CHAPTER I
Introduction

1.1 Context of the study:

The 12,500 hectares (125 sq. km.) of wetlands lying on the eastern side of the city of Kolkata (Map 1.1) is acting as both kidney and lung of the city by serving as a natural sewage treatment plant and generating eco-benefits from the large open space and water bodies in the form of carbon sequestration, nitrogen restoration and air purification. Sewage-fed fisheries and garbage farming are operating for more than a century in this area providing the city with a low cost supply chain of fresh fish and vegetables. East Kolkata Wetlands (EKW) is a unique case where two apparently unrelated activities – the sewage treatment process and wastewater aquaculture appear to be connected as well as complemented to each other as a part of an integrated aquatic eco-system. The close interaction with nature created a number of vocations, which are both inter-temporally viable as well as socially and economically sustainable. Because of this wise-use-practice, EKW has been conferred the RAMSAR status in 2002.

Map 1.1: Location Map of East Kolkata Wetlands

Source: Based on www.earth.google.com
In fact, this correspondence has culminated into a typical livelihood pattern in terms of a set of interdependent vocations in the area that has made the eco-system of Kolkata and that of EKW complementary to each other. So, if the livelihood practices in EKW undergo drastic changes then that may hinder the option of natural sewage treatment available to Kolkata. Once this extremely ingenious tie-up between Kolkata’s waste treatment and EKW’s livelihood dependence would break, the annual cost of mere sewage treatment in Kolkata will go up by nearly Rs.5 billion (Dey & Banerjee 2015).

This thesis discussed the nature of eco-system complementarities between the city of Kolkata and EKW, shows the benefits derived by both the systems through their geographical proximity and economic integration and identified the contribution of different innovative human interventions to put this rare natural opportunity in best-practices to recover maximum resource from waste management. However, serious inefficiency is noted in the existing sewage management practices of Kolkata including improper maintenance of the canal and underground sewer network, which raised the severity of flooding and water logging problem of the city. It is observed in Dasgupta et.al. (2013) that Kolkata being one of the most vulnerable urban centers to climate risks, is experiencing frequent flooding due to intense rainfall, sea level rise and coastal storm surges which is bringing the city to a standstill for several days. A major reason behind this flooding is the adaptation deficit that includes (a) deficit in sewer network and treatment infrastructure, (b) deficit in drainage infrastructure and (c) deficit in financial resource and institutional capacity. According to Bose (2008) the rapid change in the pattern of urbanization in the city, replacing almost all short buildings by multistoried constructions and more and more eastward expansion is increasing the sewer-load per plot of land and encroaching in EKW to constrain the absorption capacity even further. It is interesting to note that though there is no deficit in sewage generation by the city of Kolkata and there is no deficiency in the demand for sewage water from the fish-farmers in EKW, due to silted canals and obstructed channels the insufficiency of natural fish-feed is frequently felt by the users. Finally, mention should be made of the lack of integration in urban development related planning and wetland conservation strategies in Kolkata. In the North-East of EKW there is the planned development of Rajarhat-New
Township and in the South-west there is relatively unplanned urban growth in Mukundapur, Atghara, Ranabhutia, etc. Though the nature of housing construction is architecturally quite different in these two extremes, both are placing pressure on EKW and the continuation of its eco-system based livelihood support. In fact, injudicious land-use practices may threaten the sheer existence of this fragile eco-system. The future of this unique system would be contingent on the proper balancing of inherent strength against weakness and contextual opportunities against threats.

Thus, an aggressive urban expansion in the eastern fringe of the city has led to the unplanned conversion of wetlands into urban settlements. This practice is disturbing the age-old eco-balance and the eco-system based livelihood making the sewage-water-pisciculture less profitable. Now the neighborhood of the core wetland area is infested with high-rise buildings and institutional establishments creating opportunities for different types of modern vocations for the local people. This opportunity is culminating into a real threat for the sustenance of the ecosystem that crucially depends on the continuity and dominance of the traditional livelihood practices; more explicitly, the sewage fed fisheries.

