

*Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange*

Project Paper No. 8

**Integrated Study on Wetland Conservation and
Urban Growth : A Case of Calcutta's Wetland**

by

**Institute of Wetlands management and
Ecological Design, Calcutta**

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***Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange***

A project implemented by the

**Institute for Housing and Urban Development Studies (IHS),
Rotterdam**

In co-operation with the

**Instituto de Desarrollo Urbano (CIUDAD), Lima
Institut Africain de Gestion Urbaine (LAGU), Dakar
Instituto para la Democracia Local (IPADEL), Lima
Human Settlements Management Institute (HSMI), New Delhi
Centro de Servicios para el Desarrollo Urbano (PROA), La Paz**

Sponsored by

**Directorate General for International Co-operation (DGIS),
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and

**Swiss Development Co-operation, Federal Department of Foreign
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Introduction to the Project

Focus and Outline of the Project

Capacity Building for the Urban Environment is a comparative research, training and experience exchange project that was launched in October 1994 with the support of the Dutch government. It provides an inventory and review of the experiences of relevant bilateral and multilateral organisations and of Best Practices in urban environmental management. For the countries of India, Peru and Bolivia, it identifies, communicates and extends the application of Best Practices in environmental management for cities. In May 1995, the project was expanded to include Senegal/West Africa with the support of the Swiss government.

The focus of the project is on learning from experiences in urban environmental management at the city level and on developing strategies for capacity building in order to replicate and scale up the best of these experiences elsewhere. The overall co-ordination of the project is the responsibility of the Institute for Housing and Urban Development Studies in Rotterdam, while co-ordination in the participating countries is the responsibility of the following partner organisations:

- Human Settlements Management Institute (HSMI), New Delhi, India;
- Instituto para la Democracia Local (IPADEL), Lima, Peru;
- Instituto de Desarrollo Urbano (CIUDAD), Lima, Peru (since January 1997);
- Centro de Servicios para el Desarrollo Urbano, (PROA), La Paz, Bolivia, and
- Institut Africain de Gestion Urbaine, (IAGU), Dakar, Senegal.

Project Activities

Support to cities in the form of applied research and development activities in the area of urban environmental management has been, and continues to be, provided by the co-ordinating partner organisations through the following set of activities:

Research

Within the applied research programme undertaken in the project, Best Practices in urban environmental management in Bolivia, India, Peru and, to some extent, Senegal were identified, and their lessons and experiences reviewed. An analysis and review of the identified Best Practices then took place involving a large number of individual research groups and professionals. In a process of on-going monitoring and review, guidance and support were provided by IHS and its partner organisations. The results of both the individual studies of Best Practices and their review are being published in several books and papers in both English and Spanish. These and their publication dates are listed in the *Introduction to the Project Papers*, which follows this note.

Networking

In identifying the research priorities of the project, during the conduct of the research studies, and throughout the review of research findings, a structure was developed and utilised to ensure the participation of all interested and concerned individuals and institutions through a consultative process. Expert group meetings and consultative seminars were organised for this purpose.

Capacity Building Strategies

After the Best Practices research, analysis and review were completed for all countries, outline capacity building strategies were developed for each based on what was learned from these local experiences and practices. These strategies were developed through a broad-based consultation process involving a large number of research institutions, individual professionals and academics, city representatives, NGOs and local representatives. They are currently being modified based on the outcome and findings

of Habitat II, which was held in Istanbul in June 1996, and the emphasis has now shifted to applying a number of Best Practices to selected cities.

Best Practices Documentation

Concurrent to and co-ordinated with this project, IHS served as the secretariat of and contributed to the review of the Best Practices that were submitted to the United Nations Centre for Human Settlements (UNCHS) for the *Global Best Practice Initiative for Improving the Living Environment* in preparation for Habitat II. HSMI, PROA, IAGU and IPADEL were also involved and contributed to the national preparatory processes that took place in their own countries. An overview of the Best Practice submissions to UNCHS, as well as summaries of the additional case studies received by IHS, are being made available on the Internet through the IHS Home Page.

Databases

Two databases are also under preparation: an institutional database and a literature database. The institutional database is being developed in co-operation with the International Institute for Environment and Development (IIED) in London. It contains entries on relevant organisations, some of which are documented in extensive profiles, while others are included as shorter reference information entries. IHS is developing the second database, which provides references in the literature on experiences with urban environmental management.

Rotterdam Seminar

The Rotterdam Seminar, which took place in May 1996 during the two weeks preceding Habitat II, brought together all principal researchers, as well as city representatives and other professionals involved in the project for a period of intensive discussions. The seminar resulted in a document that provided a comparative analysis of practices and experiences in the field of urban environmental management. This analysis included the project process and network building, governance, job creation and poverty alleviation and gender. This was published as a book in February 1997 and is listed later in the *Introduction to the Project Papers*.

The Rotterdam seminar also discussed *city-level capacity building strategies* for the cities of Calcutta, India; Ilo, Peru; Santa Cruz, Bolivia and Dakar, Senegal. Experiences in *urban environmental management* were reviewed for the cities of Tilburg, The Netherlands and Nairobi, Kenya.

Habitat II

At Habitat II the project was presented in the Special Meeting on Implementing the Urban Environment, organised by UNEP and UNCHS, as well as in other fora.

Capacity Building Strategies for Peru, Bolivia, India and Senegal

The outline capacity building strategies which were developed in preparation for Habitat II (i.e., by CIUDAD, PROA, HSMI and IAGU with the support of IHS). They are being modified for implementation, which is expected to begin late in 1997.

Outline Training Program for Local Officials, CBO Workers, and other Partners for Peru, Bolivia and India

These training materials are to be developed over the next few months and will comprise curricula for short courses related to the most directly applicable Best Practices identified for each country in view of its national strategy for capacity building in urban environmental management.

The Development of a Medium-Term Capacity Building Strategy for Senegal and West Africa

This activity is in progress and addresses the building of individual and institutional capacities at the local level for urban environmental management in both Senegal and throughout West Africa.

Introduction to the Project Papers

A number of publications have appeared under the Capacity Building for the Urban Environment project. These are listed below and can be ordered from IHS or its partner organisations respectively:

- *Capacity Building for the Urban Environment*, edited by David J. Edelman and Harry Mengers, summarises the research findings of the project and the conclusions of the Rotterdam Seminar. It was published by the Institute for Housing and Urban Development Studies (IHS) in Rotterdam in February 1997;
- *Urban Environmental Management: The Indian Experience*, edited by B.N. Singh, Shipa Maitra and Rajiv Sharma, reviews the Indian experience in urban environmental management and presents all the Indian Best Practice of the project in detail. It was published by the Human Settlements Management Institute (HSMI) and (IHS) in New Delhi in May 1996;
- *Problems and Issues in Urban Environmental Management: Experiences of Ten Best Practices*, also edited by B.N. Singh, Shipa Maitra and Rajiv Sharma reports on the Indian Best Practices of the project in an abridged form. It was published by HSMI and IHS in New Delhi in May 1996, and
- *Ciudades para la Vida: Experiences exitosas y propuestas para la accion*, edited by Liliana Miranda Sara, presents the Best Practices and outline capacity building strategies for Peru and Bolivia for a Spanish speaking audience. It was published as Volume 6 in the Urban Management Series of the joint UNCHS/UNDP/World Bank Urban Management Programme in Quito in May 1996.

The objective of this series of *Project Papers*, then, is to bring to an English speaking, audience the results of the project research in Peru and Bolivia appearing in the Miranda book. In addition, the Indian research, while documented in English in the second and fourth references listed above, has not appeared as complete, individual studies. Consequently, a selection of these will also be chosen for this series. Finally, the first reference in the above list covers aspects of the research undertaken in all four countries of the project.

As a result, the selection of work appearing in the *Project Papers* includes the following:

Bolivia

- 'Urban and Environmental Reality Workshops' by Zoila Acebey;
- 'Urban Agriculture in Community Gardens' by Julio Prudencio Böhr, and
- 'Institutional and Development Framework for Urban Environmental Management in Bolivia' edited by Gastón Mejía.

Peru

- 'Defence and Conservation of the Natural Swamp Area Pantanos de Villa, Lima' by Arnold Millet Luna, Eduardo Calvo, Elsie Guerrero Bedoya and Manuel Glave;
- 'Consultation in Urban Environmental Management: The Case of Ilo' by José Luis López Follegatti, Walter Melgar Paz and Doris Balvín Díaz;
- 'Promotion of Employment, Health and the Environment, Lima' by César Zela Fierro and Cecilia Castro Nureña
- 'Environmental Sanitation and Infrastructure: The Case of the Marginal Urban Areas of the Southern Cone of Lima' by Silvia Meléndez Kohatsu, Víctor Carrasco Cortez and Ana Granados Soldevilla, and
- 'Inter-institutional Consultation and Urban Environmental Management in San Marcos Cajamarca' by Marina Irigoyen and Russeles Machuca.

India

- 'Power to the People: The Local Government Context' by the Times Research Foundation;
- 'Carrying Capacity Based Regional Planning' by the National Institute of Urban Affairs;
- 'NGOs/Civic Societies and Urban Environmental Advocacy' by Development Associates;
- 'Integrated Low-Cost Sanitation: Indian Experience' by Sulabh International Institute of Technical Research and Training;
- 'City-Wide "Best Practices" in Solid Waste Management in Collection, Transportation and Disposal' by HSMI/WMC of UIFW;
- 'Environmental and Health Improvement in Jajmau Area, Kanpur: Lessons and Experiences for Wider Replication' by Ministry of Environment and Forests;
- 'An Approach to Pollution Prevention in Electroplating Sector' by Development Alternatives;
- 'Integrated Study on Wetlands Conservation and Urban Growth: A Case of Calcutta's Wetlands' by Institute of Wetlands Management and Ecological Design;
- 'Sustainable Urban Development: A Case of Navi Mumbai (New Bombay)' by City & Industrial Development Corporation;
- 'Community Based Sanitation and Environmental Improvement Programme: Experiences of Indore, Baroda and Ahmedabad' by Shri Himanshu Parikh, and
- 'Institutional and Development Framework for Urban Environmental Management in India' by HSMI.

It should be emphasised here that the nineteen *Project Papers* in this series reflect the views of their authors only and have been edited to varying degrees. Initial English language editing was done by, among others, B.N. Singh, S. Maitra and R. Sharma for India and by D.J. Edelman for Peru and Bolivia. In fairness to both the authors and the publishers, they should, therefore, be characterised as working papers rather than full academic papers.

David J. Edelman, Series Editor
Rotterdam, February 1997

**Intergrated Study on Wetland Conservation and Urban
Growth: A Case of Calcutta's Wetland**

by

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TABLE OF CONTENTS

| | |
|--|-----------|
| INTRODUCTION | 1 |
| THE WETLANDS IN EAST CALCUTTA | 3 |
| THE TECHNOLOGY OF SEWAGE-TREATMENT FISHERIES (S.T.F.) | 7 |
| VALUE OF EAST CALCUTTA WETLANDS | 9 |
| INSTITUTIONAL ARRANGEMENT AND PARTNERSHIPS | 16 |
| WETLANDS MANAGEMENT ISSUES | 13 |
| THE GENDER ASPECT | 16 |
| IMPACT AREAS AND ASSESSEMENT | 18 |
| STRATEGIES FOR CONSERVATION OF INTEGRATED WETLANDS SYSTEM | 19 |
| CAPACITY BUILDING AND INSTITUTIONAL STRENGTHENING | 25 |
| BIBLIOGRAPHY | 26 |

Integrated Study on Wetland Conservation and Urban Growth : A Case of Calcutta's Wetland

Institute of Wetlands Management and Ecological Design, Calcutta

INTRODUCTION

OBJECTIVES OF THE STUDY

The East Calcutta wetlands are peri-urban wetlands near the metropolis of Calcutta. The functional use of the East Calcutta wetlands has developed it into a unique man-made eco-system. The area has been identified with waste recycling practices. Waste recycling not only provides fish, vegetables and crop production throughout the year but also supports low cost urban sanitation and spill basin to reduce water-logging of a congested metropolis like Calcutta.

Such waste recycling practices in these natural wetlands have been evolved by folk culture through indigenous methods. This traditional approach may be useful in alleviating urban sanitation problems in many other cities and towns of the third world countries.

However, the East Calcutta wetlands are threatened by the continuous expansion of the city of Calcutta. The present study has attempted to identify environmental management practices and has helped in designing a capacity building programme for the implementation of environmental management plans through such practices in other cities/towns.

AN OVERVIEW OF CALCUTTA'S WETLANDS

The East Calcutta wetlands stretch across the eastern margin of the city of Calcutta. These peri-urban wetlands lie between 22° 25'N and 22° 30'N latitude and from 88° 24'E to 88° 35'E longitude. Physiographically the region lies between the River Hooghly in the west and the River Bidyadhari to the east. These marshes and waterbodies are the results of intricate drainage patterns over the moribund delta. Till the nineteenth century the Bidyadhari River flowing over the region was active and tidal. The region actually turned into a spillway basin with the incursion of saline tidal water and hence is popularly known as salt water lakes. With the decay of the River Bidyadhari the eco-system has been greatly modified.

In 1928 the River Bidyadhari was declared dead by the Irrigation Department, Government of Bengal. In the early thirties of this century a storm water flow (SWF) channel was excavated by B.N.Dey, the then Chief Engineer, Calcutta Corpo-

ration, to drain the sewage water of the city and was connected with the Kultigong and ultimately drained by the River Raymangal into the Bay of Bengal. Later on to facilitate efficient drainage a dry weather flow (DWF) canal was laid parallel to the SWF. This change in the drainage layout resulted in the development of a changed eco-system linked with the environment of the city of Calcutta. The entire domestic sewage of the city of Calcutta (estimated 680 million litres/day) runs through a system of principal and ancillary channels passing through the East Calcutta wetlands. These flows are utilised in the sewage treated fisheries (STF) for pisciculture as nutrients and the wetlands purify the sewage water through a natural process of oxidation, radiation, biological breakdown of organic waste and pisciculture. The tropical climate with moderately high temperature and abundant solar radiation (250-600 langley/day) and shallow depth of water (less than 1m) have facilitated the evolution of this unique eco-system. Interestingly, these complete ecological processes have been understood by the folk fishermen of this wetland region and experimented upon to generate resources and employment.

ECO-SYSTEM AND RELEVANCE OF THE STUDY FOR WETLANDS CONSERVATION

The East Calcutta wetlands are physically identifiable with the deltaic floodplain wetlands, generated by the intrication of drainage channels related to delta-building. The natural decay of the river systems has resulted in the changing aquatic environment. The wetlands eco-system has also been interfered with by the anthropogenic activities and has deteriorated. The biodiversity of these wetlands had been lost many centuries back. According to the Asian Wetland Bureau (1989) the Salt Lake Swamp (the East Calcutta Wetlands) has been too degraded to merit any special conservation effect. But as mentioned earlier these wetlands have acquired unique importance integrated with urban environmental and peri-urban resource management. These peri-urban wetlands fulfil the criteria for identifying Wetlands of International Importance (Ramsar Convention) that these are of substantial value in supporting human communities dependent on the wetlands. In this context, such support would include :

- provision of food, fibre or fuel
- or maintenance of cultural values



- or support of food chains, water quality, flood control or climatic stability.

The functional use of the East Calcutta wetlands for sustainable development has become the focal point for delineating the wetland area. The area has been identified with the Waste Recycling Region. The Waste Recycling Region includes the mouzas where anyway the sewage or garbage wastes are being utilised either for fish farming or crop farming. This Waste Recycling Region covers nearly 11032.23 ha. area.

DEFINING THE WETLANDS AND RELATED ATTRIBUTES

Though there has been attention to the study of wetland ecosystems, there is yet no single, universally accepted definition of wetlands. This has been due to wide diversity in the nature of the wetlands. However, a definition of the wetlands has been outlined by the 1971 Ramsar Convention. (WWF, 1992)

The wetlands are defined as "area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or saline including areas of marine water, the depth of which at low tide does not exceed six metres". Moreover, the wetlands "may incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands". This definition appears to be the most comprehensive one extending to a wide variety of habitat types including rivers, coastal areas and even coral reefs. Identification of these distinctive characteristics will be useful in designating a wetland. These are : (1) when an area is permanently or periodically inundated; (2) when an area supports hydrophytic vegetation; and (3) when an area has hydric soils. By all criteria the Salt Lake Swamp (East Calcutta Wetlands) can be identified as wetlands.

