Urban Wastewater: Livelihoods, Health and Environmental Impacts in India: The Case of the East Calcutta Wetlands

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Objectives:

- Identify the livelihood options in and around East Calcutta Wetlands based on use of Urban Wastewater
- Estimate the value of Direct benefits derived from the use of Urban Wastewater by the stakeholders in ECW
- Health Impacts of Urban Wastewater on Stake holders
- Environmental impact of ECW on Stakeholders

Geographical Features of ECW

- The wetlands to the East of Kolkata, well known over the world, situated in between 22°25´- 22°40´ N latitude and 88°20´-88°35´E longitude and covering the area of about 12,500 ha.
- It has a hot and humid monsoon climate governed by the Himalayas in the north and the Bay of Bengal in the south

- January is the coolest month with temperatures ranging between 10°C to 20°C while May experiences maximum temperature ranging between 30°C and 40°C
- Average relative humidity is high between 70 percent and 90 percent approximately. Average annual rainfall is about 1582 mm and is mainly concentrated in the months of June, July, August and September.

Hydrology of East Calcutta Wetlands

- Sewage is largely water but it contains organic and inorganic solids in dissolved and suspended forms.
- Major bacteria accompanying these solids are *coliform*
- A major problem in the hydrology of East Calcutta Wetlands, is arsenic. The percentage of arsenic which is considered safe for consumption is 10mg/litre as estimated by WHO. However in the northern limits of greater Kolkata, in the areas like Bhangar, Kharibari, Rajarhat, Bishnupur I and II, Gangra, Mahisbathan II the levels of arsenic has been found to be 10-15mg/litre.

Biodiversity in East Calcutta Wetlands

Wetland ecosystems are rich sites of bio-diversity:-

There are about 100 plant species, which have been recorded in and around the East Calcutta Wetlands. These include *sagittaria montividensis*, *cryptocoryene ciliata*, *cyperus spp.*, *crostichum aureum*, *lpomoea aquatica*, etc

Amongst the rare mammals in the area the Marsh Mongoose and Small Indian Mongoose can be found. Palm Civet and Small Indian Civet are significant in and around East Calcutta Wetland area. About 20 mammals are reported from this region

Snakes are also common in the East Calcutta Wetland among these some that can be mentioned are Checkered keel back (*Xenochrophis piscator*), Smooth water snake (*Enhydris enhydris*), Buff striped keel back (*Amphiesma stolata*), and Bronze back tree snake (*Tendrelaphis pristis*).

History of Urban Sewage System of Kolkata

- The salt-water marshes between the river Hoogly and Bidyadhari gave rise to the present East Calcutta Wetlands
- By 1928, the river Bidyadhari had become defunct due to siltation. Cessation of tidal flow converted the area into a vast swamp. There were a series of basins like Tollygunge-Panchagram basin, Keorapukur basin, Sonarpur-Arpanch basin.
- In 1903 the city drainage was directed artificially into river Hoogly against the gradient. A combined scheme for disposal of storm water sewage and dry weather flow was constructed in 1884. In 1943, a new scheme was commissioned for internal drainage and outfall systems. The outfall was changed from southeast to east to river Kulti. As land inclination is toward east all sewerage lines are in that direction and at present there are 17 pumping stations spread over north-south stretch.
- The total wastewater going through the Kulti outfall has been around 1000 million litres per day. Due to the existing drainage system, pisciculture with waste water is mainly located in the East Kolkata Wetlands in the vicinity of dry weather flow channel and near Tolly's nallah away from the wetlands