The sustainability of this interactive presence of sewage treatment and wetland dependent livelihood practices is contingent on the continuity of both ecological and social conditions, which are continuously getting challenged by the speedy urban development. As discussed in Lele (1991) sustainable development makes sense only when the ecological basis of human life is sustained and for which a crucial prerequisite is the transparent understanding among the stakeholders. In case of EKW the stakeholders are the local government of the city of Kolkata (who are deriving benefit from the low cost natural sewage treatment and the supply of fresh consumables at cheaper price), the urban development authority of the state (who are mostly responsible for the East-bound urban expansion), the local residents of EKW (whose livelihood pattern is changing due to a complex interplay of push and pull factors), the people fighting for ecologically sustainable living in Kolkata (the environmentally conscious group of citizens and different welfare organizations), and so on. In fact, any comprehensive planning for maintaining eco-balance in the face of aggressive pressure of urbanization is possible
only on the basis of such stakeholders’ consensus. In the absence of a natural solution, the regulatory authority has to play a strategic role in designing incentives to make conservation a preferred option. Whether that could be achieved successfully in case of EKW is the point of our enquiry.

To protect this unique eco-system a number of public interest litigations have been initiated by the civil society and consequently, any change in the pattern of land-use in the core wetland area has been legally prohibited. Given the inherent complexity of the interactive processes through which expectations are formed about the future prospect of the economy, mere prohibition of any change in the land-use pattern in wetlands may not be sufficient for protection of this eco-system services tied with the livelihood practices along with it. Unlike many other conservation sites, the authorities are facing a dual challenge here. First, the RAMSAR site includes land under private ownership making it much more difficult to implement conservation laws. Second, unless the traditional livelihood practices (wise use practices according to RAMSAR) continue to dominate, this fragile eco-system is almost impossible to retain its delicate balance. Unlike other critical resource conservation cases, EKW challenge the authorities to protect the resource along with conservation of the process of wastewater treatment, which is intertwined with the wastewater aquaculture practices. Moreover, retention of this eco-balance is crucial for the sustenance of the urban living evolved in the city of Kolkata and its surrounding neighborhood.

The major contention of this thesis is to establish the importance of eco-balancing in urban planning and management. In most of the old cities of the world, the ecological supports received from the local conditions like spatial advantage, natural topography, social practices and livelihood pattern remain mostly unnoticed until their discontinuity, as most of these services are unpaid and non-marketed. Availability of these services has always been taken for granted. In terms of the example of the city of Kolkata and East Kolkata Wetlands an attempt is made to unfold the story of emergence of a sustainable practice through fine eco-system development and decay of the same due to myopic but aggressive urban expansion. With this prelude, the rest of the chapter is organized as follows: section 1.2 will briefly highlight the importance of eco-system based approach in
the field of urban planning and management. Section 1.3 will present the essential features of these two adjacent and interconnected eco-systems to understand the essence of mutual dependence. Section 1.4 will discuss the research questions, key issues and methodology adopted, and finally section 1.5 will delineate the chapter plan.

1.2 Sustainable Urban Growth and Eco-system Management:

In the discipline of Economics, whenever we chalk out plan to manage any urban development problem, our focus is mostly confined on the specific area under consideration and the state of all peri-urban conditions are parameterized as given under the assumption of *ceteris paribus*. When the parameters change, we compare two equilibrium-states under two alternative specifications of parameters with the underlying belief that once the parameter values are disturbed, the system will eventually settle down to another equilibrium. The methodological position behind this comparative static exercise is driven by the *Newtonian laws of classical mechanics*, endorsing the faith that the system will ultimately reach another equilibrium state and the journey from one state to the other does not capture that much of attention of the planner/economist. Moreover, not much attention is paid to the possibility of dynamic disequilibrium as suggested by the *Courant’s laws of thermodynamics* consequent to enhanced entropy of the system. Here the eco-system approach appears to be more comprehensive in nature. The term inevitably must encompass the core elements of holism, mutualism, dialectic, inclusiveness, and—intrinsically—the concept of system (Wolford 2003). For an urban settlement to be sustainable in the long-run its supply chain has to be secured by the natural conditions. So, the impact as well as dependence of an urban eco-system on its peri-urban ecology and environment has crucial bearing on this sustainability aspect, which in its turn depends on the carrying capacity of the nature and ecological footprint of urban growth (Rees 1992). According to the official website of CBD (Urban Naturel) in 2005 cities all over the world occupy 2 percent of the earth’s surface and using 75 percent of the planet’s natural resources (www.cbd.int/authorities/doc/...).

