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Environmental Conservation and Valuation of East Calcutta Wetlands

Kunal Chattopadhyay

Indian Statistical Institute, Kolkata

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Contents

List of Figures

List of Tables

Preface and Acknowledgements

In response to the advertisement for World Bank Project- Environmental management Capacity Building (EMCaB), the present project was sent to Indira Gandhi Institute of Development Research (IGIDR) Mumbai in August 1998. After some modifications as suggested by the Steering Committee of the Environmental Economic Research, it was resubmitted on December 1998. It was then sent to external expert for peer review. We received some valuable suggestions to improve the quality of the proposed project. Incorporating those, the project was submitted again. By D.O.No EERC/JP-RS/P91/98/6-2 of February 8 1999, Dr (Mrs) Jyoti Parikh, Senior professor and Chairperson, Environmental Economics Research Committee (EERC), EMCaB Project, informed that the project had been provisionally selected for funding. The Principal Investigator (PI) was invited to present the proposal at the project development Workshop held on 11-13 March, 1999 at IGIDR. The PI attended the workshop and presented the project. Finally, the Director and PI on behalf of Indian Statistical Institute and Chairperson, EERC, IGIDR signed the memorandum of understanding on 25 March 1999.

Soon after receiving the assignment, contacts with relevant organizations and experts were established; interview schedules and questionnaires were framed; and villages were selected. Field survey started from June 1999 and continued for 10 months up to April 2000.

The draft report of the project was submitted on 1 November 2000 and PI presented the report before EERC members and other experts on January 5 2001. We were requested to incorporate some suggested revisions and resubmit the final report. The present report is the output of the same.

We express our thanks to Dr. (Mrs.) Jyoti Parikh, Senior Professor of IGIDR for entrusting this study. We must express our gratitude to Professor S.B. Rao, Ex-Director, ISI and our present Director Professor K.B. Sinha in making available to us various facilities we needed at different stages of this study. We are thankful to Professor Robin Mukherjee of ISI who was very inquisitive about our project. Our grateful thanks are due to Professor Arijit Chowdhury of ISI for his valuable advice in various stages of the study. It is a great pleasure for us to record our deep appreciation of the enthusiasm shown by Dr. Dhrubajyoti Ghosh, Chief Environment

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Kunal Chattopadhyay

Principal Investigator

Krishna Mazumdar

Co-Investigator

Chapter 1: Introduction / Background

Environmental degradation associated with development and population growth is visible all over the world. India is not an exception, where daily survival is put at stake when environment degrades. Both economists and natural scientists have appreciated this environmental consciousness that has emerged in the context of development debate. The old notion that we will first grow rich and then take care of environmental problems is an unmaitenable concept (Chakrabarty, 1992). In economic terms, path dependent equilibrium makes it very clear that it is often not possible to revert an old state of affair, once certain things have been destroyed, and destroyed irreversibly. This is one reason, analytically speaking, why it is important for the environmental dimension to be brought into the general development debate.

However, economists and natural scientists tend to differ with environmentalists. While economists tend towards short run, environmentalists emphasize the long term.

There is also a dispute among national account statisticians and economists about how to value environment. While accounting approach prefers to record the actual financial transactions, the economists go beyond that. Further more, true damages of environmental degradations remain uncaptured in the pure accounting approach. It can be argued that the accounting approach will give an under estimate due to minimum coverage and economic approach may give an over estimate due to subjective valuation.

In addition to these approaches there is also the environmentalists' perspective. The latter see our economic system as a part of natural system and not the other way around. The price of environmental amenities such as lakes, rivers, mangroves, national parks, coral reefs, wetlands and so on may be a difficult proposition but needs to be addressed.

Economic valuation of environmental resources (and consequently their impact assessment) can make decisions on resource utilization and allocation more meaningful. These need to be undertaken when markets fail to generate the true price of the resource in question. Once one goes beyond anthropocentrism, the valuation problems become issues of deep philosophy with the question like 'how much is bio-diversity worth', or 'what is the value of water body'.

The economic arguments supporting environmental conservation in wetlands, national parks and forests are well known and well documented (Dixon and Sherman, 1990; Panayotou, 1990; Pearce, 1990; Norton-Griffiths et al, 1995; Pearce et al, 1994; Hadker et al,1995; Bishop, 1997; James and Murty, 1999). Authors distinguished carefully between use and non-use values. Use values can include the direct values from production of goods (eg agricultural produces) and services (eg Eco-tourism) and the non-use values follow from the immediate or future benefits of nutrient recycling, watershed and erosion protection and bio-diversity.

There are three types of resources in building the base of what is popularly known as conservation economics. These are stock resources (non-renewable), flow resources (renewable) and critical zone resources. A critical zone resource can be replenished until threshold of irreversible depletion has been reached. Beyond that level it may be lost forever. The wetlands of Calcutta are considered as critical zone resources. The total area of the water body had been reduced by two thirds during last forty years and still under threat now. In the present study, this complex ecosystem has been examined both economically and ecologically in the context of sustainable existence of the great metropolis, Calcutta.

1.1 Definitions of Wetlands

Wetlands are one of the most important ecosystems, which have multiple utilities. Some of the functions of wetlands are stated in table1.1.The products that are produced in wetlands are: forest resources, wild life, fisheries, agricultural resources, water supply, energy resources etc. These are lands, transitional between terrestrial and aquatic systems where the water level is unusually at or near the surface. Wetlands must have one or more of the three attributes: (i) at least periodically, the land supports predominantly hydrophytes; (ii) the substrate is predominantly undrained hydride soil and (iii) the substrate is unsoil and is saturated with water (Vass K K, 1998). This definition is widely accepted by wetland scientists all over the world.

Due to wide diversity of wetland types and ecosystems, the definition of wetland is much controversial. According to Ramsar Convention (1971), wetlands are, " areas of marsh, fen, peat land or water, whether natural or artificial, permanent or

temporary, with water that is static or flowing, fresh brackish, or salt, including areas of marine water the depth of which at low tide does not exceed six metres".

The Asian Bureau (1991) defined the wetlands of south and west Asia as: "Estuaries and deltas, salt marshes, mangroves and mud flats, coastal lagoons, fresh water lakes and marshes oasis, salt marshes, seasonal flood plain wetlands, swamp forests, rivers and streams, man managed systems such as rice fields, fish ponds and reservoirs".

Science and Environmental Education Society, New Delhi gave a very lucid and straightforward definition of wetlands. According to them," Wetlands are those areas that remain waterlogged or submerged under water, seasonally or throughout the year. Generally, the land is so muddy that one can not easily walk over it, and the water is so deep that one can neither swim nor get drowned".

The main biotic feature of wetland ecosystem is the low depth of water cover over the soil. This shallowness of water cover causes the wetlands to occupy a position intermediate between terrestrial (dry) and aquatic (deep-water) ecosystems and also allows sunlight to penetrate up to the bottom. With the helps of solar energy and existing nutrients, wetlands allow in them luxuriant growth of plants, the primary producer in food chain. These plants in turn support the lives of secondary and tertiary producers.

One category of wetland fauna that has assumed worldwide interest and concern of environmentalists are the waterfowls, that largely depend upon the water bodies for their livelihood. The first Ramsar Conference held in Ramsar, Iran was the result of such concern. The focus was largely on the role of wetlands as waterfowl habitat. The participating countries decided to launch a programme of identifying and conserving selected wetlands within their territory as 'Ramsar sites'.

Over last 30 years, the perception of Ramsar convention has undergone significant changes. Wetlands are not only waterfowl's, but for a whole range of wise-use practices. That includes fisheries, tourism, bio-diversity conservation, waste recycling etc. The list of sites under Ramsar convention increased significantly. So has been the number of participating countries. The 1996 convention meet at Brisbane, Australia dealt at length on the future direction.

India, as one of the signatories of Ramsar convention has so far been able to declare six sites as of international importance. These are: Chilka (Orissa), Loktak (Manipur), Wular (Jammu and kashmir), Sambhar (Rajasthan), Bharatpur (Rajasthan), and Harike (Punjab).

Recently, Ramsar Bureau selected 17 case study sites all over the world to demonstrate and understand wetlands. In that list, East Calcutta Wetlands (ECW) are the only entry from India. On February 3 2000, ECW have been designated as Ramsar site.

1.2 Early History of East Calcutta Wetlands

Being a part of the mature delta of the river Ganga, the wetlands of eastern Calcutta were marshes. Before the establishment of Calcutta, the salt-water lake was a backwater swamp and spill area of the Bidyadhari river. The tidal flow from the Bay used to increase salinity in water. The vast expanse of the water bodies located to the east of the city had long been known as salt-water basin.

During early days of settlements, the Britishers were more concerned with transportation of goods for commerce from the hinterlands of Bengal (like Assam, Chandpur, Khulna, Dhaka or Barisal) than drainage system of the upcoming city. Majore William Tolly, chief engineer was permitted to excavate the Tolly's Nullah (the silted up bed of Adi Ganga) at his own cost. He was also allowed to collect toll (tax) from the cargo boats. The Tolly's Nullah was finished in 1776. This canal connected Bidyadhari at Shamukpota (a mouja under present waste recycling region) and river Hooghly near Hestings.

The natural elevation of city Calcutta is six to seven metres along the levee of the river Hooghly and .26 metre at the existing wetland sites. Further more, about 80 per cent annual rainfall in Calcutta takes place during monsoon (i.e. between June and mid September). Given these geo-climatic factors, the sewerage planning authority could not realize the natural gradient of the city in early days. In 1803 the city drainage was directed artificially to the river Hooghly. But it required not much time to realize the early decisional misfire.

Subsequently, as the city began to grow faster, the British authority started to engineer an advanced drainage system. But it took fifty more years to come to grip with the problem. By that time Beleghata canal (an old channel) was excavated in

1810 and circular canal was dug in 1829. The then Governor General of India, Lord Wellesly appointed a committee to examine the problems and submit recommendations. The committee approved a combined scheme for the disposal of (a) storm water, (b) sewage and (c) dry weather flow. It also proposed a scheme of under ground drainage for disposal of sewage. The entire scheme followed the natural slope of the land towards the south east through Bidyadhari and Matla River. This drainage scheme was finally completed in 1884.

In the mean time, several interference took place including human intervention. As a result, due to increased siltation, Bidyadhari failed to flow down the collected sewage. Finally, in 1928, the river was declared dead. In 1943, the out fall system was changed from south-east to the Kulti Gung (river).

1.3 Ecological and Economic Functions of East Calcutta Wetlands

Wetlands of Calcutta play a significant role in the ecological and economic security of the region. The large numbers of population living in and around ECW depend upon this water body for their sustenance. The staple food of the local people along with fish and vegetables is directly linked with ECW.

Although a part of ECW belongs to the Calcutta Municipal Corporation (CMC), the entire area is rural and agricultural. People are mostly engaged in agriculture, pisciculture and trade related to these primary activities. The main agricultural produce of this region is paddy. Among others are maize, oilseeds, sugarcane and vegetables.

With the diversion of city sewage and storm water into the salt lakes and the deterioration of river Bidyadhari there was a gradual change in aquatic environment from saline to non-saline. This led to the change in the composition of fish raised in the region. A large number of local inhabitants are gainfully engaged in aquaculture at the site of ECW.

Calcutta has been described by many as ecologically subsidized city for its two special geographical features. One is the existence of river Hooghly on the west as the source of drinking water. The other is the vast low-lying area on the east that plays the role of a sink. Naturally, government got hooked to several ideas about the potentials that the wetlands under study could offer.

The whole of the northern and eastern parts of Calcutta area including Calcutta city and other suburbs in the eastern part of the metropolitan district together now drains its surplus water into the Haroa- Kulti Gung system. Its capacity to clear the water is indeed questionable. More over, Calcutta has no sewage treatment plant. The only one that was installed at Bantala had long been left out of order. It is the wetlands that act as bio-treatment plant and treat the sewage without involving any cost.

At present there are altogether 69 lock gates in four out fall canals on Kulti near Ghatakpukur. All these canals meet Kulti River within a distance of about two kilometres. The number of respective lock gates are given in table 1.2

About 75 per cent of the total waste flow through Dry Weather Flow (DWF) and Storm Water Flow (SWF) channels from Bantala to Kulti. Fifteen per cent waste is carried from the northern part by Bagjola canal and Krishnapur canal. In the south, Tolly's Nullah carries 10 per cent of the discharge from the city. Almost all the canals are in extremely palpable condition now.

ECW also help in removing heavy metals, like lead, chromium, etc. by ion exchange. On the basis of 11 sampling sites it had been found that as distance increases from pumping stations concentration of organic nitrogen, dissolved phosphorous, lead and chromium is lowered (IWMED, 1997).

Among other ecological functions, ECW act as primary producer of carbon, bio oxygen, biota like zooplankton, phytoplankton and so on. Their role in reducing BOD and coliform bacteria is also significant. ECW are also important sites for controlling climatic stability with assured wind circulation. Finally, ECW with variety of habitats sustain rich biological diversity.

