INDIGENOUS AND ECOLOGICAL DEVELOPMENT OF WETLANDS IN KOLKATA METROPOLITAN AREA

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Abstract
There are large number of wetlands in the aqueous Bengal delta. Such wetlands are formed due to shifting of rivers. Kolkata Metropolis is built on marshy land and wetlands are filled up due to urbanisation. But many wetlands still remain in the fringe areas which serve a number of functions. They preserve the environment and biodiversity, partially solve city's drainage problems and sewage fed waste water and aquaculture produce fish and vegetables. Three case studies are presented and regulation and management with participatory development are emphasized. Wetland should be part of overall water resource planning and should be treated with principles of conservation, environment and development. These should be part of overall regional environment plan.

Key words : Aqueous, Aqueculture, Ecohydrology, Phytoplankton, Recycling.

1. Introduction : The Aqueous Bengal Delta

Bengal Delta, adjoining the Bay of Bengal is formed by two great rivers of India i.e. the Ganges and the Brahmaputra, many small rivers and tributaries. It is the largest delta in the world, located in the eastern India and Bangladesh. The lower Gangetic plain with mangrove forests, flora, fauna and small islands is a complex area with cities and villages including a megacity Kolkata (Calcutta). It is a vulnerable area for cyclone, flooding during monsoon and due to tidal waves, upstream pollution, erosion and sedimentation. The urbnisation and manmade activities have filled up marshes, canals and waterbodies in haphazard fashion and many wetlands are scattered mostly delinked with river system. It is said that wetlands originated largely from the interdistributory marshes created by shifting of the major rivers during the last few centuries. This has changed ecology also. The wetlands in east Kolkata lie between the levee of the river Hooghly and river Bidyadhari, now defunct, decleared dead in 1928. As the tidal flow of water stopped in the low lying marshy land and sewage fed waste water from city was used for fish farming in the remaining wetlands. Kolkata has been built on water bodies and marshy land which, were spread upto 5-6 km on the east from the river.

These wetlands serve a number of functions (a) Drainage outfall/water storage basins especially during the monsoon (b) Aquaculture with fishery providing food, nutrition and employment (c) Recycling of wastewater and water in wetlands for irrigating urban agriculture. Providing a blue and green buffer between the rural and urban areas (d) Improvement of environment and production of oxygen (f) Providng biotic environment for flora and fauna in wetland.

2. Wetland Regulation and Management

Wetlands are generally low lands with shallow water. The Ramsar Convention, 1971 defines wetlands as "areas of marses, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water the depth of which at lowtide does not exceed six meters".

Wetland which is multifunctional resource is difficult to manage because of several factors affecting these which include filling up due to the pressure of urban development, sedimentation from upstream where it has connection with canals and rivers, flooding, pollution and contamination, putting new species of plants and fishes, pumping water for irrigation etc. and excessive shedding by trees with less exposure to sunlight.

Many countries have enacted legislation to prevent pollution, filling up etc. But regulation and management have not been adopted in many wetlands in Asian countries, though first written account of pond management was by a Chinese fish farmer Fan Lai, in 475 B.C. There are several controls : (McComas, 2003).

(a) Weeds and plants including submerged plants.
(b) Algae which are harmful, mosquitoes etc.
(c) Biological control – aquatic plants and fishes
(d) Wastewater treatment technology
(e) Shoreline protection, sediment control, small dredging etc.
(f) Vegetation control in the surrounding.

The operation and maintenance (O & M) module of integrated wetland system projects include the following components. (USAID, 1995)

(1) maintenance of the levels of water in the pretreatment and recycling ponds.
(2) wastewater pressure mains.
(3) release of system effluent to the best satisfaction of the downstream users.
(4) appropriate recruitment and harvesting schedule for recycling ponds adjusted to the condition of wastewater loading.
(5) maintenance of structures, appurtenances and equipments.
(6) periodic desilting of pond beds.
(7) maintenance of conditions and peripheral drains.
(8) maintenance of dykes and dyke gardens
(9) evaluation and monitoring of user region ecosystems
(10) reducing risk through an early working system.

Establishing mitigation objectives require well defined goals, and identifying all mandatory requirements. In USA in the State of California there is legal provision in this regard. Mitigation goals of wetlands may include : (Cylinder et al, 1995).

