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Geovisualization of East Kolkatta Wetl and: A Spatial Resource Infographic

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Abstract: It took long for East Kolkata Wetlands (EKW) to get the recognition as a wetland of national importance and then as a Ramsar Site. It's uniqueness as a waste recycling region, the exceptional indigenous knowledge of local communities gained through decades of experiments and practices, and hard work of the like-minded environmentalists have made this possible. However, instead of the significance and recognition of this protected site, this region is facing threats towards conversion and extinction.The ongoing struggle among various wetland protection groups and authorities over Kolkata's eastern fringes and wetlands is complex and multifaceted. This region interests different groups in different ways , like one group of experts categorically opposes any further development on Kolkata's east; Second group suggests that environmental needs be reconciled with the pressures of urbanization through strictly controlled and implemented planning; while the third group is apparently convinced that the issue of wetlands protection should not be exaggerated and that the city should be allowed to expand. Management of resources of this wetland is therefore very relevant today and the first step towards it is resource appraisal and that is the focus of this paper using geospatial tools including ground survey, remote sensing technology, GPS and Geographic Information System (GIS). The software used in this paper is Arc GIS extensively, however, any geospatial software could be used for geospatial mapping and geovisualisation of the EKW. This paper therefore not only map and visualizes the region , but also describe the 'East Kolkata Wetlands', outlining its various geographical, biophysical and socio-economic aspects including information on climate, hydrological regime, geological and soil conditions, and background on dominant vegetation and fauna of East Kolkata Wetland along with presenting deeper insights to general information on socio-economic character of the study areaand also the role played by different NGOs present in the region. This paper presents deeper spatial insights of the region like an infographic readily to be used by researchers, policy makers and any person who is interested in understanding this important Ramsar Site.

Keywords: Waste Recycling Region, Geovisualisation , physical aspects, socio-economic aspects, Sewage fed bheries, canal networks, NGOs

1.1: Introduction:

It took long for East Kolkata Wetlands to get the recognition as a wetland of national importance and then as a Ramsar Site. It's uniqueness as a waste recycling region, the exceptional indigenous knowledge of local communities gained through decades of experiments and practices, and hard work of the like-minded environmentalists have made this possible. However, instead of the significance and recognition of this protected site, this region is facing threats towards conversion and extinction.

This paper describes the study area 'East Kolkata Wetlands', outlining its geographical, biophysical and socio-economic aspects. The first section describes the physical setting and biodiversity of the study area that includes subsections onlocation explaining geographical layout and administrative divides, followed by general information on climate, hydrological regime, geological and soil conditions, andbackground on dominant vegetation and faunaof East Kolkata Wetland Area. The second section discusses general information on socio-economic character of the study areaincluding demographic, educational, health, drinking water, sanitation, land-use and land-cover, canal network and role of NGOs and thereby present an overview of the physical and social space of EKW Ramsar Site like an infographic,

1.2 Physical Setting and Biodiversity of the Study Area

Location:

The East Kolkata Wetland Areaencompasses an area of 125 sq km., is located along the eastern part of the Kolkata city (10 km away from the city heart) in the state of West Bengal, India.The East Kolkata Wetlands (figure 1) lie approximately between 22°25' to 22°40' latitude North and 88°20' to 88°35' longitude East. The conservation boundary of the resource recycling region is based on a West Bengal State Planning Board Report

of 1985 and subsequently made mandatory by the 1992 ruling of the Calcutta High court for land use conservation within the designated area and later designated as "Wetlands of International Importance" by Ramsar Convention, in 2002. The area comprises of Kolkata Municipal Corporation and the Bidhananagar municipal Corporation (table 1) and the seven Panchayat Areas of Kolkata, North 24 Pargana and South 24 Pargana, namely Bamanghata GP, Beonta I GP, Beonta II GP, Tardaha GP, Kheyadaha I GP, Kheyadaha II GP and Pratapnagar GP. It covers 37 mouza[i] within the police stations of Tiljala, Sonarpur, Kolkata Leather Complex (formerly Bhangor KLC), Purba Jadavpur, South Bidhan Nagar, and Rajarhat.(figure 2).

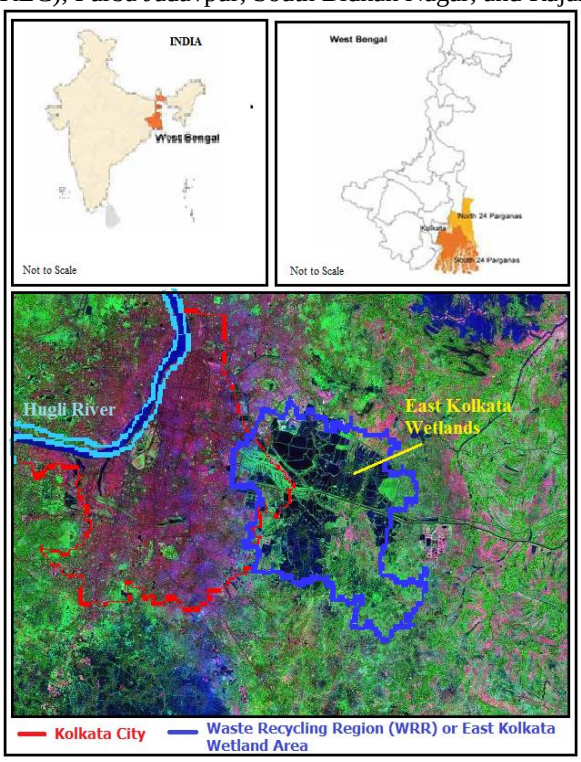

Figure 1: Location map of EKWA

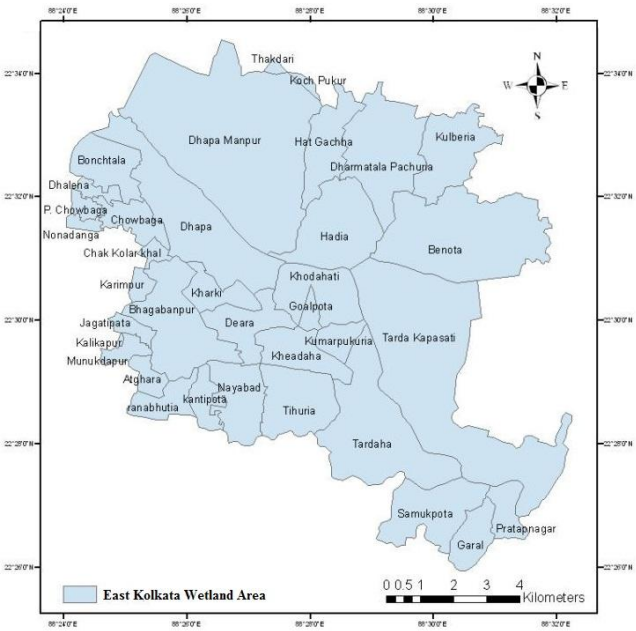

Figure 2: Mouza map of EKWA

[i]A mouza is the lowest revenue collection unit in West Bengal and may include one or more villages.

