difficult to achieve efficiency in the allocation of resources in the economy. Lack of well structured property regimes also contribute to the process. We argued that although economic valuation provides useful guidelines for resource pricing in estuarine ecosystems, more meaningful interventions are necessary to ensure sustainable development and governance of estuaries. These interventions have to be integrated with the policy making process of the government and the crafting of various formal and informal institutions for the governance of estuaries. In other words, socio economic management of estuarine biodiversity would require a holistic procedure that recognizes not only the economic values of various resources and the ecosystem/environmental functions, but also the strengths and weaknesses of the institutions to ensure a socially acceptable, fair and equitable distribution of resources and environment. Policies definitely should support such initiatives at the international, national and local levels, which are essential to ensure these benefits to the present generations without denying them to future generations also. The findings of the study indicate the possibility of such an approach for the sustainable development of Indian estuaries.

The major emphasis of chapter 3 was to characterise fish and shellfish diversity in estuaries and to describe their ecological services. The availability of species, however, depends on the hydro biological and anthropogenic interventions. We noted that 73 finfishes and eight shellfishes are recorded during 2001-2002 in Cochin estuary while 63 fin fishes and nine shellfishes are reported in Kali estuary. The lowest specie diversity is recorded in Fort Kochi bar mouth region due to specialised use of Chinese nets. The northern bar mouth region on the other hand recorded species availability between 61 and 68. High species diversity is recorded in the southern side of the medium saline zone (ranging between 68 and 71) while the diversity recorded along the northern side of the medium saline zone varies between 26 and 53. In the fresh water zone, on the other hand, the species diversity varied between 68 and 70.Comparing different zones in Cochin estuary, we find that diversity is higher in the southern side of the medium saline zone followed by the fresh water zone, the northern part of the medium saline zone, northern bar mouth station and finally the Cochin bar mouth station.

Comparing these estimates with previous studies **(Kurup, 1982),** we notice a definite reduction in the availability of estuarine fishes in Cochin estuary. It may be mentioned that previous researchers had recorded a greater number of species in Cochin estuary. For instance, Kurup (1982) had listed one hundred and fifty species of fishes belonging to 100 genera under 56 families from this estuary. The species, which inhabit the different zones of the estuary, are oligohaline fishes (23 species), and truly estuarine fishes (38 species). They reported that Cochin estuary has a highly diversified fishery consisting of about 150 species of fish and shellfishes during early eighties **(Kurup, 1982; Kurup and Samuel, 1985 and 1990).**

From this comparison, it appears that a large number of species, especially fin fishes, from Cochin estuary has vanished during the last 20 years, although it would still be difficult to pinpoint them due to the methodological differences between our study and that of Kurup (1982). However, the fact that large number of species have vanished warrants our concern.

Estuarine biodiversity ensured an equitable distribution of livelihood opportunities for rural communities that lived on the banks of these water bodies. The gazani/ pokkali farmers, the fisher folk, the aquaculturists, clam pickers, the traditional sand miners, the small scale kayal based industry workers etc have all eked out their living from these systems for centuries. Agriculturists and fishers (the ecosystem people) have always been the most prominent users of this ecosystem since times immemorial. It was the main source of livelihood for them and they had their own historical informal institutional arrangements for sharing resources. A detailed analysis of how various stakeholders enforced their claims on estuaries and how modern claimants developed their economic interests on this environment was undertaken in Chapter 4.

The analysis revealed that the process of resource sharing and the economic organization of various production processes had been influenced by local perceptions about ecosystem services and functions. These values are internalised in traditional social institutions. The traditional common property institutions which regulated fishing activities, the padashekara committees that supervised crop rotation in wetlands and the institution of kalakkippidutham, which regulated labour allocations and circulations, stand out clearly as social arrangements for ecological and socio-economic sustainability of estuaries. Rights over fishing grounds/ territories were enforced by defining territorial boundaries and rules for fixing nets within defined territories by respective gear groups during the process of fishing.