- Enhance, create or restore wildlife and fishes habitat
- Protect water quality
- Provide flood protection
- Stabilize shorelines
- Facilitate ground water recharge
- Maintain flow
- Protect socio economic value – recreation aspects etc.

The Figure I describes the restoration of wetland process.

The paper mainly deals with Kolkata wetlands which are natural wetland. Many constructed wetlands – pond or tank systems are also used for aquaculture. Some wetlands which have defunct are being restored for ecological design. The following parameters are to be considered for wetland design (Mulligan, 2002) :

(1) pretreatment used (2) siting of the wetland (3) wetland area, aspect ratio, slope, porosity and substrata (4) type and flow of wastewater and hydraulic conductivity (5) Hydraulic loading rate (6) nominal retention time (7) inlet and outlet BOD etc (8) bacteria (9) design of inlets and outlets (10) types of plants used (11) operation and maintenance requirements (12) monitoring requirements (13) performance of the system (percent removal of contaminants) (14) temperature, rainfall, and other environmental influences (15) capital, operating, and maintenance costs and (16) problems encountered during operation (i.e. mosquitos, etc.) and their solutions.

3. Case Studies

(a) East Kolkata Wetlands

Recycling and reuse of waste water is practiced throughout the world. East Kolkata has the largest recycing district in the world with 12000ha area but encroachment and unsustainable pattern of development are widespreed despite protective regulations. Previously the wetland area itself was 10,000 ha but now 2500 ha and fish production has fallen from 30,000 to 15000 tons annually. These wetlands consist of lagoon type natural ponds, 254 in numbers, owned by individual owners which are managed by fishermen. The objectives of Kolkata case study presentation is to focus attention on the indigenous system of waste water treatment and reuse after recycling for potential benefits with people's own management (Ghosh S, 2001). Kolkata municipal system generates about 750 million litres of waste water daily and 2500 mt of solid waste (garbage) is disposed on the east Kolkata. After separating the papers, plastics and metals, the waste is naturally composted. The natural compost is used in the production of good quality of vegetables on 300 ha area (150 mt/day). No fertiliser is added and sometimes the nutrient rich sewage fed waste water or sludge is used. About 800 persons have some sort of proper proprietory rights and 8000 workers, are directly employed, while employment of another 8000 workers is generated indirectly (Giri, 1995). In 1974 Kolkata Municipal Corporation acquired 'one square mile' area in the eastern fringe of Kolkata for dumping of refuse and there was municipal railway system to carry city wastes. The marshy areas were filled up with waste in long strips, intercepted with water bodies and the filled up land were leased to the cultivators for vegetable production while water bodies were leased to the fishermen for fish production. The railway line does not function any more and the mechanical treatment system has become obsolute. Now the trucks engaged by the municipalities dump the solid waste near the agriculture fields which are decomposed and mixed with soil. Solid waste is also dumped at one entry point where street children and women separate many items and the rest is decomposed to become natural compost. The waste water from sewage fed channels which pass through the cultivation for fisheries is used in fields also. In 1985 All India Institute of Public Health and Hygiene calculated the average value of recovery from solid waste which was quite high and in present time with US $1 = 45.00 it might be US $ 50,000 per day (Sen, 1995).

The sewagefed fisheries of east Kolkata in practice since 1930 constitute essentially a stage of sewage treatment system in anaerobic facultative maturation pond combination. This method of sewage treatment is not only cost effective but requires relatively less amount of area. There is more ecological considerations. The ecosystem can be studied as follows (USAID, 1995) :

(a) Functioning of recycling pond as a solar reactor where solar energy is trapped as chemical energy in the aquatic micro and meso flora by the process of photosynthesis.
(b) Algae bacteria symbiosis : The algae in the shallow waste water pond – ecosystem has two major utilities. It is the food for some fish species and is a source of oxygen in the aquatic habitat.
(c) Oxygen transaction : Aquatic ecosystem is rich in plankton and algae which also contains supersaturated dissolved oxygen. Such oxygen escapes partly to environment.