District	Police Station	*Mouza*
(1)	(2)	(3)
24-Parganas (South)	Tiljola	Dhapa Chowbaga Bonchtala Dhalenda Paschim Chowbaga Nonadanga
	Sonarpur	Chak Kolar Khal Karimpur Jagatipota Mukundapur Atghara Ranabhutia Kantipota Bhagabanpur Kharki Deara Kheadaha Khodahati Goalpota Kumapukuria Tardaha Tihuria Nayabad Samukpota Pratapnagar Garal
	Kolkata Leather Complex	Dakshin Dhapa Manpur Dhapa Manpur (presently Kochpukur) Hatgachha Hadia Dharmatala Pachuria Kulberia Beonta Tardaha Kapashati
	Purba Jadabpur	Kalikapur
24-Parganas (North)	South Bidhan Nagar	Dhapa Manpur
	Rajarhat	Thakdari

Table 1: Listed Mouzas of EKWA

Climate:

The area experiences hot and humidmonsoonal climate (figure 3), with maximum temperature during summer (April–May) risesaround 40 ° C, while minimum temperature during winter (December–January)remains around 10° C (IMD 1901–2000). The annual mean rainfall is around 160 cmand is concentrated in the months of June to September (IMD 1901–2000). (*graph*) Average relative humidity is high between 70 percent and 90 percent approximately. During April and May the region is frequently visited by Nor'westers[ii], when the average wind speed rises to about 7 kmph from 2.9 kmph.As per agro-ecological subregion, it is hot moist subhumid type, with LGP[iii] varies between 240-270 days.

[ii]Afternoon rainfall (convectional type) associated with thunder and lightning.
[iii]Length of Growing Period.

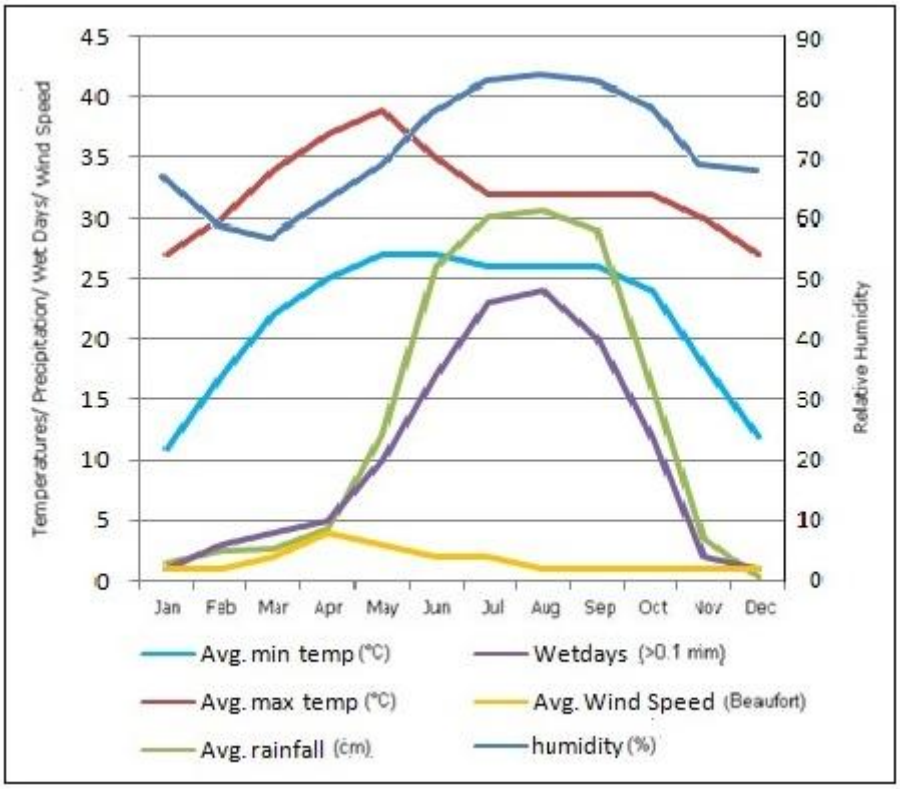

Figure 3: Climategraph (data source: IMD, 1901-2000)

Hydrological Regime:

East Kolkata Wetlands (figure 4), which wereinitially tidal wetlands (a backwater swamp and spill-reservoirs of Bidhyadhuri River) formed as a consequence of the fluvial-geomorphic processes through centuries,became sewage-fed wetlands with the decay in the tidal influx since thelate nineteenth century. From the standpoint of hydrological regimes of East Kolkata Wetlands,this wetland area lies in theKolkata Sub Basin, surrounded by Kulti Upper Sub Basin, Kulti Lower Sub Basin, Piyali – Bidyadhuri Sub Basin and Adiganga Sub Basin. (*map*)

a) *Kolkata Sub Basin* which contributes both sewage and storm flow into the wetlands through an elaborate network of channels, finally terminating into Dry Weather Flow (DWF) and Storm Weather Flow (SWF) channels.

b) *Kulti Upper Sub Basin*comprises of three channels,i.e, Sunti, Nowaee and Nonagong.

c) *Kulti Lower Sub Basin* drained by Kulti River and the tidal influx from Sunderbans(theseform a vast marsh complex known as GoabariaBeel)

d) *Piyali – Bidyadhuri Sub Basin*mainly drained by Piyali and Bidhyadhuri channels, that are dominated by tidalinflows.

e) *Adiganga Sub Basin* drained by currently derelict Adiganga River (connects to the HooglyRiverthrough Tolly's Nullah)

With the subsequent decay of River Bidyadhuri and decline of hydrological connectivity between the freshwater and marine systems, the north- south hydrologicalexchange was artificially engineered into awest to east connectivity regulated through construction of locks andpumps. However, in the upstream the drainages of Bidhydhurimerge into the Kulti estuary through Sunti, Nowaee and Nonagong. The estuaryis connected to the Bay of Bengalthrough a complex network of distributaries.Anestimated amount of approximately 1100 MLD (1.1 million m3) from the city of Kolkata is beingcharged into the wetlands everyday (Bunting et al).