ECW – A Ramsar Site

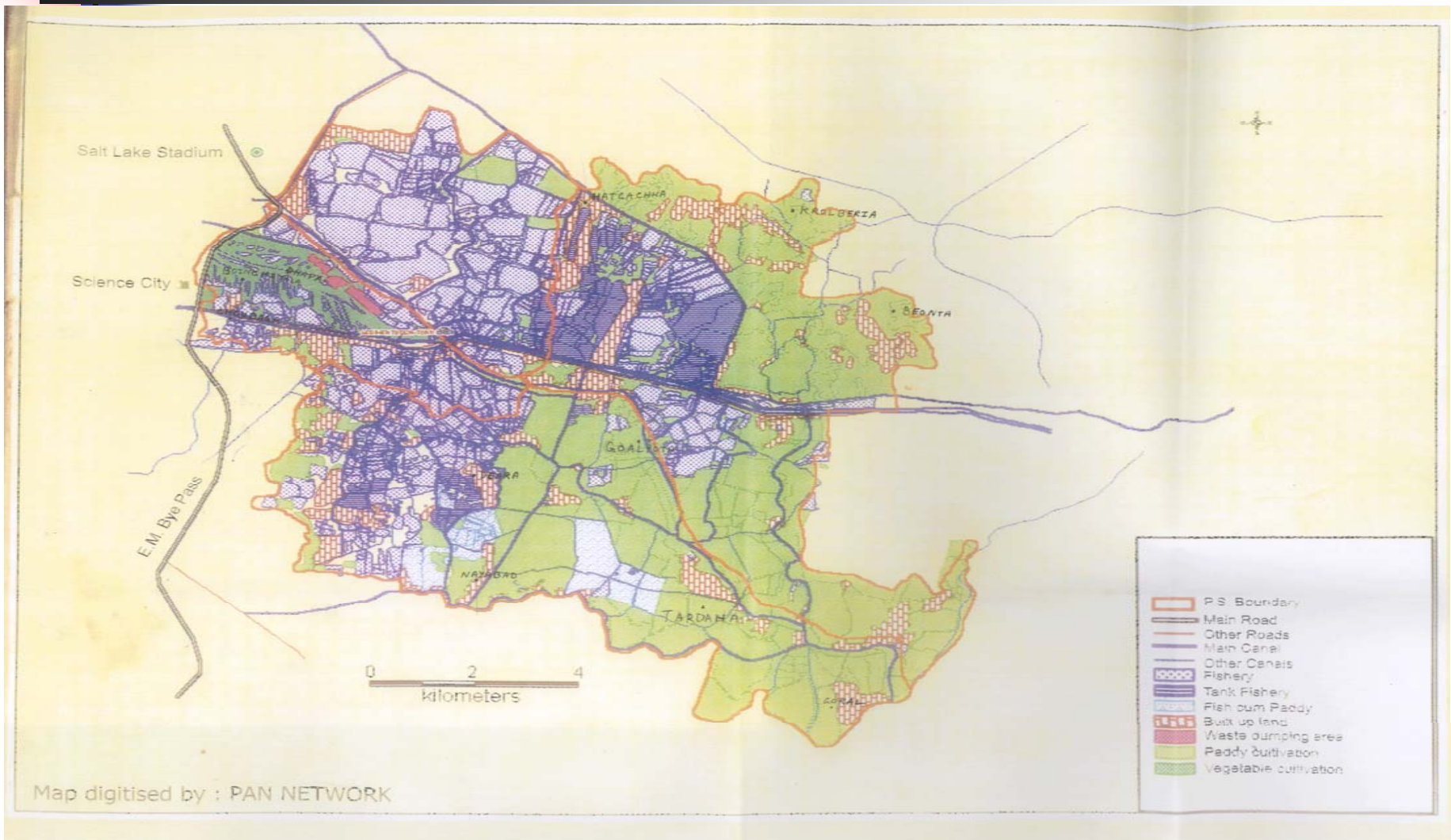
ECW were declared as a Ramsar site on November 2002 as per Ramsar guidelines. The justification for declaring ECW as Ramsar site were:-

It was an example of wise use of a wetland ecosystem where usage of city sewage for traditional practices of fisheries and aquaculture were practiced

It was a rare example of combination of environmental protection and development where the local farmers have adopted a complex ecological process by mastering resource recovery activity.

It is the largest sewage-fed aquaculture in the world.

Map


Salt Lake Stadium
Science City
E.M. Bye Pass
HATGACHHA
KAGJHEKIA
BEDANTA
GOALTORE
TARA
NAZIRABAD
TARDAHA
0
2
4
kilometers
P.S. Boundary
Main Road
Other Roads
Main Canal
Other Canals
Fishery
Tank Fishery
Fish cum Paddy
Built up land
Waste dumping area
Paddy cultivation
Vegetable cultivation
Map digitised by : PAN NETWORK

Other Wetlands in India

Harike wetland in Punjab:

- Occupies 86sq. Km. in districts of **Amritsar, Ferozepur, Kapurtala**
- 67 species of fish, 7 species of turtles, 28 species of trees and 20,000 species of birds, both resident and migratory.
- Dependency of four communities: **Agrarian, Reed gatherers, Grazers, Fishing Community.**

Chilika Prawn Fisheries:

- Water-spread area of the lake during summer season is 666sq km.
- Fish landings during 1999-2000 were mere 1642.5 metric tones.
- Siltation has closed all links with the bays except one, *Magarmukh*.