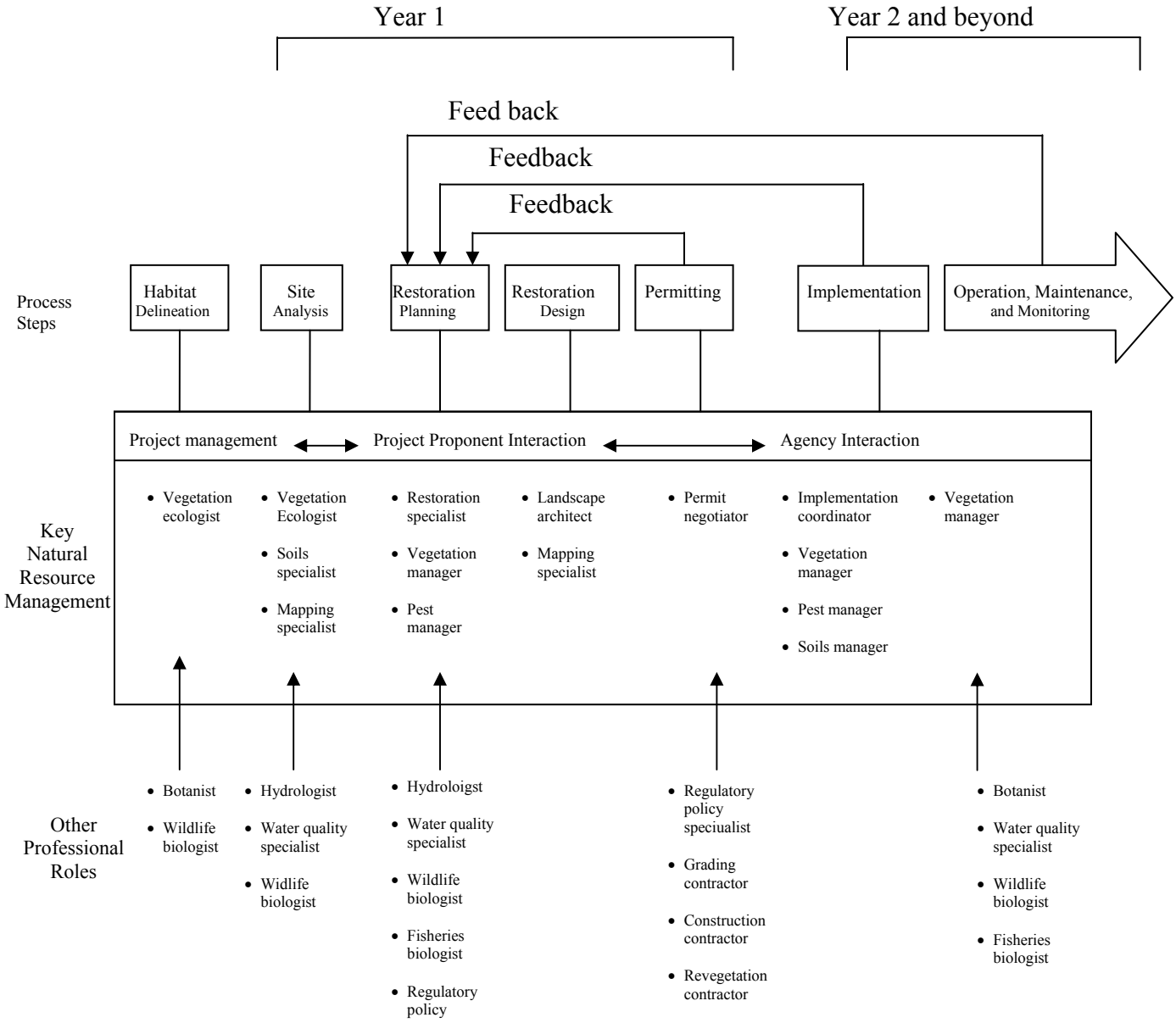

Figure I : Recommended restoration project process (Source : Cylinder et al, 1995)

The pond unit each of lagoon type (between 7-10 ha in size) to facilitate natural aeration through wind action of shallow depth 1.0 – 1.5 mm allow sufficient sunlight to reach upto its bottom to promote growth of algae and photosynthetic oxygen, the pond is fitted usually with two sluice boxes as inlet and outlet points for periodical sewage fed, exchange from the city's drainage outflow channels and canals. The high productivity of these sewage fed fish ponds is mainly due to rich nutrient element contents in waste water like nitrogen (25-40 mg/l), phosphorous, potassium and the high alkanity stimulate production of phytoplankton plant based micro organism, a primary production in the fish food chain. Using aquatic plant like water hyacinth (*Eichhorria crassipes*) and duckweed (*lamnaceae*) some metals are removed and water is purified. There are several parameters worth mentioning. It generates abundant quality of algael photosynthetic oxygen at the assured rate of 1 gm algae synthesized to produce about 25 gm of oxygen and thus dissolved oxygen level is found to be 0 mg/l at the inlet point to 16-20 mg/l at the outlet zone. The biochemical oxygen demand

(BOD), a critical parameter of waste water quality is 150-180 mg/l at the inlet to about 15-32 mg/l at the outlet.