POST INDEPENDENCE PERIOD

Since the Partition of India, there has been an unprecedented pressure of population over the metropolis of Calcutta creating an urgent need for the acquisition of new land for urbanisation. The growth rate for Calcutta's urban population since then has increased phenomenally with refugees from what was once East Pakistan and is now Bangladesh. In the early fifties, as quoted in the West Bengal Assembly, nearly 5.17 lakh families had officially migrated from East Pakistan; an additional number had entered illegally. Out of the total nearly 2.45 lakhs of families demanded house building loans. Proper housing provision lagged far behind this rapid influx of immigrants. On the other hand economic activities in Calcutta's city increased but no such growth was seen in any other city in the State. Thus, following the natural laws of economic and geographical agglomeration new entrants to the state tended to converge on Calcutta city to maximise the benefits of employment and income generating opportunities. The scarcity of urban land has forced them to settle down in outlying areas on the periphery with access to road and rail transport. Howrah city along

the western bank of the Hooghly prevents the expansion of Calcutta westwards. Howrah city could have been developed into a twin city had there been more bridges over the Hooghly connecting it with Calcutta.

The city has expanded from north to south to accommodate the immigrants and the spill over population of the city. Most of these areas are inhabited by dwellers dependent on the core city for education, services, livelihoods, better health care facilities etc. With the continued increasing pressure on the railway and roadway transport system it has become virtually impossible to cope with the tremendous pressure of the daily commuting to and fro.

Since 1960-61, the Calcutta Metropolitan Development had been subjected to various planning decisions. There had been a frantic search for alternative directionalities as the land use of the city had become ungovernable with unbearable density. The first choice was to expand the city area to the east on the marshy tract of the northern salt lake area. Following a BDP (Basic Development Plan) nearly 17,333 acres was to be acquired for developing a new township. Later, an estimated area of around 4 square miles was reclaimed and the new Salt Lake City was established mainly to provide housing facilities to urban people. This was certainly a shift in the directionalities of the city area which had been earlier in the north-south alignment following the eastern railway track on the east bank. The construction of the Eastern Metropolitan bypass along the eastern fringe has opened up the possibility of infringement on the wetlands further towards the east. With the existence of this acute problem in maintaining this infrastructural framework, the vast East Calcutta wetlands have thus been brought under focus of urbanisation besides the present level of utilisation as a vast area for sewage and garbage disposal and area for sewagefed fisheries and agriculture.

METHODOLOGY OF THE STUDY

Generation of data base and information appears to be very useful in outlining methodologies. Capacity building now-a-days is considered as state of the art in time-development-process for understanding the problem in depth. Capacity building will attempt developing a holistic approach to training with focus on strengthening the capacity of national, regional and local institutions of training.

In this study, a comprehensive method for collection of data, analysis of research inputs and formulation of strategies has been adopted.

A detailed report has been prepared on the East Calcutta wetlands to study and understand the age-old waste recycling practice both conceptually and practically. An attempt has been made to study the evolution of the practice in historical perspective related to the growth of the city of Calcutta. Present mechanisms of operation in terms of technical inputs, institutional and legal framework, demographic situation, resource genera-



tion, role of different interest groups/NGOs and gender aspect have been discussed. The objectives of the best practices are highlighted for sustainable use and potentiality of their replicability and scaling up.

The study is also intended to formulate a national strategy towards the protection and utilization of periurban wetlands. The low cost technology of oxidation pond for urban waste water treatment will open up a new vista for urban sanitation in the Third World countries in particular. Modification of present policies and legal framework has been suggested for effective implementation of this model for sustainable use.

THE WETLANDS IN EAST CALCUTTA

ROLE OF WETLANDS

It is now universally accepted that wetlands, far from being the wastelands of past perception, can have a wide range of valuable functions which provide goods and services to mankind. The essential ecological roles of wetlands are converted into important benefits to mankind through the relevant ecosystem elements and functions.

The wetlands are ecotones since these are transitional from terrestrial to deep water aquatic systems. Such transitory location often leads to high diversity in wetlands. Mitsch and Gosselink (1986) considered the wetlands as amongst the most productive ecosystems on earth. In recent years the manifold values of wetlands have been identified (Maltby, 1986). These are: i) Genetic Conservation, ii) Water Treatment, iii) Nutrient and Heavy Metal Removal, iv) Freshwater Fisheries, v) Flood Mitigation, vi) Tourism, vii) Wild Life Habitat, viii) Energy and Carbon Dioxide Storage and Release of Oxygen etc.

Serial determination of the probable value of wetland functions and uses has been indicated in Table 8.5. The East Calcutta wetlands do also possess all such values. In a recent judgement of Calcutta High Court in the case *PUBLIC-VS-State of West Bengal*, the values of East Calcutta wetlands have been highlighted. The court observed that "Wetlands being a bounty of nature do have a significant role to play in the proper development of the society be it from environmental perspective or economic perspective. Pollution-wise this metropolitan city of Calcutta tops the list in the country. Can we in this city further endanger the environment by reclaiming the nature's gift to mankind when, in fact, such a reclamation is only for the purpose of expansion of the satellite township on the eastern fringe of the city of Calcutta?" (CLJ, 1993).

AREA OF WETLANDS

The East Calcutta wetlands lying on the eastern fringe of the city of Calcutta between lat. 22° 25'N - 22° 30'N and long. 88° 24'E - 88° 30'E, stretch over an area of about 11,000 ha.



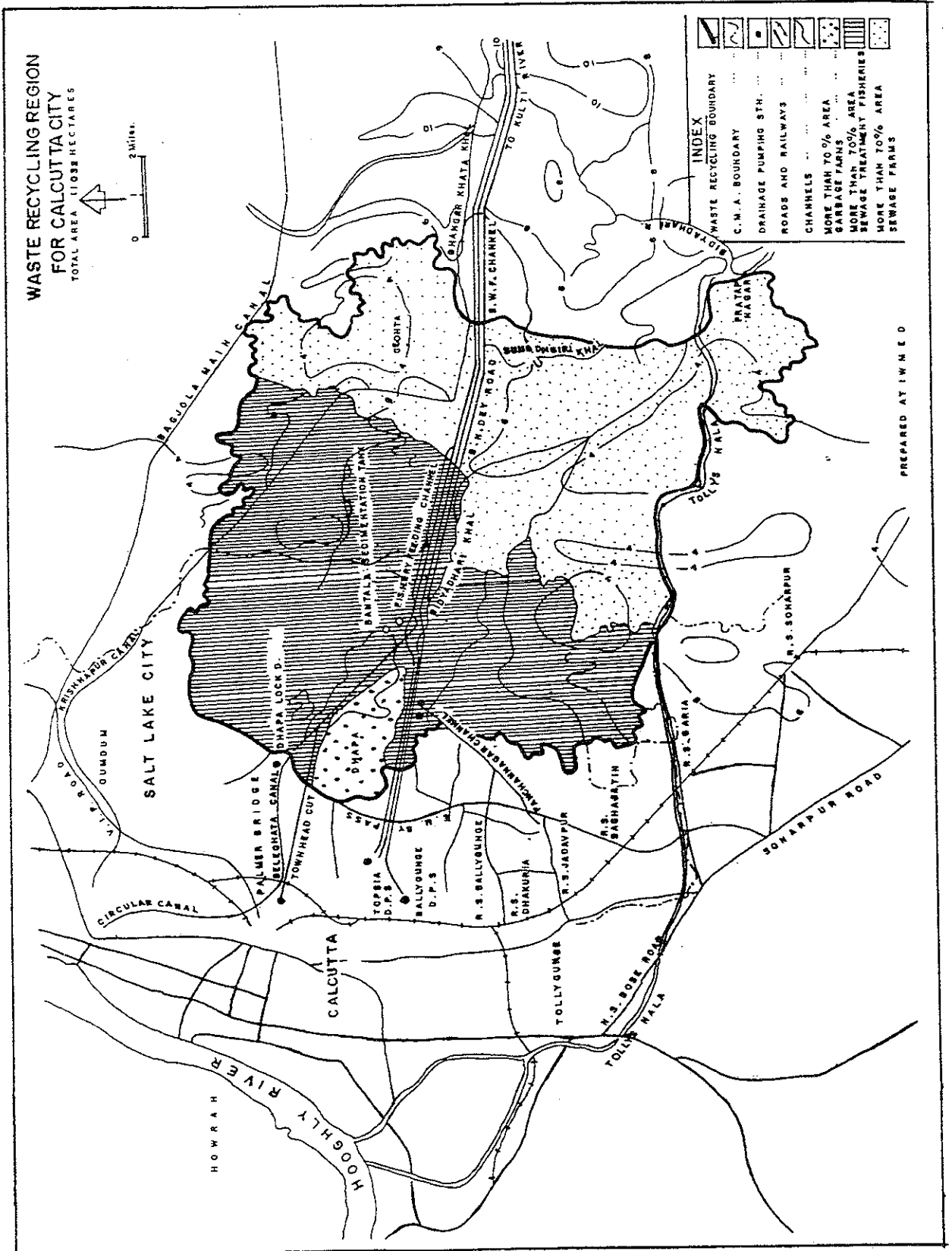
East Calcutta Wetlands

Though Calcutta's location was the least likely place for a metropolis the proximity of the wetlands came to the rescue of the city's environment in a later period. Calcutta grew as a metropolis without any sewage treatment plant and all its sewage was drained through the wetlands and garbage was dumped on the wetlands. The wetlands played a significant role in treating the sewage and in turn converted the municipal wastes into resources. Three distinct transformations into wealth are evidenced in the use of this garbage and sewage, namely, 1) Garbage Farming (GF), 2) Sewage Treated Fisheries (STF) and 3) Sewage Farming (SF).

GARBAGE FARMING

- i) A study of IWMED (1986) (village-based) reveals that out of a total of about 720.23 acres of agricultural lands, about 393.78 acres utilise municipal garbage and sewage for farming, either partly or fully. Production of vegetables (about 11 to 16 crops produced per year) and fruits together with paddy cultivation are carried out on garbage and sewage-fed farms.
- ii) The garbage farms in Dhapa cover an area of about 800 acres, comprising nine villages of Dhapa, Hatgachha, Boinchtala, Shahababad, Durgapur, Anantabadal, Arupota, Khanaberia and Chowbagha. The practice of garbage-dumping and farming dates back to the 1870s and the entire ground level has been raised by 1.5 to 2 metres or so at present, after continuous garbage dumping for a period of more than 100 years. The average annual increase of the ground level is about 6 mm, composed entirely of consolidated garbage.
- iii) The unique system of garbage dumping by leaving long strips of waterbodies in between two dumping grounds, has resulted in the development of alternate strips of garbage filled areas (to be utilised for garbage farming) and strips of waterbodies (containing





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Vegetables produced in Garbage Farming meet 30% of city's demand

sewage for irrigation of the crops and vegetables produced on such garbage farms).

- iv) There are about 2490 farm plots in the Dhapa area practising garbage farming, ranging in size from 5-30 cottahs (1 cottah=720 sq ft). Usually 2-3 main crops are grown in the area, namely, cauliflower (in winter), ridge gourd (in summer) and maize (in autumn). According to the season, however, a variety of secondary crops are also grown along with the main crops. About 11-16 varieties of crops can also be grown in certain plots.
- v) At present the Calcutta Municipal Corporation owns the entire Dhapa Region with all the farmers being tenants or sub-tenants. The entire responsibility of farming operations, marketing, rent payment and so forth lie with them. The rent of the land varies from Rs.1800 to Rs.2400 per acre per year, depending on the number of crops cultivated and the productivity thereof.

The present area of garbage farms in Dhapa covering about 315 ha. and under the direct control of the Calcutta Municipal Corporation (CMC) has been subjected to intense pressure owing to rampant urban sprawl. The best solution therefore lies in introducing proper legislation in order to prevent further destruction of these wetlands. The CMC along with other competent authorities should move for a "Wetland Protection Bill" to save the wetlands.

SEWAGE FARMING

Paddy cultivation, utilising nutrient-rich fishery effluent as irrigation is also prevalent here. Such cultivation is known as Sewage Farming. Such farming covers nearly 4888 ha. area. *Aman* (during rainy season) and *Boro* (during winter season) are grown. The production of *Aman* is about 8 quintals per acre (nearly 2000 kg per ha) per year and that of *Boro* is about 10 quintals per annum. However, compared to the production

from the adjacent fisheries which produce fish all the year round, the overall production from the sewage-irrigated farms is poor. This is because about half of the *Aman* land (which is not suitable for production of *Boro*) lies fallow after the first harvest.

On the whole, about 5000 ha. of lands in East Calcutta are covered by sewage-farms (fishery-effluent irrigated agriculture) and provide about 11-16 crops every year. The daily average production of fresh vegetables is about 147 tonnes, growing about 15 times, besides a variety of paddy. (Table 8.4).

TABLE - 8.1 YIELD OF VEGETABLES PER YEAR IN A ONE-ACRE FARM (AVERAGE OF 10 FARM PLOTS)

| Name of Crops | Yield |
|--------------------|--------------|
| Cauliflower | 15,000 heads |
| Ridge Gourd | 45 Quintals |
| Maize | 45 " |
| Radish | 45 " |
| Yam | 70 " |
| Brinjal | 90 " |
| Bottle Gourd | 240 " |
| Bottle Gourd Plant | 126 " |
| Pumpkin | 180 " |
| Pumpkin Plant | 30 " |
| Bitter Gourd | 9 " |
| Spinach | 90 " |
| Pui | 108 " |
| Danta | 90 " |

Source: Growing Vegetables on Garbage : A Village Based Experience, Nov., 1986, Published by IW MED, Calcutta

SEWAGE TREATED FISHERIES

- i) Sewage-fed fish culture in the wetlands of East Calcutta might have originated a long time back in the nineteenth century than is generally supposed to be. The person who took lease of a piece of land (Dhapa Square Mile) in this part of the city evolved a unique garbage disposal plan in order to cultivate the lands (garbage farms) as well as produce fish. Thus, elongated finger-like waterbodies or ponds are left in between large tracts of farm lands (garbage farms) so that water could be stored to be utilised for irrigating the crops in the adjacent lands. Such fish culture could be the sewage-fed type.



- ii) Since 1850 the wetlands of Calcutta were reclaimed for brackish water aquaculture. The source of water was the tidal river Bidyadhari. Such *Nona Bheries* used to produce salt water fish namely, *bhetki*, *parse*, *bhangor*, *prawns*, shrimps etc. proved to be a very lucrative occupation, the yield being 148 kg per ha.
- iii) With the silting up(officially declared dead in 1928 by the Irrigation Department of Bengal) of the river Bidyadhari, the entire area became a vast derelict swamp.
- iv) Subsequently, with the entry of increasing volumes of sewage from the city of Calcutta into these areas, the original salinity of 800-1200 ppm. dwindled to 500-600 ppm. Thus an ideal condition for fresh-water fish culture was initiated.
- v) In 1945, an area of 11,570 acres was used for sewage-fed fisheries, yielding an average of 3.40 quintals per acre. By 1985, however, this area has reduced considerably to only 7500 - 8000 acres. On the other hand, the yield of fish has increased from 3.40 to 10 quintals per acre with scientific management. The main fish produced are *rahu*, *kaila*, *mrigal*, *carp*, *tilapia*, *prawns* etc. - about seven varieties.
- vi) Sewage-fed brackish water aquaculture has flourished since 1960 in estuarine areas, 30 km. east of Calcutta (WBSLUB, 1984). These systems use city sewage that drains into the river Kulti.

The fisheries taking in raw sewage as an input, release a highly purified nutrient-enriched effluent through an internal grid of drainage channels, excavated and maintained by entrepreneurs. They are again utilised for irrigating the crops and paddy grown in adjacent garbage-farms. At present there are about 176 sewage-fed farms, the holding pattern being 10 acres to 200 acres.

Calcutta's immense urban waste output of about 680 million litres per day is thus treated naturally - a unique cost-effective system.

The sewage-fed fisheries are considered to be the world's largest single such system of sewage treatment. Along with sewage treatment, stereo-breeding of fish is another technology which can be exported. The fish produced in this method meet about ten percent of Calcutta's fish supply. Sewage treatment ponds range in size from 10-30 acres, but may also be as large as 200 acres.