The respective gear groups while they fish excluded outsiders from these territories and these territories remained open to all other stakeholders as soon as they finish fishing. As other stakeholders became economically and politically powerful, these customary rights became redundant and projected an illusion of free access relations. We have argued that whether the net is fixed or moving, customary rights existed among the fishermen. An individual fisherman could not encroach upon the territory of others in normal situations. The kayal environment has always belonged to these ecosystem people and no management strategy excluding their customary claims would be effective. Today, fishing households

are centred in zone II while gears are concentrated in zone I. The dominant fishing gear belongs to the category of free nets while fixed nets (Chinese nets and stake nets), constituted one-third of the total nets. A high gear diversity is seen in zone I followed by zone II. The bar mouth area experienced the lowest gear diversity.

The agrarian communities organised their activities through “padashekaram’, an organisation of peasants for initiating collective action. The organisation helped to reduce risks and uncertainties, minimised transaction costs, legitimised labour recruitments and supervised crop rotation in saline wetlands. The Padashekarams also controlled the socio-political life in many villages.

As the fishing communities and agrarian communities enforced their claims on different resource endowments and territories, inter community conflicts were rare among traditional stakeholders. In other words the rights defined and enforced by fishing communities and agricultural communities were mutually exclusive. Fishermen were treated as polluted subaltern classes by the landed gentry and this social distance exists even today.

Although the traditional economies appeared to be equitable and sustainable, they could not generate enough economic surpluses to undertake any substantial investment for development. The state therefore assumed itself the responsibility of undertaking development programmes and projects. This brought in new stakeholders like the port, the navigation and tourism industry; modern industries etc and each group had its own modes of appropriating the resources and the environment. Estuarine resources were subject to high rates of exploitation with the entry of modern enterprises.

Resource degradation is an inevitable outcome of the manner in which the economy (whether undertaken by state or private enterprises), chooses its development path. This study has underscored this crisis clearly in the case of Cochin estuary. Degradation also occurs due to the failures of markets, institutional failures and government failures. Modern stakeholders have produced various externalities through industrial pollution, construction activities, reclamation externalities and dredging. The lack of well-defined property rights runs as a

common thread through all these externalities on estuarine resources including environment.

Available information shows high growth of sediment accumulation in Cochin estuary mainly brought through the rivers joining the backwaters at various points. Sedimentation is also cased by soil erosion, reclamation and construction activities and is found to obstruct the tidal functions of the backwaters at various locations. Sediment accumulation has reduced the mean depth of estuaries in many places affecting fishing activities, water transport and trade. The accumulation of sediments in Cochin estuary has produced serious imbalances on the eco system functions of backwaters seriously in recent years.

Reclamation of estuaries directly impinges on its capacity to deliver their ecosystem services smoothly. We have indicated that reclamations of estuaries and the adjoining wetlands have been undertaken by different stakeholders for various purposes such as agricultural expansion, aquaculture practices, harbor development, urban development and other public and private uses. Of these, reclamations for agricultural purposes mainly paddy cultivation and paddy-cum-shrimp culture has contributed immensely to the horizontal shrinkage of the backwater. Destruction of mangroves has also resulted in the low quality of estuarine services.

Dredging of the estuary has affected estuarine activities badly. The Cochin Port Trust has been (and still is) dredging backwaters without considering the ecological and socio economic implications of such unscientific activities. The local fishermen are the most affected of the lot. Construction activities centered around the harbour and urban agglomerations have also generated serious externalities.

Industrial pollution is an ever-growing menace in this area. Two of the largest industrial agglomerations of Kerala are located on the banks of the estuary. We argued that the level of many pollutants in Cochin estuary is very high even to the extent of causing serious threats to its biodiversity. Industrial pollution has already caused fish mortality in the region and indicates for taking strong regulatory measures to prevent such practices. Many scientists have hence suggested the

need for implementing compulsory regimes to treat the effluents before discharging into the backwaters.

A major failure of the centralised planned development initiatives of the past is its failure to recognise the role of traditional coastal zone institutions and organisations in the control of resources and environment. Institutional failures are also reflected explicitly when the nation and world community fail to craft modern institutions for the management and control of estuarine ecosystems. The major findings of this study clearly indicate that these failures are responsible for biodiversity degradation in the study areas.