The silt in the wetland system, called 'detritus' offers an ideal niche for a complex chain of micro organism to act and decomposes thereby providing habitat to primary consumers (invertebrates) and secondary consumers (fishes and birds). A study by Zoological Survey of India with biotic component of wetland was assessed on the pre-reclamation of Saltlake township when 22 species of mammals and 248 species of birds were found (Ghosh A, 1991).

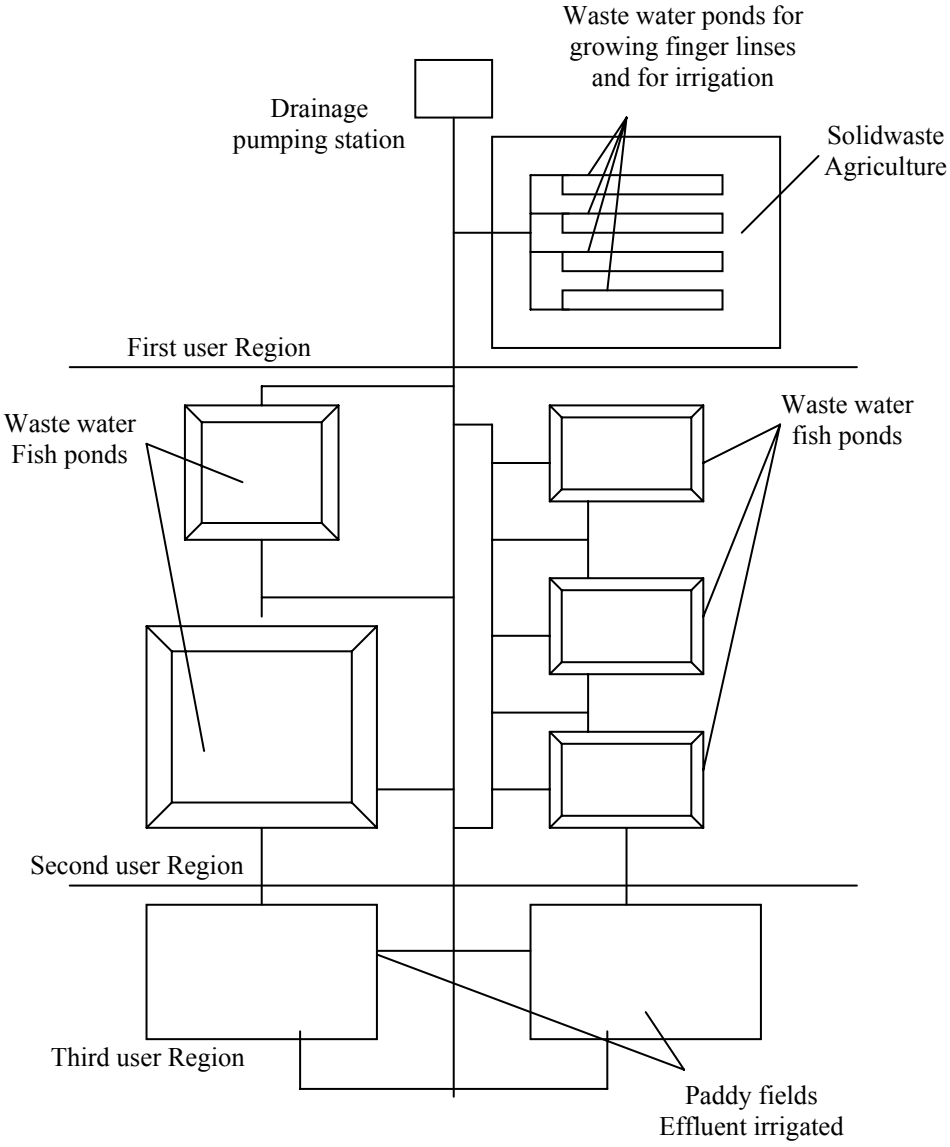

Figure II: Successive Utilisation of Wastewater in Kolkata Wetlands (Source : USAID, 1995)

A recycling zone of 12500 ha has been declared by the Govt. of West Bengal which is divided into 11 zones, mainly consisting of water, agriculture, rural and urban settlements and productive farming the landuse is water bodies 5852 ha (about 3899 ha used for fish farming), agriculture has 4960 ha, gerbage farming 603 ha, rural settlement 1235ha, urban settlement 81.5ha, (total 12500 ha.) (Kundu et al. 2005).

