Article

Ecosystem and Livelihood Support: The Story of East Kolkata Wetlands

生态系统与生计支撑：东加尔各答湿地的故事

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Abstract

The wetlands in the eastern fringe of Kolkata, popularly known as the East Kolkata Wetlands (EKW), work as an absorber of sewage water and excess rainwater runoff from the city. The local people are utilizing this waste water in pisciculture through adoption of a number of traditionally inherited practices. Moreover, pond effluent based paddy cultivation and garbage based vegetable farming are integrated with fishery in the ways that make the production processes complementary to each other. However, since the development of Salt Lake City and the construction of Eastern Metropolitan Bypass, the connectivity of EKW with the main city has improved and pressures of urbanization are leading to the conversion of wetlands into urban settlements. This is disturbing the ecological balance, as well as making traditional economic activities less profitable. This article illustrates this crisis of existence and critically assesses the remedial attempts.

位于加尔各答东部边缘的湿地，被普遍称为东加尔各答湿地 (East Kolkata Wetlands, EKW)，它被用于吸收从城市排出的污水和过剩的雨水径流。通过采用一些传统的承袭下来的做法，当地群众利用这些废水养鱼。此外，基于池塘污水的水稻栽培以及基于垃圾的蔬菜种植和渔业集成在一起，集成方式使生产流程相辅相成。然而，由于盐湖城的开发和东部大都市区公路的建设，东加尔各答湿地和主城的连通性得到了改善，同时城市化的压力导致湿地转变成城市居住区。这扰乱了生态平衡，也使传统的经济活动利润降低。本文说明了这种危机的存在，并批判性的评估了补救措施。

Keywords

Wetland ecosystem, traditional knowledge, fisheries, livelihood, land use

Introduction

The natural gradient of Kolkata Metropolitan City is towards South East. The wetlands in the Eastern fringe of the city, popularly known as the East Kolkata Wetlands (EKW), are working as an absorber of sewage water and excess rainwater runoff from the city (Figure 1). The local people are utilizing this waste water in pisciculture through adoption of a number of wise-use practices. Moreover, pond effluent based paddy cultivation and garbage based vegetable farming are integrated with fishery in a way making their production processes complementary to each other. The close interaction with nature creates a

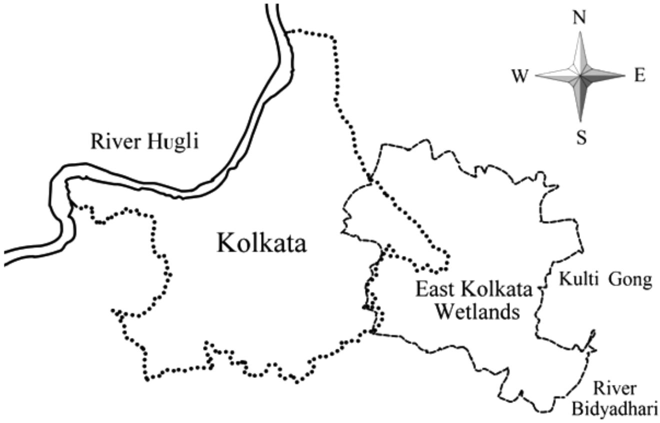

Figure 1. Location Map of East Kolkata Wetlands

Source: Google map.

number of vocations which are inter-temporally viable as well as socially and economically sustainable. Because of these wise-use practices EKW is a designated Ramsar site since 2002.

However, since the development of Salt Lake City and the construction of Eastern Metropolitan Bypass, the connectivity of EKW with the main city has improved and the pressure of urbanization is leading to conversion of wetlands into urban settlements (Dey and Banerjee, 2013). This practice is disturbing the age-old eco-balance and the ecosystem-based livelihood making the sewage-water pisciculture less profitable. To protect the ecosystem-based livelihood a number of public interest litigations have been initiated by the civil society and as a consequence, conversion of wetland into any other alternative form of land use has been legally barred. In this backdrop, this article will discuss the emergence of traditional skill based livelihood practices in the second section, the detailed application of traditional knowledge is discussed in the third section, the fourth section is about pattern of land use change induced by population pressure and urbanization and the remedial measures undertaken The final and fifth section will present an overall assessment.

Ecosystem based Livelihood and the East Kolkata Wetlands

The East Kolkata wetlands are situated at the Eastern edge of the city of Kolkata spread over 32 mouzas with total 11,085 water bodies covering about 12,500 hectares (approx.) and is the largest of its type in the world (Ghosh, 1999). It has a hot and humid monsoon climate (Aich and Kundu, 2010). A complex system of photosynthesis acts as a key agent in cleaning the sewage and making it convenient and rich in nutrients for fishery purpose.