Government does not have a holistic vision in crafting policies for ecosystem governance, particularly for estuaries. In fact, government adopts an opportunistic behaviour and collects revenue by issuing permits and licenses to various stakeholders. The State has, over the years, established a number of institutions and organisations with specialized tasks. Most of the formal institutions are either the departments of the State or Central governments, which are created either for implementing various programmes of the government or with the sole intention of management and governance. Autonomous institutions with specified tasks of resource management and development are also seen.

State being the new entrant into this ecosystem, has established State property rights for undertaking new activities like navigation infrastructure developments, port Trust etc. The nationalisation of waterways and enforcement of state property rights has led to the forced eviction of fishermen and other agrarian communities from productive areas of the estuaries. Since state rights are legal, it makes decisions for the management of estuaries ignoring traditional regimes that existed and managed estuarine resources till now.

Informal Institutions, on the other hand, are indigenously evolved sets of customs and societal practices. For instance, the institution of common property seen in backwater ecosystems had performed the allocation and distribution functions efficiently for centuries. Similarly, the padashekhara committees, in the agricultural sector, the Dheevara sabha in fisheries and the institution of Kalakkippidutham

had also been performing similar functions in the traditional economy. It may be mentioned here that, these organisations are still active in many places even today. The analysis revealed that community rights that remain even today are rules that sustained pressures for generations despite State efforts to undermine it. These rights coexist with other forms of property rights regimes.

Biodiversity degradation in estuaries is also caused by government failure to craft appropriate policies in time that are easy to implement, equitable and efficient in managing the resources and environment. As a matter of fact, there exist a variety of legal prescriptions designed for regulating fisheries, agriculture, aquaculture, water quality and pollution, biodiversity protection, reclamation, dredging, resource ownerships, movement of cargo and trade at the international, national, regional and state levels. These policies are scattered in various documents and laws relating to fisheries, minerals, agriculture, Industries, navigation and the Port development, coastal environment and tourism.

The existing policies of the government do not help the traditional stakeholders due to many inherent structural features of the ecosystem and socio economic relations in the estuarine economy. For instance, most of the legal controls in fisheries sector are not easy to implement due to the low living standards of active fishing communities, high costs of enforcements, high political costs and lack of resources and capabilities of implementing agencies to introduce resource management strategies and programmes. The costs of externalities are seldom internalised in state sponsored projects/enterprises. Pollution abatement measures are either not implemented or not enforced due to the very nature of co-existence of state and private enterprises in industrial activities. Abatement costs are easily externalised to other traditional stakeholders.

The environmental and ecological problems of estuarine economies begin here. Biodiversity degradation has imposed severe pressures on the economy and society of various traditional communities. When State sponsored development of resources threatens rural livelihood patterns, conflicts are bound to arise. There are many instances where conflicts occur frequently due to internal contradictions

and plurality in public policies. As is well known, the economic pressures of these conflicts are borne by the traditional fishermen and agricultural communities. State bureaucracy complains that fishermen do not obey government regulations. The mediations of the government are also not efficient either. Disputed parties sometime approach the formal courts to redress grievances. As this mode of redressal is time consuming and expensive very few people have faith in the state and legal machinery. Instead, they look forward for speedy and cost effective grievance redressal mechanisms. A look at the conflict redressal mechanisms show that in most cases attempts are made to redress them at the grass root level itself with the help of local leaders. It is curious to observe that very rarely do political leaders have any say in this matter. People approach courts only in cases where other kinds of settlements impossible. Regulating the modern enterprises, especially to compel them to invest on pollution abatement, is not an easy task due to a variety of problems. As a result these enterprises continue to pollute water bodies and crate externalities.