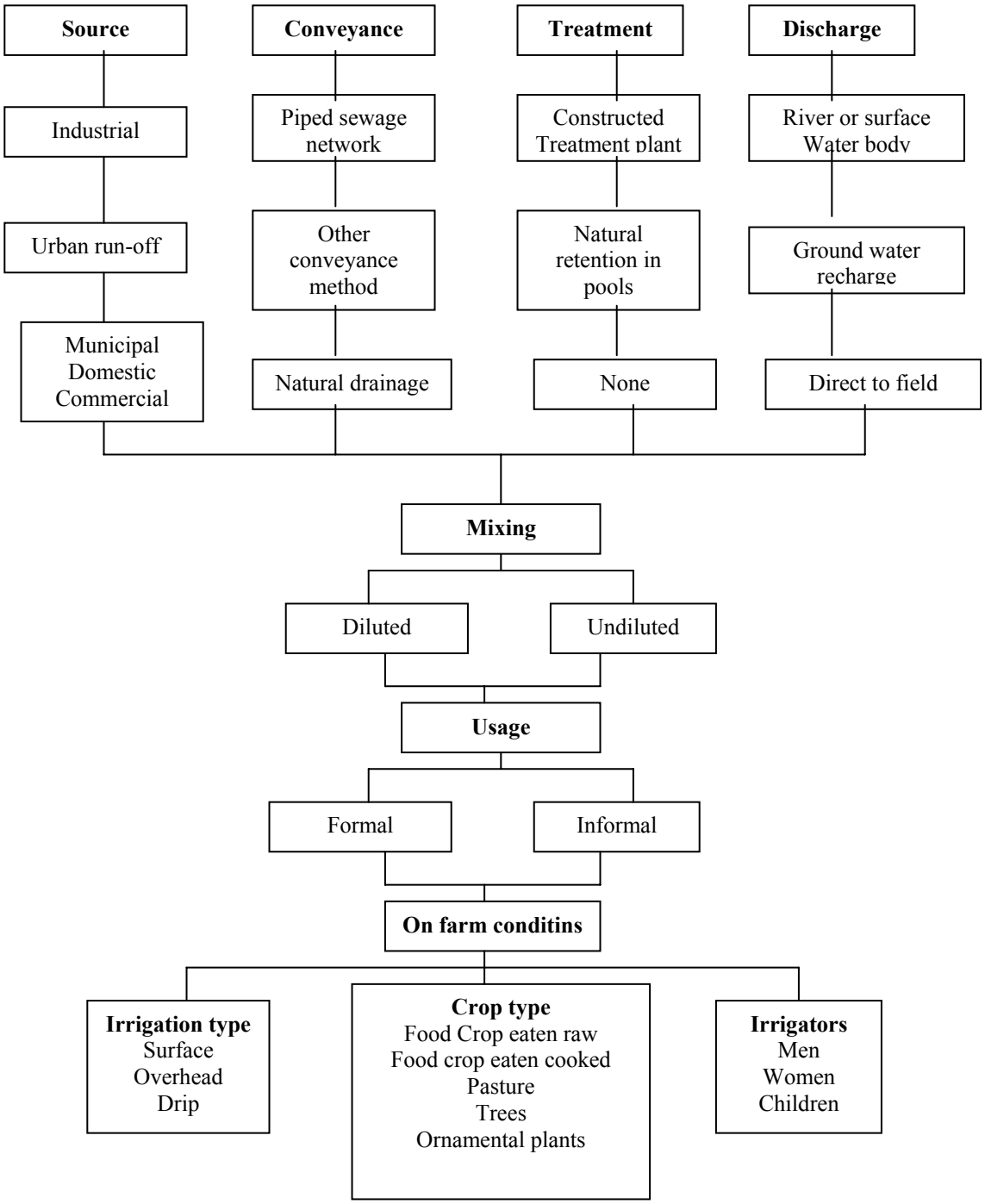

Figure III Typology of wastewater irrigation (Source : Buechlar, 2002)

(b) Mudialy Wetlands Ecosystem

In Southeast Kolkata a fishermen's cooperative has taken lease of 15 ponds, 50 ha in area from Kolkata Port Trust where 25 million liters of sewage fed waste water is treated to the same indigenous process. The area has been declared as Nature Park microflora, birds, etc. this becomes on education for children also. The

management of the wetland is done by Mudialy Fishermen Cooperative Society (MFCS) without any external help.