Table 1.1: Wetland's Functions

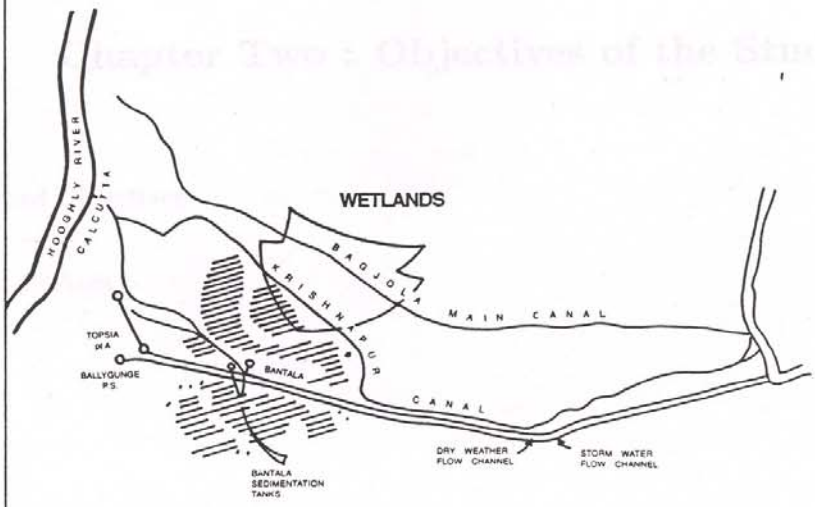
Functions	Components
1 Hydrology	Flood control Ground water recharge/discharge Shore line anchorage Dissipation of erosive forces
2 Water quality	Waste water treatment Toxic substances Nutrients
3 Food-chain support/cycling	Decomposition Nutrient export Nutrient utilization
4 Habitat	Invertebrates Mammals Fishes Non-game birds Game birds
5 Socio-economic	Consumptive use value Non-consumptive use value (e.g. recreation)

Table 1.2: Canals carrying wastewater of Calcutta

Name of Canal	Number of Lock gate
Bagjola	9 + 10
Bhangar Kata Khal	14
Storm Water Canal	20
Dry Weather Flow Canal	16
Total	69

(Fig.-1)

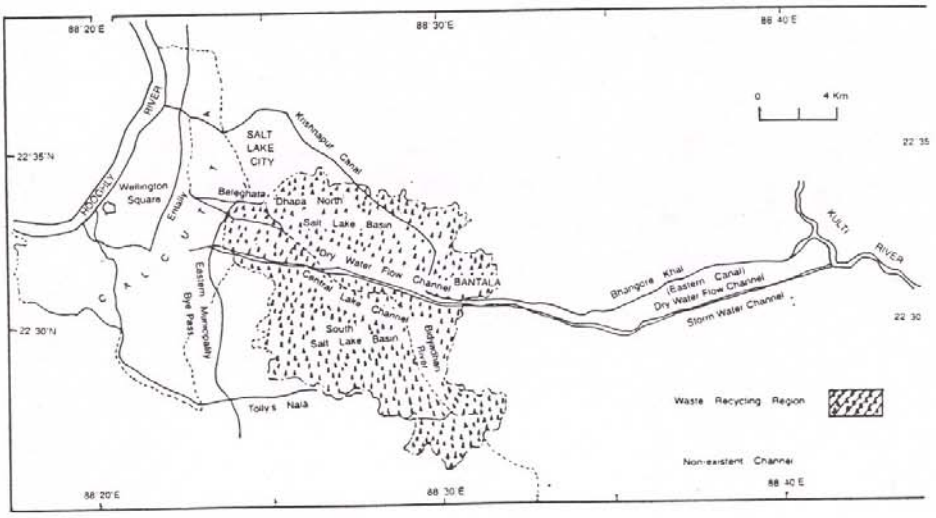
WETLANDS ON THE EASTERN FRINGE



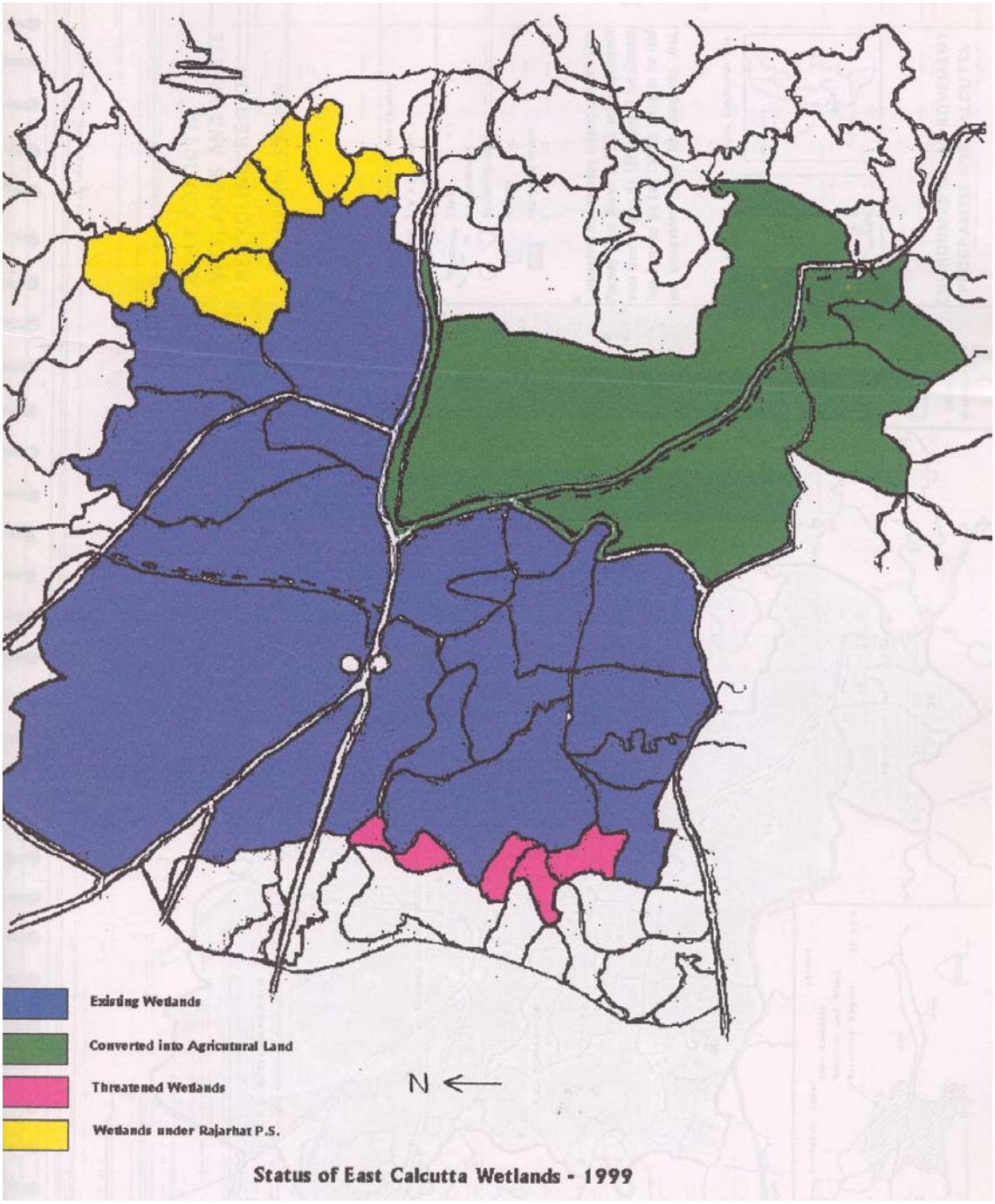
Source: The Institute of Wetlands Management

(Fig-2)

CALCUTTA'S WASTE-RECYCLING REGION



Source: The Institute of Wetlands Management


Existing Wetlands
Converted into Agricutural Land
Threatened Wetlands
Wetlands under Rajarhat P.S.
N
Status of East Calcutta Wetlands - 1999

Chapter 2: Objectives of the Study

2.1 Broad Objectives

Wetlands in Calcutta demonstrate the surfeit of positive externalities. Very few of them have been internalized in the commodity pricing system or municipal tax evaluation. Therefore, the conservation of this unique natural resource faces an uneven challenge in the market where other opportunity costs are well calculated. For sustainability of this ecosystem, the threatened livelihood of the people living there is required to be inventoried properly. To assess these, it was necessary to collect information on the following aspects:

1 Socio-economic characteristics of the wetland dependent people.
2 Factors influencing the activities.
3 People's perception about wetlands.
4 People's willingness to pay for preserving the resource.
5 Employment generation through wetland based activities.
6 Ascertaining the damage (if any) caused by conversions.

The broad objectives of the study were

i) To identify economic activities.

ii) To estimate as far as practicable the quantity of directly and indirectly generated income and employment through various economic activities based on ECW.

iii) To examine and weigh the arguments and justifications if any to divert the growth process of ECW .

iv) To ascertain the nature and extent of damage likely to be caused due to the ecosystem by urban expansion.

2.2 Study Area

The study area lies between Latitudes $22^0$25' to $22^0$40' North and Longitudes $88^0$20' to $88^0$35' East approximately. It has a hot and humid monsoon climate governed by the Himalayas in the north and the Bay of Bengal in the south. January is the coolest month with temperatures ranging between 10^0C to 20^0C while May experiences

maximum temperature ranging between 30^0C to 40^0C. Average relative humidity is high being 70 per cent to 90 per cent approximately. Average annual rainfall is about 1582 mm and is mainly concentrated in the months of June, July, August and September.

The study was primarily based on the area of WRR that lies to the east of Calcutta. The conservation boundary of the map was based on a W B State Planning Board Report of 1985 and subsequently made mandatory by the 1992 ruling of the Calcutta High court on the ECW for land use conservation within the designated area. The map was almost identical with that of 1960.

During last 40 years, a significant change has taken place in land use pattern and character of the soil in east Calcutta. One determining feature that could be considered as the basis of getting waste recycling status was using waste water for agriculture as well as pisciculture. But, in spite of having this character, some neighbouring moujas were left out of the official map. One mouja is a small administrative unit consisting of few villages. Six such moujas of adjoining Rajarhat police station and one mouja of Tiljala Police station had been identified as wetlands by our research team and were brought under the present study. Moujas under Rajarhat Police station of 24 Parganas(N) district are: Ghuni, Jatragachi, Mahisbathan, Mahisghot, Rekjuani and Thakdari**.** The combined area (1808.53 hectare) of these moujas had come under notification of acquisition for new Calcutta Township. This new town is coming up on the proposed land of 3075 hectares located mostly in Rajarhat Police station. The mouja under Tiljala Police station lying out side the WRR boundary is Madurdaha. This mouja is under word number 109 of CMC. Both land use and the occupational pattern of the residents of this mouja fairly reflect wetland character. But the close proximity of the Eastern Bypass increased the externalities with short run speculative opportunity cost in recent years.

Thus, altogether 39 moujas (32 from WRR and seven from outside) have been taken as our area of study in four Police stations of three districts (table 2.1). The official WRR comprises 32 moujas from four police stations: Bidhan Nagar (south), Tiljala, Sonarpur and Bhangar. Of these, Tiljala comes under Calcutta district; Bidhan Nagar (south) belongs to North 24 Parganas district and Bhangar and Sonarpur fall in the district of South 24 Parganas.

We examined in detail different studies and maps of ECW of the local governments and other agencies. Going through the available reports of various organizations like Ministry of Environment, government of West Bengal; Institute of Wetland Management and Ecological Design (IWMED), we noted certain ambiguities. Most of these ambiguities originated from the very definition of wetlands. We felt it necessary to resolve these ambiguities.

It was noted that wetlands and canals were inseparable in this complex ecosystem of Calcutta. It was found from the historical records and maps that many of the natural drainage channels were excavated after siltation. It was therefore, decided to extend the existing area of wetlands and waste recycling area up to Bagjola canal to the north in stead of Krishnapur canal.

Table 2.1: Summery Table on Study Area and Sample Size

District	P. S.	Mouja	No of Listed Households	No of Sample Households
Calcutta	Tiljala	Paschim Chowbaga Dhapa Madurdaha	201 313 288	18 46 31
24 Parganas(N)	Rajarhat	Jatragachi Ghuni	405 307	32 36
24 Parganas(S)	Bhangar Sonarpur	Kulberia Dharmatala Pachuria Hatgachia Hadia Kheyada Kharki Bhagabanpur Karimpur	606 400 232 381 280 183 435 60	54 57 25 33 24 18 62 07
Total			4091	443

Table 2.2: Total Population at the Site of East Calcutta Wetlands ('99-'00)

District	Police station	Population
Calcutta	Tiljala (with Madurdaha)	41199
24 Parganas (North)	Rajarhat (six mouzas)	39082
24 Parganas (South)	Bhangar	28227
24 Parganas (South)	Sonarpur	35915
Total		144423

Table 2.3: Moujas under East Calcutta Wetlands and Waste Recycling Region with Area (hectare)

District	Police station	Mouja	Area
Calcutta	Tiljala	Dhapa	294.37
		Chowbaga	176.19
		Paschim Chowbaga	51.58
		Bainchtala	312.70
		Dhalalda	51.14
24 Parganas (N)	Bidhannagar (S)	Dhapa Manpur	2417.00
24 Parganas (S)	Bhangar	Kulberia	384.57
		Dharmatala	602.14
		Baonta	1040.52
		Hadia	506.82
		Tardahacapasati	75.08
		Hatgachia	298.66
	Sonarpur	Chak Kalar Khal	35.23
		Karimpur	52.52
		Jagatipota	61.57
		Mukundapur	68.10
		Atghara	79.80
		Ranabhutia	148.78
		Kantipota	119.86
		Bhagabanpur	568.17
		Kharki	157.97
		Deara	364.17
		Kheyada	246.03
		Khodahati	307.13
		Goalpota	47.59
		Kumarpukuria	105.23
		Tardaha	794.08
		Tihuria	385.36
		Nayabad	293.72
		Samukpota	393.51
		Pratapgarh	119.48
		Garal	136.53
Total			10 685.60

Source: Dept. of Environment Govt. of W.B.

Table 2.4: Total Conservation Area of the East Calcutta Wetlands.

Police station	Total Area (hect)	Percentage
Bhangar	4548.58	36.00
Bidhannagar (S)	2100.00	17.00
Sonarpur	4416.83	35.50
Tiljala	1426.73	11.50
Total	12492.14	100.00

Source: ECW and WRR (Primary Data), Base Line Document Action Plan (As per Ramsar Convention Guidelines), Creative Research Group, December 1997

Table 2.5: Mouja-wise Description of Area Surveyed

District	Police station	Mouza	Area (hectare)
Calcutta	Tiljala	Dhapa	294.37
		Pas. Chowbaga	51.58
		Madurdaha	250.95
24 Parganas (N)	Bhangar	Kulberia	384.57
		Dharmatala	602.14
		Hadia	506.82
		Hatgachia	298.66
24 Parganas (S)	Rajarhat	Jatragachi	290.93
		Ghuni	389.18
	Sonarpur	Karimpur	52.52
		Bhagabanpur	568.17
		Kharki	157.97
		Kheyada	246.03
Total			4093.89

Rajarhat P.S. has not been included in the map of WRR

Chapter 3: Methodology

3.1 Relevance of Impact Assessment

In the present study three different surveys were conducted. The major thrust was on 443 households staying within ECW zone. The other two were directed to wetland experts and non-stakeholder citizens. In the household survey, direct asking method is followed. The survey on expert was based on Delphi technique while the third one was basically opinion survey regarding general awareness of the city dwellers on ECW. Finally, a cost-benefit study was attempted to find out the net loss due to conversion.