From the perspective of eco-system management, the following attributes make cities unique: (a) they are heterotrophic (primary production is much smaller than respiration)
and extremely energy intensive; (b) they therefore require large inputs of energy and materials. The relative importance of external inputs compared to internal production and recycling is very high in cities. (c) They produce copious amounts of waste compared with most ecosystems and often lack effective assimilation mechanisms to handle these wastes (or strain existing ones). (d) Urban ecosystem function is controlled not just by biophysical factors but also by social and political forces (although this type of control now affects most ecosystems to some extent, it affects cities in a profound manner); and (e) one keystone species—humans—exerts overwhelming control on ecosystem processes (Rees 2003). In nature, the waste of one life form becomes food for another life form (Anderson 1998). The voluminous waste produced by humans in urban settlements need to be utilized by some other production process as resource. Since the human wastes are highly biodegradable in nature, combination of the treatment of city sewage and wastewater fish cultivation is a unique example of ecosystem correspondence between a city and its hinterland. In fact, some of the space abundant cities are trying to construct wetlands for waste management purposes and the researchers are studying the physical, chemical and climatic parameters of EKW as a tutorial ecosystem.

Though these factors are of utter importance in understanding the functioning of an urban ecosystem in terms of exploring particular places, environments or regions as functional and geographic units, Bryant & Callewaert (2003) have observed that understandings of ecosystem exist within a cultural context, and particular meanings assigned to ecosystem reflect this context. In order to understand any ecosystem, then, a researcher necessarily must understand the importance of human involvement. People are part of a natural environment not simply as biotic agents and actors; they also are primary in shaping the forms and affecting the viability of a natural environment. The cultural context, living and livelihoods are no less important in understanding these biophysical realities (Bryant & Callewaert op.cit.). Livelihoods analysis entails an examination of the capital assets (resources) that are available to people and how they are able to transform those capital assets through various livelihood strategies (activities) into positive livelihood outcomes, such as reduced poverty and vulnerability (Carney 1998, Scoones 1998). Livelihoods analysis also takes into account other contextual factors that influence peoples’ choice of livelihood strategies, including institutions and organizations, policies, opportunities and
socio-cultural factors. The ways in which households are able to deal with pressures on their livelihoods – and the effectiveness of these strategies – are critical determinants of the sustainability of their living (Chambers & Conway 1991). Capacity of Individuals and households to respond to shock and stress is positively correlated with their access to capital assets (Aberra 2006) including the quality of human capital.

To appreciate the interconnectedness among sustainable urban development, livelihood support and ecological footprint exploration of the nature of urban and peri-urban interface (PUI) deserves some special attention. The growing debate during the early 1990s about urban sustainability helped to focus on the impacts of cities beyond their boundaries. Peri-urban areas are the transition zone, or interaction zone, where urban and rural activities are juxtaposed and landscape features are subject to rapid modifications, induced by human activities. These critical areas of land cover change, leading to transformations in the hydrological, ecological, geomorphological and socio-economic systems are often neglected by both rural and urban administrations. Many peri-urban activities move outwards as the city grows; other activities and land uses become incorporated within the urban fabric. Peri-urban areas are mosaics of temporary, new residents and activities mingled with longstanding land uses, including farms, villages, quarries and forest patches. What makes the peri-urban environment so interesting is the complexity of political, economic and social drivers impacting locally on the biogeochemical cycles and the resulting outcomes for the health, well-being and economic survival of people in fringe areas. Ecosystem dynamics can be used to link decisions and actions by one agency to outcomes and consequences for communities and individuals. In this way, we can allocate responsibilities, identify environmental injustices and assess the consequences, both on-site and off-site of planned future peri-urban changes (Dauglas 2006). Because of the availability of open space and good accessibility from urban areas, the PUI is often the ‘backyard’ for urban waste disposal.