Stocking density of such fisheries (sewage-treatment fisheries) varies from 3 to 8 tonnes per ha. With adequate management

and technological support it may even reach 10 tonnes per ha. It must be noted that low concentration of trace metals in Calcutta's sewage and the natural protection provided by the abundant water-hyacinth restrict the transport of metal from the sewage to the fish. Table 8.2 shows the amount of treatment.

TABLE - 8.2 IMPROVEMENT OF WASTE WATER QUALITY THROUGH IN SEWAGE TREATED FISHERIES

| Characteristic | Inlet | Outlet |
|----------------|-----------------------------------|----------------------|
| B.O.D. | (ppm)120-150 | 20-30 |
| D.O. (ppm) | 0 | 5-7 |
| pH | 6.5-7.5 | 6.5-7.5 |
| Coliform Count | 10 ⁵ - 10 ⁷ | 10 - 10 ² |

Source: D.Ghosh - 'Calcutta : Fisheries for Sewage Treatment in Science-Technology. Focus - June-July, 1988.

It is thus proved that the sewage treated fisheries improve the water quality to an extent which may be comparable with a well-managed stabilisation tank, in addition to which they produce a fish yield of 3-7 tonnes per ha in a moderately efficient tank.

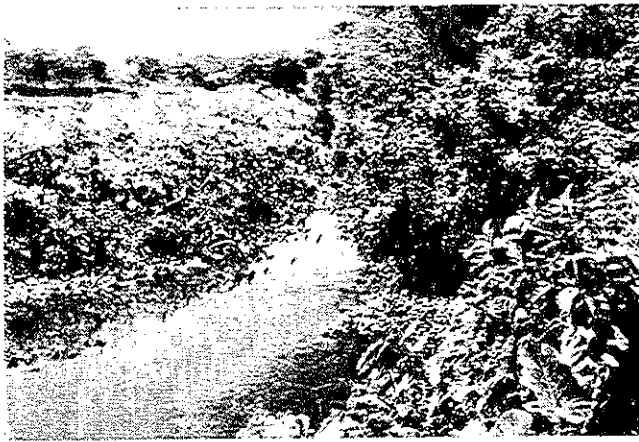
TABLE-8.3 THE OWNERSHIP PATTERN OF PISCICULTURAL LAND IN EAST CALCUTTA.

| Type of Holding | Area (Acres) | Percentage |
|---|--------------|---------------|
| Private | 6520 | 93.14 |
| Co-operative | 60 | 0.86 |
| State Fisheries Development Corporation | 420 | 6.00 |
| Total | 7000 | 100.00 |

Source: Directory of Sewage-Fed Fisheries in East Calcutta, Directorate of Fisheries, Govt. of West Bengal

Pisciculture is a more labour-intensive and profitable activity than vegetable and paddy cultivation in the same area. Today Calcutta's yearly fish requirement is about 1.6 lakh tonnes, but the supply is a mere 50,000 tonnes, out of which 33,000 tonnes comes from other states, contributing 65 percent to 70 percent. The state's fish production has increased more than 8 tonnes per acre in the past thirty years. However, the fish supply from other districts of West Bengal to the city of Calcutta has





Sewage Feeder Canal

declined from 17 percent in 1947 to 4 percent in 1981. At present, the fish supply from the East Calcutta wetlands to the city has declined from 12,720 tonnes a decade ago to 4,000 tonnes (10 percent of fish supply). This trend calls for the protection of the fish ponds in the wetlands of East Calcutta.

THE TECHNOLOGY OF SEWAGE-TREATMENT FISHERIES (S.T.F.)

Pisciculture in sewage requires a unique environment because it should neither be an impounded waterbody nor a flowing stream. Waste water which is released intermittently is detained in the shallow ponds for a definite period in order to allow the cycle of nutrient recovery in the aquatic food chain to be completed.

The importance of a drainage outfall system is thus great in sewage-fed aquaculture. Domestic sewage and storm water from the city of Calcutta are mostly carried through combined sewers. The outfall drainage channels were separately designed for 'dry weather flow' (DWF) and 'storm water flow' (SWF) channels. The population covered by the outfall channel capacity is 4 million, over an area of about 94.5 sq.km.

The DWF channel starts from Topsia Point A, covering a length of 32 km to reach the river Kulti Gong at Ghusighata. At a distance of 6.4 km from Topsia Point A, the outfall channels are connected with the sedimentation tanks at Bantala (constructed in 1943). The design capacity of the DWF channel is 387 cusecs (14.3 cu.m/sec.) which accounts for 296 cusecs of waste water generated by an assumed population of 4 million, allowing for a water consumption of 50 gallons/capita/day. Since river Kulti Gong is a tidal river and its water level is higher than that of the drainage canal for a part of a day, the gates at the mouth of DWF are closed to stop entry of river water into the drainage canal- a period called Tidal Lockage.

The SWF channel, covering an area about 150 sq. km, begins at Ballygunge Drainage Pumping Station for 34 km to reach

river Kulti Gong. The original capacity of 2011 cusecs was subsequently revived to 4966 cusecs.

The main purpose of the SWF channel was to carry storm water of the city along with its parts to adjacent urban and rural areas.

In Sewage Treated Fishery, raw sewage enters through an inlet into the septic zone from where it flows into the eutrophic zone where fish grow and develop for about 10-15 days and from there it goes out through an outlet. It is to be noted that the water in the eutrophic and outlet zones possesses a much lower E-Coli and BOD value and a considerably higher DO value than the septic zone through the natural biological process allowing the production of fish. The depth of the sewage-fed tank is about 3 ft. (50-150 cm.) with a flat bottom, allowing the entry of the sun's rays which kill much of the bacteria and allow the algae to photosynthesise.

Waste water or sewage is introduced into the fish ponds in limited quantities at intervals and is similarly released. However, when these ponds are large (more than 40 ha.), the waste water flow is almost continuous for about 15-21 days. It must be borne in mind, however, that the dissolved oxygen level should be maintained, so that fish do not die. The fish require dissolved oxygen in the pond for their survival.

There are basically two ways in which the organic content of sewage influence fish production - (a) Indirectly through mineralisation (the rate is higher in warmer climates) of the organic material to provide inorganic nutrients to the algae or phytoplankton, which can, in its turn, be used as a source of food by appropriate fish species, and (b) through direct consumption of the waste as food.

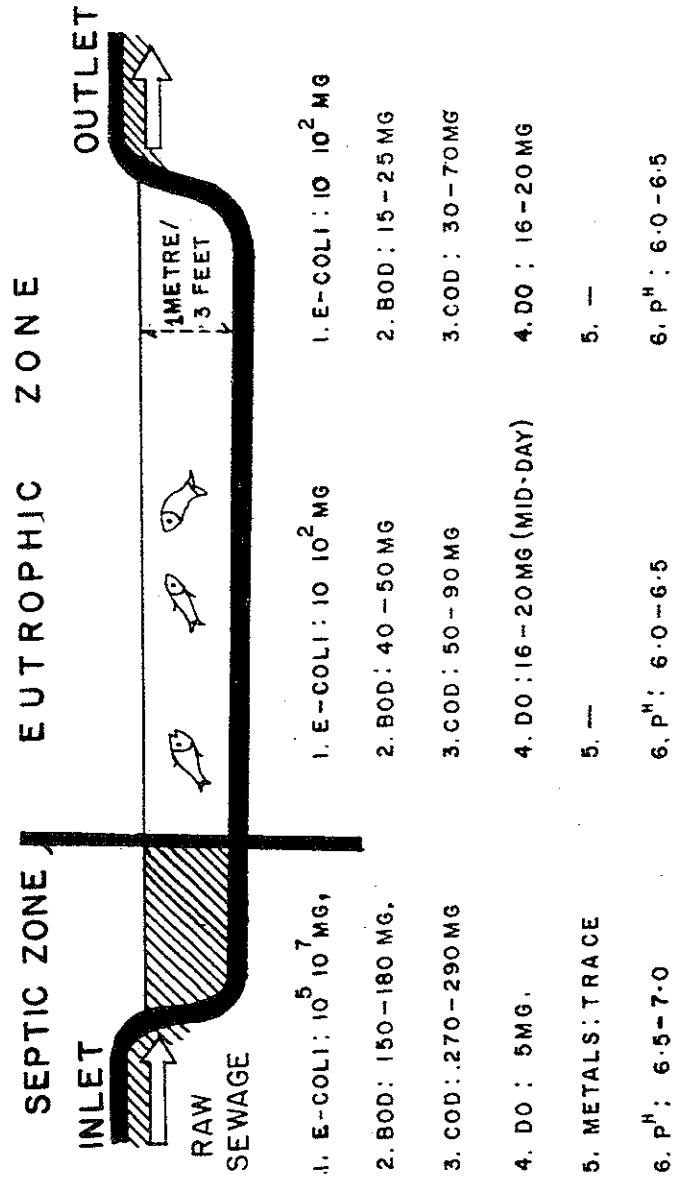
Table-8.4 shows the five major phases (each involving one or more activities), characterising the sewage-fed aquacultural system.

TABLE-8.4 PHASES OF STF CULTURE

| Phase | Activity |
|-----------------------|--------------------------------------|
| Pond preparation | a) Pond draining |
| | b) Sun drying |
| | c) Desilting silt traps |
| | d) Tilling |
| | e) Repairing dykes |
| Primary fertilisation | a) Filling with sewage |
| | b) Facultative |
| | c) Stirring |
| Fish stocking | a) Test fish |
| | b) Fish stocking proper |
| Secondary | a) Filling with sewage fertilisation |
| Fish harvest | a) Net selection |
| | b) Team management |
| | c) Haul disposal |



CHART ON SEWAGE TREATMENT FISHERIES IN EAST CALCUTTA



ADVANTAGES OF SEWAGE-FED FISHERIES

- The large algae production from sewage oxidation ponds or those fed by effluents can be utilised either by directly stocking into these (provided they can tolerate the difficult environmental conditions that occur).
- The algae can be harvested and used as a protein-rich additive to compound diets for fish or other domestic animals.
- The appreciable disinfection effects of such fisheries cannot be overlooked. The community production system found in fish ponds appears to have no coliform bacteria(including the enteric or pathogenic types). Thus each drop of water is purified raw sewage.
- The air quality is also improved. Thus, the wetlands are considered to be the 'lungs of the city'(Fig.6). The atmosphere is free from dust and imbued with oxygen produced by the multitude of pond algae and macrophytes' respiration. Dissolved oxygen (DO) ranges between 2-5 ppm. (early morning) to 20 ppm. (mid-day) with variation of temperature of 30-35 C. under pH condition of 6.-6.5 which is comparable with the finest eutrophic lakes. The villagers have been using the pond water for domestic purposes for the last 50 years with no record of epidemic or enteric diseases.

The sewage-treatment fisheries act as an excellent stabilisation pond. The reduction of BOD and coliform bacteria has been remarkably high, even 99 percent in some pathogene bacteria. The metal ion contents also appear to be very low (less than 0.1 ppm.) for copper, lead, zinc, nickel, chromium and cadmium.

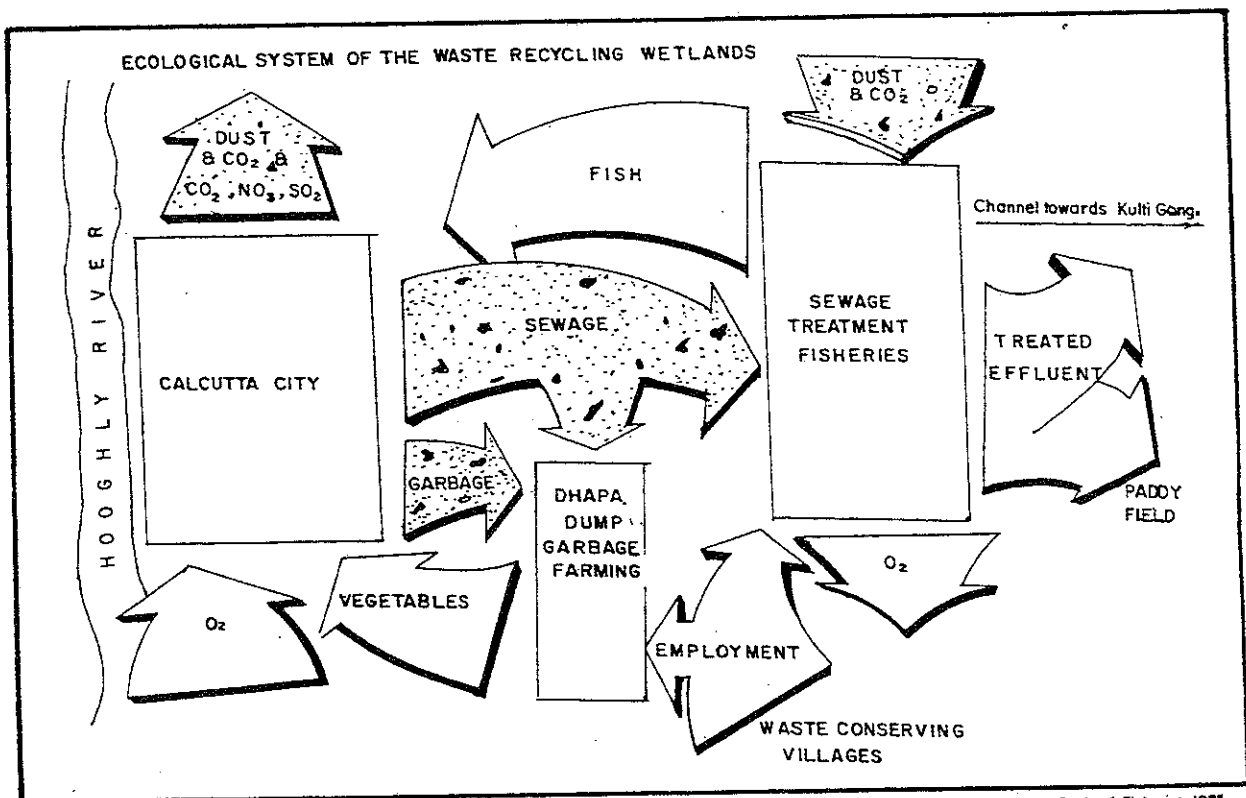
- The sewage-treatment fisheries provide nutrient-enriched safe effluent for irrigating the crops and paddy in the adjacent farms.
- Undoubtedly sewage-treatment fisheries prove to be the low-cost natural way of sewage-treatment and this sanitation technology can even be exported.

VALUE OF EAST CALCUTTA WETLANDS

As already mentioned, the East Calcutta wetlands provide the four major elements of natural resources, and that too, free and in a purified form - i) sunshine, ii) air, iii) land, and iv) water.

The value of flood plains and marshy tracts may thus be stressed upon. This holds a key to sustainable use of a resource base. Hence, land and water management practices hold much value.

The underground water-table of the wetland area is recharged through natural seepage, both from precipitation and percolation (through drainage channels to a certain extent) in the sub-surface layers. Thus, the area may serve as a potential



Source Dept. of Fisheries 1985



area for groundwater development to cater to the water needs in the irrigation, domestic (drinking, bathing) and industrial sectors alike - in case of paucity of water arising in the near future subsequent to further reclamation (for various purposes) of the wetlands.

The East Calcutta wetlands act as an ideal Waste Recycling Region located beyond a mere 5 km. from the city centre and covering an area of about 11000 ha. A completely natural and indigenous method which is also cost-effective is employed here, serving about 1 lakh people in the fringe area.