It was found that a restricted volume of sewage discharge into the lake was favourable to fresh-water fish culture. Since late 1920s, attempts were made to cultivate fresh-water fishes like *Carps* in the lakes with a small quantity of sewage waste used as food. In 1929, a land-owner, B.B. Sarkar, discovered that the output of *Carp* cultivation could be raised manifold by letting in small doses of sewage into the swampy area (Chattopadhyay, 1990). Within a short time, the whole area was converted into a freshwater aquaculture system.[1] Here the total time needed for rearing an egg into a carp of 1–1.5 kilogram size takes almost eight to nine months whereas to generate a comparable yield the time needed in any conventional pond would be more than a year and a half where the sequences are carried out vertically and not horizontally. In a vertical arrangement the sunshine cannot play the magical role that it could play in a horizontal sequence through rapid conversion of waste into fish feed and making the water cleaner as well as rich in nutrients. Solar radiation being adequate for photosynthesis and sewage fed ponds as solar reactors tap the solar energy in dense plankton population which is consumed by fish. However, overgrowth of these creates problem in managing ponds. Fishes act as *ecological manipulators* by keeping the population of planktons under control (Figures 2 and 3).

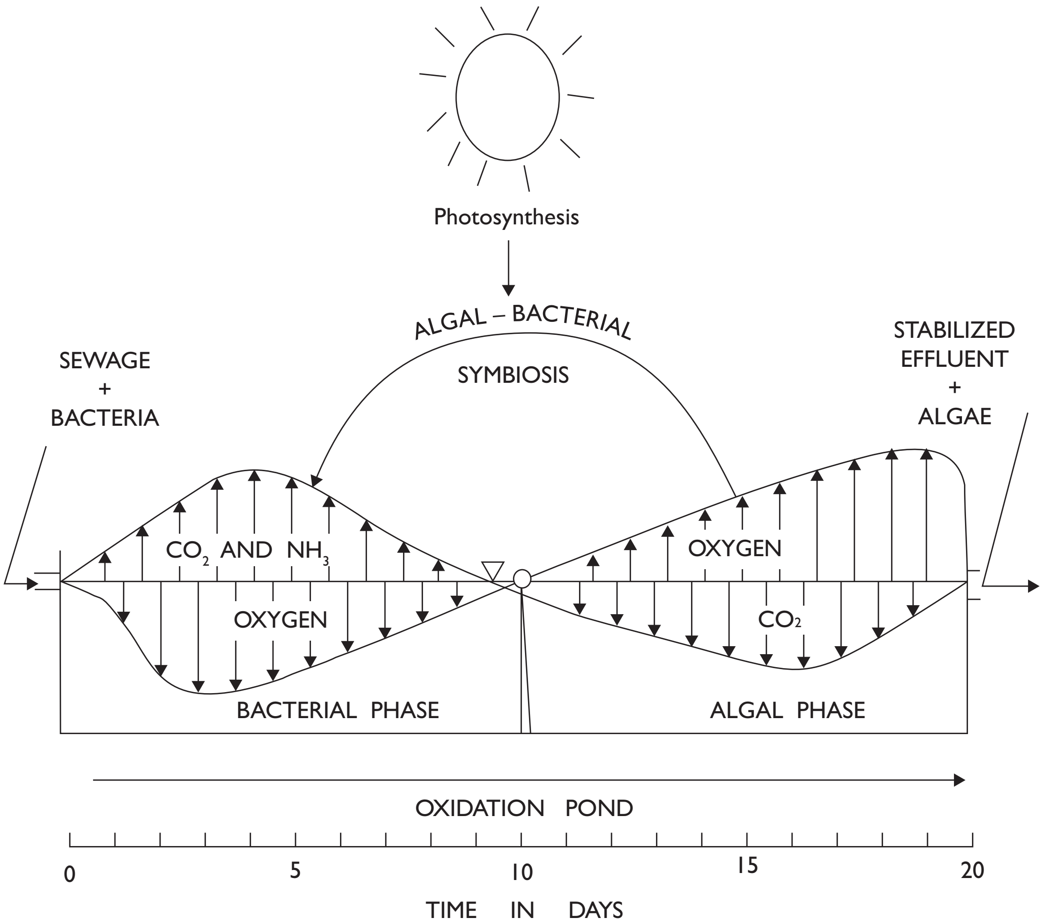

Figure 2. Algae Bacteria Symbiosis

Source: Oswald et al. 1953.