There are 15 ponds of various sizes of these of smaller ponds are used for improving the water quality before it enters the bigger ponds where fishes grow. In a survey conducted in 1990 on water quality at this site, Removal of BOD and coliform is influent water 77.00 and 15.00 and coliform 46000 to 0.91 (USAID, 1995).

(c) Titagarh – Bandipur Resource Recovery Project

The recycling of waste water for aquaculture in wetlands in other municipal discharge areas and its coordination with irrigation and agriculture is being advocated. Such project will stakeholder participation fishermen, farmers, state and municipal governments and village is known as Community Based Wetland Ecosystem, (CBWE) first introduced in 1995 in Titagarh, a northrn municipality within Kolkata Metropolitan Area, This is also known as Integrated Resource Recovery project. Titagarh, industrial town has an old sewage treatment plant (STP) with a capacity to treat 9.08 million litres of sewage/day (mild) a new stabilisation tank system has been built at Bandipur, in adjacent rural area with a capacity of 14.10 mld. The system at Bandipur which includes waste water treatment and reuse for aquaculture is termed as the resource efficient stabilisation tank system. The integrated complex is leased out to 110 farmers and about 3000 tons of vegetables are produced. About 800 people are engaged. Fish yield is 7 towns per ha per year. The stabilisation tanks are rented out to local fish farmers.

The requirement for sewage is brackishwater aquaculture both quantitative and qualitative is to be assessed before a comprehensive planing of resource recovery incorporating wastewater fed fishponds and the brackish water for agriculture (Ghosh D, 1988) communities.

4. Wetlands Livelihood Options

The wetlands with productive ecosystem can provide food mostly in developing countries. More and more cities in India, China, Vietnam, Bangladesh and other countries are practicing aquaculture for production of fishes and edible aquatic plants are using wetland water and sludge for vegetable production in nearby or surrounding areas. Stephanie Buchler et al (Buechler, 2002) of IWMI advocates developing typologies of waste water use for the purpose of standardizing categories. there are also health related aspects. Figure III provides a chert. Wetlands have high potential for food production.

A conference in Hyderabad, India in Nov, 2002 recommended :

“Safeguard and strengthen livelihoods and food security, mitigate health and environmental risks and conserve water resources by confronting the realities of wastewater use in agriculture, through the adoption of appropriate policies and the commitment of financial resources for policy implementation”.

It is estimated that about 2.4 million people in Bengal (India part) are presently dependent on wetland products for their subsistence (Ghosh, Dr. S, 2004). There are more than 380 wetland plants and more than 44 species are important as food and vegetables. Traditional commercial practices include indigenous building materials, aquatic plant for ornamental handicraft, mats, nuts water chestnut, lotus, aquarium plant, supplementary vegetables are medicinal herbs.

5. Integrated planning

Wetland should be part of overall water resources planning. Impact of climate change, urban development and other aspects need to be studied. Ecohydrology becomes important as it is an integration of ecology and hydrology the application of ecohydrology concept for improvement of quality environment and water resources results socio economic facilities also. (UNEP 2002) FMS and wetlands are to be treated on the principles conservation, environment and development of wetlands are considered as biosphere role the UNESCO’s zoning pattern may be used core area, inner buffer zone and outer buffer zone subsequently

called core area, buffer zone and transition zone. It is also recommended for a plan on the basis of all focus subsystems of waste reuse in wetlands in Kolkata case, - vegetable cultivation, wastewater fed freshwater aquaculture, fishpond effluent utilisation in rice cultivation and sewage fed brackish water aquaculture (Ghosh, D, 1988).

The planning for wetlands cannot be in isolation, the while region containing these wetlands is to be and the framework of regional environmental plan. Many Asian cities are producing food and fishes in the periphery through urban agriculture and aquaculture. This is providing a buffer a blue and green belt between the urban and rural areas and enhancing ecological objectives.

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