Thus the aquatic ecosystem has failed miserably to provide decent means of survival to many indigenous agrarian and fishing communities. At the same time, a few group of people use this estuary for making quick profits by dumping industrial and agricultural wastes into its environment mainly by producing externalities. Large scale economic activities on the estuarine environment, different forms of externalities and the increasing amounts of wastes and pollution, if unregulated, will deplete biodiversity and ultimately ruin the environment and the people who depend on it for their livelihood. It may be noted that environmental depletion such as loss of estuarine biodiversity accelerates rural poverty, especially among the marginalized and weaker sections of the population.

Development of markets and state sponsored development projects are believed to degrade the quality of the environment. The case studies narrated in chapters 6 and 7 of this study provided a lot of insights into the manner in which different stakeholders use estuarine resources and environment in the context of modernisation or liberalization. The analysis conducted in this study revealed that the stakeholders use estuarine resources and ecosystem services in their

production activities free of costs to generate economic values. Modern enterprises appropriate and accumulate a greater share of the traditional stakeholders' using the liberalized economic climate and modern technologies. Modern uses of estuaries therefore generate economic disparities between various ecosystem communities and modern users causing resource conflicts and further degradation of resources. An important reason as to why this happens is that the economic worth of these ecosystems are not properly understood by the resource managers and stakeholders. As argued above, lack of a well-defined property rights over coastal zones and resources, externalities, institutional failures and government policy failures also add fire to this growing crisis.

Under such circumstances, environmental economists normally resort to environmental economic valuation to estimate the economic worth of estuary. Economic valuation of estuaries can definitely guide good policies of resources use. Estimation of the economic worth of estuaries is useful for environmental planning and governance. Unfortunately, this exercise is not very popular in developing countries. This study has undertaken such a task for advising the resource governors and various resource users on the need for promoting a rational use of estuaries, which ensure a sustainable living.

The popular method suggested by economists and resource governors is the use of command and control measures and market based instruments for the control of externalities, especially industrial pollution. It is interesting to note that the Indian Government has passed many legal rules for the regulation of industrial pollution in water bodies. These rules are to be enforced by the respective Pollution Control Boards with the help of local bodies and the district civil administration. Unfortunately, the process of enforcements has never been a successful exercise and the problem of water contamination and its impact on the society at large continue to be the major problem in the study area. Therefore we feel that an alternate arrangement involving the cooperation of various stakeholders (both traditional and modern), local bodies and the Government agencies responsible for enforcing regulations could ensure conservation of estuarine biodiversity by mitigating externalities including industrial pollution.

In chapter 6 we discussed how traditional activities are organised by ecosystem communities in the selected estuaries. The lowest level of production is recorded in zone II B that is badly affected by the effluents and waste emissions of the modern manufacturing industries. The average level of estuarine fish production in the Cochin brackish water area is estimated as 4300 Kg. per hectare. Zone II A recorded the highest yield of 2773 kg per hectare, followed by the Munambam bar mouth region with 2761 kg per hectare, zone I with 1169 kg per hectare and Cochin bar mouth with 642 kg per hectare. The lowest productivity is recorded in zone II B with average landings per hectare recording a lowest yield of 288 kg per hectare. In fact this area receives lots of industrial pollutants from the nearby factories.

However, we did not get any clear proof to indicate that traditional wetland paddy cultivation is affected due to biodiversity degradation, especially in areas, which are highly polluted. The annual production of pokkali paddy in zone II B is 2168.6 tonnes (33.02%) followed by zone I with 2094.7 tonnes (31.89%) 9876.856 (30.07%) tonnes, zone II A with 1773.05 tonnes (26.99%), zone III B with 350.17 (5.33 %) and zone III A with 182.01 tonnes (2.77%). The total production during the year is estimated to be 6568.5 tonnes. As a matter of fact, the productivity in this zone (977.30 kg per hectare) exceeded the average productivity for the entire wetland paddy cultivation (854.5 kg per hectare). This may be attributed to the traditional institutions and organisations still playing active role in the organisation of agricultural activities in this region.