Environmental impact assessment (EIA) or valuing extra market commodity has recently been addressed successfully by a range of valuation methods developed in environmental economics. Two basic methods of solving measurement problems are (i) physical linkage method and (ii) behavioral linkage method (Smith and Krutilla, 1982). In behavioral linkage method, the most popular and debated is Contingent Valuation Method (CVM). This method simulates a market for a non-market good that provides environmental services and thus obtains a value for the good contingent upon the hypothetical market.

CVM can replicate either a private goods market or a referendum to obtain benefit estimates. The present problem of ECW is more akin to the referendum method where respondents were asked whether they would be willing to pay in order to preserve the environmental amenity in question. WTP is defined as the maximum amount of compensation that the consumer would willingly pay to have a project completed. Willingness to accept (WTA) or willingness to sell equals the minimum amount of compensation that would have to be paid to consumers to make them as well off as they would be if the project were completed. While the Blue Ribbon Committee (Arrow et.al.1993) guardedly approved the CVM, if it is done correctly and certain conditions are followed, other mainstream economists remain skeptical.

In our study CVM was followed to a limited extent. It was felt that WTP was hardly needed, as there were so many measurable benefits of ECW. More over, applicability of CVM may be questioned in view of the fact that ECW are not entirely common property resources. Excepting canals, either individuals or cooperatives own most of the areas. In case of Borivly National Park study (Hadker et.al.1995)

and study on Ganga Action Plan (James and Murty, 1999) this question of ownership did not arise. It should be cleared that what is to be measured here is not the wetlands as such, but the environmental cum economic services which these wetlands generate.

Apart from objective assessment, a subjective assessment of impact is equally important. Environment is a multi disciplinary concept. Hence, in order to get an unbiased result, personal and group values of opinions had been collected. We therefore, followed the Delphi technique in collecting opinions of the experts related to wetland environment.

Delphi is one of group judgmental methods that have gained recognition for their value in forecasting. It is one of the most well established means of collecting expert opinion and of gaining consensus among experts on various factors under consideration.

In our study, benefits arising out of both use and non-use value of ECW had been considered. Non-use benefits arise when the possible loss of the water body, say due to eutrophication from industrial or agricultural affluent would be of concern to the general public including people who never visited the site or may never do so. The proper role of non-use value in economic analysis was a subject of debate. Many economists agree today that inclusion of non-use values in damage assessment is essential if compensations are to constitute the proper price signals for resource use.

3.2 Different Sampling Plans Associated with Different Type of Surveys

(a) Household Survey

We started our field survey at a time when the local government had stopped land selling at Bhangar. People were reluctant to respond and cooperate with our investigators due to the fear of losing their lands for new township at Rajarhat. Some remote villages were infamous for crime. Some villages very close to the Eastern Bypass were also politically disturbed for real estate question.

Keeping these in view, a brief pilot study was done very carefully in the beginning. Consistent with Blue Ribbon Panel, we preferred face to face survey. An interview schedule as opposed to questionnaire was framed. The basic schedule was designed in English, which was translated into local language later.

Income data of the households were estimated through their consumption expenditure data. Due to unstable nature of their occupation, it was found difficult on their part to keep any record on income. For this purpose we sought help from the approximate log-normality of the expenditure distribution thrown up by the NSS inquiries. Accordingly, we based this approach on two major assumptions: (i) income before tax equals consumer expenditure in the lower range and (ii) ten per cent of total household expenditure above Rs 40000.00 may be added (Ahmed and Bhattacharya, 1972).

ECW span on over three districts viz. Calcutta, 24 Parganas(north) and 24 Parganas(south) covering an approximate area of 12735 hectares is divided into five police stations. Two of them falling in district 24 Parganas (north), viz. Rajarhat and Bidhannagar police stations, two in 24 Parganas (south), viz. Sonarpur and Bhangar and one, Tiljala in Calcutta district. However, Bidhannagar police station has not been considered for our present study due to its demographically uninhabited status. Thus population is limited in four police stations. These police stations account for 77 per cent of the total area of ECW.

Each police station is further divided into a number of moujas totalling 39 moujas. However, one mouja, namely, Dhapa Manpur was excluded since, Bidhannagar where the mouja is located was not at all considered. Thus, in terms of the number of moujas, the distribution of different police stations by number of moujas is shown in table 3.1

Thus, our population can be viewed of being a stratified one, the districts forming the primary strata and police stations within a district are further split into moujas. The ultimate units, i.e, the households are distributed physically or geographically over different moujas in different police stations in a given district. In following the procedure we paid heed to the maxim, 'Randomness and purposiveness are two irreducible ingredients of a sound sampling system.'

In order to get stated WTP the open ended bidding game was followed. By open ended bidding, the respondents were initially asked, "How much would you pay for the good?" This open ended bidding game is the oldest and widely used format. On this question, most of the respondents preferred to quantify their willingness by amount per unit area of land or per quintal of output.

Cares were taken to reduce numerous biases that might affect WTP figure. For example, to check the information bias, the consistency of responses was stressed. In case of strategic bias, interviewers were carefully trained to remind the respondents their ability to pay. Similar instructions were given to avoid the warm glow effects.[1]

Household survey continued for 12 months covering three broad seasons: summer, monsoon and winter. Investigators were instructed to meet the sample households according to the convenience of the latter. This was because, in the brisk seasons, farmers and fishermen remained busy in their fields and ponds.

(b) **Experts' Opinion Survey**

Environmental aspects of ECW attracted researchers from various disciplines like Zoologist, Botanist, Hydrologist, Town planner, Engineer etc. Linstone and Turoff (1975) defined Delphi as "a method of structuring a group communication process so that the process is effective in allowing a group of individuals as a whole to deal with a complex problem." This technique has two major advantages. First, the expert opinion expressed, stem from the individuals, not from a group of individuals in constant contact of each other where peer pressure and desire to conform may alter greatly any given prediction. Second, because the Delphi technique guarantees anonymity, the method can aim at gaining a more candid response.

We followed the method of Green and others (1990) what was attempted in studying the environmental impact stemming from a tourism project in England. We proceeded in three stages. First, a Delphi panel was formed consisting of 46 members from 15 disciplines. Experts included in this panel were Administrator, Botanist, Councilor, Economist, Engineer, Geographer, Geologist, Hydrologist, Journalist, Marine Scientist, NGO Leader, Ornithologist, Parasitologist, Sociologist and Zoologist. Next, the experts were asked to mention the aspects of impact what they deemed fit for the expansion of the city in wetland areas. The general questionnaire ensured that any impact what had not already been envisaged would be highlighted and could be incorporated into the second round questionnaire. Having received responses from the members, the final round postal questionnaire was drawn up. The basis of the questionnaire was an extensive checklist of impacts

[1] Warm glow effects occur when the respondents triy to impress the interviewer rather than state true response.

mentioned by the experts. Seven broad impacts had been identified. The experts were requested to rank them according to their judgment.

Table 3.2 illustrates a high drop out rate what was anticipated in a study of this nature. Two months after the distribution of first round correspondence, 25 questionnaires had been returned. This number was judged to be sufficient number to allow second round approach. This process ended up with 20 responses.

(c) **Citizens' Awareness Survey**

In order to get non-stakeholders non-experts' perception about ECW, a small survey on hundred selected individuals of Calcutta was carried out. The survey was purposive in nature. First, some occupational classes were identified. The respondents were then asked to give their opinion on conversion of ECW with respect to the sewage system, primary produces, supply of bio oxygen etc. Finally, they were asked to state the amount in rupees what they were willing to pay for the preservation of ECW.

As expected, the response rate was very low. Despite the sincere efforts of our investigators we received cooperation from half of the approached individuals. Considering the total population of Calcutta, the sample size was very small. Never the less, an impressionistic modest inference was drawn from the collected data.

(d) **Cost-Benefit Study**

A commonly used method of cost benefit study is essentially financial and partial equilibrium approach. We followed this approach for a single year 1999-2000. Net benefit (NB) of ECW conservation was defined as:

NB (ECW) = NB (Direct Use) + NB (Indirect Use) + NB (Non Use)

- OC (ECW)

where OC indicates opportunity cost. We adopted this method from the study of Michael and Southey (1995). Here direct uses were estimated economic values. Indirect uses were soil and water shed protection including environmental services like public sanitation. The non-uses presented such things as existence values. OC (ECW) represented the opportunity costs from alternative uses of wetlands after conversion. That is net benefits that might have been generated.

Direct uses mostly comprise primary commodities. For estimating indirect and non-uses, we mainly considered environmental or ecological benefits. These included generation of biota, minaralization and releasing of Nitrogen, Sodium, Potassium, Carbon, Phosphorus, Lead, Chromium etc. Net benefits from these indirect uses and non-uses were of very different nature than those of direct uses and also difficult to quantify.

3.3 Sampling Design and Estimation Procedure for the Household Survey

3.3.1: Sampling Design

The sampling design adopted here has been that of a stratified multistage one with districts forming the primary strata and also further sub-stratification has been made at the mouja level in a given police station within a district. The different hierarchical sampling units are police stations, moujas within the police stations, followed finally by the households belonging to a particular mouja in a given police station within a district. For our sampling procedure, the penultimate units, viz. The moujas have been sub-stratified into three categories according to the degree of infrastructure amenities available in different moujas. The sub-strata have been numbered by 1,2,3, where 1 denotes the mouja with maximum infrastructure facility followed by substrata 2 and 3 in a descending order of infrastructure facilities.

Simple Random Sampling (SRS) was made in the police stations in 24 Parganas (north), whereas all the police stations in both Calcutta district and 24 parganas(south) were taken. In selecting the moujas as well as and the households within the selected moujas, the method of SRS was adopted. Thus, our design is that of a multi stage stratified sampling with SRS being adopted at different hierarchical stages, namely there of police stations, moujas and the households stages.

The figures in the brackets as shown in table 3.3 indicate the number of units being included into the sample. One can find that total number of households interviewed was 443. The sub-stratification structure at the mouja level is indicated in table 3.4

3.3.2 Estimation Procedure

Let y_{lijtk} be the observation collected through the k th household belonging to the j th mouja in t th substratum of the i th police station in l th district where

{ k = 1,2,…H_{lijt} (h_{lijt}); j = 1,2,…N_{lit} (n_{lit}); t = 1,2,…m_{li}; i = 1,2,…S_l (s_l);

l = 1,2,3; 1 = Calcutta, 2 = 24 Parganas(north), 3 = 24 Parganas (south) }. The figures in the bracket denote the corresponding sample size.

Let the estimate of the character y for selected j th mouja in t th substratum of the i th police station in the l th district be denoted by $\hat{Y}_{lijt}$; then

$$\hat{Y}_{lijt} = \frac{H_{lijt}}{h_{lijt}} \sum_{k=1}^{h_{lijt}} y_{lijtk}$$

Now, the estimate of the total of the character y for t th substratum in the i th police station in l th district would be $\hat{Y}_{lit}$; where,

$$\hat{Y}_{lit} = \frac{N_{lit}}{n_{lit}} \sum_{j=1}^{n_{lit}} \hat{Y}_{litj}$$

Further, the estimate of the total of the character y for i th police station in l th area will be $\hat{Y}_{li}$; where $\hat{Y}_{li} = \sum_{t=1}^{mli} \hat{Y}_{lit}$

Consequently, the estimate of the total for l th district and hence that of ECW would be

$$\hat{Y}_l = \frac{S_l}{s_l} \sum_{i=1}^{s_l} \hat{Y}_{li} \text{ And } \hat{Y}_{ECW} = \sum_{l=1}^{3} \hat{Y}_l$$

3.4 Procedure of Calculating the Multipliers

1 The multiplier needed to form the estimate of the total for the selected j th mouja in a given stratum belonging to a selected police station in a given district is equal to

$$\frac{\text{Number of the total households in the above cross - classification}}{\text{Number of the sample households in the above cross - classification}}$$

The multiplier needed to form the estimate for the t th substratum is equal to

$$\frac{\text{Number of population mouja in the t th substratum}}{\text{Number of sample mouja selected in the substratum}}$$

The multiplier needed to form the estimate at the district level is equal to

$$\frac{\text{Number of total police stations in the district}}{\text{Number of sample P.S.}}$$

Thus, the combined multiplier has been the product of those computed at1, 2 and 3.