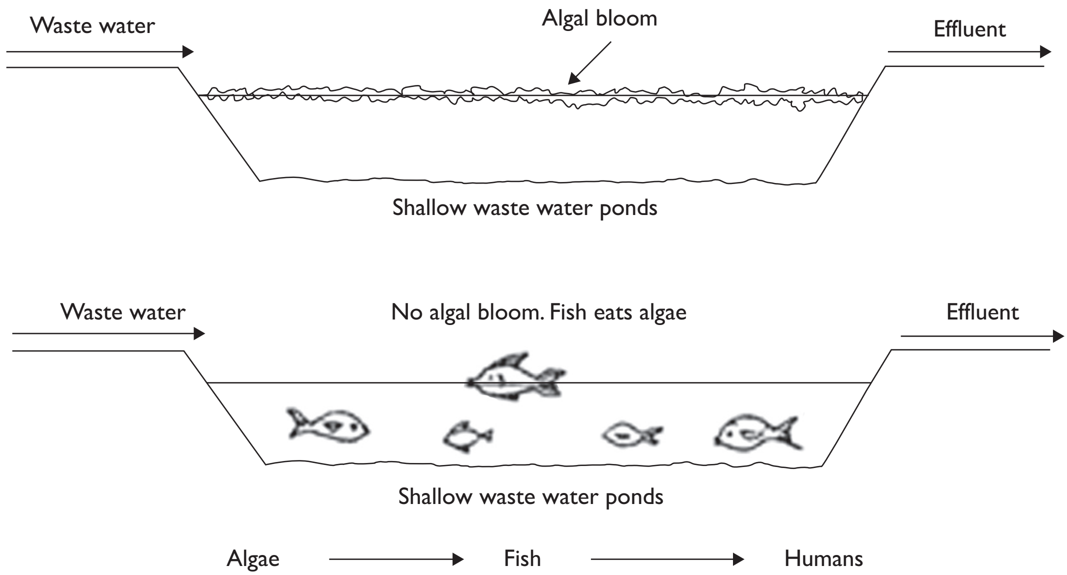

Figure 3. Fish as an Ecological Manipulator
Source: Ghosh (2005).

Traditional Knowledge, Wise-use Practices and Livelihood

When the sewage arrives in the pond network, it is kept standing in the sun, which results in biodegradation of the wastes through an algae-bacteria symbiosis. The local people have searched out this process right. They know exactly how to excavate the ponds to the correct depth, clean the water by spraying kerosene, lime and *khol*, mix the right quantity of sewage, allow optimal time for conversion of the waste into fish feed, when to add spawns, how to protect the embankments through water hyacinths and so on.

Pond Prepration: The pond preparation begins with draining out water through locally made sluice gates or by pumping out the water into the canals. The bottom surface is allowed to be dried up completely. If there is an excess sludge, then the land has to be dug up to a depth of 8–9 inches and brought on top to dry. This thorough drying is important to eliminate the possibility of any foul smell retained in the fish. The sides are generally dug down deeper and the middle of the pond remains shallow. Another channel about 6–8 inches deep inside the pond bed is excavated leaving a gap of few feet from the bank of the *bheri* (Figure 4). Raw sewage is now allowed to enter the pond and *Mahua khol* (grounded oil cakes) is applied to the pond bed. The colour of water mixed with *khol* turns black and muddy, and subsequently Calcium Carbonate ($CaCO_3$) or *Chun* is applied to filter the water to give it a crystal clear appearance. The remaining dirt particles settle down at the bottom of the pond. After four to six days, the water is mixed up a number of times using *Moi*.[2] The remaining solid waste in water gets deposited in the 6–8 inch deep channel cut at the time of pond preparation. The preparedness of pond water for receiving fish spawns are judged by examining its colour, smell and taste. A small amount of fish spawns are

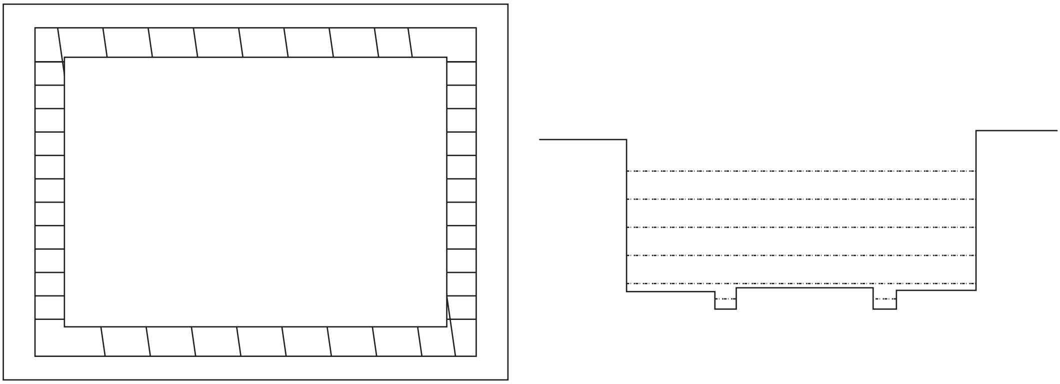

Figure 4. 6–8 Inch deep Channel Excavated in Pond Bed

Source: Authors.