The estimation of direct, indirect and non-use values of Cochin estuary undertaken in chapter 7 is interesting for many reasons. Market valuation is used to estimate the gross sales proceeds of traditional activities like fishing, clam fishing, meat processing, lime shell sales, paddy production, aquaculture, traditional ferry services. Valuation of the modern activities is also undertaken mainly to establish the nature of production capabilities of different resource users. This exercise has provided useful insights and simple prescriptions for the better use of estuarine resources and environment. We found that the total gross direct value generated both by the traditional and modern stakeholders from Cochin estuary for the year

2001-02 is Rs. 409.85 crores. Around 77 percent of this is the contribution of modern stakeholders. Estuarine capture fisheries contributed around 22 percent while agriculture contributed only one percent. The available evidences indicate that the farming system is likely to be taken over by modern aquaculture activities very soon due to the existence of high levels of profits and the willingness of farmers to shift from agriculture to aquaculture. Estimation of values has also indicated the taking over of modern activities by modern enterprises. Since no institutional arrangements exist to negotiate a "win-win-win" game among the traditional and modern stakeholders and the environment, modern development activities are likely to ruin the ecosystem and the people alike.

Economic valuation, however, indicates environmentally viable development trajectories for the sustainable use of estuarine resources that accommodate the claims of both traditional and modern stakeholders alike. For instance, the study negates the widely held notion that estuaries are not valuable and hence it can be used as a dust bin both for the urban city and industries. Similarly, it indicates towards the need for pricing the estuarine space and including such costs internal to development projects in future, whether activities are undertaken by the government or the private sector.

The limitations of this approach are also obvious! As repeatedly claimed in this study, valuation of environment supported by the appropriate institutional and organisational arrangements can only resolve the evolving crisis of the estuarine economies. The state has to accept and learn from the experiences of traditional coastal zone institutions. Moreover, it has to initiate the crafting of appropriate modern institutions, if necessary for the better governance of these ecosystems. The collective action necessary for the healthy co-existence of various stakeholders can only be generated through this process. This study is only a beginning to convey this message.

8.1 Principal Recommendations

This inquiry into the nature and causes of fish and shellfish diversity degradation in Indian estuaries revealed that modern development activities adopted for the

growth of estuarine economy and the population had serious impacts on the activities of traditional stakeholders. The loss of fish and shellfish diversity in the Cochin estuary has reduced the income earning capabilities of traditional inland fishing communities. The traditional agricultural communities of this area have expressed strong preferences to convert their paddy fields for aquaculture activities, although the present legal and social rules discourage such enterprising initiatives. Reduction in traditional activities like coir making, ferry services, sand mining etc. had also led to an economic crisis in many estuarine villages/islands. This study indicates that the evolving crisis is mainly due to the degradation of estuarine resources and measures have to be initiated immediately to arrest the process of degradation of biological diversity of Indian estuaries.

From the study, two types of recommendations can be put forward. The first set involves certain measures that need to be undertaken immediately by the Government to slow down, if not stop, the process of degradation of estuaries. The second set of recommendations relates to legal and institutional reforms and corresponding policies that should be evolved at various levels for the management of natural resources and sustainability of Indian estuaries.

Short Run Measures

The recent economic activities promoted by the state have led to the entry of a number of modern stakeholders into the estuarine environment. We found that these stakeholders produce four kinds of externalities namely **dredging, reclamation, industrial pollution and construction externalities**. Since these externalities cause biodiversity degradation and directly impinge on traditional activities we suggest that,

Recommendation 1 Externalities have to be immediately regulated to ensure the ecological sustainability of Cochin estuary.

More specifically we recommend that,

1.1 The Cochin Port Trust should introduce immediate measures to internalise the ecological and social costs of dredging

activities. Instead of using the material accumulated through dredging for reclaiming estuaries as is currently done, the Port Trust should explore the possibility of developing markets for such materials by introducing appropriate economic incentives.

1.2 The Government has to adopt a differential policy for allowing reclamations that support livelihood securities of traditional estuarine communities. It should immediately instruct the local bodies (grama-panchayats) to implement, enforce and monitor an action plan that allows such reclamations.

1.3 At the same time, the government should discourage large scale reclamations of modern enterprises through legal or economic instruments and integrate the initiatives of various government departments and agencies through district panchayats.