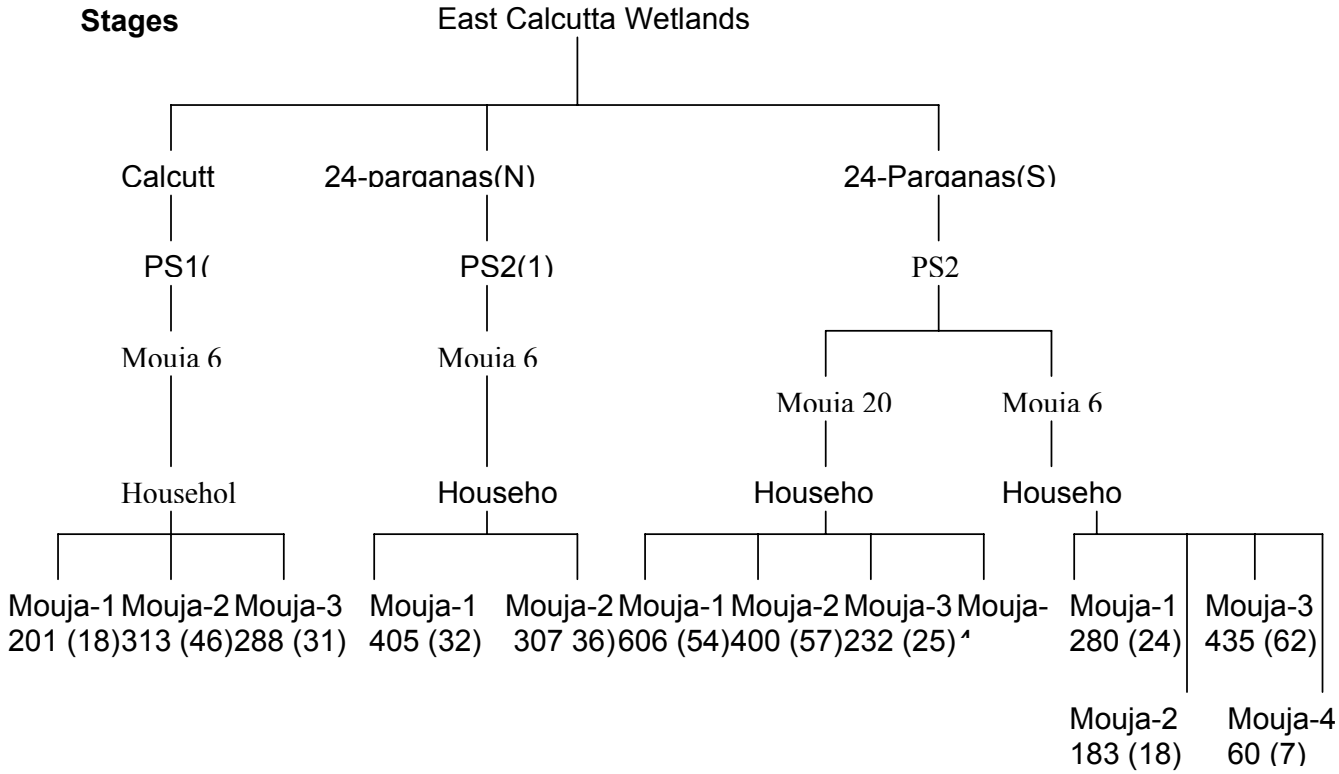
Table 3.1: Distribution of Different Police Stations in terms of Moujas.

Police Station	Number of Moujas
Tiljala	6
Rajarhat	6
Sonarpur	20
Bhangar	6
Total	38

Table 3.2: Delphi Panel Composition

Sl. No.	Panel Member	Preliminary Stage	First Round	Second Round
1	Administrator	3	3	1
2	Botanist	3	3	2
3	Councilor	5	2	2
4	Economist	3	-	-
5	Engineer	8	5	4
6	Geographer	5	2	2
7	Geologist	1	-	-
8	Hydrologist	2	1	1
9	Journalist	2	1	1
10	Marine Scientist	1	1	1
11	N.G.O. Leader	3	2	2
12	Ornithologist	3	2	1
13	Paracitologist	1	-	-
14	Sociologist	2	1	1
15	Zoologist	4	2	2
Total		46	25	20

Table 3.3: Distribution of Number of Sampling Units at Different Hierarchical Stages



The figures in the bracket indicate the corresponding sample size.

Table 3.4: Sub-stratification of Moujas in a Police Station

	Tiljala P S				Rajarhat P S			Sonarpur P S				Bhangar P S			
	Moujas				Moujas			Moujas				Moujas			
	1	2	3	T	1	2	T	1	2	3	T	1	2	3	T
Total	1	2	3	6	2	4	6	5	8	7	20	1	2	3	6
Sample	1	1	1	3	1	1	2	1	2	1	4	1	1	2	4

Chapter 4: Data Analysis

The study started with an aim of covering 500 households. But, after careful scrutiny of the canvassed schedules we ended up with 443 households consisting of 2215 residents in about 25 villages of 13 moujas. Most of the people were found of local origin. And they were mostly of backward classes. A few were found to be migrant.

4.1 Educational Data

In analyzing data on literacy and other educational data, we took the help of UNDP tools what they had followed in their calculation of Human Development Index. We, therefore, deflated the literacy figures into educational attainment index. For this purpose, we used the following formula:

$$E = \alpha L_1 + \beta L_2$$

Where L_1 is percentage of literacy level, L_2 is average years spent in school and coefficients α and β are assumed subjective weight values of 2/3 and 1/3 respectively. Distribution of educational level is shown in table 4.1. It was observed that 37 per cent of the total sample households were illiterate. Percentage figures for primary and higher level were 40 and 23 respectively. Converting these percentage figures of primary and above levels into educational attainment index, we got for primary level it was 29 per cent and for above it was 20 per cent only.

Even the figure would further go down if the level of learning were considered. It had been observed from a study among class four standard students of West Bengal that 80 per cent of the students could not achieve the minimum required level. The minimum required level being 20 out of 100 marks (ISI, 1992).

4.2 Data on Production, Consumption and Income

Productivity of paddy was estimated on net area, Total production was divided by land size. For fish production, same method was applied. These productivity figures were expected to be more reliable than other studies. In another study, Dutta Mukherjee (1999) estimated productivity on the basis of secondary data on total fish production per year and total fishery area for the year 1994. This method failed to include possibility of poaching or loss of production due to flood.

Household data of the survey explained the fact that poverty figure on the basis of consumption data was on an average 24 per cent in ECW area. Per capita annual

consumption expenditure of Rs 4114.00 was accepted as the poverty line in rural West Bengal. The Planning Commission in draft 9th plan estimated the figure. The figure was lower than 27 per cent as estimated by the NSS in August 2000.

Although the poverty figure of the wetland people was below the national average, that hardly explained the economic condition of the people due to the wide inequality in income distribution. Lorenz curves for four Police stations had been drawn. All the curves depicted the fact of inequality in almost identical fashion.

Distribution of poverty was found uneven among police stations. The largest number of poor had been found in Bhangar followed by Tiljala, Sonarpur and Rajarhat (Table 4.2).

Expenditure pattern of the households was also highly skewed in favour of consumption on food. In Rajarhat, as much as 70 per cent of the total consumption expenditure was spent on food while in other places the figure was on average 60 per cent. The expenditure on health ranged from nine to 13 per cent (Table 4.3).

4.3 Nature of Association

An attempt had been made to find out the association between willingness to pay and any of the following variables: consumption, income, fishing land, agricultural land, fish production and agricultural production. We had also tried to test the association between response and income size. A simple non-parametric $\chi 2$ chi-square test of association was done on the categorical frequency cell values for different categorical tables. For this purpose, we constructed seven bivariate frequency tables.

Table 4.6(a) shows the cell frequencies for consumption expenditure and WTP. The consumption levels were divided into three size classes, viz. up to Rs 20000, Rs 20000-Rs 50000 and above Rs 50000. Similarly, the WTP was divided into three broad groups: up to Rs 50, Rs 50-Rs 100 and above Rs 100. Naturally, the frequencies were distributed among nine cells of the table. Table 4.6(b) shows the cell frequencies of income and WTP. Similar to table 4.6(a) income and WTP were divided into same size groups. In table 4.6(c) the first two groups of WTP figures were merged. The groups became up to 100 and above 100. This table gives the cell frequencies of fishing land. Thus the frequencies were distributed among six cells only. But in table 4.6(d) for agricultural land, only two size classes were taken: .13

hectare to .4 hectare and above .4 hectare. Since WTP classes remained same, the total number of cell was four only. The total number of cell for tables 4.6(e) were also four. The only change was in the size class of fish production where the class intervals were up to 5 quintals and above 5 quintals. Naturally, the total number of cells of Table 4.6(f) and 4.6(g) was six again. For Table 4.6(f) agricultural production of size classes up to 5 quintals, 5-10 quintals and above 10 quintals were associated with WTP of same size classes. In Table 4.6(g) WTP was divided between two categorical variables, yes and no while income classes were up to Rs 20000, Rs 20000-Rs 50000 and above Rs 50000 only.

The corresponding $\chi 2$ values of each table are presented in column two of Table 4.7. It had been found that the association between level of consumption and WTP was significant at one per cent level. Similarly, association between level of income and WTP was also statistically significant at one per cent level. Again, we categorized the land holding pattern for two types of lands: fishing land and agricultural land. In the case of fishing land, association was not statistically significant. However, the association was found significant between holding size of agricultural land and WTP. The associations between WTP and production were found to be statistically significant in both the cases of fish and agriculture.

Suffice it to say that r^2 of table 4.7 called shared variance. Shared variance is a portion of the total behaviour (or distribution) of the variables measured in the sample data which is accounted for by the relationship we've already detected with our χ^2. For Table 4.6(d), $r^2 = 0.135$. So, it can be said, 13 per cent of total WTP is explained by or predicted by corresponding variable. In case of fish production (table 4.6(e)), $r^2 = 0.108$. That means approximately, 11 per cent of total WTP is explained by corresponding variable, i.e. production of fish.

Computing a measure of association like Phi of Cramer's Phi is an important benchmark of 'how much of the phenomenon under investigation had been explained. For example, in table 4.6(d) $r^2 = 0.135$ means that one or more variables are still undetected which, cumulatively account for and predict 87 per cent of WTP. In table 4.6(g), no association was found. This implies that responses of the households were not biased.

It is to be noted that Tobit, Probit models are used to deal with dichotomous, binary or dummy variables as dependent variables. In our case, we did not have such variables for CVM data analysis. Naturally, we restrained from such discrete and limited dependent variable models

With a view to capturing cumulative variance, a step wise multiple regression was attempted. OLS regression results were drawn with six independent variables against dependent variable WTP. The variables were income, consumption, fishing land, agricultural land, fish production and agricultural production.

In the first step, all the independent variables were regressed against WTP. But, only the coefficients of fishing land became statistically significant at five per cent level. The only other variable that appeared nearer to significance was agricultural production. As shown in table 4.8, five different combinations of variables were taken as independent variables against the dependent variable WTP. The coefficient of fishing land was found statistically significant in all the cases estimated and agricultural production also responded significantly at five per cent level when these two variables were taken. Each regression analysis was done using 194 observations.

It can thus be inferred that people engaged in two crucial activities, pisciculture and agriculture were very much keen to protect the wet lands.

Table 4.1: Distribution of Educational Level of Households [N=443]

P. S.	Illiterate	Primary	Secondary	Above	Total
Tiljala	49	31	13	2	95
Rajarhat	18	25	23	2	68
Bhangar	59	69	35	6	169
Sonarpur	37	51	21	2	111
Total	163	176	92	12	443

Table 4.2: Percentage Distribution of Households below Poverty Line In East Calcutta Wetlands [N=443]

District	P.S.	No of Household	Percentage Share
Calcutta	Tiljala	26	24.30
24 Parganas (N)	Rajarhat	11	10.30
24 Parganas (S)	Bhangar	52	48.60
24 Parganas (S)	Sonarpur	18	16.80
Total		107	100.00

Table 4.3: Average Annual Share of Food and Health Care in Household Consumption Expenditure (Rs.) [N=443]

Police Station	Consumption	Expenditure on Food	Expenditure on Health Care	Percentage share of Food	Percentage of Health Care
Tiljala	34768	11937	4526	57	13
Rajarhat	32955	23157	3056	70	09
Sonarpur	33948	18165	3223	54	09
Bhangar	29403	16846	3164	57	11

Table 4.4: Average Annual Household Income for each Police Station [N=443]

Name of Police Station	Average Household income per year in each Police Station
Tiljala	36979
Rajarhat	35528
Sonarpur	36760
Bhangar	32395

Table 4.5: Number of Households belonging to Different Income Groups In Four Police Station [N=443]

Income Group (Rs.)	Number of Households				
	Tiljala	Rajarhat	Sonarpur	Bhangar	Total
Upto 10000	2	0	6	4	12
10000-20000	19	8	21	44	92
20000-50000	56	49	66	98	269
50000-100000	17	8	14	22	61
100000 and above	1	3	4	1	9
Total	95	68	111	169	443

Table 4.6 (a): Distribution of Households in terms of Consumption (Rs.) And WTP (RS.) [N=237]

WTP	Upto 20000	20000-50000	Above 50000	Total
Upto 50	22	64	16	102
50 – 100	4	22	26	52
Above 100	18	33	32	83
Total	44	119	74	237

Table 4.6 (b): Distribution of Households in terms of Income (Rs.) and WTP (Rs) [N=237]

WTP	Upto 20000	20000-50000	Above 50000	Total
Upto 50	22	61	19	102
50 – 100	3	23	26	52
Above 100	17	31	35	83
Total	42	115	80	237

Table 4.6 (c): Distribution of Households in terms of Fishing Land (hectare) and WTP (Rs.) [N=97]

WTP	Upto .13	.13 - .4	Above .4	Total
Upto 100	41	11	10	62
Above 100	18	7	10	35
Total	59	18	20	97

Table 4.6 (d): Distribution of Households in terms of Agricultural Land (hectare) and WTP (Rs.) hectare [N=109]

WTP	.13 to .4	Above .4	Total
Upto 100	46	28	74
Above 100	8	27	35
Total	54	55	109

Table 4.6(e): Distribution of Households in terms of Fish Production (Kg.) and WTP (Rs.) [N=85]

WTP	.Upto 500	Above 500	Total
Upto 100	47	7	54
Above 100	18	13	31
Total	65	20	85

Table 4.6(f): Distribution of Households in terms of Agricultural Production (Kg.) and WTP (Rs.) [N=156]

WTP	Upto 500	500 – 1000	Above 1000	Total
Upto 100	25	31	53	109
Avove 100	7	8	32	47
Total	32	39	85	156

Table 4.6(g): Distribution of Households in terms of Responses (Yes / No) and Income (Rs.) [N=443]

Yes/No	Upto 20000	20000 – 50000	Above 50000	Total
Yes	55	138	39	232
No	45	141	25	211
Total	100	279	64	443

Table 4.7: χ^2 and r^2 values

Variables	χ^2 values	R^2values
Consumption and WTP	23.86	0.052
Income and WTP	23.13	0.049
Fishing land and WTP	2.54	0.026
Agr. Land and WTP	14.68	0.135
Fish production and WTP	9.19	0.108
Agr. Production and WTP	5.03	0.032
Responses and Income	3.11	0.007

Table 4.8: Results of Step Regression between WTP and Six other Variables

Dependent variable: WTP

Model	Const.	Income	Cons.	Fish land	Agr. Land	Fish Prod.	Agr. Prod	$\overline{R}^2$	Observation
I	81.21 (2.18)	.0007 (.18)	-.001 (-.230)	35.1* (4.99)	2.42 (.816)	.011 (.585)	.019 (1.56)	.196	194
II	80.10 (2.19)		-.215 (-.249)	35.5* (5.23)	2.45 (.830)	.011 (.619)	.019 (1.58)	.200	194
III	73.28 (3.02)			35.3* (5.25)	2.23 (.794)	.011 (.609)	.019 (1`.60)	.204	194
IV	75.07 (3.13)			37.6* (6.84)	2.15 (.766)		.019 (1.57)	.207	194
V	76.66 (3.21)			37.9* (6.90)			.023 (2.03)	.208	194

Note 1. Figures in brackets indicate t- value 2. * Indicates significant at 95 % level

Chapter 5: Results

5.1 Economic Activities Dependent on East Calcutta Wetlands

The metropolis Calcutta being the industrial and administrative center, attracted more and more peoples after partition. But, the immigrants did not find ready entry into farming economy of this wetland region although they raised demand for agricultural land and stimulated a process of conversion of land into agricultural farm.