EMPLOYMENT GENERATING ACTIVITIES

The main occupation of the wetlands may be enumerated as follows:

- i) Farming - Vegetables and paddy are grown. Each acre of agricultural land has on an average, mandays of 2.48 persons throughout the year. On the basis of the annual crop calendar, the annual productivity of vegetables is calculated to be at 1500 quintals per acre. Vegetable production is about 10,000 tonnes per year and paddy production about 24,000 tonnes per year.
 - ii) Fishing - About 10,000 people are employed. Each acre of sewage-fed fisheries has mandays (on an average) of 3 persons throughout the year. The yield is about 10 quintals per acre. Although the area of sewage-fed fisheries has decreased from 11,570 acres in 1945 to about 7,500 - 8,000 acres, the productivity has increased from 3.39 quintals to about 10 quintals per acre - owing to effective management practices.
 - iii) Rag-picking employs about 20,000 to 25,000 people.
 - iv) Skinning of carcasses, tanning hides, shaving wool and hair etc. - About 10,000 to 15,000 workers are engaged in retrieving dead flesh, bones and hooves which are usually converted into fertiliser, cosmetics. Again the CLC - a big leather complex is also expected to be set up near this zone. This integrated leather complex will come up at Karaidanga, by assimilating about 550 scattered tanneries which are now mostly located at Topsia, Tiljala and Tangra and employ about 20,000 and 25,000 people.
- The State Tanning Industry earns valuable customs (both national and foreign exchange) by supporting an equally large population in wholesale and retail concerns and sale outlets. A single integrated waste-treatment plant covering about 1,000 acres has also been proposed for Karaidanga.
- v) Ancilliary activities - Transportation, packaging, wholesale and retail marketing of products also employ a large population.



The yield in fish pond is about 10 quintals per acre.

On the whole, about 3 lakhs mandays per year of rural employment in these wetlands has been calculated. Because of the age-old traditional practices of the local people, there has been a steady development of village communities and an economic stability has set in these fringe areas.

INSTITUTIONAL ARRANGEMENT AND PARTNERSHIPS

A Report on the Status of Wetlands in Asia by the Asian Wetland Bureau has outlined the East Calcutta Wetlands as one of the most seriously threatened wetlands in Asia. The East Calcutta wetlands are even considered to be already too degraded to merit any special-conservational effort.

The scenario has become complex with the conflicting role of different institutions in this area. As long as it is claimed that the best practices (in the Ramsar term wise use) carried on in the East Calcutta wetlands are cost-effective, the system needs to be protected from any external hindrance. Along with this protective plan appropriate measures should be taken to facilitate this indigenously evolved wise use with the participation of concerned institutions.

Conflicting interests are prevalent in the East Calcutta wetlands like any other wetlands. It is necessary to promote certain measures or procedural steps from legal perspectives for protecting the available and reversible wetlands. Along with the policies, strict legislation must be enacted at the State or Central level for the purpose of conservation. Though the introduction of the strict legal regime may be useful, it is also necessary to motivate the people in understanding the threat vis-a-vis the wise use of the wetlands. Experiences will show contradictory attitudes of different departments competing with each other for projects and associated funds, as has happened in some African countries like Guinea-Bissau. In such a conflicting situation a strong legislative framework can even be used by NGOs and other pressure groups to mitigate the destruction of wetlands.



A look into the role played by different institutions in East Calcutta wetlands reveals several agencies/institutions playing the role of actors in the East Calcutta wetlands. These are namely - Department of Forests and Environment, Department of Fisheries, Department of Irrigation and Waterways, Calcutta Municipal Corporation, Calcutta Metropolitan Development Authority, Department of Rural Development, Panchayats and Zilla Parishads, Department of Land and Land Records, Institute of Wetland Management and Ecological Design under Government of West Bengal and Geological Survey of India, Zoological Survey of India and Botanical Survey of India under the Government of India.

Of these again, a few departments such as Fisheries, Irrigation Waterways, CMC and CMDA play important roles. Their objectives are manifold. These include wastewater utilisation in fisheries, garbage farming, wastewater use for crop farming, drainage, sewage and irrigation. The role of different institutions in the management of East Calcutta Wetlands can be revealed from Table 8.6.

The Department of Irrigation & Waterways control all the channels passing through the East Calcutta wetlands. The sewage fed fisheries use the sewage water from the DWF/SWF channel which carry all the municipal sewage under the monitoring of the Irrigation Department. Even during the monsoon season, the fisheries do not get the required sewage water at regular intervals. The Irrigation Department considers the drainage to mitigate waterlogging in the city as priority. If the gauge level is maintained at a high level by locking the gates to feed the fisheries channel, it may adversely affect the drainage resulting in waterlogging with the sudden monsoon outbursts. Thus proper monitoring is needed, particularly by the Irrigation Department to ensure the regular supply of sewage to the fisheries and to maintain the gauge level throughout the year. A new outfall channel to the Kulti Gong has been proposed by CMDA to regularise the sewage supply and to facilitate the drainage outlet.

According to the Fisheries Department, the state-owned fisheries are well managed and are producing at a low cost level. Though the proportion of state-owned fisheries is very low (about 6 percent), the efficiency of these fisheries is mainly due to regular financial support. It has been surveyed that over-exploitation of some particular fishery ponds in the wetland occurred, which should be controlled by temporarily withdrawing fishery activities under the supervision of the concerned authority. Financial incentives should be propagated to increase the efficiency of privately owned as well as state-owned fisheries through possible technology inputs.

Though most of the delineated areas of East Calcutta wetlands lie outside the Calcutta Metropolitan District, CMDA has prepared a drainage development plan of the area. Many other projects on the fringe of the wetlands have also been undertaken by CMDA. The Waste Recycling Region has also been delineated based on an earlier survey made by IW MED. This

includes the area where sewage water is used either for fisheries or crop farming.

It is urgently required to delineate the area of East Calcutta wetlands as a statutory authority. In 1993, CMDA brought out a report suggesting the establishment of a Wetland Conservation Authority for the State of West Bengal. No such step has yet been taken by the State Government, only the Ministry of Environment and Forests (MOEF), Government of India mooted a proposal to declare the East Calcutta wetlands as a Ramsar site. Such a declaration without constituting any authority for conservation will be of no help. The Authority, if constituted, shall make out an Environmental Management Action Plan (EMAP). As reported such authority has been vested with the District Magistrate of South 24- Parganas, but neither action plans nor projected land-use plans have been worked out.

It is of utmost importance that one department being the designated as nodal agency oversee the working of the various developmental departments such as Fisheries, Agriculture, Rural Development and Irrigation. This would make it easier to sort out the differences, if any, between the departments whose interests are conflicting on the use of wetlands. The Department of Environment may be entrusted with this responsibility. Moreover, the institutions may be chosen to co-ordinate the government departments with the NGOs and the other pressure groups. IW MED under the umbrella of the Government of West Bengal, with an autonomous setup can do the job most effectively.

LEGISLATIVE AND REGULATORY FRAMEWORK

OVERVIEW

India is a contracting party to the Ramsar Convention and it is obligatory on her part to protect and conserve the wetlands. In India, there is no single central/state legislation relating to wetlands. However, there exist some legislations which have a direct or indirect bearing on wetlands protection and conservation. The weakness in the legislation on wetlands lies in the absence of any comprehensive law on wetlands. No statutory authority has been created for wetlands under any legal framework to oversee protection, conservation, management and to take appropriate penal measures for the violation of laws and regulations. Though different laws provide a number of avenues to seek redressal of environmental wrongs, it is difficult to serve the specific cause of wetland protection. There are two broad types of approaches to obtain correction of environmental injustice in the courts. The first is the traditional approach using the law of torts or civil wrongs. In most cases such legal procedures can be expensive and time consuming. The court will seek equitable justice for all parties to an action. This means that the court is unlikely to rule in favour of the plaintiff if the cost to deal with the environmental problem is clearly in excess of the benefits that would result from the solution. The second approach involves collective action based on shared goals among a group of people. In many cases these



are dividend paying. In this approach either an organisation is found for the purpose of conducting a suit of interest to many people, or the suit is undertaken by an organisation already in existence that specialises in this type of environmental law action.

EXISTING LEGAL FRAMEWORK

Though legal alternatives are available it is no less justified to enact comprehensive laws on wetlands. The need for such legislation was raised in the Wetlands Legislation Workshop organised by the British Council in Calcutta on 27 and 28 February, 1995. The existing laws in India which have direct or indirect bearing on wetlands protection and conservation can be examined to determine the extent of their influence.

1. The Wildlife Protection Act, 1972 (53 of 1972, later amended in 1982 (23 of 1982) and 1986 (23 of 1986) provides for the establishment and management of Sanctuaries (s.18), National Parks (s.35), Game Reserves (s.36) and Closed Areas (s.37). The Act also provides for an administrative regime to manage these protected areas and in its various schedules, lists many plant and animal species that are wholly or partially dependent on wetlands.

Some of the sanctuaries and national parks that have been created by state and central governments after the enactment of this Act incorporate important wetland sites within their designated areas. The Act no doubt enacted with laudable motives has fallen short of attaining its objectives.

2. The Water (Prevention and Control of Pollution) Act 1974 (No. 6 of 1974) and later on amended in 1990 with basic objectives of maintaining and restoring the cleanliness and wholesomeness of national aquatic resources by prevention and control of pollution.

Section 2(j) of the act reads as follows :

"In this Act unless the context otherwise requires, a 'Stream' includes i) river, ii) water course (whether flowing or for the time being dry), iii) inland water (whether natural or artificial), iv) subterranean water, v) sea or tidal water to such extent or as the case may be, to such point as the State Government may by notification in the official Gazette specify in this behalf"

"Wetland" would also clearly be included (in terms of *inland water*) in the above broad definition of 'stream' for the purposes of the Act. Thus the Central Pollution Control Boards have the power to obtain information and to plan a comprehensive programme for the prevention, control, or abatement of pollution of 'wetlands', and secure the execution thereof.

The implementation of the Water Act, however, is not possible so long as the Central Board does not lay down the level of wholesomeness of water for a particular wetland or where the standard has been laid down, if the State Boards do not take adequate steps for the maintenance of those standards, the appropriate remedy would be to file a writ petition on the ground of violation of fundamental right to life which as per aforesaid decisions would include the right to a clean, pure and unpolluted environment, praying for a *writ of mandamus* against the appropriate authority.

3. The Forest (Conservation) Act, 1980 (No. 69 of 1980) and Forest Conservation Amendment Bill, 1988 stipulate, without any special reference to wetlands within forest land, the conditions for conversion of any forest land for non-forestry purposes. While the conditions, subject to clearance for carrying out such conversion by appropriate authority are specific about the rules for compensatory afforestation, they do not refer to any such compensation for wetland areas that may be undergoing degradation/drainage/other changes due to development projects.
4. By notification dated 19 February 1991, under section 3(1) and section 3(2)(v) of the Environment (Protection) Act, 1986 and Rule 5(3) (d) of Environment Protection Rules, 1986, the coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action (in the landward side) up to 500 metres from the high tide line (HTL) and the land between the low tide line (LTL) and HTL has been declared as Coastal Regulation Zone (CRZ). It is also clear that most important coastal wetland sites within 500 metres of HTL would fall within the purview of Category I (CRZ-I).
5. Section 3(a) of the Land Acquisition Act 1894 (No. 1 1894) defines the 'land' - "The expression "land" includes benefits to arise out of land, and things attached to the earth or permanently fastened to anything attached to the earth".

It is well established in a Court of Law that the term "land" includes land covered with water. A pond or a pool of water comes under the caption "land covered with water" and is "land" for the purpose of the Act. It is thus clear that "wetlands" would come within the purview of the Land Acquisition Act of 1894 and can be acquired by the state for public purpose on payment of adequate compensation.

6. The West Bengal Town and Country (Planning and Development) Act, 1979 has empowered appropriate authorities, including urban development authorities to call for return under Section 46(1) with respects to any development work, foreseeing change of wetland



area. It has emphasised that no permission for filling of tanks, ponds, water bodies, marshy land etc. will be given if it is considered necessary for being used as a) public waterbody, b) maintaining drainage facility, c) fire fighting purposes, d) environmental and ecological reasons, e) piscicultural purposes. This provision for the first time in India offered categorically a directive against wanton conversion of any wetland area.

7. The Indian Fisheries Act, 1897 was enacted to regulate certain matters relating to fisheries. This Act has not been repeated by state/central legislatures and therefore continues in operation. Some Indian States, however, have adopted the Indian Fisheries Act with some modifications.

In 1984, the West Bengal Inland Fisheries Act (excluding small water bodies) was implemented to achieve proper use of water. In this Act though the protection of wetland areas was intended, the term 'proper use of water' was not very specific. By another amendment, dated 5 December 1985, the Competent Authority was authorised to take over the management and control of any tank for the purpose of proper utilisation thereof under Section 8(1) of the West Bengal Inland Fisheries Act, 1984 (West Bengal Act 25 of 1984).

A few other cognate Acts or Rules pertain to the management of wetlands. For instance, wetlands, or any part of such area which are forests and notified as "forest lands" earlier would come under the purview of all the provisions of the Indian Forest Act, 1927, the Forest Conservation Act, 1980 (and Rules, 1991)

Where management of cattle has to be done in wetland areas, the Cattle Trespass Act, 1871, would be applicable. The area on which it will apply has to be notified separately.

Where villages exist inside wetland areas, Article 243 (b), Schedule XI of the Constitution will apply. This is the 73rd Amendment of the Constitution after which most states have passed new Panchayat Acts. The Panchayat Acts vest the power of management of common lands and water in Panchayats. Any management plan for wetlands, in which Panchayats are involved, shall take cognizance of these statutory bodies. Joint Protected Area Management or Eco-Development Programmes need to take this into account.

In so far as the constitutional power of the central and state governments to protect the wetlands is concerned, this is distinctly applicable through Article 31A of the Constitution which permits acquisition for public purpose and Entries 17(a) and (b) of the Concurrent List III which provide the power to legislate for protection of forests and wildlife to both the central and the state governments.

The above documentation reveals that within the existing legal framework, the protection and conservation of wetlands can be

made, though it deserves to enact a comprehensive legislation for the wetlands. Even in cases of notified wetlands of national importance, like the East Calcutta wetlands, any strict legislation for conservation is yet to be framed.

WETLANDS MANAGEMENT ISSUES

The East Calcutta wetlands stand as a unique eco-system, highly fragile within the periphery of the expanding metropolis. These wetlands had been playing a crucial role as natural drainage basins for the sewage of the city of Calcutta and as dumping grounds for urban solid waste. These wetlands receive the sewage and garbage and in return provide a significant part of its requirements of fish and vegetables. Their role cannot be evaluated in economic terms alone. They play a significant role in treating the sewage of Calcutta in a natural and indigenous method of recycling without maintaining any sewage treatment plant. They may provide a foremost example of a low cost alternative in municipal waste recycling in the city's backyard.

These wetlands (particularly fisheries) are shrinking due to anthropogenic interference. From more than 20,000 acres in the sixties, today they have already been reduced to a mere 10,000 acres. Even more thrust is directed for the shrinkage of these wetlands. This had been continuing for the last several decades, even centuries.

Calcutta being the trade centre of the whole of eastern and north-eastern India, it needs continuous expansion with the growth of trade, industries and urbanization. The western side of the city is embanked by the river Hooghly, which excludes all possibilities of expansion towards the western side. The city gradually becomes elongated from north to south with a ribbon like development while vast stretches of land on the eastern side of the city remain unutilised as wetlands. The history of the development of the city of Calcutta will reveal that the city was grounded on the eastern levee of the River Hooghly with an expanse of flood plain wetlands on its eastern periphery. The city expanded towards the east by the process of land filling the basins and marshes which later impeded the natural drainage. In the last century and early part of this century, the river Bidyadhari was active and the problem was hardly felt. But since the 1930s the problem has been accentuated.

Since 1960-61 the CMD had been subjected to various planning decisions. There had been a frantic search for alternative directionalities as the land use of the core city had become ungovernable with unbearable density. The first choice was to expand the city to the east on the marshy tracts of the northern Salt Lake area. This was certainly a shift in the directionalities of the city area which had been earlier in north-south alignment following the Eastern Railway track on the east bank. The construction of E.M. Bypass along the eastern fringe opened up the possibilities of infringement on the wetlands further towards the east.



THREATS TO WETLANDS

The wetlands of the southern Salt Lake serving as drainage basins of the city core now have been threatened with the decision for the setting up of New Calcutta in nearly 186 sq. km. area of Sonarpur, Baruipur and Bhangar police stations. Serious questions have been raised on the rational land use of the area for the sprawling city. Environmental and ecological considerations suggest a judicious use of these wetlands, if not protective at all. The values and functions of these wetlands must be understood properly before the blueprints of development shall be imprinted upon them.