1.4 Since the level of industrial pollutants is high especially in and around the areas where modern industries concentrate, steps may be taken to mitigate industrial pollution using environmental economic principles. The Kerala State Pollution Control Board which is responsible for monitoring water pollution and taking corrective measures does not seem to be successful in bringing forth the expected results. Hence we suggest that the Board should develop and initiate concrete action plans for mitigating brackish water pollution and implement such plans/projects with the participation of various stakeholders and local bodies.

1.5 As the construction of bridges and related structures is seen to obstruct the ecological functions of the estuaries, particularly, their tidal functions, measures should be taken both in the engineering design and site selection to minimize such ecological damages. The Public Works Department of the State, the Central Government and agencies like Greater Cochin Development

Authority (GCDA), Goshree Island Development Authority (GIDA) etc should undertake impact assessment studies before introducing such large projects using ecosystem services.

1.6 Since a number of State sponsored industries are seen to pollute Cochin estuary, steps should be taken to ensure such enterprises internalise the environmental damage costs that they create. The Department of Industries should bring out a status paper indicating the social and ecological costs applicable to various potential industries planning to locate their plants in the catchment areas of Cochin backwaters and should strictly enforce these rules. Industries that emit water pollutants should not be allowed to locate their activities along the catchments of the estuary.

1.7 The State should view public resistances and agitations against environmental degradation in the proper spirit and attempt to integrate these feelings in environmental policies. Oppression of social and environmental movements brings more harm than good.

Long Run Policy Measures

Need for a comprehensive national policy on estuaries

In order to achieve an equitable and sustainable sharing of estuarine resources, the Government should immediately declare an "estuarine development and management policy". It is unfortunate that India does not have a comprehensive policy document for the exclusive development and conservation of its estuaries. The economic activities on estuaries are still governed by the general rules of the Environment Protection Act, 1986, while the Coastal Zone Regulation Act regulates only those areas which lie within the limits of the Act. Therefore,

Recommendation 2. The Ministry of Environment and Forests should draft a comprehensive "estuarine development and management policy" to ensure equitable and sustainable use of estuarine resources and environment.

It should be born in mind that the measures taken by the Government so far have not been successful enough to ensure the sustainable and equitable sharing of estuarine resources mainly due to the adoption of centralized bureaucratic governance which do not provide enough space for the participation of local stakeholders and aboriginals. Therefore, the study would recommend a change in the perspective and approach that has been adopted in estuarine management so far and the proposed policy document should indicate the rights and responsibilities of the Central, State, local self Governments and other stakeholders in the use of estuarine resources and environment.

Empowering local institutions for governance

Once the shift in the approach towards governance is established through the policy declaration, the state has to initiate a process to empower the local self-governments to undertake the task of resource management. The existing structure of estuarine governance in the state does not seem to be working effectively for various reasons. Structural reforms, including enactment of legal codes and informal codes of conducts, are therefore required at the grass root level. Therefore,

Recommendation 3. The Government of Kerala State should enact a legislation empowering the local grama panchayats as nodal agencies responsible for the control and management of estuarine resources and environment.

Co-management of estuaries

The government should also take measures to dissolve obsolete organizations and decentralize activities. The local bodies responsible for resource management should then develop and implement strategies and procedures which provide incentives for different stakeholders to comply rules. Since supervisions and enforcement are expensive, local bodies and other enforcement agencies should aim for cost effective methods of resource conservation. Accordingly,

Recommendation 4. The state has to ensure the participation of local stakeholders in the management and governance of estuaries.

Traditional knowledge systems and institutions

Most of the recent policies and management principles, however, make use of knowledge systems of modern science and technology for initiating and managing the process of development and change in estuaries. The role of traditional institutions and organisations in the allocation, control and governance of estuarine resources has been grossly under estimated by the policy crafting authorities in India. Policy makers have to remember and recognise that traditional communities around estuaries have been managing their activities with the help of traditional coastal zone institutions and organisations. Therefore we recommend that,

Recommendation 5

Traditional coastal zone institutions based on estuaries have to be studied in detail and indigenous knowledge systems have to be properly integrated for the better governance of estuarine systems in India.