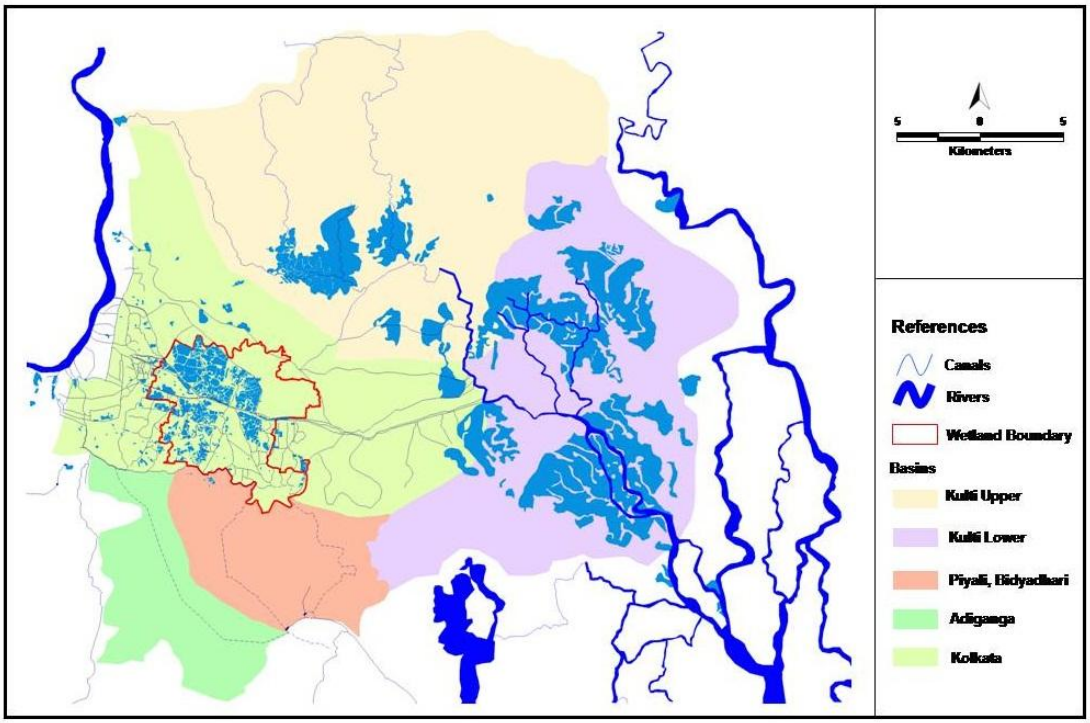

Figure 4:Sub-Basins of EKWA (map source: EKWMA)

Geology and Soil:

Being located at the lower part of the deltaic alluvial plain of South Bengal Basin, the subsurface geology of the East Kolkata WetlandArea is completely blanketed by the Quaternary fluviatile sediments comprising a succession of silty clay, sand, and sand mixed with occasional gravel.(Sahu and Shikdar, 2011).Deeper exploratory boreholes, drilled by various agencies, suggest the existence of underlying Tertiary clay/silty clay at an average depth of 296 m (Chaterji et al. 1959), which continues up to a depth of not less than 614m below the surface(Sikdar 2009).The Quaternaryaquifer of the area is sandwiched between two aquitardsmade of silty clay/clay and is more or less continuous in nature.Thus the groundwater exists in perched acquifers, lying upto a depth of 100-150 m. A study by Sahu and Sikdar during 2004revealed that within the wetland region, a groundwater trough existsnear Dhapa–Manpur region from where groundwater moves towards this depression, while agroundwater mound exists near the south-eastern corner of the region near Pratapnagarfrom where ground water flows to all directions (Sahu and Sikdar, 2008).

The region has three types of soil (figure 5): Fine Aeric Haplaquepts I, Fine Aeric Haplaquepts II and Fine Loamy Aeric Haplaquepts. Fine Aeric Haplaquepts I is characterized by very deep, poorly drained, fine soils with clayey surface and severe flooding. Fine AericHaplaquepts II is characterized by very deep, poorly drained, fine soils on inter-distributory sediments with clayey surface and moderate flooding. And Fine Loamy, Aeric Haplaquepts is characterized by very deep, poorly drained, fine loamy and subjected to severe flooding. (NBSS & LP[iv], ICAR)

[iv] National Bureau of Soil Survey and Land use Planning, Nagpur.

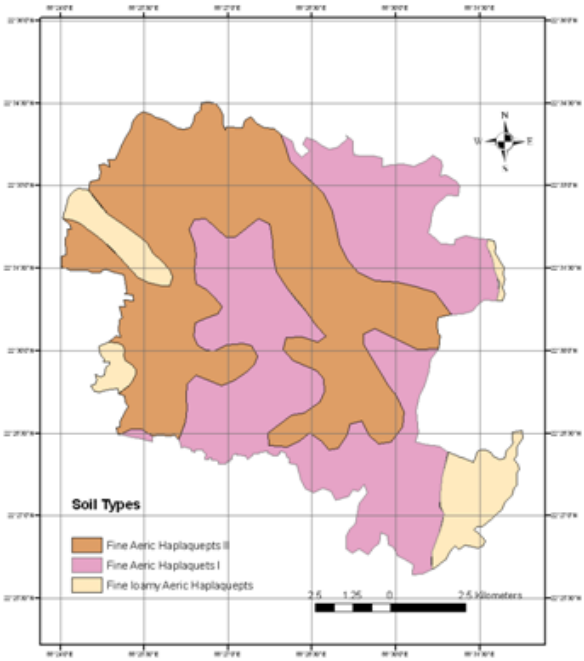

Figure 5: Soil Map of EKW (map source: NBSS & LP)

Flora and Fauna Diversity:

East Kolkata Wetland Area is the store house of a broad spectrum of flora and fauna. This wetland is complex and dynamic, with wide varieties of microbial population having diverse genetic characteristics ranging from spore formation for stress adaptation to high pH and temperature tolerance, nitrogen fixation capacity and the capacity of bioremediation (ref[1]).

The aquatic vegetation in the wetlands is mainly dominated by floating microphytes. The study carried out by Ghosh and Ghosh, 2003, a total of 106 aquatic plants belonging to 70 genera and 36 families have been reported. From the study area (figure 6), 30 genera of phytoplankton, 96 species of vascular plants species under 79 genera and 38 families, wetland plants showing a totalnumber of 55 species under 41 genera & 26 species, 41 species under 39 genera and 20 families of herbaceous floral diversity on the bank (other than helophytes), major trees / shrubs at the bank site of 35 species, climbers / lianes having14 species have also been reported by Institute Of Wetland Management andEcological Design. (IWMED,June2004). The wetland plant resources are economically very important for generating medicine, paper-pulp, thatching materials, food for water-fowl and fish, greenmanure & compost, water purifier and fodder. Water hyacinth plays a crucial role in the function of this complex ecosystem. Beside preventing the bheri banks from erosion, they provide shade to the fishes, to leach out heavy metal ions from the surrounding water, its periodic harvesting leads to successful bioremediation (since its roots act as “biocurtains” or “biofilters” for the passive remediation of wastewater. (Raychaudhuri et al., 2008)Beside this there are 24 species of vegetable & crops, 5 species of fruit plants and 10 species of ornamental plants are also cultivated for higher economic benefits.