Other Wetlands in India

Sunderbans mangrove Forest:

- Occupies an area of 6017 sq. km. or 600,000 hectares
- Provides a livelihood for an estimated three hundred thousand people working variously as **woodcutters, fishermen and gatherers of honey, golpatta leaves, hantal and grass**

Mangrove Ecosystems of Kerala:

- 1700 hectare of mangrove forests along 560 kilometre coastal belt and has mangroves coming under 36 families.

Cochin Estaurine Fisheries:

- Alappuzha in the South to Azhikode in the North Kerala is generally known as Cochin estuarine system
- Major activities : are fishing, shell collection, coconut husk retting, water transport, water tourism, and aquaculture and agriculture in low-lying paddy fields adjacent to the backwater

Methodology

- A pilot study of 40 households were conducted to develop the questionaire.
- The questionaire has 4 sections pertaining to various aspects of livelihood, health and environmental conditions of the stakeholders in ECW
- 500 households were finally surveyed through *interviewer method in villages including Bantala*, *Chowbaga*, *Panchannagram*, *Boinchitala*, *Durgapur*, *Krolberia*, *Bamonhata* and other villages.
- This to the best of our knowledge the most exhaustive survey ever done. We present here some of our selected observations.

Population around canals

Canals	Households	Population
Bagbazar-Beleghata	3,300	16,500
Bagjola	5,200	26,000
Tolly's Nallah	4,400	22,000
Total	12,900	64,500

Livelihood in ECW

Fishery

Agriculture

Garbage Farming

Waste Recycling

Miscellaneous Activities

Prospects of fish production

- The wastewater aquaculture system in the wetlands consists of approximately 254 fisheries (*bheries*) that covers an area of 4779.21 hectares.
- The wastewater aquaculture system receives 55,000 m^3 of untreated sewage per day (Edward and Pullin, 1990)
- Estimated productivity of aquaculture as measured by carp production is seven tons per ha for areas receiving wastewater. This results in total annual production of approximately 13,000 tons of *Carp* and *Tilapia*

Ownership Pattern of Sewage-fed Fisheries

Type of holding	Percentage
Private	93.14
Cooperative	0.86
Government	6.00

Findings:

- General Information:

No. Of Household	Total no. of members	Average household size	Total no. of female members	Total no. of working members
500	2469	4.9	1150	825

- Females account for 46.57% of the sample

Distribution by Religion

Religion		
	No. Of Households	Percentage
Hindu	469	93.8
Muslim	29	5.8
Others	2	0.4

Monthly Family Expenditure

Expenditure class (Rs per month)	No.of households	Percentage
0-1000	15	3
1001-5000	412	82.4
5001-10,000	67	13.4
10,001-15,000	5	1
15,001-25,000	1	0.2

Monthly family expenditure

- Most of the people work against **daily** or **monthly** payments. However, in some *bheris* there are also arrangements for **weekly** payments.

- The median is at Rs.1001-5000 because most fisher men households are single earner households with average monthly income ranging between Rs2000 – 3000.

Distribution By Occupation

- 53.2% are engaged in fisheries performing various tasks from catching fish to carrying them to the market, night guards and maintenance workers, auctioneers, fish sellers, boat makers, net makers, and others. 29.2% are engaged in wastewater agricultural activities. Vegetables are usually carried out as garbage farming, that is, in areas where the city wastes are dumped officially. Many fishermen have vegetable farming or paddy cultivation as secondary occupation.