The recommendations listed above points towards the crafting of a new approach towards the management of Indian estuaries. The current study observed that the estuarine ecosystems generate a huge gross value. While the issue of value elicitation could be debated, the analysis still points to the fact that a large proportion of this value is being appropriated by the modern stakeholders through

spatial restructuring of the ecosystem challenging both the sustainable use and equitable sharing of the resource. **One has to seriously look into why none of the traditional stakeholders have entered into any of the modern activities. Therefore we recommend that**

Recommendation 6 State has to ensure a choice of coastal zone development strategies that improve national wealth without affecting the livelihood of traditional communities.

We have already indicated that the partnership between the public and private stakeholders could deliver an outcome that is acceptable to various parties and environmental economic approaches are helpful in deriving such arrangements of good governance.

Glossary

Biodiversity

The variety and variability of life in all its forms, levels and combinations and the ecosystem complexities in which they occur. They include species diversity and genetic diversity and ecosystem diversity.

Cheena vala (Chinese Net)

A fishing gear that is commonly seen in the estuaries of Kerala and along the coast of China. It is a kind of dip net, attached to a huge wooden structure that is lowered into the water so that over a period of time, fish or prawns will swim over it and get caught in the net when the wooden structure to which the net is attached is lifted up.

Chemmeen

The commonly used local name in Kerala for different species of estuarine and brackish water prawns.

Devaswoms

Dewasoms are Temple Trusts formed for managing the resources of Temples.

Dheevara sabha

An organization of fishermen belonging to the Dheevara community or caste. They specialize only in the use of Stakenets.

Ecosystem

An ecosystem is a system where populations of species group together into communities and interact with each other and the abiotic environment.

Ecosystem Diversity

The variety of unique biological communities found on the Earth. A component of biodiversity. Also see genetic diversity and species diversity.

Estuary

Somewhat enclosed coastal area at the mouth of a river where nutrient rich fresh water meets with salty ocean water.

Externality

An externality is said to exist when the welfare of one agent (firm or consumer) depends directly on the actions of another agent.

Gill net

The most commonly used kind of fishing gear in the Cochin backwaters and adjoining areas. It is a single walled net whose lower edge is weighted down by sinkers and upper edge is raised by floats and with a mesh opening of such size that the fish of the required group can gill themselves in the netting. Common local names of this kind of net include Vysali vala, Chemmeen vala, Karimeen vala, Kozhuva vala, Neettu vala, Odakku vala, Ottam vala, Ozhukku vala and Pattu vala.

Kalakkipiditham (Thappiyedukkal)

It is a social arrangement, an informal institution, by which the land owning classes granted free access to the local working classes for fishing at the end of the prawn filteration season. This usually takes place for a week during the festival of Vishu in April.

Karimeen

The commonly used local name in Kerala for the species of estuarine and brackish water fish referred to as the Pearl spot or *Etroplus maculatus*.

Kayal

The commonly used local name in Kerala for the backwaters or estuaries. They generally refer to water channels that that have connects with the backwaters also.

Ooni-nira (Oonnipadu)

It refers to a single row of Stakenets set up across the estuary. Number of nets in a single Ooni-nira vary depending upon the length of the Nira and the strength of water current sin that area.

Oonni-sangham

It refers to the informal group of fishermen who have put up nets in a single Ooni-nira. The Ooni sangam determines rules of access and sharing rights.

Oonni vala (Stake net)

A fishing gear used in the backwaters and estuaries of Kerala. It consists of a conical net fixed in streams and tidal waters to filter out small fish and prawns that are swept along its course.

Padashekaram

They refer to a collective of individual neighbourhood farmers having fields that vary in size but are located in a particular geographical space.

Veliyirakkam

The process of outflow of water from the estuary into the sea during low tide.

Veliyettam

The process of inflow of fresh water into estuaries from the sea during high tide.

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