The planktonic diversity studies by IWMED (June2004) reveal 17 species of zooplanktons, only 4 fresh water crustacean species and 6 species of molluscs. 37 fish species arerecorded, of which 14 species are cultured ones and 23 species are wild fish species.The study also revealed 4 amphibian species, 19 reptilian species and 66 species of avi-fauna (other than migratory birds) recorded from the wetlands. The survey showed that 16 of mammalian species recorded from the wetland areasrepresenting Carnivores (8 species), Bats (2 species), Squirrel, Rat and Mouse (6 species).

1.3: Socio-Economic Setting of the Study Area

Demographic Features:

Being located at the fringe of Kolkata city, the region has seen high population growth rate during last few decades, nearly 7%. With respect to the population density (figure 6a & 6b), the mouzas close to Eastern Metropolitan Byepass have higher population concentration compared to the mouzas far from it. Mouzas such as Atghara, Mukundapur, Nonadanga and Paschim Chowbhaga has population density greater than 32 persons per sq km.(*figure*) Whereas Dhapa Manpurand Dhapa has least population density of 2 Persons per sq km., since

these two mouzas are occupied by Sewage fed bheries and agriculture land specialized in horticulture, respectively. Western and northern part of the wetland area also has low population concentration (less than 8 persons /sq.km.). These regions are mainly agricultural lands. Among the population, Scheduled caste is the dominant group having > 80% population, while the dominating religion is Hindu in the study area (ref).[2]

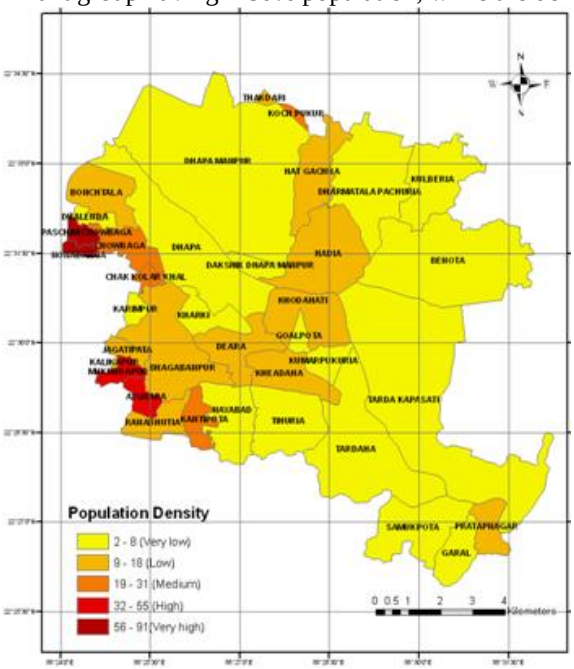

Figure 6a Population Density Map

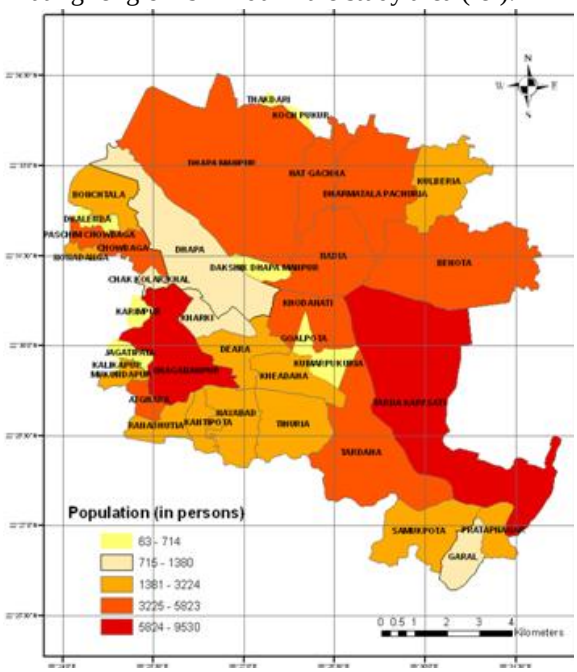

Figure 6b Population Distribution Map

(Datasource:census 2011)

Mouzas such as Bhagabanpur, Chowbaga, Tarda Kapasati, Hadia and Benota has total population more than 5000 persons, while Dhalenda, Karimpur, Goalpota and Kumarpukuria has total population less than 500 persons. (*figure*) Villages such as, Arupota (Dhalenda mouza), Purbo Panchannagram (Nonadanga), Uchchhapota (Bhagabanpur), Kharki (Kharki), Geotala (Deara), Goalpota (Goalpota), Jhinukpara (Kumarpukuria), Chayanabhi, Kashmahal, Kulipara and Trinath pally (DhapaManpur), have sex ratio greater than 1000. These villages are mainly located at the eastern part of the study area close to the Kolkata, suggesting out migration of male population for occupation other than agriculture and fishing.

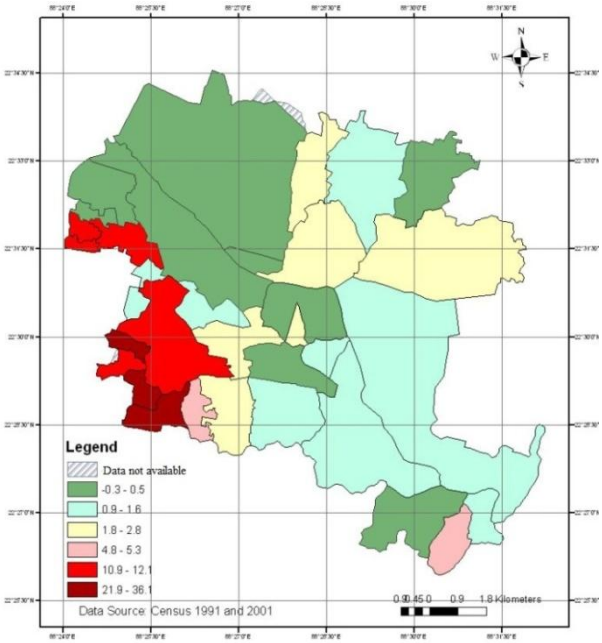

Figure 6c. Population Growth Rate Map

Thepopulation growth rate map (figure 6c)of the East Kolkata Wetland Area shows that the growth rate is high (> 10%) for most of the mouzas e.g. Atghara, Jagatipata, Ranabhutia, Mukundapur, Bhagabanpur, Nonadanga, Paschim Chowbaga and Chowbaga, locating at the margin of Kolkata district suggesting the growing population pressure on the city fringes. Samukpota is a single mouza that has registered negative growth rate. Other low population growth rate mouzas (< 0.5%) are located in the area under horticulture and fish bheries. Kheadahaand Kulberia are exceptional ones under this category. Rest of the mouzas have growth rate less than 3% per annum.

