Exploring Urban Change in South Asia

Jenia Mukherjee

Blue Infrastructures

Natural History, Political Ecology and Urban Development in Kolkata

Springer

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Dedicated to dadu: Shri Paramesh Kumar Mukhopadhyay

Foreword

In this book Dr. Jenia Mukherjee has used what she calls the perspective of Historical Urban Political Ecology (HUPE) to analyze the history and the present condition of canals and wetlands in and around Kolkata. Here, she uses the insights and findings of hydrologists, experts in fisheries, political scientists, geomorphologists, students of activist movements against the encroachment of real estate capitalists, urban planners, municipal and state officials on the livelihoods and habitats of fishers, farmers, and dwellers of squatments. She has brought formidable qualifications to her task. She has written papers on the political history of India and China, on the history of the wetlands around Kolkata, on the *char*s (sedimentary formations of islands in the bed of the river, which, if large enough can invite settlements or cultivators, creating social and sometimes diplomatic problems when they happen to be on the border of India and Bangladesh), has studied the problems of human development and diplomacy created by the *char*s upstream and downstream of the Farakka Barrage, studied the way a branch of the Bhagirathi (the Adi Ganga) has been converted into a sewer of Kolkata and how to remedy the situation, and so on.

For this purpose she has studied colonial archives dating back to the 1770s, the state and municipal archives of Kolkata (Calcutta), and combined those studies with interviews with the stakeholders involved—fishers, municipal and state officials, and activists.

Historians of European trade and later, the British conquest of India, knew that the choice of Calcutta as its base by the East India Company (EIC) was not an accident, whatever Kipling might have written about it. The Bengal *subah* (province) was the richest in the Mughal Empire, and it was also the base of the richest trade of the empire from the beginning of the 18th century, namely, cotton textiles, followed by silk textiles and saltpeter. The Dutch, the Portuguese, the French, and the Danes had factories along the Hooghly. The swamps of Calcutta proved to be an added advantage. Long before Job Charnock had established a factory in Calcutta, the EIC had sent Joseph Townsend to chart the course of the Ganga. Calcutta had the Hooghly on the west, the Bidyadhari in the East, and the Adi Ganga, a tributary of the Hooghly in between. These were all used by the English and Indian traders as

transport routes. The British had begun to interfere with the waterways already in 1742 when they excavated the Marhatta Ditch, a 3-mile long moat for a possible invasion by the Maratha army, which never came. It was later filled up to build the Circular Road, which was considered to be the boundary of Calcutta proper. There was also a creek from Chandpal Ghat of the Hooghly up to Sealdah, called the Bourani's Khal (the Bride's Canal), which was used for transport. It was later filled to create most of the area west and east of Writers' Building, Lalbazar, and Bowbazar. The neglect of this water route caused havoc to the houses along Durga Pithuri Lane and Madan Datta Lane, and displaced dozens of families.

Mukherjee does not believe that all the ills of today's Kolkata are due to post-independence errors or that all of today's Kolkata is the result of "bourgeois environmentalism." The British had already radically interfered with the hydrology and environment of Kolkata and its satellite city Howrah, when they built the East Indian Railways and the Eastern Bengal Railways on the west and east banks of the Hooghly respectively.

The best example of "bourgeois environmentalism" in West Best Bengal is the Salt Lake City (now renamed Bidhannagar) which was built between 1956 and 1965 by filling up saline swamps with sand. It has an area of 13.16 km^2, a population density of 16,590 persons per square kilometer, and a literacy rate of 80.44% (all 2011 census figures), as against that of the jurisdiction under the neighboring Kolkata Municipal Corporation (KMC) which has an area of 205 km^2, and according to the 2011 census a population density of 24,718 persons per square kilometer and a literacy rate of 86.31%. In both cases, the literacy rate is far above the state average of 76.26%.

While Bidhannagar was built up primarily to house the upwardly mobile middle class, the other three townships under the jurisdiction of KMC housed either an older population of primarily poor to lower middle class people, the Baishnabghata-Patuli and the East Kolkata Township housed a large fraction of refugees from East Pakistan and Bangladesh. The KMC only made cosmetic changes to the roads and drainage systems of these localities.

To get back to Mukherjee's story, I will illustrate the nuanced conflicts between different interest groups with two of her in-depth case studies: the Adi Ganga and the East Kolkata Wetlands. The Adi Ganga that had been a major waterway connecting large parts of Calcutta during the colonial times, was turned into a smelly and polluted sewer when the need for such transport was over. After independence, a campaign started to clean up the Adi Ganga by blocking the sewage outlets into it, and evicting the squatters who lived along its banks. As a reaction to that, activists took up cudgels on behalf of the squatters. However, with the demand for metro construction, the squatters lost out: they were evicted with the help of the police in 2002. Those who moved willingly were given a compensation of Rs. 2000.