To account for the contribution of PUI in ensuring sustainable development of the adjacent urban area the mainstream economics suggests assessment of the unpaid ecosystem services provided by PUI. The ecosystem services are never recognized as bounty of nature so long they are available in abundance. Only when there is any
disruption, their contribution is noticed. However, given the entropy laws, here the damages are mostly irreversible. Therefore, any sustainable city planning demands explicit adoption of ecosystem approach. Otherwise, the aggressive growth of one system will make the other non-viable and that in turn will threaten the sustainability of the former one.

1.3 Kolkata and East Kolkata Wetlands– nature of eco-integration:

East Kolkata Wetland Eco-system is receiving global attention as an illustrative example of ecological engineering by local people in disposal, treatment and reuse of wastewater in a low cost way nearly over the last twenty five years. To understand the complex process involving plants, microorganisms, soil matrix and substances in the wastewater along with their interactions with sunshine in hot and humid climate, researchers from different corners of the world are perceiving EKW as a tutorial eco-system (Furedy & Ghosh 1984, Sarkar 2002, Bunting 2004, Kundu et al.2005, Bunting & Lewins 2006, Hofman 2013). It is a unique case where two apparently unrelated activities – the sewage treatment process and wastewater aquaculture are connected as well as complemented as a part of an integrated aquatic eco-system.

1.3.1 Some relevant facts about Kolkata:

The city of Kolkata is one of the most populous cities of the world and is located at the Eastern part of India. It is the home of 4.5 million people\(^1\) with density of 24,252 per sq. km; it is spread over 187 sq. km., consists of 15 boroughs or administrative blocks and 141 wards, and stretches for more than 96 km along the Hugli river, which skirts the western flanks of the city. Kolkata is generating 1112 million liters of sewage (CSE 2011) and 4460 metric tons of solid waste per day (Das & Bhattacharya 2013). Only 50 percent of the city population is covered by sewerage network, which covers 55 percent of the city area. Length of sewerage network is 1610 km of which 180 km is brick sewer line and the rest is piped sewer line (Kolkata Municipal Corporation [KMC] website).

\(^1\) The day population inclusive of floating population is close to 10.5 million.
Till the initiation of the Ganga Action Plan (GAP) in 1985 there was no technical sewage treatment facility available in Kolkata. Under GAP three Sewage Treatment Plants (STP) were set up in the outskirts of the municipal limit of KMC at Garden Reach, Cossipore-Chitpur (Bangur) and in South-Suburban (East) respectively (Map 1.2). The first two have started working since the end of 1990s and the third one is yet to be commissioned. Another STP has been planned to be set up in Bagha Jatin by KMC, which has not started functioning yet.

Map 1.2: Location of Sewage Treatment Plants in Kolkata

The natural gradient of the city of Kolkata is towards south-east, almost entire sewage water and rainwater runoff are disposed off to wide wetlands in the Eastern fringe of Kolkata. Only 15 percent of this huge amount of wastewater gets treated through sewage treatment plants and a major portion of the rest (nearly 78 percent of total) goes to the

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2 In fact, the river Hugli is the downstream of river Ganga and, hence, cleaning up of Hugli water also came under the purview of GAP.
wetlands located at the eastern side of the city, popularly known as East Kolkata Wetlands (EKW) through an intricately designed canal network for natural treatment (Wetlands International 2008).

1.3.2 Some relevant facts about EKW:

The East Kolkata wetland is situated at the Eastern edge of the city of Kolkata spread over 32 mouzas\(^3\) with total of 11085 water-bodies\(^4\) (PAN-GIS 2011)\(^5\) covering about 12,500 hectares (approx.) and is the largest of its type in the world (Ghosh 1999). It lies approximately between latitudes 22°25’ to 22°40’ North and longitudes 88°20’ to 88°35’ East. The wetlands are located to the East of Calcutta between the levee of the River Hugli to the West and that of the River Bidyadhari, presently abandoned, to the East. The area extends almost equally on both sides of the Dry Weather Flow (DWF) Channel. This channel acts as a connector to discharge off city sewage from city of Kolkata into the Kulti Gong (Ghosh & Sen 1987). It has a hot and humid monsoon climate, with annual average rainfall of about 1600 mm (Aich & Kundu 2010).