Educational and Health Status:

Since the region is mainly fisheries and agriculture oriented, the education status is pitiable. Only three mouzas namely Deara, Kheadaha and Khodahati have literacy rate higher than 80%, and only two namely Nayabad and Mukundapur have literacy rate between 60-80%, while rest have less than 60%. Among all, three mouzas namely Dhalenda, Kumarpukuria and Dhapa have literacy rate as low as 22%.(figure 7a)

Regarding the literacy status, the status has been calculated as number of literate persons under primary, secondary, graduation or post-graduation and non-formal education category. It is found that only three mouzas namely, Hadia, Nayabad and Tihuriahave more than 60% secondary educated literates followed by primary (<30%), non-formal (<8%) and graduation or post-graduation (>4%). Only Two mouzas namely TardaKapasati and Garal, have 30-60% secondary educated literates followed by primary (<30%), non-formal (<8%) and graduation or post-graduation (>4%). Likewise three mouzas namely Kharki, Deara and Bhagabanpur have least education status, since they have > 60% primary educated literates, with <1%literates having done graduation and above. Mouza Deara is most contrasting since in one hand it falls in high literacy rate category and in the other hand also falls in least literacy status category.(*figure 7b and 7c*)

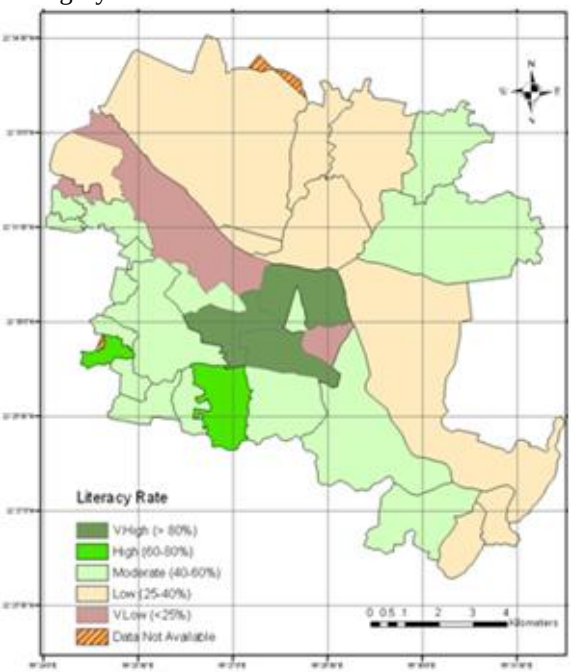

Figure 7a. Literacy rate
(data source: census, 2011)

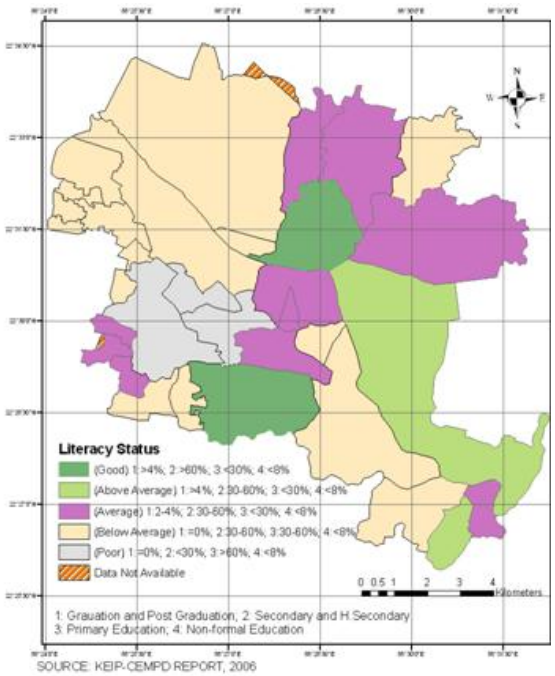

Figure 7b: Literacy status (2006)

Education Institution status represents Primary institution that includes Sishu Sikhsha Kendras and primary schools; and Secondary institutions that includes secondary schools and colleges. Only two mouzas namely Hadia and Hatgacha have more than five primary institutions and more than two secondary institutions, followed by Nayabad with two primary institutions and three secondary institutions and Kheadaha with one primary institution and two secondary institutions. Dharmatala Pachuria is only mouza that has more than five primary institutions but no secondary institution. Kulberia, Benota, Tarda Kapasati, Tardah, and Garal have more than five primary institutions and one secondary institution each. DhapaManpur and Pratapnagar have more than two primary institutions and one secondary institution each. Chowbaga, Karimpur, Bhagabanpur, Munundapur and Kantipota have less than two primary institutions and only one secondary institution. Rest of the mouzas has less than two primary institutions with no secondary institution. The distribution of the

educational institutions is to a large extent limited by the land-use i.e., mouzas with area under wetlands have less educational institutions.

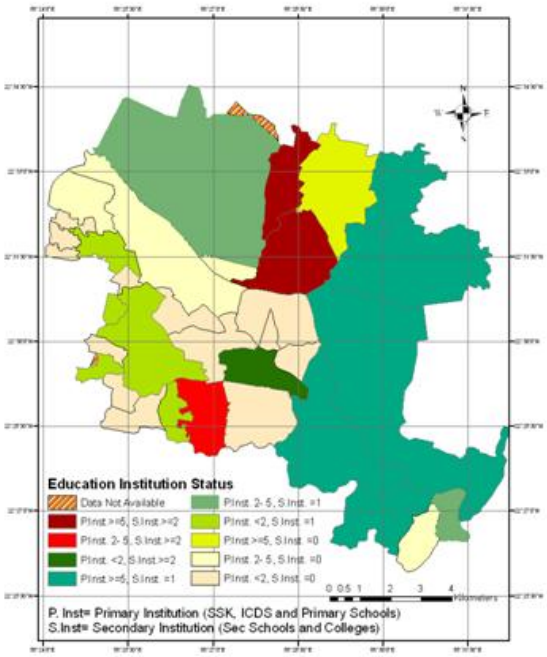

Figure 7c: Status of Education Institution (data source: Census2011)

Health is another development indicator of a region. Since there is no Govt. hospital in the whole region, the local residents have to depend on Kolkata city for critical and emergency treatment. Some of the most common health problems are cold and cough, fever and stomach infection.Among the medical facilities (figure 8), few dispensaries, mother and child welfare centres and community health workers are present here. Kheadaha and Jagatipata has better medical facility compared to other parts with more than two dispensaries, one mother and child welfare centres and more than two community health workers each. Most of the mouzas under Sonarpur block have better facilities than other blocks of this region. The mouzas under KMC and Bidhannagar Municipality with fishing bheries and horticulture as dominant landuse have very poor medical facilities.