Related occupation or good produced	No. of Households	Percentage
No good produced (other activities)	46	9.2
Rice	85	17.0
Vegetables	61	12.2
Fish	266	53.2
Garbage	42	8.4

Relationship between religion and primary occupation:

Good Produced	Religion			Total
	Hindu	Muslim	Others	
No commodity produced	38	8	0	46
Rice	74	11	0	85
Vegetables	60	1	0	61
Fish	263	2	1	266
Garbage	34	7	1	42
Total	469	29	2	500

Relationship Between Income Type and Occupation

Good Produced	**Income Type**				Total
	Daily	Monthly	Yearly	Weekly	
No Commodity Produced	21	19	5	1	46
Rice	22	2	60	1	85
Vegetable	45	7	9	0	61
Fish	106	129	9	22	266
Garbage	12	30	0	0	42
Total	206	187	83	24	500

Distribution by type of house

House category	No. of Households	Percentage
Kuchha	238	47.6
Pucca	238	47.6
Slum	15	3.0
Temporary	9	1.8

Distribution by type of house

- 63.8% of the households use wood as their **cooking fuel**. This wood is normally collected from the open space. However, most of them have their cooking arrangements outside in the courtyard
- only 40.6% of the households complain of **air pollution** inside their houses
- Only 42.6% of the households complain of **foul smell** in and around their dwelling areas, in spite of them living around the waste water areas.

Literacy Level

- Literacy level is calculated by summing up the years of schooling by each member of the family and then dividing it by the number of members to arrive at the average years of schooling by each household. We have coded the years of schooling as follows:

Years of school:

0-illiterate/no schooling

2-can read and write

5-primary

10-Madhyamik/class X

12-Higher Education

Literacy Level

Class	Frequency	Percentage
0-1.0	40	8
1.1-2.0	50	10
2.1-3.0	71	14.2
3.1-5.0	184	36.8
5.1-8.0	113	22.6
8.1-10.0	28	5.6
10.1-12.0	14	2.8

Relationship between the education of the main income earner and religion.

Religion	Illiterate	Can read and write	Primary	Madhya mik	Higher education (above Madhyamik)
Hindu(469)	101	111	160	56	41
Muslim(29)	10	5	8	4	2
Others(2)	0	2	0	0	0

Source of Drinking water

Source of drinking water	No. Of Households	Percentage
Freshwater Pond	3	0.6
Tube well	329	65.8
Well	1	0.2
Municipality	159	31.8
Others	8	1.6

Source of Drinking water

- For other activities 47.0% of the households depend on water from nearby ponds and 32% use water from tube well

Combination options of production:

Primary occupation	Secondary Occupation					Total
	No commodity produced	Rice	Vegetable	Fish	garbage	
No commodity produced	27	8	11	0	0	46
Rice	75	1	6	3	0	85
Vegetable	59	0	0	1	1	61
Fish	255	5	6	0	0	256
Garbage	38	0	3	1	0	42
total	454	14	26	5	1	500

Average Productivity using Wastewater

Produce	**Average productivity per month (kg/acre)**
Fish	104.10
Paddy	1359.18
Vegetables	1021.30

Profit Per unit of produce using wastewater

Produce	**Profit per kg**
Fish	Rs. 8.82
Paddy	Rs. 6.08
Vegetables	Rs. 2.30

Value Addition per Hectare per year using wastewater:

Produce	**Value Addition per hectare per year (Rs)**
Fish	33,053.85
Paddy	1,48,748.658
Vegetables	84,563.64

Value Addition per year

- Annual value of the wetland, roughly, stands around **Rs. 924.53 million per year** for **10,1342.2 ha .**of land

- **4779.21 hectares** is used for aquaculture
- **467.1 hectares** for vegetable cultivation.
- **4887.89 hectares** for paddy cultivation

Incident of diseases

Disease	Child (0-12 yrs)		Midage (13-60)		Oldage(above 60)	
	Male	Female	Male	Female	Male	Female
Indigestion	45	42	172	148	14	9
Diohhrea, Cholera	15	11	34	30	2	4
Typhoid, Paratyphoid	3	1	4	6	0	0
Jaundice	8	1	8	3	1	0
Skin Disease	6	1	21	12	1	0
Others	80	49	144	116	21	19

Incident of diseases

Disease	No. of incidents
Indigestion	430
Diohhrea, Cholera	96
Typhoid, Paratyphoid	14
Jaundice	21
Skin Disease	41
Others	429