put into pond water and after suitable interval water is collected in a transparent glass bowl to check condition of those spawns. If the spawns are found surviving well, the water is considered to be ready.[3]

Protection of pond banks: It is ensured in a unique way. Bamboo/*Goran* poles are fixed at a distance of 4 metre from the pond bank, tied with one another by GI[4] wires (Figure 5). A 3–4 metre wide band of Water hyacinth (collected from the freshwater ponds) is placed between pond bank and the wire. These plants work as natural buffer to save it from the waves. Moreover, water hyacinths act as good shelter for fishes from the scorching heat in summer days and the roots work as excellent absorbent of solid waste present in sewage They also serve as good breeding ground for common carp and *Tilapia*[5] or *Nilo tica*[6] and sometimes these are used as food by fishes (Ghosh, 2005).

The sequence of process of fish production has been shown in Figure 6. The whole process of pond preparation is repeated once in every year for Egg and Nursery ponds. But once the pond is prepared it can be used at least three to four times for breeding, rearing and stocking. Once spawn or fish is transferred to the next set of *bheris*, some tiny insects[7] grow in water which are harmful for fish spawns. A small amount of kerosene[8] mixed with Gamaxin powder is poured on water to solve the problem. It creates a thin layer of oil on the top of the water and blocks oxygen supply. The insects can no longer survive without oxygen and the remnants are cleaned with mosquito nets. The layer of kerosene evaporates within a day and thus water gets prepared once again for the next stage of production.

Generally, in the case of hatcheries and Nursery ponds, the whole process is repeated every year as these are more vulnerable to any kind of pollutant. For the rest, it is repeated after every three or five years or, as and when required. High opportunity cost of postponing cultivation for a year or so compels the fishermen to repeat the process for larger *bheris* at greater intervals ranging from 8–12 years or more. Nevertheless, the application of *Mahua Khol* and *Chun,* mixing of water using *Moi* etc. are regular affairs.

After procurement of eggs[9] from hatcheries, they are put in the nursery pond[10] initially, from there sequentially shifted to the rearing pond,[11] stocking pond[12] and finally to the harvesting pond.[13] The right time of transferring fishes from the lower to the higher stage is decided on the basis of long standing practices and traditional wisdom which is mostly related to the size of the fish and its rate of growth (see Table 1). In the larger *bheris*, fish feed like grounded oilcakes (Mahua or Mustard) are applied inside a

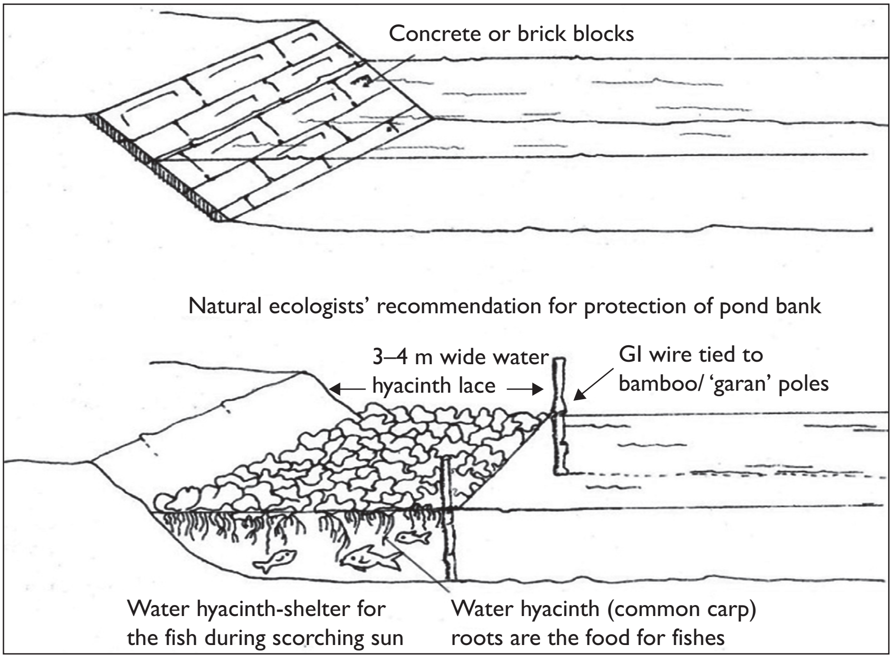

Figure 5. Embankment using Water Hyacinth

Source: Ghosh (2005).

1. Draining out water by Motor Pump from '*Bheri*'
2. Drying up pond bed
3. Ploughing up pond bed
4. A channel of 6 to 8 inch deep excavated border-wise leaving a gap of a few feet from the bank
5. Sewage allowed into the pond
6. Application and mixing of '*Mahua Khol*'
7. Application and mixing of '*Chun*' or Calcium Carbonate
8. Mixing water using '*Moi*'
9. After few days, embankments using water hyacinth is attached

Figure 6. Stages of Pond Preparation

Source: Authors.