Such conflicts between urban development and the wetland ecosystem have been operative for a long time. The conflicts must either be resolved or mitigated by judicious use leading to best practices. Sustainable development has become a keyword for the utilisation of resources on ecological consideration. The East Calcutta wetlands had been recycling the municipal sewage and solid wastes in a novel way for resource generation. In these shrinking and decaying wetlands thrive traditions of resource conservation and environmental protection which can lead to harmonious development of the city and its fringe.

PROBLEMS

Various other problems arising out of reclamation of land for different purposes namely, residential, industrial and agricultural (scientific management) in the wetlands may be enumerated thus responsible for the decay of a natural runoff system. It is a fact that the existing network of canals and channels have become inefficient, resulting in retention of stormwater and effluent within the city area even in the dry months.

The underground sewers constructed in the British period are now age-old and obsolete. Renovation costs have escalated.

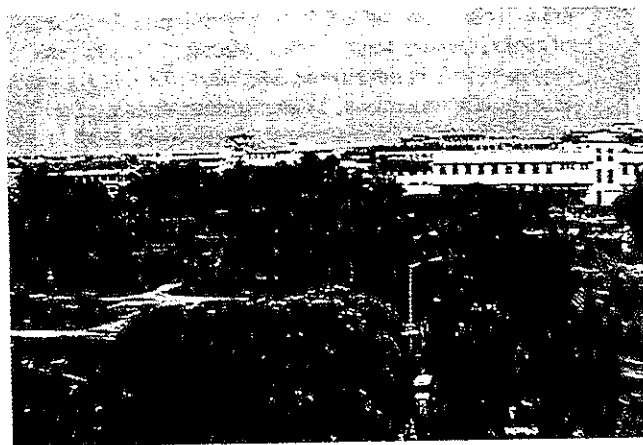
The badly laid culverts of the rail-tracks and the newly constructed (1980) Eastern Metropolitan Bypass (EMB) directly impede overland drainage from west to east, following the natural slope of the land.

Health hazards may arise because of waterlogging in the city area.

Occupational displacement of a large population (engaged in various activities) will occur creating social tension. Allied with this, there will also be a reduction in the production of fish, vegetables to be supplied to Calcutta's market.

CONSERVATIONISTS VS. EXPANSIONISTS

Nevertheless, the common arguments of planners and politicians and even environmentalists is that - "We cannot afford



The sprawling city raises a conflict between urban development and the wetland eco-system

not to develop". They stress the basic fact of over population (including a large number of immigrants not only from Bangladesh, but also from other neighbouring states for example, Bihar, Orissa etc.) and lack and breakdown of existing civic, infrastructural facilities of the age-old city (viz., drainage and sewer system, accommodation/housing, open space, transport, employment etc.) Thus, the East Calcutta wetland areas may be encroached upon for new built-up areas along with provisions of basic infrastructural facilities. This would, on the whole, upgrade not only the civic and economic life of the local community, but also their social outlook.

Thus, "development policies must widen people's options for earning a sustainable livelihood, particularly for resource-poor households and in areas under ecological stress" (World Commission on Environmental Development). For formulating plans, the CMDA is considered to be one of the principal authorities with reference to the eastward expansion of Calcutta City. The CMDA has formulated a plan for this viable area. Along with the reclamation of part of the wetlands for residential purposes and industries to a certain extent, the 50-year long traditional "best practices" must also be conserved. Thus garbage disposal should be limited to selected portions of the wetlands (later to be converted into green belts). CMDA proposes to use the derelict water courses of Dhapa for garbage-filling with scientific operation in order to minimise pollution.

The more common issue voiced by the conservationists is the problem of natural drainage which follows the natural slope of the land (from west to east - i.e. from the high levee of Calcutta city towards the low gradient wetlands to its east) arising out of the construction of the 17.6 km. long Eastern Metropolitan Bypass on the city's eastern outskirts. This fact, however, is rendered unimportant by the expansionists' view since they point to the fact that about 326 sq ft of culverts are already provided for cross-drainage and there are provisions for



about 1008 sq ft of bridges - which would facilitate the city's overland flow. They state that this provision is more than adequate as per normal engineering practices.

The CMDA has counteracted another vital issue raised by the conservationists that the area of the water reservoir in the low-lying wetlands has been reduced with the creation of new townships. They state that since the filling up of the township of Salt Lake and Baishnabghata - Pauli has been done by borrowing earth from the nearby burrow area the total reservoir capacity of accumulated water has not decreased. In fact, these burrow areas being of greater depths, can accumulate more water.

Thus, leaving aside certain areas exclusively for garbage-disposal and fisheries, the East Calcutta wetlands may be developed for future residential and industrial purposes.

The CMDA has introduced a very tentative outline development plan for east Calcutta, dividing it into six zones. A brief outline of the proposed landuse of CMDA is as follows :

| Zone | Area in Acres | Land Use |
|--------------|---------------|--|
| 1 | 4550 | Agriculture, big waterbodies, (2,000 acres and above) |
| 2 | 1037 | CMDA Township |
| 3 | 3768 | Agricultural and residential |
| 4 | 2303 | Agricultural and residential |
| 5 | 1450 | Administrative Complex, Garbage Disposal |
| 6 | 270 | Open-type Insitutions, being waterbodies (2,000 acres and above) |
| Total | 13378 | |

PROPOSED RESIDENTIAL AREAS

The New Calcutta Township, covering an area of about 186 sq. km. at Sonarpur, Baruipur and Bhangar police stations, has been proposed. Other township areas in zones 3 and 4 are also to come.

PROPOSED INDUSTRIAL COMPLEX

Since it is economically viable to set up a large and single tannery complex by assimilating about 550 odd small tanneries scattered mainly in the areas of Topsia, Tiljala and Tangra, a CLC (Calcutta Leather Complex) is proposed to be set up (covering an area of 1000 acres) at Karaidanga. A single common integrated effluent-treatment plant is also to be set up here. It would be economical on one hand and would reduce pollution (from the numerous scattered tanneries) to a great

extent. Karaidanga is located just outside the Waste Recycling Region of East Calcutta wetlands. The treated effluents from the tannery complex will be certified by a German firm to be free of pollutants. And then the effluents will be allowed to drain into the SWF channel. At present the effluents from the tanneries in East Calcutta are flowing through the SWF channel untreated. Distinctly the Karaidanga tannery complex will help in mitigating the pollution of SWF. Moreover the project site had been earlier requisitioned for refugee settlement in the late fifties. Since then the land has been reclaimed for paddy cultivation. However a part of the project site includes a few bheries and should be retained as wetlands.

CONFLICTS

In all types of environmentally related conflicts, one observation is common: lack of information and lack of understanding on the part of some or all parties to the conflict is an essential ingredient in the mix of factors fomenting the conflict. Such observation also holds true for the wetlands where multitudes of conflicting interests dominate.

ENVIRONMENTAL EDUCATION

Environmental education may resolve this lack of information and lack of understanding among the conflicting parties. Environment is essentially a partnership programme in which an individual plays a pivotal role. If individuals become environmentally aware and educated, the society and the government are automatically educated, because the latter two are only an extension of the individual.

The Tbilisi Declaration, 1978 has identified the categories of environmental education objectives as:

- Awareness To help social groups and individuals acquire an awareness and sensibility to the total environment and its allied problems.
- Knowledge To help social group and individuals gain a variety of experiences in and acquire a basic understanding of the environment and its associated problems.
- Attitudes To help social groups and individuals acquire a set of values and feeling of concern for the environment and the motivation for actively participating in environmental improvement and protection.
- Skills To help social groups and individuals acquire the skills for identifying and solving environmental problems.
- Participation To provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems.



Wetlands management issues are closely related to environmental education. People's views on environmental matters are typically based on information rather than direct observation. This has made it possible for special interest groups to spread distorted views of environmental issues by manipulation of the availability or content of information.

East Calcutta wetlands have drawn the attention of the citizens through a long-drawn legal battle against the Government of West Bengal by one NGO (People's United for Better Living In Calcutta) to resist the encroachment on wetlands for the setting up of a World Trade Centre.

In the late fifties the conflicts between the bheri-owners and bheri-labourers led to forcible attempts to reclaim the bheris into paddy lands. It needed long persuasion to understand that it was the bheri-owners not the bheris that should face the might of distributive justice. This awakening of the people that the fishery is the most efficient eco-system in the East Calcutta wetlands has guaranteed the protection of these wetlands against the market forces.

POLICIES AND STRATEGIES

Appropriate policies will be necessary for the management of wetlands and strategies are to be evolved for the protection of these wetlands. The market forces are strongly operating with rising land values in the city fringe areas. Many fishery owners are tempted to sell their fisheries for immediate profit. The land speculators and promoters have become a strong lobby, both economically and politically to interfere with the status of the wetlands. The attitude of the state government is also elusive and not clear. The government must consider necessary action for conservation, otherwise the conservation of wetlands may result in:

- i) Loss of the tradition of urban waste recycling, which in turn may affect urban sanitation;
- ii) Loss of fisheries which in turn may affect supply of fish to the city of Calcutta;
- iii) Loss of a natural system of sewage purification;
- iv) Loss of macrophytes and algae, resulting in decrease of oxygen content in the air;
- v) Loss of wetland flora and fauna, affecting bio-diversity;
- vi) Loss of detention and spill basins which in turn results in waterlogging of the city and silting of Kultigong and drainage outfall channel;
- vii) Social tension and conflicts owing to loss of primary activities;
- viii) Increased pollution and silting of the outfall channel which may even affect the ecosystem of mangrove forests in the Sunderbans.

THE GENDER ASPECT

THE ROLE OF WOMEN

The role of women in developmental programmes has been assigned greater importance in a progressive society. In the field of environmental conservation the gender bias has been tilted where the women play the key role (e.g. in Forestry - Chipko Movement). From a cursory view it appears that there exists a gender bias regarding people's participation in the various best-practices found in this wetland area.

The main employment of this wetland area particularly in the fishing activities is male dominated. In agricultural activities also, the participation of female workers is poor. Census data (1981) show that the total main workers in the Mouzas under Police Station Bhangar, where STF's are found is 3899 of which only 330 are female workers (i.e. only 8.46 percent).

The total number of women associated in the best-practices found in East Calcutta wetlands as cultivators, agricultural labourers and as other workers is 319 in the referred Mouzas within Bhangor Police Station while the number of male workers is 3551. In the 10 Mouzas under Sonarpur Police Station in the East Calcutta Wetlands area where STF is practised, the percentage of women labour participating as main workers of the total main workers is also as low as 7.89 percent (total male main workers is 2154 while total female main workers is just 170).

In the sewage farms, in this wetland areas, the participation of female labour force is relatively low, (just like the case of sewage treated fisheries). In the three Mouzas under Bhangor Police Station, where SF's are found, the percentage of female to male workers is just 4.64. In case of the other 10 Mouzas, under Sonarpur Police Station, where SF's are mainly found, this proportion is 6.49 percent.

Actually women are mostly associated with tertiary services namely, marketing of vegetable products, fish products and so forth.

THE STATUS OF WOMEN

An attempt has been made to explore some of the experiences of Scheduled Caste women (since they comprise the majority of the female population) in the study area, in order to identify the spheres which might take care of their socio-economic abilities/disabilities both at home and outside.

A descriptive analysis of the status of women is related to the following aspects: a) Education; b) Labour Force Participation; c) Paid Work and Household Work; d) Autonomy and Decision Making; e) Food, Nutrition and Health; g) Knowledge, Attitude, Practice and Autonomy in Family Planning; h) Participation in Organisation; i) Perception of Discrimination with regard to Caste. The 13+ age group has been taken in consideration.



a) Education

It is found that almost half of the female population is deprived of formal schooling, the main reasons being poverty and gender discrimination. A girl-child is deprived of education because of demand for household work and early marriage.

b) Labour-force Participation

As is typical for the lower-caste groups in our country, the majority of the people belong to landless households. The households again, are dominated by male earning members, ranging from 2-5 members per household.

Working women comprise less than half of the population (about 30 percent), of which widows, divorcees and separated ones (being female heads of households and compelled to earn) assume a majority.

It is interesting to note that all women engaged in paid labour belong to the unorganised sector. They are self-employed as egg, fish, rice or vegetable vendors, while the rest belong to the category of domestic servants, piecemeal workers, agricultural day labourers etc.

Income on a daily or weekly basis is the usual norm and so meagre that a hand-to-mouth existence is only possible, with no savings whatsoever. There is thus, an urgent need for providing remunerative work among the womenfolk. Lack of opportunities (and even awareness to a certain extent) is often revealed in their complaints - "We do not work because there is nothing available"

c) Paid Work and Household Work

It is found that the women spend only one to five hours per day in outside work (paid), the main reason being their commitment to household work (where they spend 10+12 hours per day).

d) Autonomy and Decision-Making

In order to judge the women's status in the household, their decision-making empowerment, both about personal and family matters were probed into. It was found that in both the cases their powers were limited since the senior members, parents, in-laws and husbands of the household were the sole authority in such matters.

e) Food, Nutrition and Health Status

It is found that in general the majority of the women consume vegetables daily, but intake of milk, eggs, fish, dal and other nutrients is usually lacking in their day-to-day diet.

As a result, illnesses are common which often include high fever and congestion, gynaecological problems, gastro-enteritis, body pain and inflammation etc. It is an encouraging

feature to note though that most of these sick women visit doctors regularly.

f) Knowledge, Attitude and Practice in Family Planning

In general women have little say in family planning methods. Even if family planning measures are adopted, female sterilisation has a preponderance over male contraceptives and sterilisation.

g) Participation in Organisation

In the light of recent legislation pertaining to reservation of 33 percent of village-level administrative position for women, women's status in the public sphere is revealed by their participation in political, governmental and non-governmental organisations.

It is such that women's participation in political or social organisations is almost absent in all age-groups. However, some women in the younger age-group (26-35 years) have become active organisationally, (in spite of familial restrictions and long gruelling hours of household work).

h) Discrimination

It is found that untouchability and related forms of discrimination (ills of our society) are experienced in villages where there are hierarchies among the sub-castes in the Scheduled Caste Group (viz. the Padmaraj Groups are considered superior to Bagdis, Dhobas and Napits). General awareness has to be created by educating the masses in order to eradicate this disgraceful and evil practice of the society. It is heartening, however, to see that the womenfolk are not in favour of discrimination.

Though the East Calcutta wetlands lie close to the city of Calcutta, the infrastructural facilities prevailing in the region are very poor. In such a backward set-up, the social environment is also not very conducive for the awakening of womenfolk. Such backwardness has been reflected in the status of women like womenfolk elsewhere in rural India. It has been universally recognised that the education of the girl child in a region is a positive index not only for social upliftment of women but also signifies economic development of the region. On the other hand, all social maladies and gender discrimination are eliminated in the long run with economic development. It has become urgently necessary to strive for an appropriate policy for the upliftment of the status of women in East Calcutta wetlands. This cannot be framed in isolation for a micro-region of East Calcutta wetlands, but must be advocated for the whole nation or at least for the State of West Bengal.

As the Scheduled Caste women comprise the majority of the total women, they should be given special incentives for compulsory education, both formal and informal, before marriage. They should also be provided with income opportunities through gainful employment in different economic activities to make



them economically independent. Through such activities the womenfolk will earn a status of gender-equality and the discrimination and atrocities against women will be eradicated. Reservations for the women in Panchayati Raj institutions has opened up opportunities for women in public and social life enabling them to take part in decision making, both at household level and community level. The participatory role of women will usher in a prosperous future for all in the long run.

IMPACT AREAS AND ASSESSMENT

BENEFITS OF THE PRACTICES

Why has such recycling of city wastes been considered as best practices under the wetlands system? The concept of city waste as pollutant is an urban view. Waste as a resource is a rural view because pollution to one living system will provide nutrients for others. Hence, urban wastes can be converted to resources for the livelihood of rural folk.

The importance of waste recycling is not limited to economic terms. The city of Calcutta has no sewage treatment plant to day. Two giant settling tanks at Bantala have never functioned for more than a decade and were abandoned. The system in particular, could not compete with the stabilisation ponds for STF, which appear to be cost effective in a developing country like India. Such a model stands as a low-cost alternative for other developing countries.