Type of doctor visited

Type of doctor consulted	No. of households	Percentage
No Doctor	76	15.2
Qualified Doctor	297	59.4
Hospital Outdoor	62	12.4
Med. Camp (NGO)	15	3
Quack	50	10

Cost per Illness

Doctor s' fees (avera ge , Rs)	Avg. no. of times visited doctor	Avg. cost of medi cine	No. of days absent per illness	Value of one man days lost @Rs 2/hr. (Rs	Time lost in visiting the doctor (hrs)	Avg. Value of man days lost @Rs 2/hr	Avg. Cost per illness Rs. (1*2+3+4 *5+2*6)
50.53	2.54	556.7 08	17.17	16	0.90	274.72	961.58

Per Capita availability of food

Food	Per Capita Monthly Availability (kg)
Fish	1.948
Rice	8.58
Vegetables	7.30
Pulses	0.755

Test reports of water:

Sl. No:	Parameters	Upstream of canal	Downstream of canal	Norms(IS 2296 Class C)
1	Dissolved Oxygen mg/l	5.00	4.00	4.0
2	pH	6.85	7.10	6.5-8.5
3	Total suspended Solids mg/l	125.40	188.0	n.a.
4	BOD, 3 days at 27^0C	130.25	395.00	3
5	COD mg/l	253.44	568.00	n.a
6	Total Coliform MPN/100ml	$8x10^4$	$12x10^4$	5000
7	Cadmium mg/l	BDL	BDL	0.01
8	Total hexavalent Chromium mg/l	0.02	0.03	0.05

Test reports of water(contd)

Sl. No:	Parameters	Upstream of canal	Downstream of canal	Norms(IS 2296 Class C)
9	Lead mg/l	BDL	BDL	0.10
10	Copper mg/l	0.05	0.08	1.5
11	Manganese	0.18	0.26	n.a.
12	Zinc mg/l	0.12	0.16	15
13	Arsenic mg/l	BDL	BDL	0.20
14	Phenolic compounds mg/l	BDL	BDL	0.005
15	Oil & grease mg/l	4.60	8.60	0.1
16	Nitrate mg/l	12.45	22.65	50

Test report of Fish

Parameters	**Boinchitala (near Dhapa)** ***sample 1: collected from bheri in ECW** **** sample 2: from fresh water pond in Garia**					
	Bone		**Liver**		**Flesh**	
Physical	1*	2**	1	2	1	2
Weight	2.8 gm	3.32 gm	0.196 gm	0.572 gm	80.21 gm	121.36 gm
Chemical	Mg/kg	Mg/kg	Mg/kg	Mg/kg	Mg/kg	Mg/kg
Copper	133.07	4.27	23.89	11.00	6.62	21.90
Zinc	28.50	29.28	220.13	20.34	26.15	35.16
Manganese	22.63	20.19	67.61	21.05	18.86	36.64
Chromium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Lead	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Mercury	BDL	BDL	BDL	BDL	BDL	BDL