Table 1. The Process of Fish Production in EKW through Pond-sequencing

Pond Type	Stage of Production for IMC (Indian Major Carp)	Stage of Production for Common Carps	Specific names size (size wise)	Time required to keep before transferring	Inlet information (Average)				Number of the pond ideally required	Size of the pond ideally required
					Count	Average weight	Average Size	Rate of Increase		
Hatchery Pond		1								1–2 *bigha*
Nursery Pond	1	2	Fish Spawn (aged 2–3 day)	15–16 days (not exceeding 20 days)	50,000 spawns per bowl (100 gm per bowl)	0.002 gram per piece	Not visible properly		1 (10 bowl egg is applied in this size pond)	1–2 *bigha*
Rearing Pond	2	3	*Dhani-pona* (20 days old)		30,000–50,000 per kilogram	0.02–0.03 gram per piece	2–3 mm	10 times	1	4–6 *bigha*
Stocking Pond [stage I]	3	4	Early Fry		250–300 per kilogram	3.5–4 gram per piece	2.5–3 cm	150 times of *dhani pona*	2	10–20 *bigha*
Stocking Pond [stage II]	4	5	Finger-lings		100 –150 per kilogram	7–10 gram per piece	5–6 cm	2 times of early fry	3	60 *bigha*
Harvesting Pond	5	6	*Chara-pona*		25–30 per kilogram	35–40 gram per piece	12–13 cm	4 times of finger-lings	1 or 2	Large pond
Final Catch	6	7	*Pona*	After 4–5 months after applying spawns	8–10 per kilogram (in 4 months)	100–150 gram (4 months) 1–1.5 kilogram (8–9 months)	15–16 cm	3 times of *chara pona*	1 hectare = 7.41 *bigha*	

Source: Authors.

triangular frame made of bamboo where it works like a sieve allowing only smaller fishes to enter and access the food and prohibit larger fishes from eating up all the stuff (Figure 7).

The regular mixing of sewage water with the pre-existing pond water requires the draining of excess water from these fish ponds. This excess water is used for irrigation in the adjacent agricultural fields. Again when the waste residues and accumulated water are discharged from the ponds to prepare the pond bed for another breeding-rearing cycle, the sludge is used as fertilizer for vegetable farming. In dry season these shallow watery and marshy lands are utilized for paddy cultivation. Thus, fishery and agricultural activities have become complementary processes (Figure 8). The uniqueness of this ecosystem lies in the fact that the sewage, otherwise considered as waste is being used as an input by the fishermen. Besides natural water treatment services, EKW is providing the city of Kolkata food, shelter and livelihood for a large section of population.

It seems that the *waste* is being used as a *resource* which gets transformed into the consumable food products through both visible and invisible processes embedded in the system. The visible parts come with garbage farming and fishing activities whereas the invisible part lies within the very process of Algae-Bacteria symbiosis, which transforms waste into nutrients. The two ecosystems namely city of