Through such discharge to the eastern wetlands the city environment becomes free of raw wastes. What is the status of environment over the East Calcutta wetlands, where all the sewage channels converge? One will be overwhelmed with the air quality and water quality of the wetlands where each drop of water is purified raw sewage. The atmosphere is free from dust and imbued with oxygen produced by a multitude of pond algae and macrophytes respiration. Dissolved oxygen ranges between 2.5 ppm (early morning) to 20 ppm (mid-day) with variation of temperature 30 C - 35 C under pH condition of 6 - 6.5. Such conditions can be comparable with the finest of eutrophic lakes. The villagers have been using the pond water for working and bathing for the last 50 years and there has been no record of epidemic of enteric diseases. STP acts as an excellent stabilisation pond. The reduction of BOD and coliform bacteria has been remarkably high, even 99 percent in some pathogenic bacteria. The metal ion contents also appear to be very low (less than 0.1 ppm) for copper, lead, zinc, nickel, chromium and cadmium.

The economic activities carried on the East Calcutta wetland areas, thus, can be divided into three activities as agricultural activity, piscicultural activity and rag-picking activity. In terms of economic viability, all the three activities are quite regular in respect to West Bengal. Moreover, resources are not optimally utilised in agricultural and fishery activities as both are performed following age-old indigenous methods. But the uniqueness of these two practices is the utilisation of bio-

degradable and non-biodegradable nutrients. The use of nutrient-rich sewage water in fishery ponds to help the quick algal growth is a natural process, free from any usage of modern technology. In the case of agriculture, the water from the fisheries is used for irrigation since it has a high level of BOD. The vegetable farming is also accentuated on the lands acquired from the low wetlands through garbage dumping. With the existing amount of compost elements, highly rich in nutrients, the vegetable cultivation is a success with nearly 14 types of vegetables and production of 1500 quintals per acre. Thus the utilisation of city sewage and garbage, has made this economic activity unique in some sense.

INNOVATIVE PROCESSES FOR TRANSFER

Recycling of wastes into resources in the periurban wetlands, though a unique feature of East Calcutta wetlands, may be replicated under identical conditions particularly in Third World countries. It has been reported that many countries in the world, even the developed countries have evolved such utilisation of municipal wastes. Sewage-fed fisheries or aquaculture has been reported in China, Indonesia, Israel and at several places in Germany. The Calcutta Sewage Fisheries are a natural sewage system, a system for a city that lacks a conventional treatment plant which may be successfully replicated for other areas in Calcutta Metropolitan Area and also other metropolitan areas in India. It has been suggested that Calcutta Metropolitan District should develop a combined waste water treatment and recycling system including fish production; because a system, based on solar energy and the fertilizing capacity of waste water is ecologically sound and should generate good income to pay back capital and money expenses.

It has now been recognised that the model of Calcutta Sewage-fed Fisheries has significant implications for areas all over India. From the report of the Central Pollution Control Board, it appears that the largest source of riverine pollution in the country is untreated municipal sewage discharge. The volume of sewage generated in the cities around the Ganga Basin is about 3 million cubic metres per day of which less than 20 percent is treated and the rest discharged into the river directly. It has been proposed that establishment of sewage-fed fisheries including treatment and use in aquaculture appears to be an economically feasible means of decreasing riverine pollution in the Ganga Basin. The sewage treatment plants are considered too costly for a country like India. In the Calcutta Metropolitan Area where a replica of East Calcutta wetlands, namely, a sewage-fed fishery has been attempted to treat the raw sewage.

East Calcutta wetlands area along with its ecological system and all its existing best practices is unique in the sense of recycling of garbage and city sewage in an indigenous, age-old method. With utilisation of industrial sewage, a well-managed sewage-fed fisheries is an ongoing system at Mudiali in South Calcutta on the fringe of the river Hooghly in the Calcutta Port Trust Area.



MUDIALI FISHERMEN'S COOPERATIVE SOCIETY

In a recent effort, an outstanding example of recovery and management of a wetland has been set by a fishermen's cooperative known as the Mudiali Fishermen's Cooperative Society Ltd (MFCS). The MFCS has obtained about 70 ha of wetlands from the Calcutta Port Trust. The Calcutta Port Trust granted the MFCS fishing rights in the wetland area and implementation of necessary modification related to fishery activities. This wetland is situated in the industrial south-western part of the CMC area and to the south of the river Hooghly. The area known as Mudiali, was previously part of the Garden Reach Municipality. In 1983, it was merged with the CMC area. In the process, a part of the wetland area has been filled up and recovered by MFCS. At present, the MFCS wetland covers an area of about 70 ha. The culturable water area of 65 ha. comprises three tanks ranging in size from 11 to 16 ha each, three tanks between 5 ha and 8 ha each and some smaller ones.

Of the leased out wetlands to MFCS by CPT 48 hectares revive waste water from the adjoining 152 industries (Table 8.7) and domestic establishments. This area includes five important jheels (water bodies) namely, 1. Crocodile Jheel (9.3 ha), 2. Taltala Jheel (14.0 ha), 3. Khdi-I Jheel (8.0 ha), 4. Khdi-II Jheel (11.7 ha) and 5. Loha Jheel (5.0ha). The depth of these jheels is less than 1 m.

Raw waste water is drained to the jheels at the north eastern end of the Taltala Jheel through multiple inlets. After passing in a series through Khdi-I, Khdi-II and Loha jheels the waste is discharged into Manikhali Canal joining the River Hooghly. The Crocodile jheel is, however, a single compartment water body fed by waste water at the north eastern end while the effluent from this jheel is drained into the River Hooghly through Netaji Subhas Dock of Calcutta port.

The physico-chemical water quality of these jheels has been analysed and presented in Table 8.8. The base line data will show remarkable improvement in water quality of raw sewage at a low cost. Such performance has been evaluated in Table 8.9 for all the jheels. On the other hand these jheels are producing fish and generating good income for the fishermen under the cooperative. Total fish production in these jheels has been shown in Table 8.10.

NEERI (1995) has studied in detail the problems caused by excessive nutrients, higher BOD, higher COD, higher concentration of heavy metals and imbalance of planktonic growth. All these problems lead to reduction in the productivity of the ecosystem. These problems could be overcome through improvement in the quality of water inflowing the wetlands. This demands primary treatment of raw sewage entering the wetlands. For such treatment the following measures may be undertaken:

- i) Waste-stabilisation ponds for pre-treatment of waste water
- ii) Use of macrophytes as toxicant absorber in jheels to reduce the heavy metal levels

iii) Mixed culture consisting Tilapia, mossambica and India's major carps namely, Catla Catla, Labeo rohita, C Mrigala and Cyprinus carpio to improve the jheel water quality

iv) Bio-gas generation using macrophytes as resource.

With the adoption of such appropriate indigenous technology the raw sewage can be treated in any peri-urban wetlands at a low cost and will also generate income and food resources for the local people.

STRATEGIES FOR CONSERVATION OF INTEGRATED WETLANDS SYSTEM

NATIONAL STRATEGY FOR CONSERVING WETLANDS

World Conservation Strategy in 1987 recognised the significance of wetland ecosystems as key life support ecosystems. Since then the perception of wetland management has undergone qualitative change. It has now become imperative to have a well defined strategy for the conservation of wetlands and to draw the action plans on the basis of identified thrust areas.

The Asian Regional Meeting of the Contracting Parties of the Ramsar Conservation, held in New Delhi from 23-25 March 1995, also recognised the importance of wetlands in Asia as life support systems in sustaining the human population. The meeting credited the wetlands in Asia with a very high biological diversity and productivity and noted the high levels of threat to wetlands from encroachments, degradation of catchments and pollution. The meeting called upon the national governments to undertake 19 point actions for conservation and wise use of wetlands.

In this context, it has become obligatory on the part of the Government of India to evolve a national strategy for conservation of wetlands in Asia, as India is a contracting party to the Ramsar Convention. In July, 1992, it was decided to prepare a Strategy and Management Plan (SMAP) for conservation of wetlands by each state after due consideration of its natural resources characteristics and for addressing the problem of specific eco-systems. The scope of SMAPs will depend upon the nature of conflicts it has to resolve, the financial affordability and willingness of the people. It is clear that no single strategy and management action plan will be effective for conservation of wetlands in a vast country like India having so many different ecosystems. The Department of Environment, Government of West Bengal has prepared a Strategy and Management Action Plan for conservation of wetlands in West Bengal. This SMAP has largely corroborated the guidelines of the Ramsar Convention for judicious use of wetlands as accepted by the Government of India. It includes inventorisation of wetlands, identification and monitoring of wetlands of importance, environmental issues in wetlands including the threats,



management of wetlands, wise use promotion and traditional wetland practices. The document on Strategy and Management Action Plan in West Bengal will be used in formulating the National Strategy for Conservation of wetlands. The Action Plan as suggested for East Calcutta wetlands in this study is based on recommendations of SMAP prepared by the Department of Environment, Government of West Bengal.

NEED FOR CONSERVATION OF EAST CALCUTTA WETLANDS

The planning of East Calcutta Wetlands has been intimately related with the growing metropolis of Calcutta. The colonial build-up of the city on the most unsuitable terrain restricted the growth on all sides. Calcutta never grew like any other city of the west, as the urbanisation in the Third World was not a spontaneous process, but an integral part of industrial growth. With such haphazard urbanisation and influx of labour from its vast hinterland, Calcutta, by the middle of this century developed into a city of slums. With the Partition of India this premature metropolis was confronted not only with socio-economic degradation but also with environmental degradation. In the sixties, the environmental awareness was poor and the wetlands to the east were considered only marshy wastelands. Though the role of the wetlands as a waste recycling region was practised, the value of such practice had not been appreciated much by a large section of the people. But with growing awareness of the role of these wetlands various authorities have modified their activities.

The CMDA plan for metropolitan development between 1990-2015 AD records that investment need has been assessed on various environmental aspects including regulatory measures for controlling air, water, noise pollution and waste recycling areas and resource measures. The role of the East Calcutta wetlands as waste recycling of raw sewage of the city of Calcutta has been taken into account. CEMSAP has also been preparing an Environmental Management Plan (EMP) where the role of wetlands vis-a-vis urban development will be reviewed. The Metropolitan Development Plan for 1990-2015 by CMDA also expresses concern on the unabated encroaching on wetlands, water bodies and green belts in the periurban areas.

A study has recently been done on problems and prospects of Calcutta's growth (Ghosh, 1992). This study has accounted for the loss of wetlands and environmental degradation if there is each and south-eastern extension of city-periphery. This observation is of utmost importance under the unique topographical and environmental situation in Calcutta. Table 8.11 enumerates the situation with reference to different parameters.

SUSTAINABLE UTILISATION OF EAST CALCUTTA WETLANDS

Integrated resource recovery systems and waste recycling regions in the fringe areas of East Calcutta wetlands are new

concepts in urban planning. Urban waste can be used in sewage-fed aquaculture and agriculture for improved sanitation in order to provide food and employment to a wide section of the population. Though the system is informal, the Calcutta wetlands demonstrate the viability of such a system.

Expansion of the city of Calcutta being restricted in the west, north and south, its eastward expansion by way of draining and raising the level of wetlands may appear as an easy solution to the urban planner. Immediate planning, on the other hand, is needed to preserve the heritage of the wetlands of East Calcutta (best practices zone) which are gradually being lost owing to urban expansion. This creative heritage which is the world's largest system of resource-recovery practices, is not only a unique example of its kind in India but also in the whole world.

It may be appropriate to plan for the preservation of Calcutta's wetlands through the Biosphere Reserves Programme undertaken by the Government of India. Such planning is based on definite spatial planning of Biosphere Reserve Areas. A special task force convened jointly by UNESCO and UNEP in 1974 in Paris recommended a zoning pattern comprising a "core area", "buffer-zone" and an outer "transition zone". This is more viable if applied to planning of the East Calcutta wetlands because of its close proximity to dense human settlement.

Thus, a unified plan should be drawn up on the basis of all four sub-systems of waste recovery in the wetlands viz.,

1. Garbage farming for vegetable cultivation
2. Sewage-fed fisheries
3. Sewage-fed brackish water aquaculture
4. Effluent utilisation in paddy cultivation.

The effective maintenance, monitoring and upgrading of the wetlands is thus recommendable. The seasonal requirement of sewage/wastewater must then be provided to ensure improved utilisation and management practices.

Balanced growth of East Calcutta wetlands is recommended for maintaining the existing "best practices" together with future developmental works for infrastructural facilities. It has to be borne in mind, however, that the planning policies should be such that they should ensure long-term stability and sustained resource availability in the region.

COST BENEFIT ANALYSIS - SALT LAKE MODEL

Calcutta, once a premier city of eastern India, gradually became an over-populated city with all its adverse consequences. With the establishment of the city as a port city the export-based industries gradually developed like the jute industry. The expansion of these income generating activities caused a huge increase of migrant people.



After Independence, the influx of refugees from East Pakistan aggravated the problem of over-population. Afterwards in the following decades, rural poverty in the adjoining provinces of Bihar, Orissa, and other states forced people to migrate to this city in search of employment. From the records of the Legislative Assembly in West Bengal, it can be quoted that in the early fifties, 5,16,638 families had migrated illegally. Nearly 2.40 lakh families out of the total had asked for house building loans. Thus, rehabilitation problems were some of the deepest concerns in the State for the next two decades after Independence. This crucial problem of rehabilitating the migrants pressure put on the physical limits of the city (West Bengal State Assembly Proceedings, February, 1953). Thus, the West Bengal Government took the decision of reclamation of swampy salt lakes in the eastern fringe of Calcutta (which was a portion of the presently existing wetland areas in East Calcutta) to turn the entire area into settlement colonies for refugees.

The actual work of planning for development of the Salt Lake started in 1947, when a committee was set up to examine the drainage problem in Calcutta. The Master Plan Technical Committee, in its report pointed out the drainage problem mainly because of the silting up of the upper portion of the river Bidyadharti and Matla. The reclamation of the northern salt water lake was a follow up action of the Master Plan Technical Committee. Dr. BC Roy, the then Chief Minister appointed a Dutch Engineering Company, NEDECO to suggest an alternative path to reclamation. One of the main parts of the project under the supervision of NEDECO was reclamation of about 4 square miles of the northern Salt Lake for human settlement which was focussed in the general outlines of the preliminary report prepared in 1953.

A people's protest was organised against the acquisition of 17,333 acres of cultivable and fishery lands in the district of 24 Parganas mainly under the Police Stations Dumdum, Bhangor and Rajarhat. It was estimated that the acquisition would cause deployment of nearly 10,000 labourers engaged in fisheries with a loss of annual supply of 62,53,000 kg of fish to the Calcutta market. Moreover, this would cause a fall in paddy production to about 5,8000 kg annually. Lastly, there was a serious problem of rehabilitate nearly 30,000 people who were likely to be evicted from their huts and houses under the North Salt Lake Development Scheme.

The official estimate for the housing scheme alone was 2400 acres and accommodating 1.5 lakh people. The cost of reclamation of lands was estimated at Rs.6.3 crores and the cost of providing infrastructural facilities was estimated at about Rs.7.1 crores (cost for providing water, for construction of road, drainage, sewage ways, street lighting etc.). Thus, the cost for development was estimated at about Rs.13.4 crores.

From the point of view of costs, one can calculate all the disutilities arising from i) the acquisition of cultivable and fishery lands, ii) problems of nearly 10,000 labourers engaged particularly in fish cultivation, iii) fall in production of fish and

paddy, iv) eviction of nearly 30,000 people already settled in this area, v) problems related to the treatment of city sewage through a natural least-cost process by sewage fed fisheries and sewage fed farms, vi) lastly, the real cost of developing the suggested area of North Salt Lake with the provision of all better infrastructural facilities which was estimated at Rs.13.4 crores.

On the other hand, on the benefit side, we get i) housing facilities for nearly 1.5 lakh people in a planned township near Calcutta city at a cost of 57 crores. Considering the economic, social and environmental costs in total, the benefits appear to be less.