The story had a more favorable outcome with the fishers and farmers who used the resources of the East Kolkata Wetlands (EKW), though here also some conflicting interests worked, the most powerful of which is the real estate lobby. As Mukherjee has pointed out, Kolkata is one of the few cities in the world which has no sewage treatment plant. Most of the drainage channels of Kolkata debouch into

the EKW. So the municipal authorities are greatly interested in preserving wetlands. The fisheries department is interested because the EKW is a valuable source of fish. The agriculture and irrigation departments are interested because the farmers can use the water for irrigating their fields in the dry season and produce vegetables for Kolkata. However, the real estate lobby is always trying to encroach on the wetland, and scientist-activists like the late Dhrubajyoti Ghosh had to fight valiantly to protect the wetlands and preserve the livelihood of farmers and fishers. Everybody wanting to preserve that heritage is alarmed by the news that the West Bengal government is planning to build a causeway across EKW.

People studying Mukherjee's book will not only understand the causes and outcomes of current conflicts and negotiations surrounding water bodies, their users and their potential destroyers in the current period but also their roots going back to the 18th century and their trajectories since then. It is the only book to my knowledge which gives the history of what Mukherjee calls "blue infrastructures" (following Adriana Allen) of a South Asian city. Because of its interdisciplinary approach and its brilliant execution, it would be very useful for all students of the history of South Asia, students of political science and political economy and of hydrology. I am very happy to write the foreword of this book.

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Preface and Acknowledgements

The journey of this book, like this book itself, is long, complicated, and exciting. One cannot miss the sight and foul smell of a polluted water tract beneath the Alipur Bridge on the way to the National Library or while traveling from Naktala to Garia in the southern part of Kolkata. This filthy track is none other than Kolkata's heritage river: the Adi Ganga! I encountered her every weekend during my visit to the National Library (NL) when I was a bachelor's student (in History) at Jadavpur University, Kolkata, between 2002 and 2005. "Is this a river or a canal?" "Was it like this from the very beginning?" "Was it ever navigable and did it function as an important artery of trade?" One or two unused boats on the clogged and muddy riverbank gave some indications of the past, the past disconnected from the present and posterity, and confined in some records and documents which are no more significant, and memories fading away with age and contexts. The questions kept haunting me every time I crossed the river, and finally when I was asked by my (potential) supervisor Prof. Subhasis Biswas to present a paper at the students' panel for the National Seminar on "Rivers and Society: Historical Perspectives," organized by the Department of History, Jadavpur University, and the Netaji Institute for Asian Studies (NIAS), Kolkata, I jumped at this opportunity with the grand agenda of unfurling the history of Kolkata's canal system by tracing and tracking materials preserved at the NL itself. That the job was not easy could be realized within a week when neither systematic documentation of records could be found at the annex building nor any secondary literature on the same, except a very small chapter on Kolkata's canals in the Bengali book *Kalikata Darpan* by Radharaman Mitra. I started spending more time outside the National Library than inside, looking at the Adi Ganga—Tolly's Nullah—and traveling along the canal bank on a motorbike with Subhadeep and tracing sluices, lock gates, and other canals that circumnavigated the city as an integrated system. The dearth of historical data and my inability to trace it (till then) led me to cover more contemporary aspects of Kolkata's rivers and canal system (pollution, drainage-sewerage, etc.) which was well accepted by the august crowd in the seminar who encouraged me to pursue the research.

The corporate job in between, at Cognizant Technology Solutions in Salt Lake Sector V, exposing me to the wetlands on the city's eastern periphery, the accidental meeting with historian P. T. Nair at the annex building, NL, one fine morning who then guided me on repositories where historical sources on Kolkata's canals could be found, and the encounter with Dr. Dhrubajyoti Ghosh at the Centre for Studies in Social Sciences (CSSS), Kolkata, can all be woven together as the connected web of the journey of which I had little clue in 2007–08. That history and the contemporary, the technical and the social, canals and wetlands, are intricately interlinked was gradually becoming clearer, throwing up new challenges and increasing my anxieties about how to comprehensively capture this complex scape and system, which had to be done boldly by blurring temporal, spatial, methodological, and political boundaries.