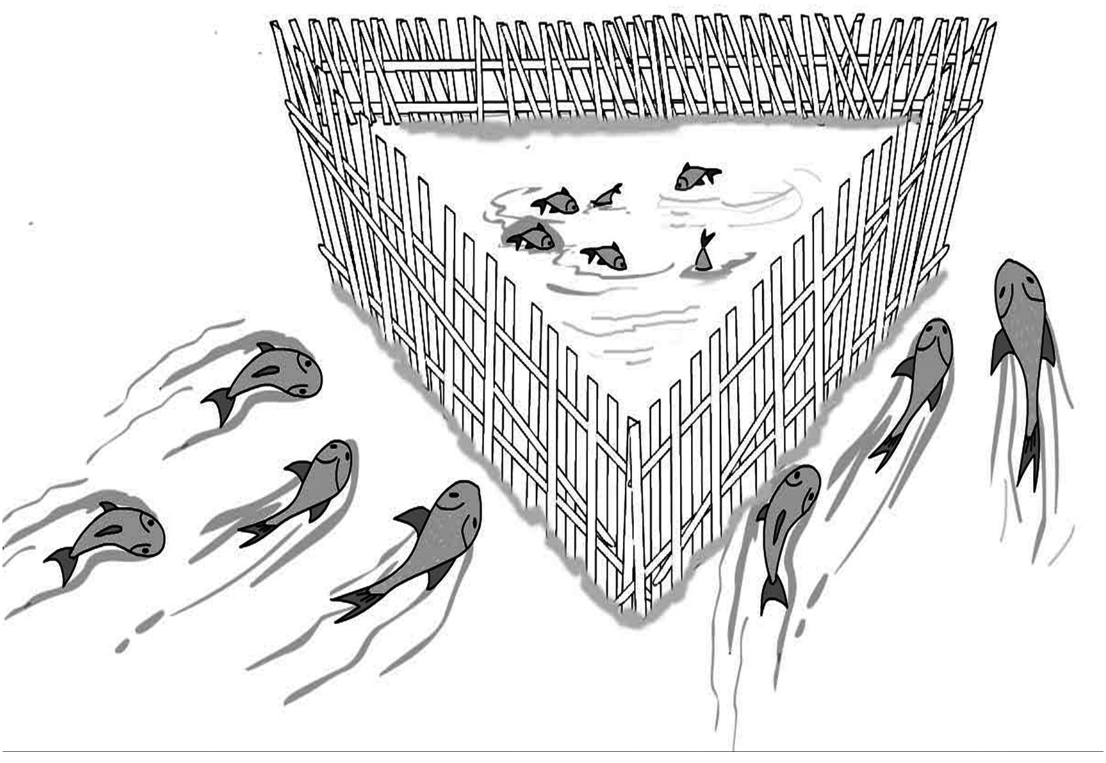

Figure 7. Bamboo Frame for Nutrient Sharing as per Requirement
Source: Authors.

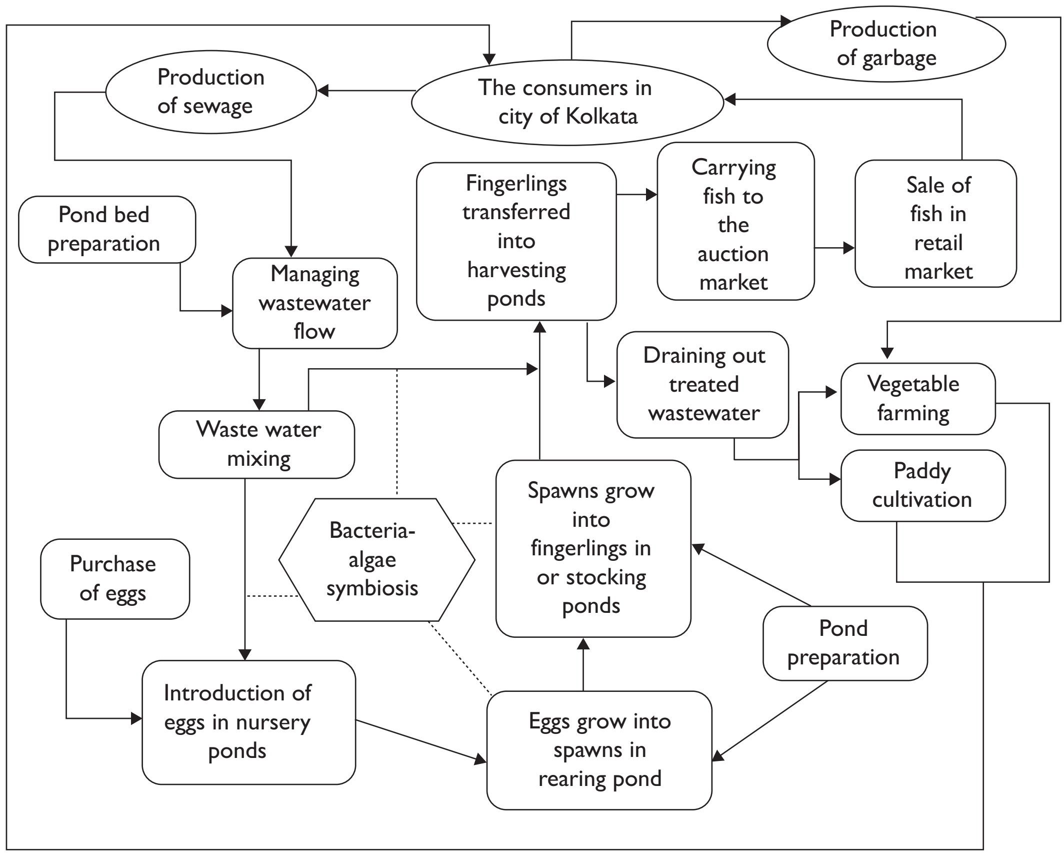

Figure 8. Complementary Relation between Kolkata and EKW

Source: Authors.

Kolkata and EKW is complementary in nature (Figure 6) and the major livelihood in this area centres around fishery and garbage farming along with the other associated vocations.