To ascertain the change, Calcutta Environmental Management Strategy and Action Plan (CEMSAP) conducted a study using secondary census data. Our study also made an exhaustive exposition. The results show not only a continuous conversion of agricultural land to non-agricultural use, the phenomenon had also been reflected in the occupational patterns. This change was pronounced in entire Rajarhat and Sonarpur as well as in Madurdaha mouja of Tiljala. In Madurdaha, about 50 per cent households switched over from cultivation or fishing to informal service sector occupations during last five years. In Rajarhat, figure of such occupational shifting was 47 per cent.

A minute study on the occupational profile of wetland based people revealed that agriculture was the foremost economic activity. During last 30 years this agricultural dependence remained more or less unchanged with varying degree in different police station areas.

Following the trend of occupational pattern during last 30 years, it was observed that households of the wetland area had increasingly been marginalized in terms of land holdings. As a result, proportion of agricultural labourers increased in the total working population. This was more pronounced in Rajarhat and Bhangar than in Sonarpur and Tiljala. Proportion of working population belonging to activities like manufacturing and construction had not changed so much.

Of the 443 households, largest number of households belonged to the categories of owner cultivator. The agricultural group (including owner cultivator, sharecropper and agricultural labourer) shared 47 per cent of the total respondents. Next came the group related to pisciculture, which accounted for 29.5 per cent of the total.

If it is assumed that workers engaged in non-agricultural activities are less dependent on ECW, we could derive the degree of dependence of the local

residents. From our collected data it appeared that Bhangar got the highest dependent status followed by Sonarpur, Tiljala and Rajarhat respectively.

Police station wise, most of the owner cultivators were found at Bhangar. About half of the sample of Bhangar own land (N = 169). Agricultural and Bhery labourers at Tiljala shared altogether 64 per cent of the total sample (N = 95). Sonarpur was strongly marked with fishing activities. Number of owner fish farmer was found to be the largest at Sonarpur among all the four police stations. Occupational distribution is shown in table 5.5. Cases of practicing both sewage fed fishery (SFF) and fresh water fishery were reported in Sonarpur and Tiljala. Number of households practicing both agriculture and pisciculture in different moujas is shown in table 5.6. Subsidiary occupations in most of the cases were related to their primary occupations.

One interesting feature of employment pattern in this wetland region was that excepting few respondents of Paschim Chowbaga, no household reported their association with tannery industry located within wetland ecosystem. Workers of tannery units are mostly outsiders to the WRR.

5.2 Primary Produces and Productivity

Both agriculture and pisciculture in this WRR of Calcutta are practiced on marginal land holdings. Average operational holding of agricultural land was found to be .46 hectare and that of fishing pond .35 hectare. Police station-wise distribution of land holdings is shown in table 5.7 and 5.8. With little scope of further subdivision, farmers are forced to use their land and pond intensively. Two varieties of paddy, Aman and Boro are cultivated, of which the former is sown during monsoon and the latter in winter. More than half of the Aman area is not suitable for Boro cultivation and remains fallow after Aman paddy is harvested. In some villages of Sonarpur, farmers use their land during rain and use the same land for Boro during summer. The entire cultivation of summer crop as well as garbage farming in ECW region is practiced with fishery effluent irrigation. Due to low supply of dry weather flow canal, availability of sewage effluent water has gone down considerably in recent years. Thus, the over all production of these sewage irrigated farms has been reduced and return is poor in comparison with neighboring regions which get waste water throughout the year. Conversion of fisheries into agricultural lands had been more rampant in Sonarpur and Tiljala than Bhangar.

Produced crops in wetland agriculture are many. Apart from paddy and vegetables, pulses, maize, sugarcane and oilseeds like mustard are popular. In recent years floriculture has become popular among farmers along the banks of the canals. Dumping of garbage in Dhapa area has resulted in raising of the general level of the land between one metre and 1.5 metres and the raised part of the land is entirely composed of consolidated garbage-filled land with water bodies between them (Ghosh, 1985). As per the study of Calcutta Metropolitan Development Authority (CMDA) in 1996, the garbage farms produced more than 2000 quintals of vegetables per hectare per year which were marketed in Calcutta (Table 5.9).

Before 1830, this low-lying region of salt-water lakes was utilized for pisciculture of brackish water fishes such as Bhetki (*Lates calcarifer*), Parse (*Mugil parsia*), Bhangar *(Mugil tade*) and Prawns *(Macrobrachum rosenbergii*). With the diversion of city sewage and storm water into the salt lakes and the deterioration of the river Bidyadhari, there was a gradual change in the aquatic environment from saline to non-saline. This ultimately led to the changes in the composition of fish raised in the region, especially in terms of species. The types of fishes currently cultured in ECW area as per our survey are given in table 5.10.

The change in salinity in the fisheries was from 800-1200 ppm in the Nona Bheries to about 500-600 ppm in the SFF (Banerjee and Roy, 1959). Unlike paddy, fishing yield remained more or less same during last 12 years in SFF, which was 31.00 quintals per hectare per year. In P S level although Sonarpur ranked last in production of paddy, in fish production, this is the leading region, which is 33.53 quintals per hectare per year (table 5.12). The fresh water ponds in the region however, produce on an average half the quantity per acre of SFF.

The factors influencing productivity in fish are (a) the supply of sewage in fishery, (b) depth of fishery (it should be around 4.5 feet), (c) degree of poaching in fishery and (d) other labour related problems.

5.3 Employment, Output and Gross Economic Return

While occupational profile of a set of population is easy to obtain from census data, it is difficult to find out the actual number of persons who are gainfully engaged in employment. It had been observed from district census data that about 30 per cent of economically active population of wetland area were not workers. We estimated

employment figure on the basis of our collected household data (vide Estimation Procedure in chapter 3.4). These data implied that average duration of employment was found to be eight to ten months a year. The estimated numbers of household engaged in agriculture, fishing and other activities in entire wetland area were 5864, 5209 and 3077 respectively (table 5.2). The total number of working households depending on wetland based activities thus came around 14150. This comprises a population of 70750.

Next to employment, the land use pattern of the wetland area was estimated. Table 5.3 explains the fact that of the total of 12743 hectares of ECW (as per our own estimate), 5151 hectares of land was used for primary production with break down of 2666 hectares for paddy, 2185 hectares for fish and 300 hectares for vegetables. The whole process turned out 1.28 lakh quintals of paddy, .69 lakh quintals of fish and 6.9 lakh quintals of vegetables in 1999-2000 (table 5.4). The generation of gross income of the households at ECW was estimated to Rs 46.33 million.

Average annual expenditure, value of the product, and market returns are shown in table 5.13. In calculating cost of production and other incidental expenses detailed data were put into four major groups in case of paddy and vegetables. These were fertilizer, irrigation, wage and others. For fish production, cost on wage, fish feeding and others were considered.

5.4 Delphi Results

A direct break down of the results of subjective impact assessment from rounds one and two are provided in tables 5.15 and 5.16. These tables show the aggregate responses to each of the environmental impacts listed in the Delphi questionnaire sent to the panel members.

From the first round response, the experts had identified a large number of impacts. Through an intensive examination, these impacts were grouped under seven broad heads. In the next round, the experts were requested to rank the impacts according to their choice. They were also allowed to make tied rank. What was interesting to note none of the expert respondents mentioned any positive impact of the conversion of wetlands into other use. Also it would be misleading to reject the aspects that had received lower rank.

Many of the observations of the panel members were as might be expected. For example, waste recycling and resource recovery system received the highest priority (Table 5.15)

5.5 Stakeholders' and Non-Stakeholders' Perception.

People living in WRR were found to be very much concerned about the existence of the wetlands. More than 95 per cent of the respondents expressed their view informing that they were not willing to leave their place and profession. Naturally, they expressed their willingness to pay for the preservation of ECW and the sustainable existence of their own.

The general economic condition of the region is far from satisfactory. Average annual income as estimated was around Rs 35000.00 and savings rate too small. As a result, stated WTP was not high. Little less than 40 per cent of the sample households expressed their WTP. The average P.S-wise WTP is shown in table 5.17.

It should be cleared that, the inhabitants, being less ecologically educated than experts have far less clear and distinct priorities when identifying environmental problems from the point of view of their importance. That is why the opinion expressed by non-stakeholder city dwellers differs on many counts from many of the stakeholders and experts.

Although 95 per cent of the citizens claimed that they knew about ECW, the lack of consistency in follow up questions established the fact that many of them suffered from 'warm glow effect'.

Three fourth of the respondents were found to be ignorant about the fact that ECW are the largest contiguous wetland fishery area adjacent to a city in the world. While the wetland experts (as observed from our survey) were of opinion that its conversion would affect sewage system of Calcutta and reduce agricultural and fish production, 50 per cent of the non-expert citizens thought so. Inter occupational variations were also much more pronounced. While 72 per cent professionals thought conversion detrimental to the city sewage system, only 50 percent academicians shared the view.

Ninety per cent citizens held the opinion that Calcutta wetlands were urgently needed to be protected. But, only 64 per cent respondents expressed their willingness to pay for preserving the resource.

Amount of WTP ranged from Rs 60.00 to Rs 1200.00 per year with mean value Rs 380.00. As predicted by economic theory, education, attitude or level of income is positively related to and important determinants of WTP. With respect to the education levels, the sample did not cover a large variance across the population. Most of the respondents had Bachelor's degree and standard deviation on years of schooling was low.

It is argued that people may demand more environments (with respect to both quantity and quality) as their income increases. The present experience of awareness survey did not have any scope to incorporate any such change in preferences and income effects over time.

To the question "Are you aware of the wetlands of Calcutta?' we found that the answer was an emphatic 'yes'. The survey was also received positively but not to the degree what was encountered in Delphi study on experts. To the question "Are you willing to pay for ECW? ', the answer was not an emphatic 'yes', but a reluctant one. Tax paying is always an unpleasant exercise. But, if a city dweller realizes the need of waste treatment, understands the consequences of siltation and thereby sustainability of the city, resource mobilization would not be difficult.

The study yielded an average WTP of Rs 30.00 per household per month. Considering the standard of living and social status of the target group, the amount might be considered reasonable. But, we can not generalize the figure as WTP of an average citizen of Calcutta from so small sample size. Apart from that, from social point of view, the unemployed human resources are the fixed cost borne by the society and hence, must be regarded as an overhead cost to the society that can not be escaped. We may therefore exclude 33 per cent slum dwellers and arrive at a very modest figure of six lakh households in CMC area only[2]. If Rs 20.00 is charged per month upon these households, that would add up to Rs 12 million a month to the exchequer. Even, 14.5 lakh slum dwellers may be brought under some kind of sewage treatment taxation.

[2] Although it does not mean that all of them are living below povertyline.

Table 5.1: Area Transferred to Towns

P.S.	Transferred to Urban Areas in Census Years (hectare)				
	1951	1961	1971	1981	1991
Rajarhat	Nil	Nil	1108.56	2301.78	2581.79
Bhangar	Nil	Nil	Nil	Nil	2417.56
Sonarpur	Nil	600.21	600.21	1505.42	1505.42

Table 5.2: Estimated Number of Households Engaged in Agriculture, Fishing and Other Activities as Direct Source of Income at East Calcutta Wetlands

Occupation	Number of Households
Agriculture	5864
Fishing	5209
Others	3077
Total	14150

Table 5.3: Estimated Area of Land under Paddy, Fishery and Vegetables at East Calcutta Wetlands

Land Use	Area(hectares)
Paddy	2666
Fishery	2185
Vegetables	300
Total	5151

Table 5.4: Estimated Production of Paddy, Fish And Vegetables at East Calcutta Wetlands

Item	Production (quintals)
Paddy	1.28 lakh
Fish	.69 lakh
Vegetables	6.90 lakh

Table 5.5: Primary Occupations of the Sample Households in Four Police Stations (N =443)

P.S.	Owner Cultivator	Share Cropper	Agricultural labour	Owner Fisherman	Sharing Coop. Fishery	Bhery labourer	Trade Relating to Pisciculture	Trade Relating to Agriculture	Others	Total
Tiljala	2	3	15	4	2	46	1	0	22	95
Rajarhat	20	2	11	0	0	2	1	0	32	68
Sonarpur	20	2	17	10	2	32	3	2	22	111
Bhangar	80	13	21	11	10	12	6	1	15	169
Total	122	21	64	25	14	92	11	3	91	443

Table 5.6: Distribution of Households practicing both Agriculture and Pisciculture (N=443)

P.S	Mouza	No. of HH practicing both Fishing and Agriculture	No of HH practicing both SFF and FWF	No of HH practicing Agriculture as Principal occupation	No of HH practicing Fishery as Principal occupation
Bhangar		60	0	114	33
	Kulberia	27	0	41	1
	Dharmatala	17	0	51	1
	Hatgachia	5	0	11	13
	Hadia	11	0	11	8
Rajarhat		7	0	33	2
	Ghuni	2	0	16	0
	Jatragachi	5	0	17	2
Sonarpur		30	3	40	44
	Kheadah	11	2	17	1
	Kharki	6	1	5	11
	Bhagabanpur	11	0	17	32
	Karimpur	2	0	1	0
Tiljala		4	1	20	52
	Paschim	0	0	4	8
	Chowbaga	3	1	4	40
	Dhapa Madurdaha	1	0	12	4