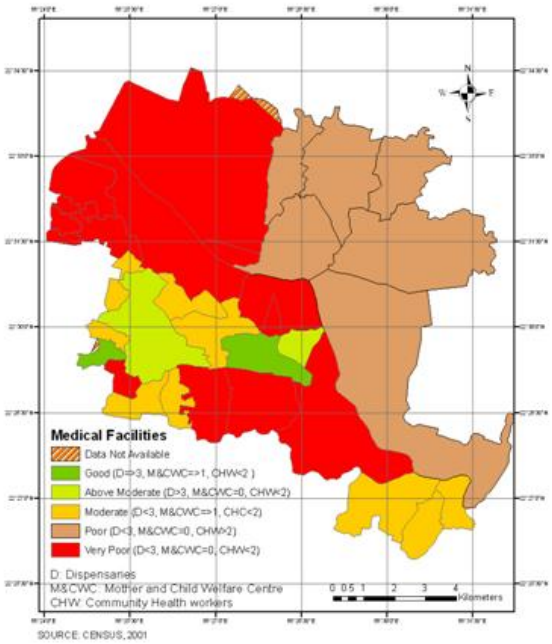

Fig 8: Status of Medical facilities (Data source: Census 2001)

Drinking Water and Sanitation:

Safe drinking water is one of the basic requirements for human survival. Since some parts of Bhangar I, Bhangar II and Sonarpurare arsenic affected, thus it is very necessary to study the sources of safe drinking water. The most common source of water (figure 9)for drinking are tube-wells, deep tube-wells, piped water supply (under Rural Piped Water Supply Scheme), well and municipality water. All the mouzas have deep tubewell as one of the major source of drinking water except Gharal which has well instead. In the KMC and BMC area more than 70% of population drinks water supplied by municipality, while rest 30% uses deep tube-well. Owing to the poor water quality all the mouzas of Sonarpur and Bhangar I blocks of this protected site is under Rural Piped Water Supply Scheme by WBPHED. Thus villagers of these mouzas get drinking water from time tap under this scheme. As per WBPHED, at Kochpukur and Hatgacha partial commission of the scheme has been done.

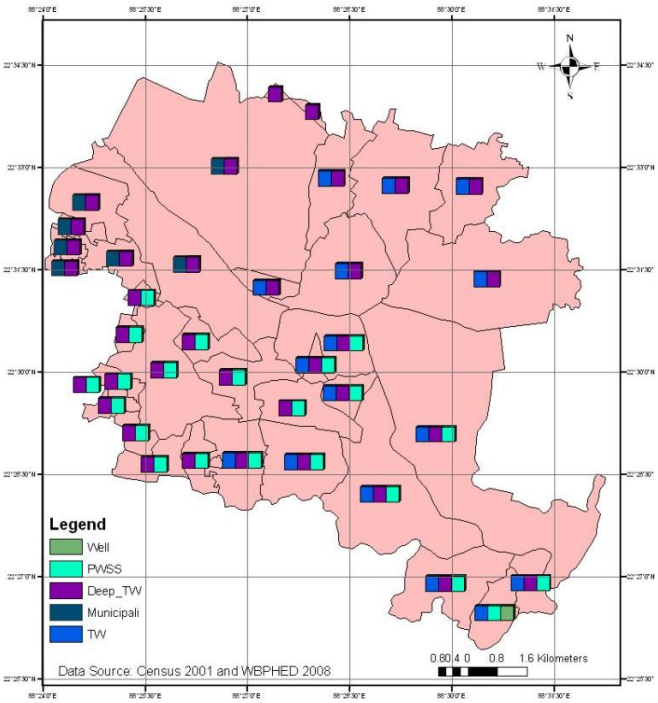

Fig (9): Drinking water sources of EKWA

Sanitation status is an important factor for health and hygiene of a society. Toilet facility (figure 10)is not available to every household. Very few mouzas have more than 70 % households with toilet facilities; they are Paschim Chowbaga, Mukundapur, Jagatipata, Nayabad, Tihuria, Beonta, Hadia and Hatgacha. Kharki and Deara have less than 30% households with toilet facilities, followed by Kumarpukuria, where less than 10% households with toilet facilities. The households without toilet facilities use open-pitor open-field. One of the basic features for the households with toilet facilities is that the toilets are constructed away from the main living area, suggesting their awareness to stop spreading of water related diseases.

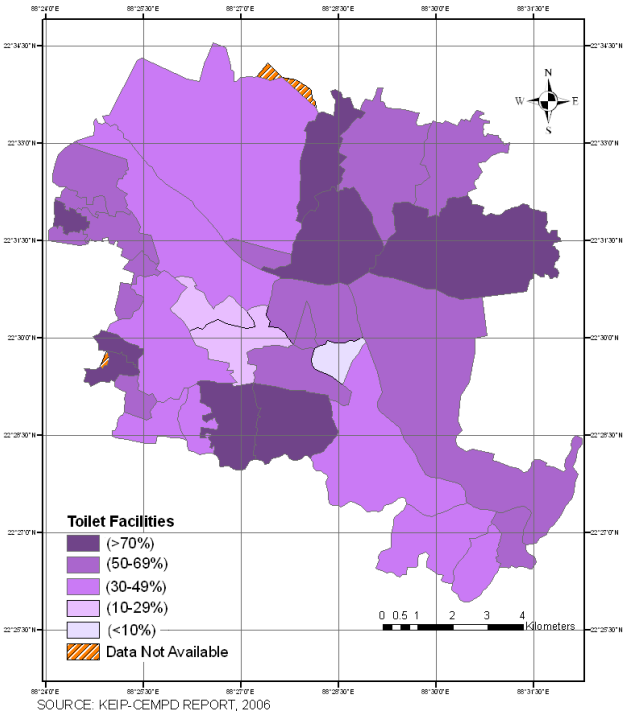

Figure 10: Toilet facilities

Landuse and Land-Cover:

The East Kolkata Wetland Area has developed into a resource recovery system, which consists of three areas: Sewage-Fed Fish Farms, The Garbage Vegetable Farms, and The Paddy Fieldsusing fishpondeffluent. Out of 12500 ha, the total area of sewage-fed fisheries (bharies) is around 3,900 ha, counting to 286, in which privately owned bheris account for 93% of this area, farms managed by co-operatives cover 6% and ponds managed by the State Government account for less than 1% (Table 2).

Table 2: The Existing Land Use Pattern of East Kolkata Wetland Area or WRR.

Land Use Class	**Area**
Substantially Water Body area.	5852.14 ha. Of which fish farming Constitute 3898.70 ha. (45.93%)
Agricultural land	4959.86 ha (38.92%)
Productive Farming Area	602.78 ha. (4.73%)
Urban Settlement	91.53 ha. (0.73%)
Rural Settlement	1234.99 ha. (9.69%)
Total	12,500 hectares

Source: The Kolkata Gazette West Bengal Act VIII of 2006. The East Kolkata Wetlands (Conservation and Management) Act, 2006

Bheries: These sewagefed fish ponds are highly productive due to high content of nutrients in thewastewater, while the high alkalinity stimulates the production of phytoplanktons. The preparation of the fish pond can be dividedinto 5 major phases.