The Change in Land Use Pattern

East Kolkata Wetlands are spread over 32 mouzas (villages) with more than 11,000 water bodies covering nearly 36 per cent of this area. It has been frequently alleged that in the face of a growing pressure of spillover population from the city of Kolkata the marshy wetlands are continually getting converted into urban land, challenging sustainability of the traditional wetland practices. However, given the bureaucratic inertia, there is no up-to-date reliable land record is available anywhere. So, a project has been commissioned under the Rajiv Gandhi Chair of the University of Calcutta in 2010 and PAN Network has prepared the present land use map by applying GIS technique. This project documented existing land use pattern and by comparing it with the previously available land use map of 1,990 identified major changes. Wide range of variations is observed in terms of number, average size and area coverage of water bodies (*bheries*) across mouzas. The number varies between 1,155 to 21, the size varies between 0.06 hectare to 1.56 hectare and the area-coverage between 3 per cent to 77 per cent. According to Census 2001, the population density also varies between 3,203 per square kilometre and 320 per square kilometre. A negative association is observed between population density and mean size of the *bheris* across mouzas. The mouzas closer to the city of Kolkata are bearing greater population pressure compared to those located far away. Between 2005 and 2011 nearly 10 per cent of land of EKW has been converted from wetland to urban settlement. Improved connectivity via Eastern Metropolitan Bypass and a number of newly built up flyovers are making the adjacent wetland areas easily accessible from the main city and that imposes a real threat to this waste recycling region.

Three types of land use changes in the EKW can be identified: from water body to urban settlement, from agricultural field to urban settlement and from open space to urban settlement. Out of 32 mouzas in all, such changes in favour of urban settlement were noticed in 12 mouzas.[14] To figure out the geographical concentration of such changes, the entire EKW has been divided into a few sub-regions like Eastern, Western, Northern and South-Western. In the Eastern and Northern part no significant change has been observed. The changes are mostly concentrated in the Western and the South-Western parts. Three groups have been denoted as high, moderate and low change regions where in the first one all three types of changes are observed, in the second one two types of changes and in the third only a single change is noted (Figure 9).[15]

The concentration of land use changes in the Western and South-Western part of EKW (adjacent to the city of Kolkata) is obvious from Figure 5. Additionally, it is interesting to note that most of the changes have taken place in mouzas where the average sizes of the water bodies are either small or at the most medium and is definitely below 0.8 hectares. The large *bheries* (water bodies) are still profitable for fish production and no significant urban invasion has been noticed in the Northern and Eastern parts around the large water bodies.

Remedial Attempts

The Calcutta Metropolitan Planning Organization (CMPO) released its basic plan document in 1966, in which it took a very strong position against the eastward expansion of the city (Banerjee, 2012). In spite of that, the Eastern Metropolitan Bypass and Salt Lake City has been constructed on reclaimed wetlands making the core wetland area more accessible and attractive to the real estate speculators. The Institute of Wetland Management and Ecological Design (IWMED) was set up in the early 1980s but it never obtained the statutory powers needed to play the role expected from it.

On 24 September 1992, high court justice Umesh Chandra Banerjee delivered the first major judgement on the matter where it has been recognized that the wetlands are *too precious to be sacrificed for a mere township*. Another landmark is the recognition of the EKW as an International Ramsar site on 19 August 2002.[16] Following this, in the year 2006 East Kolkata Wetlands Conservation and Management Bill was passed and 12,571 hectares of land was brought within the wetland boundary. According to this bill not only any new construction within EKW will be severely penalized but all existing constructions within this area would have to be demolished immediately.