Table 5.7: Average Operational Land per Household Under Agriculture in Four Police Stations [N=443]

P.S	Average Land Size (hectare)
Tiljala	.16
Rajarhat	.48
Sonarpur	.34
Bhangar	.60

Table 5.8: Average Operational Land holding per Household under Fishery in Four Police Stations [N=443]

P.S.	Average Land Size (hectare)
Tiljala	.48
Rajarhat	.09
Sonarpur	.57
Bhangar	.27

Table 5.9: Annual Expenditure and Return from 0.40 hectare Farm

Crop	No of Growing Days	No of Harvesting Days	Marketable Yield(quintals)	Total Exp.(Rs)	Market price(Rs)	Gross Return(Rs)
Cauliflower	75	30	15000 heads	4500	10800	6300
Ridge	60	30	45	3000	3750	750
Gourd	75	1	45	4200	4500	300
Maize	30	20	45	1800	3000	1200
Radish	20	10	70	1800	4560	2760
Yam	150	90	90	1275	1800	525
Brinjal	90	150	120	300	960	660
Bottle	60	300	126	1500	3000	1500
Gourd	150	75	90	750	1500	750
B Gourd	150	90	9	1950	3000	1050
Plant	30	60	30	750	780	30
Pumkin	30	60	90	3150	6300	3150
Bitter gourd	30	60	90	2400	5400	3000
Pumkin Plants						
Spinach						
Danta						
Total	850	976	850 Q to 15000 heads	27375	49350	21975

Source: Creative Research Study, 1997

Table 5.10: Names of Common Fishes at East Calcutta Wetlands

Sl No	Common Name	Scientific name
1	Lata	*Channa punctatus*
2	Sole	*Channa striatus*
3	Rohu	*Labeorojita*
4	Katla	*Catla catla*
5	Mrigel	*Cirrihinus mrigala*
6	Silver Crap	*Hypophthaimichthys*
7	Common Crap	*molitrix*
8	Tilapia	*Cyprinuscaripo*
9	Lalantica	*Tilapiamysambica*
10	Magur	*Oreochromis nilotica*
11	Koi	*Clarias batrachus*
		Anabastudineus

Table 5.11:Average Productivity of paddy in Four Police Stations

Name of P.S.	Productivity(quintal/hec)
Tiljala	37.50
Rajarhat	55.00
Sonarpur	38.34
Bhangar	49.82
ECW	48.71

Table 5.12: Average Productivity of Fish in Four Police Stations

Name of P.S.	Productivity(quintal/hec)
Tiljala	14.64
Rajarhat	19.82
Sonarpur	33.53
Bhangar	19.92
ECW	31.00.

Table 5.13: Average Annual Expenditure, Value and Return from one Hectare Farm at East Calcutta Wetlands.

Item	Total Expenditure (Rs.)	Value of Produce (Rs.)	Return (Rs.)
Paddy	12989	20295	7306
Fish	35385	47180	11795
Vegetables and Other Crops	70000	125000	55000

Table 5.14: Generation of Gross and Net Revenues from Primary Activities of East Calcutta Wetlands.

Item	Gross Revenue (million Rs.)	Net Revenue (million Rs.)
Paddy	178.05	17.53
Fish	48.70	44.51
Vegetables and Other Crops	40.00	17.60
Grand Total	266.75	79.64

Table 5.15 First round Delphi Results

Sl. No.	Aspects Environment	No.
1	Waste recycling and resource recover system will break down	24
2	Problem of water-logging in city and Suburb will be acute	24
3	Loss of open space will cause climatic Instability	12
4	Economic rehabilitation of the evicted Community will be a serious problem leading To social unrest and crime	10
5	Bio-diversity will be lost for ever	14
6	City will be deprived of fisheries and Agricultural products	20
7	Expansion of industrial units in wetland area Will jeopardize ecological balance	15

Table 5.16: Second round Delphi Results

Sl. No.	Aspects of Environment	No.	Rank	Mean Rank Value
1	Waste recycling and resource Recovery system will break down	43	1	2.15
2	Problem of water-logging in city And suburb will be acute	56	2	2.8
3	Loss of open space will cause Climatic instability	74	3	3.7
4	Economic rehabilitation of the evicted Community will be a serious problem Leading to social unrest and crime	80	4	4.0
5	Bio-diversity will be lost for ever	82	5	4.1
6	City will be deprived of fisheries And agricultural products	82	5	4.1
7	Expansion of industrial units in wetland area will jeopardize ecological balance	92	6	4.6

Table 5.17: Average Willingness to Pay of the Households

[N=194]

Police Station	Average WTP/Year (Rs.)
Tiljala	185
Rajarhat	52
Sonarpur	200
Bhangar	137
ECW	142

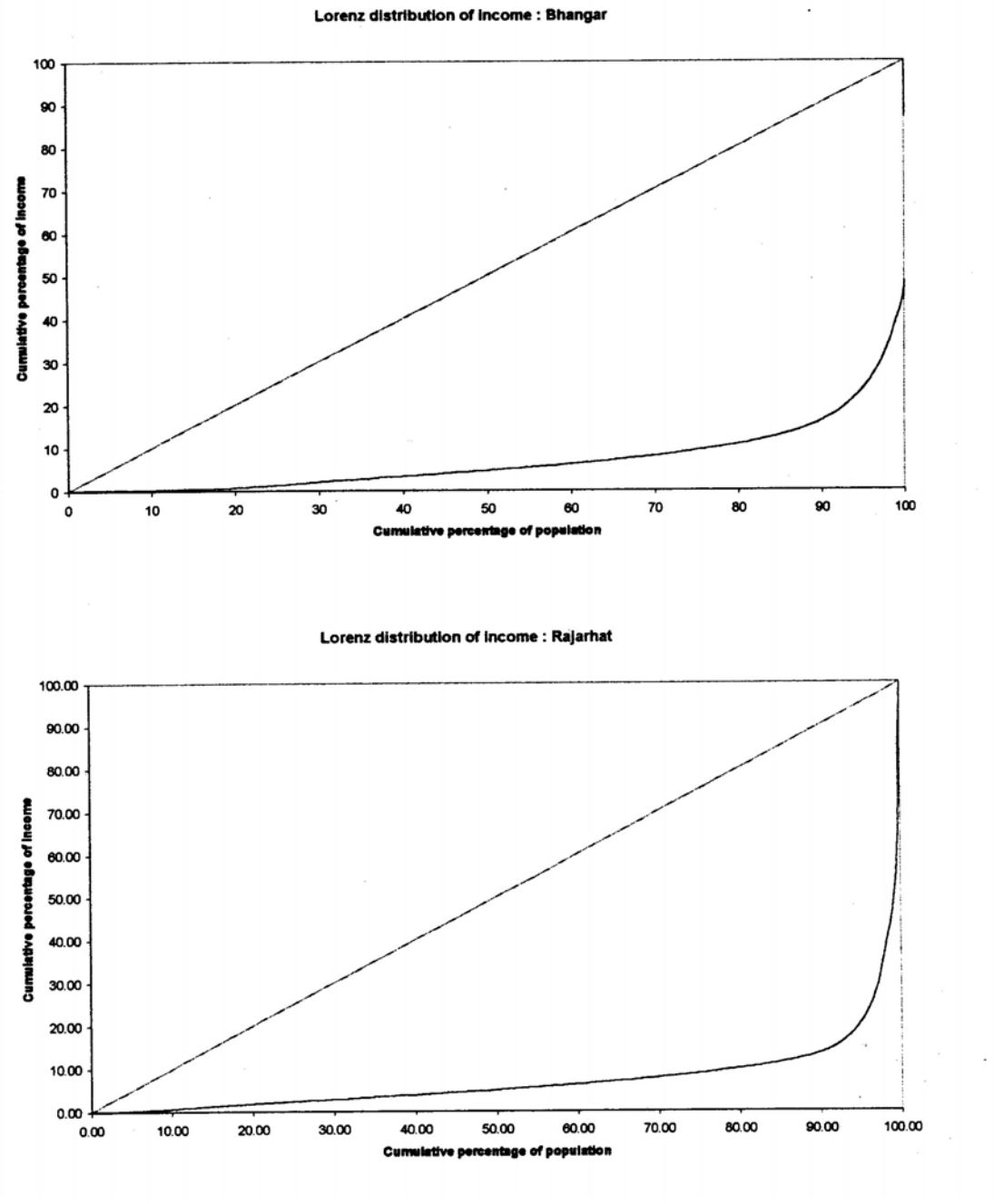


Figure 5.1 Lorenz Distribution of Income: Bhangar and Rajarhat

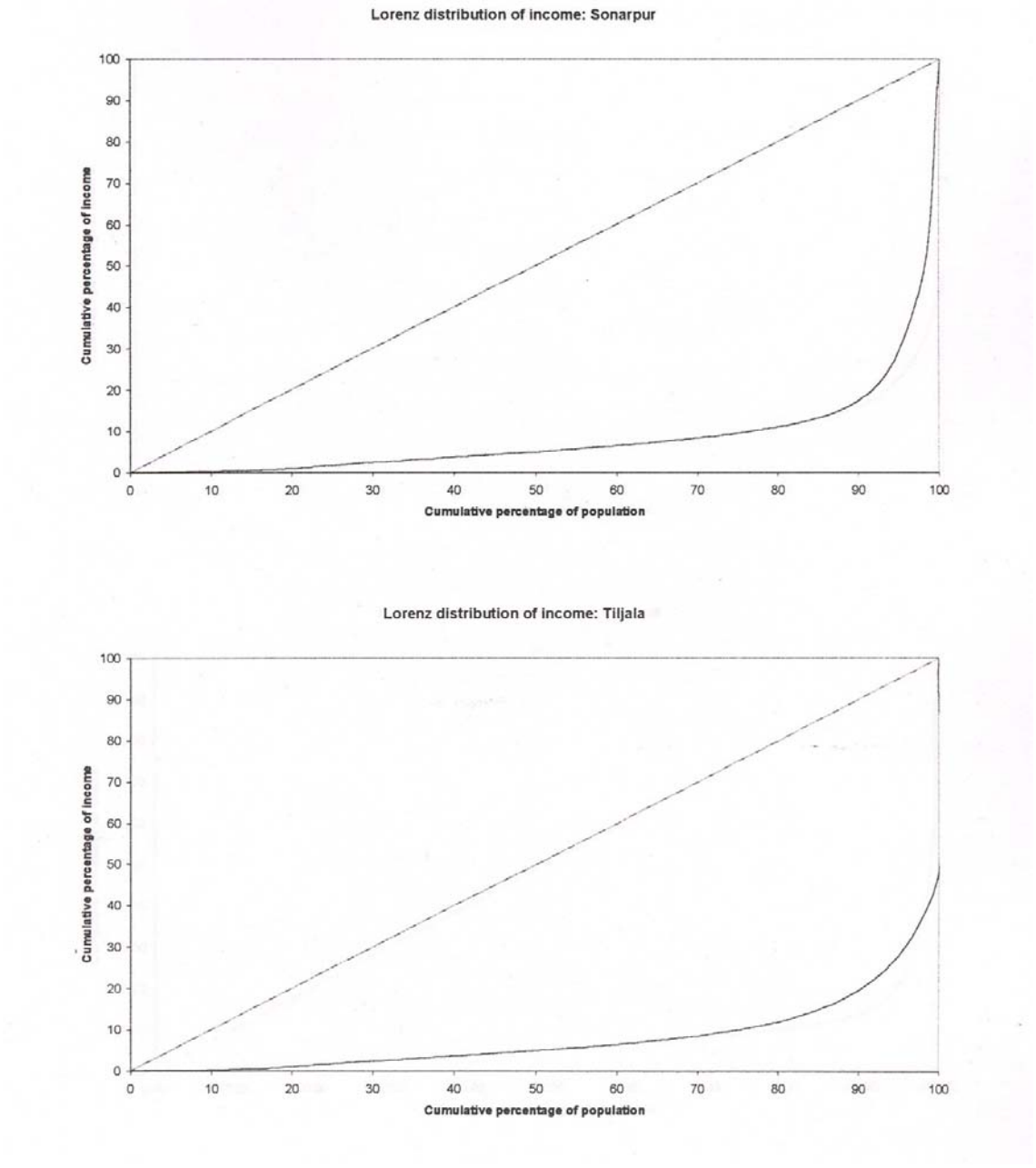


Figure 5.2 Lorenz Distribution of Income: Sonarpur and Tiljala

Chapter 6: Cost-Benefit Study of East Calcutta Wetlands

In contrast to the extensive research into the values, costs and benefits of natural resource conservation, their opportunity costs have received much less attention, although they are acknowledged to be important. Environmental conservation relating to any water body is a matter of development and essential characteristic of state lands set aside in parks, reserves and forests is that the land remains undeveloped. This carries an opportunity cost component in that the values of other economic activities are forgone.

Michael and Southey (1995) in their opportunity cost study of bio diversity of Kenya estimated that current combined net revenues from wild life tourism and forestry are inadequate to cover these opportunity costs to agriculture in the same land. Conversion of a rain forest into agricultural land may be questioned from many angles. Every year 1.5 million wild beasts (African antilopes that graze) march 500 kilometres. On this journey from Serengetti to Masai-Mara en-route they produce 250 million Kg biomass which makes the field green. It is exceedingly important that no species should go out of existence even if that does not affect our standard of living in any way. 'Any one concerned with the theory of rationality', said Professor Amartya Sen, 'have to come to terms with the narrow view of rationality' (Sen, 2001).

The site under study though not set aside as nature reserve, bears certain unique features. It plays an important role in producing primary commodities, helps in recharging sewage water and thereby generates environmental values. Water (both treated and untreated) is used here as input to agriculture and fishery. The vast expanse of water body acts as source of bio-diversity. It maintains climatic stability and meets the recreational demand of the people. Thus, both economic values and ecological values are to be considered, while estimating the opportunity cost of ECW.