EKW is spread over 32 mouzas\(^6\) at the Eastern fringe of the city (Map 1.3). The Northern and Eastern mouzas covers relatively larger area whereas, smaller mouzas are located mostly towards the Southern and South Western part of the zone. The wetlands with total 11085 water bodies, mostly small in size, are spread all over this 125 sq. km. of area. Maximum number of water body is present in Bhagabanpur mouza with total of 1155 bheris, whereas Kumar Pukuria has only 21 water bodies within its boundary. Out of the total area of EKW, 45.69 sq. km. (nearly 36 percent) are under water coverage.

\(^3\) Rural administrative unit (almost equivalent to village);

\(^4\) According to the official records there are 254 fisheries operating in this area; a fishery may be a conglomeration of water bodies and all water body may not be used as fishery.

\(^5\) A project has been commissioned under the Rajiv Gandhi Chair of the University of Calcutta, India in 2010-11 and PAN Network has prepared the present land-use map by applying GIS technique.

\(^6\) Due to increase in population concentration in 2011 Population Census of India the number of mouzas has gone up to 38.
Map 1.3: Mouza map of East Kolkata Wetlands

1 Atghara
2 Beonta
3 Bhagabanpur
4 Boinchtala
5 Chak kholar khal
6 Choubaga
7 Dera
8 Dhalenda
9 Dhapa
10 Dhapa Manpur
11 Dharamatala Panchuria
12 Garal
13 Goalapota
14 Hadia
15 Hatgacha
16 Jagadipota
17 Kantipota
18 Karimpur
19 Kharki
20 Kheyada
21 Khodhati
22 Kulberia
23 Kumar Pukuria
24 Mukundapur
25 Nayabad
26 Paschim Chowbaga
27 Pratapnagar
28 Ranabhtia
29 Samukpota
30 Tardaha
31 Terdah Kapasati
32 Tihuria

Source: Author
Map 1.4: Land-use Map of East Kolkata Wetlands

Legend
- Road
- Canal/ Nala
- Waterbody
- Settlement
- Agriculture
- Open Space
- Mouza Boundary
- EKW Boundary

Source: Compiled by PAN Network private Limited
The present land-use in EKW identifies three types of land: water body coverage, agricultural land, settlements and open spaces (Map 1.4). The area is divided almost equally on both sides of the Dry Weather Flow (DWF) canal as well as Basanti highway. Outside EKW’s Eastern boundary, on the South of DWF canal an open space and settlement chunk is seen as a part of Kolkata Leather Complex. Crisscross of canal network connects all the hinterlands with periphery. Urbanization is clear from the land-use pattern in the areas adjacent to the EM bypass and Salt lake in Nayaband, Atghara, Ranabhutia, Mukundapur, Jogadipota, Bhagabanpur and so on.

1.3.3 Nature of mutual dependence:

The case of Kolkata and EKW is a classic example of interdependent eco-system that is exhibiting a unique ecological balance between these two connected systems through vocational choice of the local people, which converts waste into wealth and makes the entire practice economically viable, naturally reproducible and socially sustainable over time (Chart 1.1).

Chart 1.1: Mutual Dependence: Kolkata & EKW

Source: Dey & Banerjee 2013b
1.4 **Research Question, Key Issues and Methodology:**