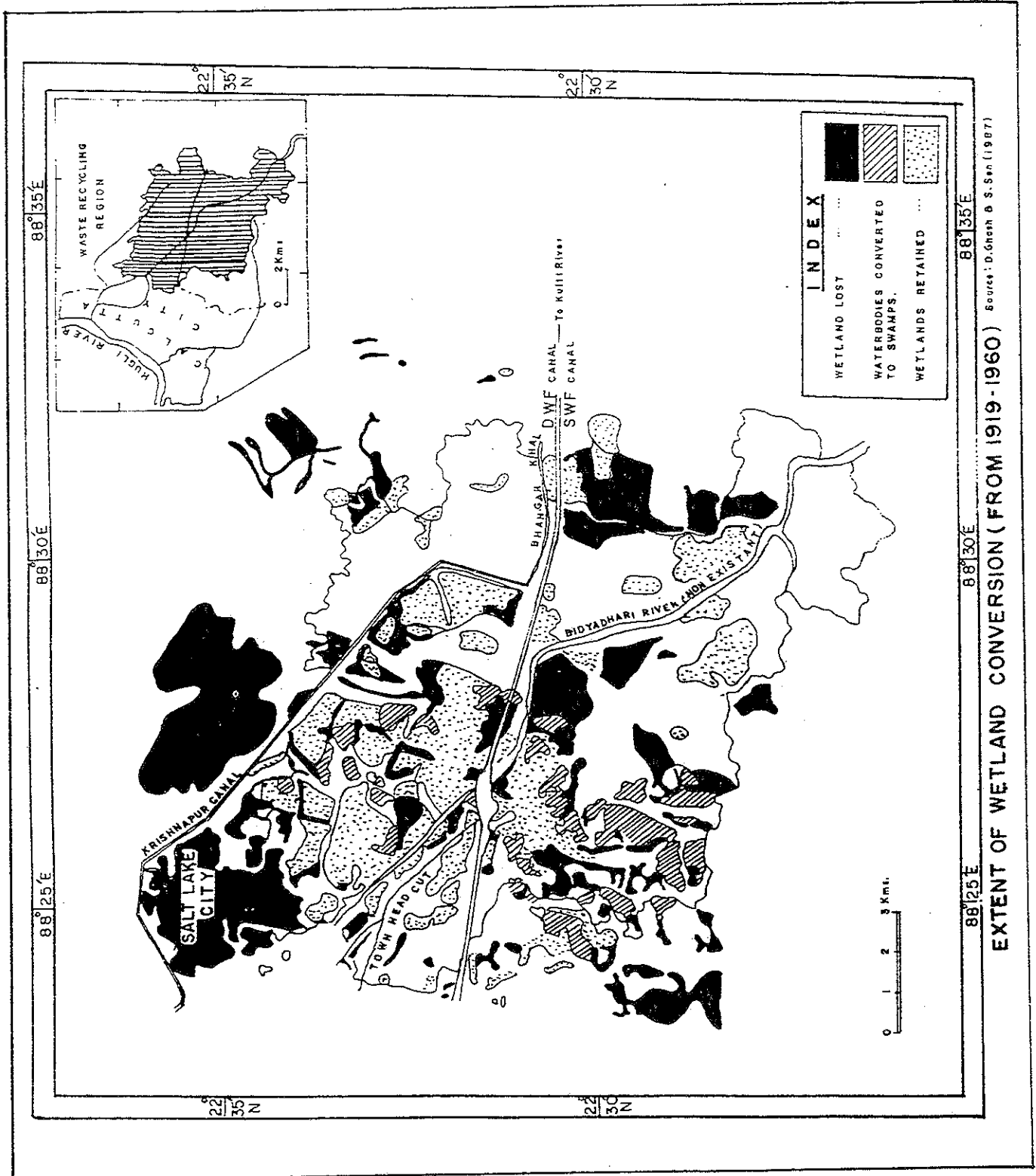
For the existing wetland areas on the eastern side of Calcutta, another urbanisation programme can be undertaken following the Salt Lake Reclamation Scheme. This urbanisation scheme will cost all the same components as have already been accounted for the already developed Salt Lake City area on a large scale. There are nearly 175 fish ponds in East Calcutta wetlands comprising 7000 acre in total, with more than 10,000 people are engaged in fish cultivation. In sewage-fed farming in this area, about 10,000 tonnes of vegetables are being grown annually with an equal number in employment. In rag-picking activities, about 20,000 to 25,000 people are engaged. Moreover, the drainage and garbage disposal system of Calcutta city has a direct linkage with the existence of this wetland area, which can be thrown out of gear with any further urban agglomeration in this area disturbing this system. Lastly, the value of the natural treatment procedure of the city sewage through STFs and SFs is very high from the viewpoint of environmental perspectives. This value is in real cost terms, also high if we consider the establishment of a sewage treatment plant to treat this city sewage.

Thus, it can be concluded that the immense benefits from the East Calcutta wetlands always raise the strong point against any further encroachment of land in this area disturbing the age-old natural system. With any further steps towards urbanisation of this wetland area, the existing system will break down causing the direct and immediate problem of disposal of garbage and sanitation of Calcutta with health hazards, regular waterlogging during the rainy season. Secondly, all the benefits coming from the existing practices will disappear with the breakdown of the practices. Lastly, the ecological balance of the city and its suburbs may break down with a huge amount of sewage and city effluent cleared in an untreated manner.

WETLANDS MANAGEMENT

The wetlands management requires an understanding of the scientific aspects of wetlands, balanced with legal, institutional and socio-economic realities in order to protect this valuable eco-system and prevent further encroachments. A sustained natural resources development based on the principles of ecology, energy conservation, economics and employment generation is urgently needed in East Calcutta wetlands.





The objectives of the wetland management for sustained development will be:

- i) waste water utilisation for pisciculture
- ii) waste water utilisation for crop culture
- iii) improvement of water quality through biological recycling
- iv) control of waterlogging in the city and drainage easement
- v) water storage and recharge for ground water
- vi) wild life conservation for bio-diversity
- vii) reduction of atmospheric pollution through silting and deposition of the pollutants
- viii) sediment and erosion control
- ix) research for baseline information and desirable landuse.

The wetland management, almost anywhere in third world countries will have to confront three primary deficiencies. These include:

- a) Awareness gap
- b) Lack of appropriate policy
- c) Absence of engineering application of wetland uses

All these criteria must be taken into account for the preparation of a management plan of East Calcutta wetlands.

The successful implementation of an action plan in the wetlands requires:

- i) establishment of institutional arrangement which will allow those concerned to identify how wetland conservation can be achieved and how wetland priorities can be integrated in the planning process,
- ii) establishment of mechanisms and procedures for incorporating an integrated multi-disciplinary approach to planning and execution of projects, concerning wetlands and their support systems in order to secure wetland conservation and sustainable development,
- iii) review of existing legislation and policies which affect wetland conservation,
- iv) increasing the awareness and understanding of decision-makers and the public of the full benefits and values of wetlands.

- v) review of traditional techniques of wise use, and elaboration of pilot projects which demonstrate wise use of representative wetland types.

Significant knowledge now exists amongst the people of East Calcutta wetlands for using wetland attributes to obtain renewable resources. A wealth, of creative knowhow has been retained in the oral tradition. It is imperative to study this knowhow substantially and to disseminate the knowledge for application in similar other wetland areas.

It is important to note that even if a project is economically viable and technically sound it has to be ecologically balanced and socially acceptable. It had been experienced that a number of basic management plans did not work because people failed to accept or conform to the recommended land use. To enhance the resource potential of the wetlands eco-friendly advanced technology will be desirable. But any change envisaged must be linked with the preference of the people and their participatory role be guaranteed. Simultaneously, appropriate coordination with the existing development agencies will have to be established.

After the preparation of a comprehensive Management Plan, the respective components of such a Plan must be transparent to all concerned agencies for review. Thereafter in project form the components of the management plan will be implemented by the concerned agencies/departments, either in full or in stages. All these management plans shall be integrated with the District Plans/Rural Development Programmes. Initial financial assistance will come from the District Plan Infrastructure. The South 24 Parganas District Magistrate has become the designated authority of the East Calcutta wetlands though a few mouzas under Salt Lake Police Station are included in North 24 Parganas District. The transfer of such mouzas to South 24 Parganas District is being considered. Moreover, a few mouzas have been included in CMC and CMDA area. The District Authority of South 24 Parganas will be authorised to incorporate the management plans in the District Plan for sustainable development of resources of East Calcutta Wetlands.

ACTION PLANS

I. Rapid Appraisal Survey (RAS)

It is necessary to develop a Rapid Appraisal Survey for comprehensive information for rational evaluation of East Calcutta wetlands. The system of classification will have to be simple and will not necessarily follow extensive and rigorous systems of classification (Deptt. of Environment, Govt. of West Bengal, 1953). They can be:

- a) area and location
- b) use of attribute of the system
- c) its generic nature.



To start with a landform/geomorphological map showing the landuse, drainage lines and the trend of wetland transformation is urgently needed.

II. Management of Municipal Solid Wastes (MSW)

A part of the East Calcutta Wetlands is being filled in with solid wastes from the city. This land-filling practice was begun in 1865 when a square mile area (2.59 sq.km.) in the Salt Lakes (Dhapa) was acquired and handed over to the municipal authorities. Besides Dhapa other dumping grounds are located at Bantala, Nowpara, Kadapara etc. Objections were raised by some people/NGOs against acquisition of the wetlands and marshy lands in Kalikapur, Barakhola, Jagarpota, Mukundapur, Dhalenda, Chowbhaga, Boinchitala and western Dhapa (as proposed by CMDA).

After evolution of such dumping grounds with heavy compactness and with adequate operational and engineering measures to maintain some drainage the filled-up lands are used as 'green belts'. As the existing land-filled sites of Calcutta Corporation will serve for another five to six years a total of about 660 ha of land would be required for the next 20 years (assuming an average depth of fill of 2 metres). While the CMC can go on filling the water courses, the CMDA should abandon the garbage dumping ground near the Eastern Metropolitan Bypass and its connectors, consolidate the land spread with the top soil and landscape the entire area.

A separate scheme is needed to distribute the city garbage according to the demand at each farm plot head in Dhapa and other dumping grounds in order to facilitate garbage-farming of vegetable and paddy.

III. Construction of Drainage Grids for STF (CDG)

The role of East Calcutta wetlands in waste recycling and resource generation (Pisciculture) has already been highlighted. The sewage treated fisheries (STF) and sewage farms (SF) based on effluent from the fisheries are the dominant landuse in the region. The system on the other hand purifies the raw sewage and absorbs pollutants from Calcutta Municipal area to create a clean and healthy environment. It is necessary to regulate the supply of sewage and meet the requirements of STF and SF. An optimum drainage grid to run the SFT and adjoining SF (for providing a continuous flow of sewage), along with a feasibility study of the secondary resource system based on the total range of bio-mass (viz. water hyacinth, sewage sludge and total waste) need to be designed. One drainage canal will be excavated in Tollygunge-Panchannagram basin and will carry sewage water of South-Calcutta.

IV. Application of New Technology in Designing the Lagoons

The fish ponds in East Calcutta wetlands act as ideal stabilising and oxidation ponds. Detritus, nutrients and pollutants are

deposited in these ponds from the raw sewage. The control of microphytes and desilting of the lagoon are necessary pre-conditions for the maintenance of dissolved oxygen in the pond at desired level for stocking the fish. Pre-treatment of sewage is also desired to regulate the BOD level. Otherwise over nitrification may result in infestation of submerged and free floating weeds that lead to hastening the process of swampification. Desiltation mechanism will also be designed for these ponds. Bio-technology/Bio-coil method may also be employed for pre-treatment of the sewage and optimum production of resources. This will in a useful way treat the city's waste, recover its nutrients to produce food and provide employment for the fringe area community.

V. Modernisation of the Fisheries

A proper understanding of complex relationship of food chain and patterns of energy flow in the ponds will help in formulation of policies for stock manipulation. The vast load of detritus available in the ponds and also the eutrophic character of the ponds will help continuous high rate of production by stocking detritus-oriented fishes, namely, *Cirrhinus mrigala*, *C.reba*, *Labeo rohita*, *L. bata* etc. The sustained fisheries development requires both micro and macro planning approaches. The micro-planning approach is project-oriented and involves investment in a carefully planned manner. Side by side with the micro-planning greater attention will be given to macro-planning namely, the sectoral development. The major issues under sectoral development are:

- i) Co-operative development, ii) credit and subsidy scheme, iii) changes in lease period (tenurial) policy, iv) technology transfer, v) marketing, vi) education and training, vii) insurance scheme, viii) socio-economic consideration.

VI. Bio-gas Generation and Manufacturing of Compost

It has already been identified that the land-filling will not be a viable alternative for the treatment of municipal solid wastes in the coming years due to the shrinkage of wetlands. It is necessary to treat the municipal solid wastes in various other methods.

With bio-chemical treatment these solid wastes can be converted into compost. Now there exists a global demand for organic manure. The production of compost will meet the growing demand of the agricultural sector. The bio-gas generation on a small scale will also be the other efficient utilisation. CMC has undertaken a project for the generation of power through bio-gas plant in the Dhapa Dumping Ground in collaboration with private entrepreneurs. This will open a new vista in the development of East Calcutta wetlands.

VII. Welfare Schemes for the Waste Recycling Community

The rag-pickers are the poorest of the poor people in the East Calcutta wetlands region. They are prone to many environmen-



tal and health hazards. Most of them have no shelter. These people also earn very low wages and are exploited by the middlemen. Appropriate health care facility and shelter may be rendered to them as social benefits. Similar benefits may also be given to other backward communities of the region engaged in other activities.

Education and training including technical counselling may also be arranged for the people engaged in pisciculture and farming. Education will certainly elevate skills and resource generation.

VIII. Build-up of Infrastructural Facilities

Infrastructural development is considered the index of development for resource potential. The region lying so close to the great metropolis is even today very backward in infra-structural facilities. Except the B.N. Dey Road passing over the region there are no other cross roadways serving the region. Economic development is based on better communication and transport. But the development of transport may also bring in market forces which will threaten the wetlands. Most of the area in the wetland region has no electricity. The progress of the rural electrification programme is at a snail's pace here. Development of rural electrification will be the pre-condition for application of new technology in the waste recycling region.

IX. Promotion of Tourism and Recreational Centre

The East Calcutta wetlands provide vast stretches of waterbodies, so close to the city with excellent ambient quality of air. Tourist cottages and recreational day centres may be developed on some selected water-fronts. Natural parks may be created under a social forestry programme and bio-diversity be maintained. One ecological centre may be established to explain the bio-diversity and the wetland eco-system. Recreational facilities will be developed without encroaching the wetlands and interfering with the eco-system. Nicco-Park like promotional development is not desirable here. Nature-loving people and environmentalists are likely to visit such places. In winter the management of the park as a sanctuary of migratory birds/waterflow will add tourist attraction in the region and augment the income of the local people.

There can be a new dawn on East Calcutta wetlands.

The backyard swamps of Calcutta will promise a better future not only for the region but also for the city of Calcutta with a glorious tradition of waste-recycling practices in the long run. Such traditional practices moulded in appropriate technology will not only prove its sustainability but also its worthiness in generating wealth for the society.

CAPACITY BUILDING AND INSTITUTIONAL STRENGTHENING

The Capacity Building for Human Settlement has been recognised by the U.N. Conference on Environment held in Rio-de-

Janeiro in 1992 as one of the principal objectives to achieve sustainable development. The uncertainty in the living system will increasingly become dominant in which all governments and communities confront themselves. In order to cope effectively with uncertainty all institutions/communities must take on the characteristics that allow natural systems to service in the face of uncertainty: resilience. The means of resilience require to have at least two components i) a quick response adaptive capacity and ii) future options not foreclosed.

Capacity building is thus a guarantor for sustainable development. Capacity building may be approached in various ways. The quick response capacity is built into organisations through a series of workshops, attended by a mix of analysts, administrators, managers and field staff. Base line information will be collected to make the model more realistic. The aim will be to build into the client organisation the capacity to develop an ongoing programme of model building and simulation that affects policy, generates new data and finally leads to a new round of modelling. Continuous assessment is made to ensure that the institution/community keeps very careful track of developments in the most important indicator variables and responds quickly and appropriately with management innovations to adapt to new situations in the managed system.

The 'best practices', in East Calcutta wetlands involve sewage treated fisheries, garbage farming and sewage farming. These practices have become sustainable based on recycling of urban wastes in the spillway basin of the Bidyadhari river. The changing aquatic environment in these wetlands had been intimately linked with sewages of the city of Calcutta draining through these wetlands.

The technology of sewage treated fish culture mainly involves: i) characterization of sewage quality ii) prestocking fertilisation with primary treated sewage iii) dilution of sewage with fresh-water in appropriate ratios depending on BOD of sewage, iv) stabilisation of the fish pond v) intensive and judicious stocking of Indian and exotic fish fingerlings vi) post-stocking fertilisation using sewage in small doses and monitoring of DO of fishpond water vii) periodic harvest of 1 kg fish, viii) final harvesting after 12 months.