In order to make Cost Benefit Analysis (CBA) of ECW more reliable, the economic valuation of wetland goods and services is required to be as comprehensive as possible. To predict in detail a policy's impact on wetland functioning is likely to push present ecological knowledge beyond its bounds. Even, wetland structure is incompletely known; for example, changes may affect the insect fauna or soil fungi and many of these species may never have been described taxonomically

(Westman, 1985). Even if these bio-diversity or public health issues were quantitatively resolved, it may not adequately influence the final decisions in the socioeconomic system. Short run commercial interests and related financial gains may appear to be more persuasive than long term ecological conservation arguments.

6.1 Identification and Valuation of Losses

It had been observed over past three decades that gradual nibbling of wetlands was directed towards urban residential and institutional projects. These included giant sports complexes, artificial parks, hotels etc. Here, we need to redefine our area of actual conversion for the purpose of identification and valuation of the losses.

The most threatened parts of ECW belong to the police stations: Rajarhat, Sonarpur and Tiljala. During past ten years, total area of conversion amounted to around 1500 hectares. Of this, 300 hectares were fisheries. The values of various goods and services (including ecological services) that this land area provided were estimated. While many of them took commodity form, for some of the services market did not exist mainly because of their public good nature.

(i) Loss of Paddy Production

The most significant loss due to conversion was measured in terms of paddy production. For assured sewage water (both treated and untreated), paddy cultivation was carried out at low cost here. Multiplying productivity per hectare with area under cultivation the total potential loss was estimated to be 57.24 thousand quintals per annum (Table 6.1). This was equivalent to a loss of Rs 87 million a year

(ii) Loss of Fish Production

Sewage fed fishing was an important economic activity in this region. The total potential loss of fish production was estimated to be 7076 quintals per annum, which was equivalent to a loss of Rs 14.15 million.

(iii) Medicinal Plants

While direct use values of wetland ecosystem had been reflected in market prices a major part of the goods and services produced by the environmental resources required shadow pricing and other indirect methods of measurement. Even some of the direct use values are not fairly straightforward. Measuring the value of medicinal

plants, for example, may be extremely difficult. Market prices wherever they were available and somewhat reflective of the true opportunity costs of the resources had been used. But, no information of the current extraction was available. We therefore, applied a rule of thumb to arrive at a potential loss of Rs 1 lakh (not a very high figure by any standard).

(IV) Waste Recycling and Resource Recovery

The proposed new town when fully developed will provide homes for 7.50 lakh people and cater to a floating population of 2.50 lakh. A little over one lakh people will be displaced and lose their employment. City will be deprived of agricultural production including fish. On the other hand, this additional population will put more pressure on the existing waste recovery and sewage management system. Thus, 10 lakh additional population will become 11.5 lakh after 10 years and subsequently put a pressure on reduced infrastructure for socioeconomic needs.

The drainage system of Calcutta was designed with 1/4"rainfall per hour for 100 days plus 40 gallon (182 litres) of sewage per head per day. This was the estimation in the beginning of 20^{th} century. The figure seemed to be comfortable to meet the demand of one million inhabitants. Calcutta today generates around 1350 million litres of sewage per day. This discharged sewage water carries about 2076 tonnes of suspended solid daily as estimated by NEERI. Extra 10 lakh people would generate 18.2 million litres of sewage and 28 tonnes of suspended solid a day and involve extra cost for treating them.

Biswas et.al (1999) observed that 3374 hectares of SFF daily generate 4.6 tonnes of Nitrogen, 1.5 tonnes of Phosphorous and 3.8 tonnes of Potassium. The total loss from 300 hectares of SFF on account of these chemical elements would come to about Rs 2400.00 a day and Rs 8.7 lakh a year.

(V) Recreation

As per 2001 Census, West Bengal is the state of highest population density in India. In Calcutta, this density is 24000 per sq km. In some areas of the city it is more than 40000. The existence of such vast water body like wetlands, that draw large number of non game aquatic birds, is an instant source of recreation. This potential can be commercially utilized.

(VI) Carbon Sequestration

Destruction of wetlands can lead to the loss of carbon sequestration. The ECW area is full of green and a large part of canals, ponds and fisheries are full of aquatic plants. Conversion of these vegetal lands and water bodies is bound to cause more worming and make the environ less vulnerable in absorbing air pollution.

(VII) Micro-Climate Stabilization

The Indian Forest Conservation Act, 1980 (as amended in October, 1992) suggested that one hectare of fully stocked forest would be taken as Rs 126.74 lakh to accrue over a period of 50 years. The value will reduce with density. Since in our case this includes loss already mentioned (like carbon sequestration), we may not consider the figure fully. Never the less, to avoid pessimistic scenario, we do not change it.

6.2 Net Benefit from Non Use Value

The data yielded from awareness survey suggested the average willingness to pay of non-stakeholder citizens as Rs 30.00 a month. Pessimistically taking it Rs 10.00, the total amount will add up to Rs 60.00 lakh per month for six lakh households and Rs 72 million a year.

So far we have considered the potential losses due to conversion of wetlands or benefits accrued from the utilization of wetlands. The alternative uses of converted land may generate values or benefits. There is no clear information or database on benefits from alternative use on which we may depend. Even the upcoming leather complex produced no damage assessment study, nor is there any impact assessment data. There is no clear information on rehabilitation of the evicted people. Costs of conventional sewage treatment through wetlands do not appear in any report. Even the argument of housing at ECW site for increasing population is untenable on the question of sustainability. Given these limitations, opportunity cost estimation will be highly subjective and any conclusion may be treated as casual empiricism. We therefore restricted our cost-benefit results only on the estimation of potential losses shown in table 6.2.

Table 6.1: Lost Annual Paddy Production due to Conversion of East Calcutta Wetlands

Police Station.	Area of Land (hectare)	Quantity (quintal)
Sonarpur	388	14744
Rajarhat	600	33000
Tiljala	250	9500
Total	1238	57244

Table 6.2: Potential Losses due to Conversion of 1500 Hectares of East Calcutta Wetlands in the Year 1999-2000

Sl No	Type of Losses	Value (Rs in million)
1	Revenue loss due to shrinkage in*	
	(i) Paddy cultivation	87.00
	(ii) Pisciculture	14.15
	(iii) Medicinal plant	.10
2	Income loss due to shrinkage of Indirect employment**	161.00
3	Loss of suspended solid	. 87
4	Loss due to micro climatic instability #	3.78
5	Los on non-use existence value	72.00
	Total	338.90

* These do not reflect income loss

** Number of affected households 4751

Single year annuity value

Chapter 7: Discussions

7.1 Sewage Fed Fisheries

Fishing activities at ECW have a long history. After the fall of Siraj (1757), the East India Company vested holding rights of the salt-water lakes to Mirzafar. But, actual right of fisheries had gone to some local families who were powerful in terms of money and influence. The SFF were earlier salt-water fisheries (SWF).

Fish culture was initially practiced by trapping the tidal waters of Bidyadhari river by building earthen embankments. This was a lucrative venture as no manuring and fish-seed costs were involved. But, with increased siltation of creek and subsequent death of Bidyadhari, fisheries got gradually cut off. The owners thought of infusing sewage water for its rich Nitrogen, Potassium and other chemical contents that helped the growth of fish crop. Thus the sewage were no more a pollutant to them but nutrient. The earliest of such attempts could be found in 1860 when one Health Officer of CMC started sewage farming (IWMED, 1986). Probably, this was the first of its kind in the world. But, on an organized commercial scale, the entrepreneurs adopted this measure only since 1929. Around 1930, on the advice of expert S Hora, regulated proportion of sewage water began to be used in Bhangar, Tiljala, Jadavpur and Sonarpur fisheries (Mukherjee, 1998).

According to one estimate of the World Bank, the fisheries of eastern peripheries of Calcutta cover an area of about 2774 hectares which is by far the largest contiguous wetland fishery area in the world (Mukherjee, 1998). China follows in the second place in regard to the extent of SFF (670 hectares) where the wetland fishing of 160 hectares is located around Changsa. In other places like Germany, Israel and Hungary SFFs are there. In India, there are SFF in 230 other locations.

While experts differ on the question of present area of wetlands and area under SFF, all accept the fact that ECW have long been shrinking due to various types of human interventions.

In 1945, of the total wetlands of about 8000 hectare, nearly 4628 hectares of area was occupied by SFF (DEC d, 1945). Since 1953, after the formulation of Salt Lakes Reclamation Scheme, area under SFF continued to decline steadily. By 1970, expanding city engulfed Salt Lakes by about 2000 hectares. In the north Salt Lake area, 26 fisheries were taken over by Salt Lake city housing complex alone (CMDA,

1976). All of these fisheries were not SFF, but SWF. The nature of conversion of some fisheries is given in table 7.1.

During 1969, there was a large-scale conversion of SFF when some of these bheries turned vested due to unsettled land question. Under political patronage these bheries were distributed among land less people. Some co-operatives were formed. But, a large part was converted into paddy fields. Total amount of such conversion was about 6000 hectares. Cultivation also started on dried up bed of Bidyadhari River.

Although local fishery owners and legal actions halted further encroachment of the wetlands, the process was not stopped. Throughout seventies, the conversion process was continuing creepingly. New townships like Kasba, Vaishnabghata, Patuli came up in an area of about 800 hectares.

One point is to be cleared that all wetlands are not SFF, but all SFF are wetlands. Some fisheries are used for pisciculture during summer and for paddy cultivation during winter. Hence, different studies give conflicting figures on area under SFF and paddy. Our estimation gives the modest figure of 2400 hectares for paddy cultivation.

Various researchers had differently estimated the number of SFF of Calcutta cluster of wetlands. In 1945, there were 350 SFF in ECW (Datta-Mukherjee, 1999). According to the estimate of IWMED, Calcutta, there were 169 units in 1995. Mukherjee's estimation (1996) gave the figure 154. The government of W B claimed that there were 148 units (Chakraborty, 1998). INSED study (1998) identified 196 units while CRG (1997) compiled 188 bheries.

The ownership pattern of these fisheries is extremely skewed as indicated in Table 7.4. The variation of fishery sizes is also fairly high -the maximum and minimum sizes are 160 hectares and 0.4 hectare respectively. (Dutta-Mukherjee, 1999).

7.2 Solid Waste management

East Calcutta had long been the obvious choice for garbage dumping. In 1865, 2.59 sq. km area was acquired and handed over to the municipal authorities for dumping of the city's garbage. 1872 completed construction of a railway line and a canal across the newly acquired area. Around 1880, sewage farming and cultivation on garbage started at Dhapa, and in 1887, Dhapa Lock was constructed.

In 1880, a 19 years lease was granted to one Bhabanath Sen for cultivation, fisheries and unloading of garbage wagons in this area. The lease was extended later and settlements grew up and at present there are about 320 hectares of garbage farms in nine villages (IWMED, 1986).

Nath (1991) estimated that the city released about 2100 metric tonnes of solid waste per day. But, this was the figure before inclusion of several sub-urban municipalities within CMC. The current estimation of CMC is about 3100 metric tonnes a day.

It is estimated that more than 15 per cent of total solid waste consists of paper, glass, metal, plastic, rag, clothes, etc. The physical composition of garbage has been presented in table 7.5

At present, out of 141 wards, CMC introduced a system of door to door collection of solid waste in 108 wards. Some voluntary organizations also have come forward in this venture. But, problem relating to dumping site has not been solved so much. Till now, destination of all the solid wastes of Calcutta is Dhapa. A negligible quantity goes to Nawpara. Out of 800 hectares identified for garbage dumping in Dhapa-Bantala area, 480 hectares have already been filled up.

More than one fifth of the total collected waste here comes from the bazars under CMC. The kitchen wastes from domestic sources and those available from the market dealing with perishable commodities get converted into compost as a natural process in the dumping site. Atmospheric oxidation of the organic substances does the job over time. This invited agricultural farming. The garbage farms are located in Hatgachia, Boinchtala, Shahababad, Durgapur, Anantabadal, Arupota, Khanaberia, and Chowbaga.

Since the traditional oxidation process of converting solid waste into organic manure is bit long, mechanical procedure of manufacturing manure from these wastes is gaining popularity day by day. One private company is now engaged in manufacturing such manure at Dhapa. The opportunity value of solid waste treatment may be put together here. With negligible fossil fuel cost, this has been proved to be a viable environment friendly experiment. The present capacity of the firm is 1400 quintals of organic manure from 7000 quintals of solid waste a day. The production cost is only Rs 120 per quintal. The manure is of high demand from tea gardens and potato farms.

The irrigation system for vegetable cultivation is completely dependent on the city sewage, both treated and untreated. The colour of untreated sewage is black in the beginning. After a week this becomes green and after a fortnight it turns completely transparent with 18" to 24" depth. A field survey on irrigation shows (Kundu, 1991) that 60.53 per cent of the 152 respondents used treated sewage from fisheries while practice of irrigation by direct sewage was 31.58 per cent.

7.3 Calcutta Tanneries

Calcutta Tanneries are part and parcel of ECW. There are about 550 tanneries in Tangra, Tiljala, Pagladanga and Topsia near Eastern Metropolitan Bypass. Many of these units are more than 100 years old. The units generate huge amount of unhygienic and highly toxic waste. The problem becomes pervasive due to increased urban expansion near these tanneries. For wise use of wetlands and sustainable development of the region, EIA of these leather-manufacturing units is important.

According to an estimate of the West Bengal Pollution Control Board, the total discharge of polluted water by the tanneries equals an approximate amount of 30000 cubic metres a day. Of this amount, Tangra alone generates 20000 cubic metres. Besides health hazards, this polluted water is affecting the quality of water and land of ECW.

In 1989, the consultant of WHO Dr S Balakrishnan visited different tanneries of Calcutta and reported that due to acute space constraint, adequate treatment arrangement can not be made in existing locations. He suggested Common Affluent Treatment Plant (CATP) within each tannery. But, since it is not possible to install CATP inside the existing tanneries, shifting of the tanneries came upper most in the agenda.