The present thesis attempts to highlight the need for comprehensive urban planning and management in an ecologically sustainable as well as economically efficient way by clicking balance among the interests of multiple stakeholders through designing of proper incentives and instruments. When the land-use pattern in the buffer area have undergone major changes and new avenues of alternative vocations opened up, what impact would it have on the perception of people in the core area regarding the sustainability of their traditional livelihood options? Will they gradually switch from their original vocations and insure their future against possible land-use changes by taking preparation for alternative occupations? To answer these questions three primary surveys have been carried out among the residents of the core wetland areas in a sequential way: First, workers were surveyed to find out whether there is any trend to opt for vocation other than traditional ones. To investigate further, adult people were asked to fill in time diary in peak production season for ten consecutive days to come up with an exhaustive listing of the prevailing vocational options in the area with almost no change in land-use pattern. Subsequently, by using these job categories detailed information is collected from the households on their pattern of current engagement and tendency to switch from the existing traditional vocations to the newly available alternative options. Whether the local people are aware of these positive environmental externalities generated by the existing wetland eco-system through their livelihood practices and if aware, whether that motivates them to protect the system was a big question to us. Our direct field experience helped us to explore the intricate interdependence among the internal balance of this fragile eco-system, integration of local people with these traditional livelihood practices and the level of their awareness and intention in investing efforts towards its conservation.

1.4.1 **Research Questions:**

It is explored here that,

(i) How did the city of Kolkata gained her ecological support from EKW and helped some specific livelihood practices to evolve there?
(ii) How do these two contiguous eco-systems derive mutual benefits through a number of economic, social and environmental interactions?

(iii) How would the process leading to conversion of waste into wealth be contingent on the dominance of traditional aquaculture practices?

(iv) How would the aggressive urban encroachment influence the available vocational choice of the local residents?

(v) Would the compatibility between these two eco-systems of Kolkata and EKW be maintained even after significant switching of occupational pattern and livelihood practices?

(vi) What role could be played by the civil society and the regulators to ensure the intrinsic eco-balance?

1.4.2 Key issues:

Challenges faced by urban planners all over the world are topical issues over the last few decades. In this discussion, Kolkata and EKW have been considered as a classic example of an urban eco-system, where sewage fed fisheries are in profitable operation for more than a century. At the same time, this fish-production process is providing basic municipal services in terms of wastewater treatment to the city of Kolkata. In fact, one can study the local issues related to management and planning of a complex eco-system as an instance of global concern related to peri-urban eco-system functioning. In this backdrop the analysis has been carried out in terms of a well-designed sequence of exercises:

(i) Exploration and elaboration of the specific nature of correspondence between the natural treatment of Kolkata’s sewage and the wastewater aquaculture based livelihood practices in EKW, to ascertain the unique standing of this eco-system;

(ii) An assessment of the extent of urban encroachment in EKW;

(iii) The impact of this pattern of land-use change on the vocational choice of the local people;

(iv) The implicit cost of this vocation-switching for the city of Kolkata;
(v) An Assessment of (in) adequacy of the interventions initiated by the regulatory authority and presentation of the case as a typical instance of co-ordination failure.

1.4.3 Methodology:

The methodological details are presented for each one of these relevant questions:

(i) The specific correspondence has been established by collating and synthesizing facts and figures from different official reports, printed documents and other secondary sources;

(ii) The temporal growth of urban population in Kolkata and its fringe has been used to establish the increasing pressure on wetlands. On the basis of a GIS map prepared in 2011 on land-use pattern of EKW, the major changes of water-bodies, agricultural lands, open spaces and other low-lands into urban settlement have been identified. Gathering information from official websites of different Government and Non-Government authorities, existing literature, and direct interview with different stakeholders in EKW, the threats imparted by the changes in topography have been identified.

(iii) The impact of this land-use change on vocational choices of the local people has been assessed from the analysis of household responses collected through primary field survey across different socio-demographic groups; Attempt has been made to investigate the changes in the livelihood pattern and the tendency to switch, if any, from traditional to relatively modern vocations, where the traditional vocation refers to all primary activities related to fisheries, agriculture, animal husbandry, etc. and the relatively modern ones are referring to more urbanized vocations. The analysis centered around the three main research questions viz. (a) who will switch? (b) what will be the likely process of shifting? and (c) why someone, in spite of all opportunities, might not be inclined to switch?

(iv) The enumerable benefits mostly refer to the direct and actual usages of the eco-services whose market valuation can be done by applying imputation method through the revealed preference approach. A Cost Benefit Analysis framework has been used here to present an estimate of the opportunity cost of Kolkata from an
alternative arrangement of sewage management through the mechanized Treatment Plants (STPs). The non-enumerable benefits are generally associated with the potential but non-market services provided by the eco-system, where existence of EKW would be considered valuable to keep the option of its future use open to the society.