STF is likely to be linked with the urban sanitation programme. In many parts of India derelict wetlands are being used as municipal sewage receptacles without any formal design. In biological methods for waste water treatment, the use of shallow (depth 1m) oxidation ponds allow water to be purified by the action of aerobic bacteria and algae. Such ponds use solar radiation for photosynthesis and the organic material is used for both bacterial and algal growth, effectively reducing BOD level and also coliform organisms.

The sewage treated fishponds of East Calcutta wetlands resemble closely stabilisation ponds. This indigenous technology is not an advanced one, conceived by the local fish farmers without any proper training. It will be appropriate to build capacity



for the 'best practices' model in East Calcutta wetland. In recent years in USA detailed studies have been made on the use of wetlands for water quality improvement. A design manual for the use of wetlands for municipal water has also been published (EPA, 1988). The technology devised by fisherfolk in East Calcutta wetlands may be a preferred low-cost technology for urban sanitation in developing countries. However it will be more useful to design sewage treatment plants so that they are sensitive to the incremental nature of sewage availability (Ghosh D, 1990).

A novel bio-coil technological system for sewage water treatment has been suggested. The technology has been offered by Biotechna Environmental Limited of London, which treats polluted water to produce biogas, clean water and micro-algae, which are useful as bio-fertiliser and feedstuff for animal and fish. The special feature of this photosynthetic technology is a closed and transparent photobioreactor in which pre treated sewage water inoculated with specially selected algae seed culture is circulated. The growing algae feed on the nutrients and are easily collected. Bio-coils are now in operation at Stoke Bardolph for nutrient removal of Severn-Trent. It is claimed that this system climates the problem of sludge and heavy metal accumulation. This system serves to capture the sewage water at source and turn it into solid feedstuff that can be packaged, stored, transported and distributed whenever needed. A project to produce the blue green algae Spirulina, similar in principle to the Bio-coil has been in operation since 1993 in the Institute of Wetland Management and Ecological Design. The expertise achieved in the Spirulina Project may be available for Bio-coil technology. This innovation will open new vistas in the use of East Calcutta wetlands more productively maintaining the eco-systems.

CAPACITY BUILDING FOR THE INSTITUTIONS

Many interests have a stake in the wetlands. Different institutions play key roles in the management of the East Calcutta wetlands. The most important task is to co-ordinate the various activities that are being taken by different agencies like the Department of Fisheries, the Department of Irrigation and Waterways, the Department of Agriculture, the Calcutta Municipal Corporation, the Calcutta Metropolitan Development Authority, the Department of Rural Development, the Panchayat and Zilla Parishad etc. It is necessary to create an appropriate authority for the management of wetlands which will coordinate different departments and seek institutional support from organisations like UNEP, World Bank, IUCN, Ramsor Bureau, ADB, ODA and so forth for the implementation of management action plans in the wetlands. The East Calcutta wetlands has become a global issue and needs support for the survival of the largest sewagefed agro-ecosystem in the world.

Capacity building for different institutions/departments would be to assess the participatory role of such institutions/ departments. Participatory techniques will be helpful in assessing the nature of the problem as well as the reality, feasibility, prac-

ticality and acceptability of potential solution. IW MED believes that people affected by the environment, (wetland) need to be involved and to feel that they have a stake in the process of developing strategies and action plans to improve it, in order to achieve a greater degree of sustainability. The experience earned by the people of East Calcutta wetlands in evolving a unique system of waste recycling is likely to be disseminated as the most appropriate technology. Such a model for urban sanitation on the one hand and resource generation on the other hand may be upscaled. The important innovation for dealing with the complex eco-system of East Calcutta wetlands would be for the Government at all levels to employ interdepartmental, inter-disciplinary integrated systems modelling to evaluate alternative environmental management policies.

CAPACITY BUILDING FOR TRAINING MATERIALS

Capacity building is also necessary for monitoring and evaluation of impacts of best practices in other areas, both on a national and global scale. Operations evaluation will identify the principal determinants of sustainable development.

Capacity building is not only for institutions/departments. Every individual in the hiring system has his stake to resolve the problem. His experiences with earned skills may not always guide him in resolving the same. But experiences from other practices in different parts of the world will largely benefit him. The documentation of different aspects of the best practices will form a store for dissemination of appropriate technology and methodologies.

The role of policy makers, administrators and managers appears very crucial in the management of practices and other related environmental, economic and social issues. On many occasions these persons have preconceived ideas which are not eco-friendly. Sometimes they consider their decisions final and binding flouting all norms and ignoring the base line situation. Value orientation in the attitude and perception of these people will reinforce the role of the institution in arranging workshops, seminars, field visits and social mixing at the local level for awareness and education.

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TABLE 8.5

SERIAL DETERMINATION OF THE PROBABLE VALUE OF WETLAND FUNCTIONS AND USES

| Function/Use | State of Nature | Variable |
|------------------|---|---|
| Flood mitigation | Rainfall ++ | Flood occurrence and severity |
| | Flood occurrence and severity, physical characteristics of the area ++ | Level of mitigation |
| | Level of mitigation, location and value of assets to be protected ++ | Value of this level of mitigation |
| Toxicant removal | Concentration of toxicants in the inflow, wetland characteristics | Capacity of the wetland in reduce the concentration of the toxicants in the outflow to below a particular level |
| | Toxicant reduction capacity, concentration of toxicants in the outflow ++ | Change in crop production downstream if concentration of toxicants reduced below a particular level |
| | Change in crop production, demand for and supply of this crop and of/for complements or substitutes | Value of in increase production |
| Fish production | Fishing effort, rainfall ++ | Amount of fish produced |
| | Demand for and supply of fish of this type and of/for complements or substitutes | Value of this production |

Source: Compiled by the Author



TABLE 8.6

THE ROLE OF DIFFERENT AGENCIES IN THE MANAGEMENT OF EAST CALCUTTA WETLANDS

| Institution | Role played for | Objectives |
|---|--|-------------|
| Dept. of Environment & Forests | Environmental protection | Environment |
| Dept. of Fisheries | Supplying technical and other inputs for fisheries | Management |
| Dept. of Irrigation & Waterways | Maintaining the channels and monitoring the distribution of sewage water to fisheries and agriculture | Action Plan |
| Dept. of Agriculture | Supplying inputs for farming both crops and vegetables | for |
| Calcutta Municipal Corporation | Conversion of garbage wastes (solid) into energy and resources, controlling the sewage outfall and also holding the rights of land of garbage farms in Dhapa | Sustainable |
| Calcutta Metropolitan Development Authority | Implementing the sewage development and drainage plans and also the authority of urban development in C.M.D. | Wise |
| Dept. of Rural Development | Providing resources for infra-structural and integrated rural development | Wise |
| Panchayats/Zila Parishad | Implementing different development plans, monitoring the people and institution for participation in development programme | |
| Dept. of Land and Land Records | Outlining the legal rights vested in the holdings | |
| G.S.I./Z.S.I./B.S.I. | Researches on landforms/structures, bio-diversity and monitoring for the ecological balance | Use |
| I.W.M.E.D. | Surveying and monitoring wetland information systems and also advising in decision making in technical matters as and when necessary | Use |

Source : Compiled by the Author



TABLE 8.7

WASTEWATER SOURCES CONTRIBUTING TO THE WETLANDS (MFCS)

| Sl. No. | Type of Industries | No. of Industries | Wastewater Flow (m/day) (Approx.) |
|---------|--------------------------|-------------------|-----------------------------------|
| 1. | Engineering Industries | 65 | 1728.6 |
| 2. | Chemical Industries | 26 | 15489.6 |
| 3. | Godowns/Garages | 42 | 1505.6 |
| 4. | Institutions | 4 | 2015.6 |
| 5. | Miscellaneous Industries | 15 | 1050.6 |
| Total | | 152 | 21790.0 |

Source: E.I.A. for Wetlands, NEERI, 1995.



TABLE 8.8

BASELINE DATA : PHYSICO-CHEMICAL WATER QUALITY (MFCS)

| Parameters | Raw Sewage | Crocodile Jheel | | Taitala Jheel | | Khudi-I Jheel | | Khudi-II Jheel | | Loha Jheel | |
|---------------------------------|------------|-----------------|-----------|---------------|-----------|---------------|-----------|----------------|-----------|------------|----------|
| | | Influent | Effluent | Influent | Effluent | Influent | Effluent | Influent | Effluent | Influent | Effluent |
| Temperature (C) | 28-29.5 | 29-29.5 | 29.5-30 | 27.29 | 27.28 | - | 26.5-27 | - | 26-27.1 | - | 26-27 |
| pH | 5-6.7 | 7-7.1 | 7.1-7.5 | 7.2-9.3 | 7.3-8.3 | 7.5-8.0 | 7.5-9.0 | - | 7.5-8.6 | 7.2-8.6 | 7.2-8.6 |
| Alkalinity (CaCO ₃) | 424-430 | 435-440 | 364-380 | 180-240 | 172-240 | - | 204-302 | - | 176-294 | 170-250 | 164-232 |
| Chlorides (Cl) | 559-380 | 340-357 | 324-339 | 226-276 | 226-301 | - | 280-286 | - | 261-281 | 250-270 | 221-259 |
| Total Solids | 1046-1084 | 1156-1160 | 932-1088 | 844-1018 | 930-1018 | - | 850-982 | - | 682-982 | - | 736-898 |
| Suspended Solids | 62-82 | 38-40 | 7-70 | 116-156 | 116-164 | - | 80-204 | - | 76-146 | - | 55-108 |
| Dissolved Solids | 984-1062 | 1118-1120 | 895-1023 | 728-862 | 728-862 | - | 774-778 | - | 752-778 | - | 629-790 |
| Total Volatile Solids | 238-302 | 220-222 | 124-202 | 170-280 | 170-289 | - | 204-266 | - | 198-270 | - | 176-330 |
| Dissolved Oxygen (DO) | 1.5-1.7 | 1.7-2.7 | 3.2-10 | 5.6-7.5 | 8.6-12.7 | - | 10-12.9 | - | 9.8-10.8 | 8.5-8.9 | 8.7-9.5 |
| BOD | 30-70 | 140-142 | 11-27.4 | 28-33.5 | 21.5-33.5 | - | 21.5-28.5 | - | 16-26.5 | 15-25.2 | 10-24.5 |
| COD | 74-208 | 373-375 | 30-67 | 119-171 | 97-161 | - | 59-126 | - | 29.7-120 | - | 29.5-89 |
| Ammonia (N) | 6-7 | 4.2-5.9 | 3.2-5.7 | bdl-1.8 | 0.5-1.8 | - | 0.5-2.8 | - | 0.5-2.8 | - | 1-2.3 |
| Nitrate (N) | 9.4-9.6 | 3-8.2 | 0.30-7.5 | 0.95-1.02 | 0.7-1.4 | - | 0.7-6.55 | - | 0.7-5.85 | - | 0.7-3.98 |
| Total Nitrogen (N) | 61.0-62.5 | 30.8-31 | 33.5-33.8 | 18.2-31 | 31.31.5 | - | 15-18 | - | 13.2-15 | - | 7.5-10.5 |
| Phosphate (P) | 0.085-0.86 | 0.53-0.55 | 0.03-1.60 | 0.4-5.30 | 0.15-4 | - | 0.30-0.82 | - | 0.29-0.36 | - | 0.15-3.2 |
| Sodium (Na) | 230-240 | 240-275 | 245-280 | 230-250 | 220.260 | - | 220.206 | - | 195-220 | - | 160-180 |
| Potassium (K) | 8-9.6 | 10-11.2 | 10-15 | 10-11.2 | 8.2-14.4 | - | 6-8 | - | 5.8-7.4 | - | 3.8-6.4 |

All values of physico-chemical parameters except pH and temperature are expressed in mg/L.

Source: E.I.A. for Wetlands, NEERI, 1995.



TABLE 8.9
PERFORMANCE EVALUATION OF WETLANDS (MFCS)

| Wetland | Influent BOD mg/l. | Cumulative & of BOD removal | Surface BOD loading rate (kg/hr/day) | Cumulative fecal coliform removal efficient (%) |
|-----------------|--------------------|-----------------------------|--------------------------------------|---|
| Crocodile Jheel | 140.0 | 85.7 | 91.6 | 26.67 |
| Taltala Jheel | 77.0* | - | 131.1 | 99.4733 |
| Khudi-I Jheel | 27.2 | 64.68 | 83.4 | 99.9906 |
| Khudi-II Jheel | 23.2 | 69.87 | 69.3 | 99.9947 |
| Loha Jheel | 15.0 | 80.52 | 58.3 | 99.9980 |

*Flow composited average BOD of five outfall (KR-1, Univ.-1, HP-1, Hide-1)

Source: E.I.A. for Wetlands, NEERI, 1995.



TABLE 8.10
FISH PRODUCTION (MFCS)

| S.No. | Wetland | Water Area (hectares) | Total Fish catch (tonnes) | Annual productivity per hectare (tonnes) |
|-------|-----------------|--------------------------|---------------------------------|---|
| 1. | Crocodile Jheel | 16 | 39.50 | 2.47 |
| 2. | Taltala Jheel | 14 | 69.00 | 4.93 |
| 3. | Khudi-I Jheel | 8 | 56.00 | 7.00 |
| 4. | Khudi-II Jheel | 11 | 40.00 | 3.64 |
| 5. | Loha Jheel | 5 | 39.00 | 7.80 |
| | Total: | 54 | 243.50 | 25.84 |

Source: E.I.A. for Wetlands, NEERI, 1995.



TABLE 8.11

PROBLEMS AND PROSPECTS OF CALCUTTA'S GROWTH

| Sl. No. | Parameter growth | East and South-eastern | Northwards growth |
|---------|--|--|---|
| 1. | Environmental consideration valuable ecosystem and waste treatment facility. | Loss of wetlands; increases air pollution; destroys | The wetland ecosystem remains intact. |
| 2. | Drainage; flood/water-logging and health hazards | Reclamation and urban constructions cause major loss of drainage outfall basins. Less facilities for disposal of rainfall excesses; increasing health hazards. | Wetland facilities in the eastern metropolitan fringe can be utilized |
| 3. | Water supplies | Increasing mineralization and hardness of water; unpredictable salinity in ground water. Consequent need to tap and treat Hugli water. | Prolific ground water supplies major basin; lesser pumping costs and mineralization problems (only iron removal called for); safe and potable for human beings. |
| 4. | Sewage/treatment and solid waste disposal. | Natural Dhapa system being lost by reclamation. Calls for costly treatment plants. Gradual loss of garbage disposal sites as well. | Natural facilities retained. Additional system can be designed in eastern metro fringe wetlands. |
| 5. | Economic products | Rich fish haul as primary source of protein rapidly dwindling. Vegetables growing areas also likely to be usurped for urban construction ultimately. | Fisheries development can be further strengthened with State/Panchayat control; more or vegetable mixed farming products. |
| 6. | Hinterland and communication | Away from the city's hinterland increased freightage and communication/traffic problems in core Calcutta. | Nearness to hinterland easier disposal of trans-Hugli facilities shall need strengthening of North communication corridors. |
| 7. | Social factors | Loss of primary sector livelihood (fisheries, farming, etc.). Increasing tertiary sector problems. Control by land speculators to take over reclaimed land parcels at the cost of middle and lower economic classes. | Distance from core will discourage such speculators. Cleaner urban development, better health due to lesser drainage congestion and lower preventive health costs etc. Greater land/water based employment in primary sector. |



| Sl. No. | Parameter growth | East and South-eastern | Northwards growth |
|---------|-------------------|---|---|
| 8. | Hugli Conservancy | Larger extraction of water for urban supplies with consequent flow reduction and increased pollution and salinity; in turn, escalating cost of treatment. | Trapping Hugli avoidable Northwards reach of river less polluted with lesser tidal salinity. |
| 9. | Land | Only by reclamation at high cost and degradation of system. | Good lands available in Kalyani-Haringhata zone. Dairy to be shifted to east Calcutta reclaimed zone. |

Source: Ecology and Environment of Calcutta, A. Ghosh, Government of West Bengal, 1992.