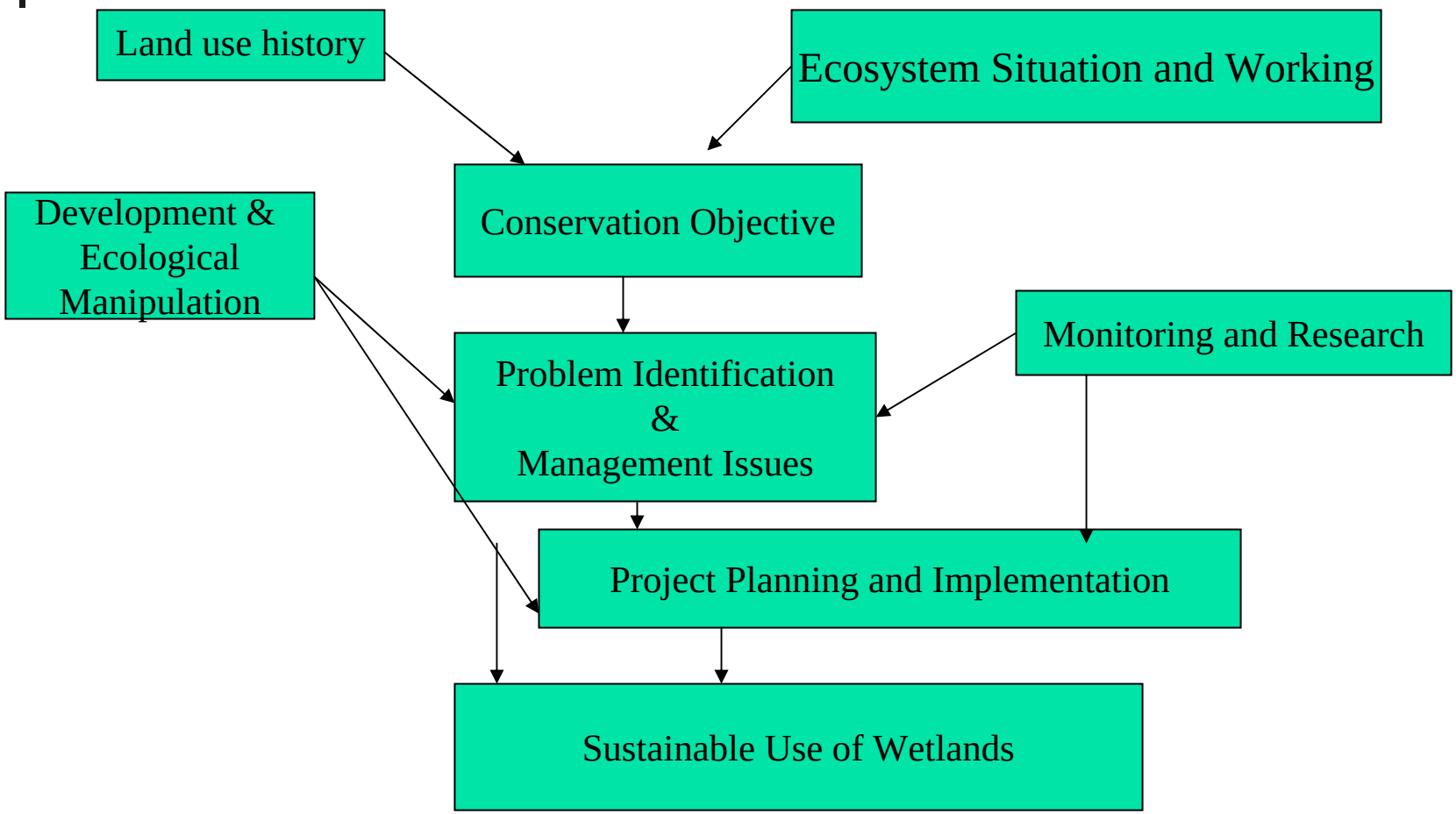
Test report of vegetable

Parameters	**Boinchitala (near Dhapa)**
Physical	
Weight	220.1275 gm
Chemical	
Chlorophyll	1.24 mg/gm (fresh weight)
Copper	11.09 mg/kg
Zinc	37.64 mg/kg
Manganese	12.89 mg/kg
Chromium	< 5.00 mg/kg
Lead	< 5.00 mg/kg
Cadmium	< 0.50 mg/kg
Mercury	BDL
Arsenic	BDL

Summary

- East Calcutta wetlands, served as the best example to the world on concepts of integrated resource recovery systems and water recycling using peripheral wetlands around cities.
- Urban wastewater use in wetland for agriculture and aquaculture provides significant income for sustaining livelihoods of poor residing in wetlands.
- Income level of the majority of the household is between Rs2000-3000 per household per month
- ECW generates a value of Rs 924.53 million per year.
- Literacy level is very unimpressive, especially among women and girls.

An approach to Sustainable Management



Issues to be addressed

- Focused and directed developmental programmes must be schemed.
- Adequate attention must be given to the indebtedness of the laborers, to the *bheri* owners /land owners / waste recycle firm owners, reducing them to the status to bonded laborers.
- Communication poses a serious problem to the residents of East Calcutta Wetland
- Improved health services are unavailable here.
- Eco-tourism can also be initiated here to increase the income opportunities of the residents.

Issues to be addressed

- Handicraft making can be strengthened through improved design and marketing opportunities
- Charge for Sewage water usage must not be introduced now.
- Use of depuration tanks is recommended to reduce the metal content in fish bones.
- Setting up of fish processing and fish based food processing industries outside Wetlands