Existing literature, official reports, budget documents, other documents available in printed form or web has been used to estimate the value of these other non-enumerable benefits. SWOT (Strength-Weakness-Opportunity-Threat) method of strategic planning and management has been used in this section where STRENGTHS provide an analysis of the eco-system’s advantages over WEAKNESSES which consider areas in which the system is at a competitive disadvantage. OPPORTUNITIES are a list of untapped prospect to exert the system better and finally THREATS explore the external environment that could affect the functioning of this eco-balance.

(v) A critical appraisal of vigilance of the civil society, institutional interventions, legal initiatives has been presented by collating information from different secondary sources including media coverage.

(vi) From the primary survey conducted in the core wetland, attempt has been made to analysis the perception of the local people about these eco-system services, their attitude towards conservation vis-à-vis urban conversion and awareness towards environmental sustainability. The stakeholders and their official jurisdictions with multiple agenda and multiple instruments have been identified and finally the challenges for the policy maker have been presented in a framework of coordination failure.

1.5 Chapter Plan:

The remaining chapters of the thesis have been organized in the following sequence: Chapter II would briefly review the literature available on need for adopting ecosystem approach in drawing development plans for urban areas. In doing so, the issues like the
nature of interaction among bio-geo-physical cycles and livelihood practices of the local people would be highlighted. Special attention would be given to the dynamics of the relationship between an urban center and its peri-urban interface (PUI).

**Chapter III** documents the history of emergence of the eco-system as an off-shoot of urban development of the city of Calcutta\(^7\) during the British era. The chapter would attempt to illustrate the inherent nature of eco-system complementarities between the city of Kolkata and EKW and the pivotal role played by the traditional livelihood practices especially sewage fed fishery in this respect. The entire process of fishery and related livelihood practices for resource recovery through eco-system functioning has also been elaborated. These wise use practices led to the RAMSAR designation of the wetlands.

Despite all these benefits, it has been frequently alleged that being located on the boundary of an expanding metropolitan area, EKW faces constant threats from growth and development of real estate around it leading to a significant change in the pattern of land-use, despite legal restrictions. In the face of a growing pressure of spillover population from the city of Kolkata the marshy wetlands are continually getting converted into urban settlements, challenging sustainability of the traditional wetland practices. It is important to scrutinize carefully the available records to assess the extent of change in land-use patterns of EKW in recent time. **Chapter IV** would discuss the nature and extent of land-use change in EKW and resultant threat to sustenance of the ecosystem.

When the land-use pattern in the buffer area changes and new avenues of alternative vocations open up what impact would it have on the perception of people in the core wetland area regarding their livelihood options? Will they gradually switch from their original livelihood practices and insure their future against expected land-use changes by preparing themselves for alternative modern vocations? **Chapter V** reports the findings

\(^7\) British name of the city of Kolkata was Calcutta and, hence, these two alternative names have been used interchangeably in the thesis.
from two field surveys conducted in the core wetland area where GIS-map did not locate any significant land-use change in favor of urban settlements.

If land-use of the core wetland area undergoes significant changes and the local people appear to be no longer inclined towards traditional sewage fed fishery what would be the opportunity cost for Kolkata? Chapter VI discusses both the enumerable cost of municipal sewage treatment and non-enumerable benefit of ecosystem services (carbon sequestration, flood control etc.) provided by EKW for the residents of Kolkata.

The authorities have partially appreciated the importance of this eco-system and legally prohibited the land-use change within the core area of EKW. However, this intervention appears to be utterly inadequate in protecting the urban ecosystem as a whole. Chapter VII critically discusses initiatives taken by the Civil Society and the legal interventions designed by the regulatory authorities, who are not much in co-ordination with each other and rather confronting at times. The extent of awareness on the part of local residents of EKW about the environmental conservation and land related issues have been reviewed from primary survey data.

Finally, Chapter VIII wrapped up the discussion by presenting an overall assessment, extending policy suggestions and indicating the direction of future research.