Phase 1 involves the pondpreparation during the coolest months ofthe year. It involves complete drainage of existing pondwater to cleanup all the previous remnants and left it for drying. Sunlight acts as the disinfectant by killing some of theparasites that affect fish production. Tilling anddesilting the bottom of the Bheri ensures that the depthof the Bheri is maintained at 50 to 150 cm whichmandatory for the purification process to operate. Silttraps which are 3m wide and 30 – 40cm deep pits arealso generated around the bheri edges. They harbour the deposited silts of the ponds.

Phase 2 is the primary fertilization which isdone during the middle of February. The ponds arefilled with wastewater and the water is allowed to stand,so that it undergoes natural purification throughprocesses mediated by microscopic biota, before fishesare stocked.

Phase 3beginning in mid March is the fish stocking. Here waterquality is tested by introducing a small number of fishesin the pond before introducing the actual fish stock.

Phase 4 is the stage of secondary fertilization where sewage andwastewater is introduced from time to time throughout the growth cycle of fishes.

Phase 5 is the final stage which involvesharvesting and continues for the rest of the yeardepending on the fish species.

Garbage Vegetable farming: The unique system of garbage dumping by leaving long strips of water bodies in between two dumping grounds has resulted in the development of alternate strips of garbage filled areas (currently utilize for garbage farming) and strips of water bodies (containing sewage for irrigation of the crops and vegetables produced on such garbage farms).The garbage farms yield 150 tonnes of fresh vegetables daily.

Fig11: Landuse of Dhapa landfill site (Source: WBPCB)

Agro-farming: Another system of waste recycling in East Kolkata Wetland Area is the paddy fields which sustain on the garbage and effluent from the waste water fed fisheries as manure and water for irrigation. The old solid waste dumping grounds have been converted into cultivable lands. The paddy fields produce 16,000 tonnes of winter paddy varieties cultivated during post monsoon period annually.Two varieties of paddy – 'Aman' and 'Boro' – are cultivated of which the farmer is shown during the rains and the later in winter. After 'Boro' paddy is harvested, 'Aman'is shown with the rains. More than half of the 'Aman' area is not suitable for 'Boro' cultivation, and remains unused after 'Aman' paddy is harvested.

Canal Network of the Study Area:

Kolkata Drainage Schemes have played a major role in the whole conversion process of the East Kolkata Wetlands from brackish to fresh water. With the decay of the River Bidyadhari, a storm water channel (SWF) connecting the city to the Bay of Bengal was excavated by Calcutta Municipal Corporation to drain the sewage water of the city. Later on to improve the drainage efficiency, the Dry Weather Flow canal (DWF) was laid down parallel to the SWF. The entire domestic sewage of Kolkata (estimated 1394.42 million litres / day) runs through a network of principal and ancillary channels transversing through East Kolkata Wetlands (figure 12).

However, East Kolkata Wetlands receive only a part of the upstream watershed flows, i.e. those arising from the core areas of town system (Kolkata Drainage System), suburban system and Manicktala, Topsia-Tangra and Tollygunge-Panchannagram systems. The rest of the flows are bypassed directly into the Kulti River through Krishnapur, Bhangar Kata and Upper and Lower Bagjola Canals.

Kolkata Drainage System: The Kolkata Drainage System includes the oldest part of the Kolkata city and is bound by the Circular Canal in the north and Tolly's Nullah Basin to the south.

Manicktala Drainage System: This system is bound by the Eastern Metropolitan Bypass to the east, Circular / Beliaghata Canal to the west and south and New Cut Canal/Keshtopur Canal to the north, and comprises drainage systems for Ultadanga, Kankurgachi, Phoolbagan, and Beliaghata.

Topsia-Tangra Drainage System: This system is bound by Eastern Railway Lines to the east, Park Circus Connector to the south and Circular Canal to the north.

Tollygunge – Panchannagram Drainage System: This drainage system partly flows into Kulti and partly into Hooghly. The drainage from the entire area leads to TP main canal through a system of lead channels, and then subsequently into the DWF channel.

Krishnapur- Bhangarkata Drainage System: From a disused navigation channel, the Krishnapur/ Keshtopur Khal was converted into a drainage channel draining part of the Salt Lake town. The Krishnapur Khal passes through the EKW area and divides the art of the EKW, lying on the north of DWF channel has the potential to feed the fisheries and brings larger inflows to the wetlands.

From above explanations, it was found that development of the broad scheme of constructed drainage network in the study area has remarkable effect on the wetland ecosystem. Human intervention is found to be main reason behind the present status of the wetlands. The drainage network no doubt eased the problem of sewage of a metropolitan city like Kolkata, but has also generated the problems like wetland bed siltation, due to improper managerial requirements. Thus, the creative and resourceful practices, associated with fishery and agriculture using urban waste, is gravely endangered. It deserves more concern from the wetland managing authorities for its protection and conservation.

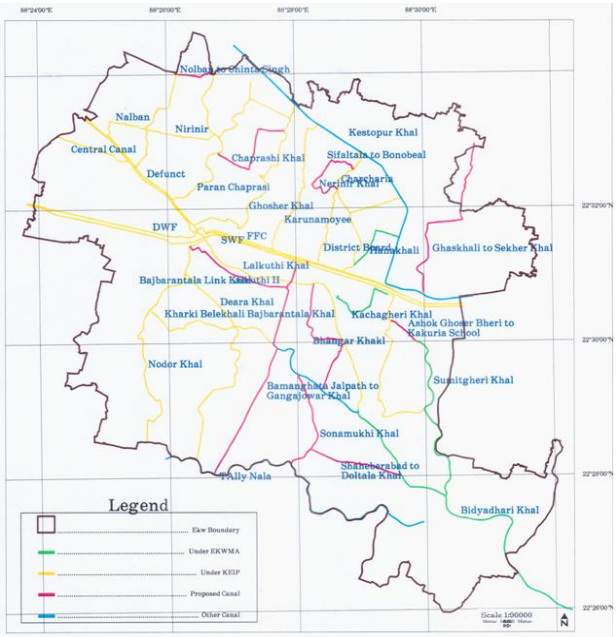

Fig 12: Canal Network of EKWA (Map source: EKWMA)

1.4: Role of NGOs:

The East Kolkata Wetlands thathas received the fate of negligence and land conversion since past; and the local masses that are affected are usually ignorant, or are too poor to raise their voice, when went unheard,it was the NGOs that have tried to establish themselves in this neglected spaceto create a revolutionized upliftment for wetland sustainability. Since then a number of NGOs namely PUBLIC, Jalabhumi Bachao Committee, SAFE, NEWS and Wetlands International - South Asia, have worked for the preservation and sustainabledevelopment of the East Kolkata Wetlands. According to Betsill and Corell (2008), "the term ''NGO'' refers to a broad spectrum of actorsfrom advocacy groups rooted in civil society to privately held multinationalcorporations and trade associations to research-oriented bodiesthat participate in international environmental negotiation processesusing the tools of diplomacy".