Central Leather Research Institute (CLRI) also carried out a study on pollution load under normal operation period. The scientists of CLRI collected samples at the outlets of tanneries. Table 7.6 presents the volume of wastewater generated from raw to finished products per 100 kg of hides and skins.

The government of West Bengal allotted the land near Bantala with an area of 440 hectares. Of this, 200 hectares came vested and rest is to be procured. The cost-benefit analysis of the proposed leather complex carried out by CLRI has been

criticized by many. Banerjee and Mukherjee (1999) found CLRI oblivious to the socio-environmental costs.

A major part of the acquired land was fisheries of the Naskar families during the sixties. The vested land was distributed among the landless farmers under the political patronage. The land use pattern is still in transition.

7.4 Question of Contamination

On the question of toxic threat to the fish and vegetables scientific inquiries have not yet come to any definite conclusion. Scientists, who are apprehensive, fear that toxic tannery waste might infiltrate the fish or vegetables through the same channel through which waters of the bheries flow. They bank upon the report of Central Pollution Control Board tests. But, other experts do not find any evidence in the report that there is an element of toxic substance (Chakraborty, 1998). But, according to M Sinha, a leading expert on fish farming, disease seen in fish of a particular species in the bheries were less pronounced than those observed in the same species in some other fresh water bodies.

The system of water-sun-waste interaction, as our panel experts suggested, is such that most of the infections are taken care of. Besides, most of the infective organs that grow in our stomach are short lived. So they die within minutes of coming out. Whatever organisms do survive, do well only in moderate temperatures like inside human body (37 degree centigrade) and just can not survive the heat of the frying pan. So observed S Ayappan, the Director, Central Inland Fresh Water Aquaculture Research Institute, Bhubaneswar (Pal et.al. 1982).

7.5 Biodiversity in East Calcutta Wetlands

Wetland ecosystems are rich sites of bio-diversity. It harbors different species of plants and microorganisms. These species are inter-linked in a chain of levels. Rich biota such as zooplanktons and phytoplanktons play a vital role as primary producer and in global cycling. Their functions are curtailed owing to destruction and filling up of these water bodies. The primary decomposers are the multitude of bacteria and fungi, which act on the detritus to produce food for the detritovores like invertebrates. Worms and insect larvae supply inorganic nutrients to the other producers of food like the algae and higher plants. ECW is a rich storehouse of this bio-diversity with algae to the one extreme to carnivorous community to the other.

The botanical and zoological strength of this vast water body has been justified in various studies (Biswas, 1927, Sewell 1934, Ghosh, 1990, 1999, Biswas, 1999).

(i) Aquatic Organisms

The bacterial population release, through metabolic process various chemical compounds that can be assimilated by plant and animal communities. The deposition of decaying matter and sludge fed wetlands/canals always assure the presence of bacteria.

The presence of algae ensures a healthy process of photosynthesis. Algae are found in all but the most polluted waters and are most abundant in nutrient rich utrophic situation. Larger macrophytic algae can keep the water clean. Many invertebrates feed exclusively on algae. Algae can bloom at increased levels of dissolved nutrients and may prevent light from penetrating the water, leading to death of most aquatic animals but survival of submerged plants. It is noteworthy that about 70 years back as many as 40 species of algae were recorded from Salt Lake area (Biswas, 1927).

It has been observed in the study of CEMSAP (Ghosh, 1997) that rich variety of macrophytic vegetation can offer suitable site for laying eggs and cover all size of fishes. The interdependence also provides facilities for roosting and breeding of aquatic birds.

The CEMSAP study recorded 22 species of mammals representing Shrew (1 species), Bats (9 species), Carnivores (10 species) and Squirrel Rat and Mouse (5 species). Marsh Mongoose is a striking addition to the stock in recent years.

(ii) Amphibian and Avian Fauna

In the wetlands that still survive, intensive aquaculture is currently being practiced. Recent observations show that while productivity in fish cultivation increased from 8.37 quintals to 31.00 quintals per hectare, habitat is totally controlled by human agency (Ghosh, 1985). Only a few selected fish species are cultivated which excludes the possibility of occurrence of other indigenous fish species.

In the past, reed beds were dominant features of the habitat. At present, there is almost absence of reed beds. Birds are thus deprived of shelters, nesting site, roosting site and food. The drastic reduction of plant diversity and biomass had

resulted in the loss of bio-diversity in avian fauna. The bheries or fishponds usually maintain a certain level of water. Those birds that are adapted to that water level flourish. The lack of variation in water level is a hindrance to most other water. Only birds like the larger Herons and Egrets gain ground. The most striking is the fall in the population of birds of prey, the top predator in the food chain.

The current status of ECW shows the drastic change in the environment that has taken place in this region. A planned and controlled habitat equipped for optimal utilization of the area for agricultural and fishery produces definitely denied the bird population of the area.

Comparison of few inventories of birds available shows a rapid change in bird bio-diversity in recent years in the area under study. A study of birds at ECW between 1960-65 has produced one of the best data set and recorded 90 aquatic birds and 158 land birds in the study area (Biswas and Ghosh, 1990). Among these 50 per cent of the aquatic birds were reported to be migratory. Prakriti Samsad recorded 123 species of birds from Salt Lakes during 1978-83 (Roy Chowdhury, 1984). A recent study recorded about 40 to 43 species of birds (Ghosh, 1997). This suggests reduction of nearly 84 per cent of original species.

7.6 Comparison of East Calcutta Wetlands with Loktak Wetlands

It is interesting to discuss another important wetland site, Loktak of Manipur. It can be compared with ECW. Loktak occupies an area of 286 sq. km. The site is located about 38 km from Imphal city at an elevation of 768.5 metres between latitudes 24 42 N and longitudes 93 46 and 93 55 E.

Loktak is a shallow water lake, with average depth recorded at 2.7 metres. As ECW is the sub-basin of Hooghly river, Loktak can be considered as a sub-basin of Manipur river. It supports a large number of inhabitants both directly and indirectly. Out of the direct catchment area of 980 sq. km, 430 sq. km is under paddy cultivation, 150 sq. km is of habitation area and forest area covers an area of 400 sq. km. There are 14 hills varying in size and elevation. Fifty-five rural and urban settlements are located around the lake with a total population of about 100,000 people. A large number of fishermen live in Thonga, Karang, Ithing and Sendra islands. Further, a large number of fishermen live on some 688 floating huts.

Loktak wetland is rich in bio-diversity. The Keibul Lamjao National Park, which belongs to the Loktak wetland, is the only natural habitat of the highly endangered deer called 'Sanghai'. This national park is a continuous mass of floating 'Phumdies' occupying an area of 40 sq km.

The very special feature of Loktak is the presence of heterogeneous mass of soil, vegetation and organic matter at various stages of decomposition. These are locally called 'Phumdies'. In ECW, no such floating Phumdi is present. This is due to the nature of water body. The biomass gets time to grow there at Lokta. But, ECW consist of ponds, bheries, canals etc. Human pressure on these water bodies is higher than that of Loktak due to its strong urban nature. Further more, unlike Loktak, a large part of water of ECW is wastewater or sewage generated by the metropolis Calcutta.

Population density of Calcutta wetlands is higher than that of Loktak. While 1 lakh people depend on the water body of 78 sq. km. in Calcutta, in Loktak, 1.21lakh people are dependent on the water body with an area of 338 sq km.

The vegetal cover in the catchment area and the construction of Ithahi barrage are major problems of Loktak. For ECW, Increasing siltation of the canals and conversion of water bodies to urban use have been identified as root-cause problems.

Table 7.1: List of Some Old Bheries and Their Conversion at Salt Lake

	Name of Bheries	Present Location
1.	Bidyadhari Spill Cooperative Fisheries	Vidyasagar, Laboni B.D. Market
2.	Knakrimari Bheri	Bbaha Atomic Research Center
3.	Boro Bheri	Baisakhi, Digantika
4.	Daser Bheri	Mayukh Bhavan
5.	Nortala Khas Bheri	Salt Lake Stadium
6.	Kansar Bheri	Baisakhi Houshing
7.	Bager Bheri	Jhilmil
8.	Kajar Bheri	Industrial Estate
9.	Hansar Bheri	Industrial Estate

Source : Deshkal, Vol. 16, No. 2

Table 7.2: Distribution of Bheries by Area (hectare)

Size Class	Number	Per cent of Total
Upto 4	55	19.89
4 – 8	35	19.89
8 – 12	43	24.43
12 – 16	7	3.98
16 – 20	9	5.11
20 – 40	18	10.23
40 – 60	15	8.52
60 – 80	9	5.11
Above 80	5	2.84
Total	196	100.00

Source : INSED, 1998

Table 7.3: Police Station-wise Number of Existing Bheries at ECW

Sl. No.	Name of Police Station	Total Number of Bheries as given by Govt, of WB	Total Number of Bheries as given by CRG
1.	Bidhan Nagar	34	46
2.	Bhangar	45	34
3.	Tilajala	45	45
4.	Sonarpur	24	63
	Total	148	188

Source :

(1) Meenbarta, 1998.

(2) ECW and Waste Recycling Regions (Primary Data) Base Line Document for Management Action Plan. (As per Ramsar Convention Guidelines) Creative Research Group, Deccember, 1997.

Table 7.4: Ownership Pattern of Sewage Fed Fisheries

Type of Holding	Percentage
Private	93.14
Cooperative	0.86
Government	6.00

Source: IWMED

Table 7.5: Physical Composition of Solid Waste of Calcutta (as % of total)

Categories	Year	
	1992	1995
Vegetable matters	13.05	11.75
Garbage	16.05	29.49
Hay & Stray	6.31	3.36
Paper	3.18	6.27
Rags	3.60	5.73
Total Compostable Material	42.19	56.60
Ash & Earth	33.59	17.20
Ignited Coal	8.08	2.44
Earthen Ware	6.65	4.15
Coconut Shell	4.96	9.12
Stone	1.36	0.39
Iron & Other metals	0.66	0.35
Bones	0.42	0.42
Leather	0.86	4.00
Plastic	0.65	2.07
Glass	0.58	3.26
Total Non-Compostable Material	57.81	43.40

Source: CMWS & A, 1995.

Table 7.6: Volume of Wastewater Generated per 100 Kg. of Hides and Skins

Source	Average (Ltrs.)
Beam House Operation	1860
Tan Yard Operation	790
Finishing Operation	395
Others (Floor Washing etc.)	440
Total	3485

Source CLRI, 1995.

Chapter 8: Recommendations

The wetland ecosystem of Calcutta is a delicate, complex and under studied area, which requires immediate attention for the survival of the city. The study confirmed most of the common apprehensions on the vectors of threat operating on ECW. Further research would undoubtedly identify more numbers of specific threats. Based on the analysis of various issues confronting wetlands of Calcutta, a set of recommendations is placed for the policy makers to consider.

8.1: Identification of Threats

After partition of 1947, due to large influx of population in Calcutta and its suburbs, development of West Bengal had been Calcutta biased. Like ever-hungry monster, the city expanded and wetlands suffered. The changing land use pattern had therefore led to

- Changes in hydrological regimes and thereby affecting ecological balances and functions.
- Inundation of periphery causing loss of property and life.
- Loss of agricultural and fish production and diversity leading to unemployment.
- Rise in urban pollution and social unrest.

8.2: Proposals

(i) On Fisheries and Agriculture

From producers' point of view, fishing activities are going to be less profitable due to various reasons mostly labour related problems and poaching. While total area of sewage fed fisheries is declining at a rapid rate, the population in the adjacent villages is increasing. Poaching problem is related to rising unemployment. To face the situation following measures may be taken:

Conversion of bheries for other uses is to be stopped. Hard legislation on wetland is urgently needed. The existing Fisheries Acts are welcome measures to this end but these are not sufficient to protect the water bodies.

Middle scale bheries are becoming unprofitable if considered in terms of opportunity cost of real estate use. Hence ecological benefits are to be recognized with sufficient importance.

Adequate amount of sewage-laden water is to be ensured. The SFF frequently complain that they do not get sufficient amount of sewage water after the management of storm water flow and dry weather flow channels were handed over to the Irrigation and Waterways department from CMC. Rational distribution of sewage water requires careful handling by a sensitive organization. There are scopes of widening the command area of sewage fed fisheries.

Poaching makes the profession risk prone and induces the owners to sell off their ponds or tun into arable land. A concerted effort of the government, political parties and owners may find out some solutions.

Vegetable growers hardly get remunerative prices due to poor storage facilities. A faster transportation system to far off markets of the country may give a booster to the garbage farmers of this region especially during winter.

The paddy growers of the region do not get institutional credits from any agricultural bank here. This is a serious problem to the poor farmers. In spite of getting advantage of both irrigation and organic manure, lack of institutional credit rises the production cost.

(ii) On Sewage Treatment

The popular belief that sewage fed fisheries is effectively solving the problem of sewage treatment is far from truth today. After the development of Salt Lake City and virtual non-functioning of Bantala treatment plant, the problem of treating sewage has become acute. More over, underground sewer system also failed to expand beyond CMC limit. Naturally the wastes enter the surface canals. Not only siltation, human interventions like unauthorized settlements along the canals almost jeopardized the drainage system. To solve the problem followings are recommended:

- Existing canals are to be cleared through regular dredging.
- Canal sides are to be kept free from settlements.
- A sewage treatment tax can be introduced for financing the cost of canal development

(iii) On Urban Built-up Area

Three-tier system of the state government regarding wetlands will be of little use to protect the wetlands. There must be a No Development Zone (NDZ). It is recommended that wetland together with the surrounding agricultural land be declared as NDZ. The tract containing existing built up areas should be a regulated Development Zone (RDZ). It would be wise to create a buffer in the shape of a green belt with variable width between NDZ and RDZ.

The proposed new township should have their own drainage outlets with treatment plants. Untreated waste should not be permitted to pass through the wetland core zone. Calcutta must have a long run action plan with canals. Canals like Bagjola, Krishnapur, Beleghata, Bhangarkata and Tolly's Nala should be brought under an organization like Canal Development Authority. An apex body with sufficient financial and executive power should control the functioning of the Authority.

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