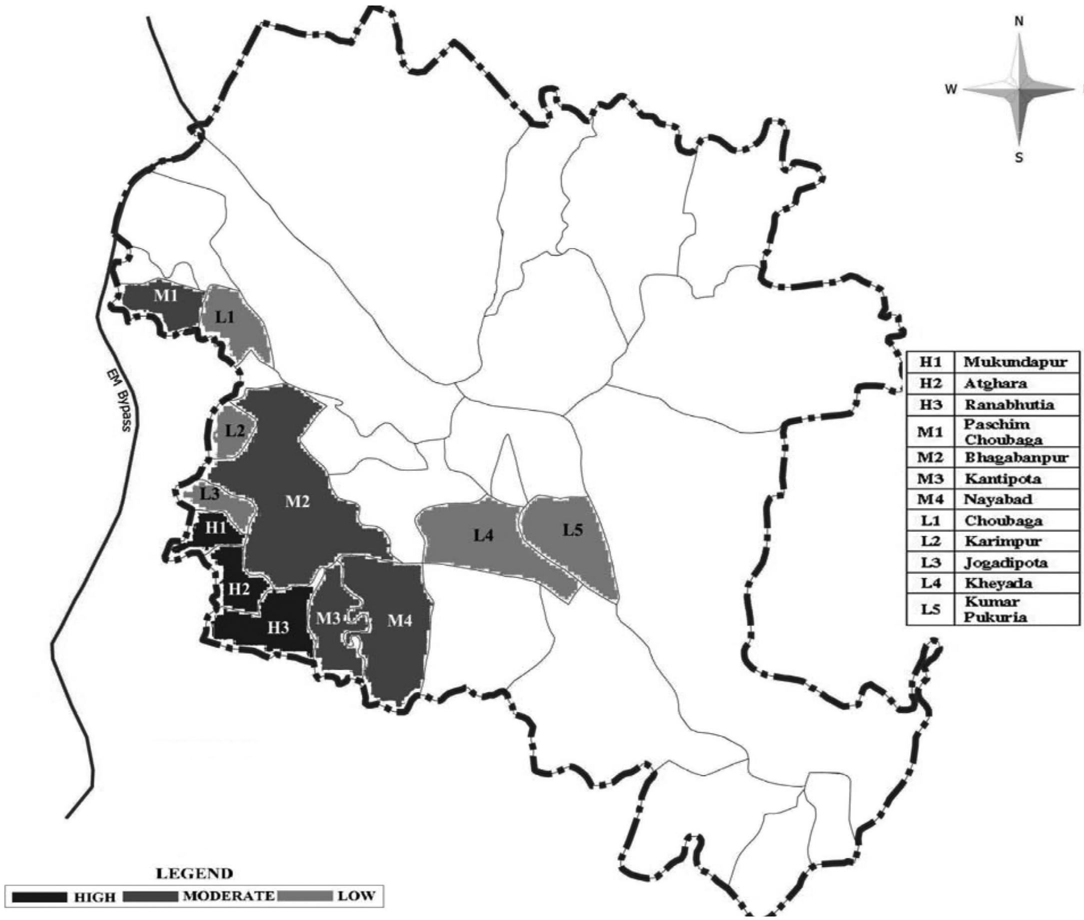

Figure 9. Pattern of Land-use Change in EKW

Source: Dey and Banerjee (2013).

Overall Assessment

Thus, the core wetland area has been legally protected to preserve this unique ecosystem. However, the legal authority failed to understand the strategic role of the buffer area (area between the main city and the wetlands) in protecting the core area. A ring of Regulated Development Zone (RDZ) around No Development Zone (NDZ) would have been helpful for sustenance of the wetland (Chattopadhyay, 2003). In the absence of any such regulatory check the majority of small pond-owners or fish-growers find the secret offers of land transfer financially lucrative enough to accept. The legal disapproval only made the path circuitous and the transactions covert. However, the end results are grossly observable from the recent GIS mapping of the land use pattern.

The foregoing discussion makes us aware of the difficulty of maintaining an ecosystem dependent livelihood in close proximity of aggressively developing urban metropolis. The ecosystem emerged through a number of historical events and provided livelihood to nearly 0.1 million people. However, with the opening up of urban opportunities the local people are not always considering the traditional options lucrative enough and those who are better placed in terms of education and skill are readily joining newer vocations. This is encouraging further urban encroachment and putting the ecosystem dependent livelihood into more severe threat. Resistance from the civil society in the form of a series of Public Interest Litigations (PIL) has compelled some legal intervention into the matter; change of land use pattern within the core area has been legally banned. However, the land use pattern in the buffer area has experienced drastic change over last two decades and the urban topography has changed altogether. This is making it almost impossible for the core area to retain its unique characteristics.

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Notes

1. Though the whole process of sewage stabilization through *Algae-bacteria Symbiosis* was in the domain of traditional knowledge source at least since late 1920s, this unique practice was first documented under formal knowledge source by Ludwig, Oswald and Lynch only in 1951 (Ludwig et al., 1951).
2. A special kind of bamboo sieve aligned vertically on pond bed with weights attached on both sides at the bottom.
3. In formal knowledge plane the test is called 'bio-assay' test.
4. Galvanized Iron.
5. *Tilapia mossambica.*
6. *Tilapia Nilotica.*
7. Locally named as *has-poka*.
8. For one *bigha* of pond area a litre of kerosene is used.
9. For a fish farmer who is rearing eggs of river-bred fish like IMC (Indian Major Carp), the fishermen purchase fish spawns from hatcheries in Bankura, Nadia etc. and in case of Common carp or Golden fish the farmers themselves hatch the eggs in *Hapa* or egg pond.
10. Locally termed as *Antur Pukur*.
11. Locally termed as *Lalon Pukur.*
12. Locally termed as *Palon Pukur.*
13. Locally termed as *Dhaul.*
14. For details, see Dey and Banerjee (2013).
15. It should be noted that the mouzas are not classified in terms of extent of change but only the types of changes.
16. According to the Ramsar Information Sheet, the EKW is one of the rare examples of environmental protection and development management where a complex ecological process has been adopted by the local farmers for mastering the resource recovery activities.

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