The ongoing struggle among various wetland protection groups and authorities over Kolkata's eastern fringes and wetlandsis complex and multifaceted. The weakness in policy implementation by the wetland

management authorities and degradation in wetland condition had made wetland conservation to turn into an issue of intensepublic debate in Kolkata since 1990s. The reason for this weakness as critics (Dembowski, 2001) explained, is the clash within the government and administration, where there were three schools of thoughts: One group of experts categorically opposes any further development on Kolkata's east; Second group suggests that environmental needs be reconciled with the pressures ofurbanization through strictly controlled and implemented planning; while the Third group is apparently convincedthat the issue of wetlands protection should not be exaggerated andthat the city should be allowed to expand.

Motivated by environmentally minded bureaucrats, the city-based non-governmental organizations took up the cause ofwetland protection and conservation in August 1991. To check the Government's apathy and insensitivity to wetlands protection, for the first time the litigation known as *People United for Better Living in Calcutta(PUBLIC) and another versus the State of West Bengal and others* (Matter No. 2851 of 1992) was filed for checking such governmental unaccountability.Since then PUBLIC has filed petition again and again and has got a number of success, like:

- In 1992, High Court gave judgments prohibiting changes of land use in the Waste RecyclingRegion of the wetland area.
- In November 1992, for the first time West Bengal government accepted proposal to declare East Calcutta wetlands an area of 'national importance'.
- In 1996, Supreme Court order directed all the city tanners from Tiljala, Topsia ,PaglaDanga and other areas to relocate to the Bantala Leather Complex, 15 km away from Kolkata. By 2007, 433 of the 550 tanners have been allocated land at the Bantala Leather Complex.
- By October 1997, both projects of an eye hospital and an old age home had been abandoned, since they were purposeful attempts of real estatepromoters to urbanize the area at the backdrop of charitable projects.

Similarly on one hand whenthe JalabhumiBachao Committee, NGOs called SAFE (South Asian Forum for Environment) and NEWS (Nature Environment and Wildlife Society) are playing a significant role in preventing conversion of wetlands, protectionecological balance and promotion of eco-tourism. On the other hand, Wetlands International - South Asia (on the proposal of the EKWMA) provided a comprehensive plan andguidelines for the development of the East Kolkata Wetlands, without violating the mandate of the Ramsar convention.

However, it is not an easy task for the NGOs to conserve and protect the wetlands from degradation. Management of East Kolkata Wetlands comes under the purview of a number of authorities, but their hierarchy and responsibilities remained unclear. Thus, often authorities' violets the Wetland Acts. Moreover, the political dynamics and economic equations in the fish farms have changed from being an inner rivalry between different factions of a political group to an open war among different political groups. Thus on one hand, while doing survey when one NGO faced resistance from the local people due to the misconception provided by certain political groups; the other NGO had to celebrate the Wetland Day under police protection to avoid any political conflict. Thus it is a great challenge for the NGOs to win the villagers over and instill confidence in them by removing the misconceptions from their mind.

Nevertheless, these organizations bear few weaknesses like lack of cooperation and interaction among themselves, absence of detailed layout map of the East Kolkata Wetland Area, application of geospatial tools (Remote Sensing, GIS and GPS applications) are still at its infant stage here and so on. The impact of NGOs on wetlands safeguard can be stronger if they upgrade their skills, mutually stand together and develop a platform for interaction and discussion. On the other hand, the NGOs deserve recognition for theirinitiatives, since if that sustained then will help to ensure sustainabledevelopment of the East Kolkata Wetlands.Government has also understood that participatory approach should be encouraged for wetlands protection. Government, NGOs and the local stakeholders should take this route of wetland management with three main motives in mind: Functional motives, Empowering motives and Philosophical motives.

Functional motives are concerned with the efficiency and effectiveness of the Government and NGOs. Their mutual understanding and co-operation strengthens the inputs of wetland management in terms of skills, strategies, research, initiatives and policy development. Empowering motives give rights to the local community to involve in the activities concerning their lives, in terms of problem prioritisation, agenda setting, decision-making, finding solutions and distribution of benefits. Philosophical motives explore the indigenous knowledge system of the local communities that needs admiration and perpetuation. By prioritising these motives when the three player of the participatory wetland management unites, a stage can be reached where technological, expert and investment solution can be put forward.

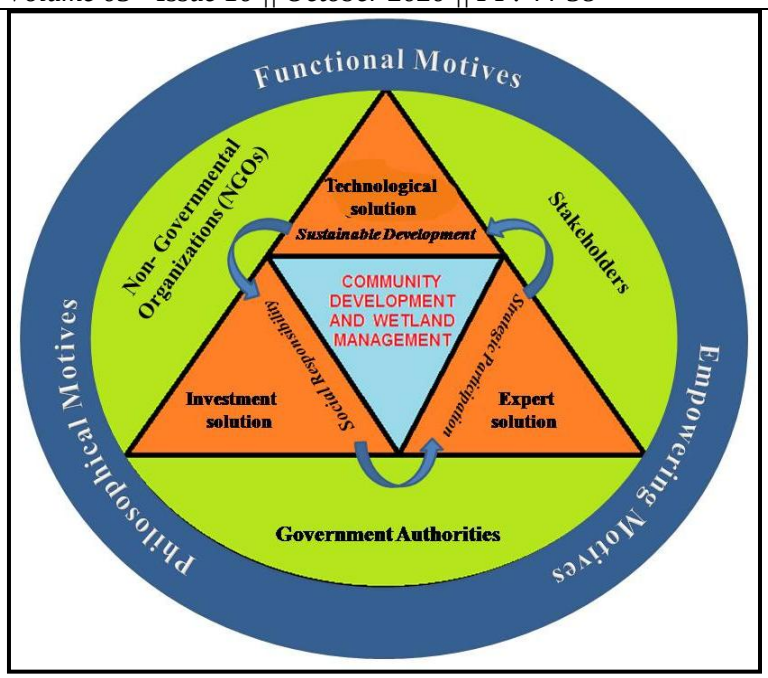

Fig.13: Roads to Community Development and Wetland Management.

Community development and wetland management is possible only when a sense of social responsibility develops among the players that generate strategic participation, leading to sustainable development and the cycle follows (figure 13).

Conclusion

The detail discussion on the physical and socio-economic aspects of the Ramsar site has addressed the need for safeguarding this precious resource from annihilation. The time has come when the equation between the need and greed has to be calculated before it is too late to save this critical resource.

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