I shivered, faltered, and remained confused and clueless as my unending quest for information to unravel complexities surrounding canal systems and wetlands, coupled with my lack of methodological training during my Ph.D. days, sheer apathy towards writing conventional history, and genuine concerns from history professors acted as strong impediments. I started following my heart; I approached people including municipal officials, engineers, grassroots organizations, and experts in the field with questions that my mind was flooded with. While NGOs and experts were passionate to share their knowledge and experience, the government officials and departments remained indifferent. Meanwhile, explorations of archival materials at the West Bengal State Archive (WBSA) and Town Hall were exciting, taking me back to the heyday of the functioning of canals where I could visualize enthusiastic colonial officials maintaining each and every piece of data, imperative for such a profitable venture: the canal trade and traffic connecting Kolkata with her fertile hinterland. The discovery of Dr. Dhrubajyoti Ghosh (who was difficult to discover with no contact information on websites) was a watershed in this research trajectory. The very first day of our meeting at CSSS translated into rigorous exchanges, deep attachment, and a commitment towards the protection of the wetlands. I was delighted at having found my guide, mentor, teacher, friend, and philosopher. He readily accepted me as his student, providing me detailed and hands-on technical training on the canal–wetland connection at the Centre and at his Naktala residence; he considered me his granddaughter with whom he was extremely comfortable sharing his academic, political, and personal space. We converged and diverged about categorizations in social sciences: "local," "state," "development," etc., and recommendations for pathways for our beloved city. However, our unchanging commonality was our passion and love for the subject.

I submitted my doctoral dissertation and earned my degree in 2010, yet no one was sure (including me) whether my work made any sense or had any potential to contribute or not. Who would read my work: historians, sociologists, anthropologists? Even I had no answer to this puzzle. Though I picked up interdisciplinarity from my university teachers, yet "undisciplined disciplines" imbricated within the context of the "Anthropocene" were yet to emerge and make their mark prominently, at least within the contours of South Asian academic campuses. Professor Amiya Bagchi appeared as the messiah to eradicate this disciplinary confusion,

cloud, and clog forever. This interdisciplinary visionary and his institute, the Institute of Development Studies Kolkata (IDSK), founded on his principles to spell out the truth (that has been unearthed by rigorous research) and to fight for justice, whether social, environmental, or at the intersections between the two, gave me the recognition that I was on the right track, instilled the confidence that I had the right to boldly assert my empirical findings, and offered me the official platform to channelize my research interests. I got the chance to listen to stalwarts like Amartya Sen, Martha Nussbaum, Jasodhara Bagchi, Jean Drèze, P. Sainath, Ashok Mitra, and others, engage in exchanges with colleagues trained in economics, sociology, and literature, and grow and mature under the strict guidance and unconditional love of Sir which was indulging and provocative enough for me to remain loyal to research forever. I had the opportunity to read cutting-edge research works available at the fascinating IDSK library where librarians like Madhusri Di and Ashok Da worked long and late hours to accomplish our research dreams. Sir kept on asking me to start working on my book from my Ph.D. thesis, but I still had no clue on how to go about it as it was messy, undisciplined, and lacked the scientific-theoretical edge on which I could superimpose my rich empirical findings.

I had to wait three more years. I applied for the 2013 World Social Science Fellowship (WSSF) sponsored by the International Social Science Council where 20 World Social Science Fellows working on the city–nature relationship were selected to be trained by eminent urban environmental experts—Prof. Adriana Allen (University College London), Prof. Mark Swilling (University of Stellenbosch), and Prof. Andrea Lampis (National University of Colombia). I was thrilled that my proposal was selected and that I would be representing my love, my Kolkata, at WSSF in Quito, Ecuador. Seven long days and nights of interactions, debates, trainings, and exchanges with the 3 mentors and 19 participants from the global North and the global South provided the much-needed perspective for getting geared up to continue this research till it materialized into something meaningful and saw the light of the day. The immediate outcome was contextualization of my research within the emerging field of urban ecology, the publication of my first book chapter on "sustainable flows" between Kolkata and its wetlands in the open-access Routledge edited volume *Untamed Urbanisms* (2015), followed by the long-term consequence of Adriana's guidance, love, and support for my research. We collaborated on projects, exchanged emails, and walked the Kolkata wetlands together under the scorching heat of the sun. This was a rare opportunity for me to understand peri-urban dynamics which she used to explain as "urbanization without infrastructures." It is to her that I owe the concept or the phrase "blue infrastructures." While my job at the IDSK, the wide range of books on contemporary environmental (justice) challenges, and my collaboration with the University of Lausanne, Switzerland, and more particularly with my collaborator and dear friend Flore Lafaye de Micheaux made me more passionate to pursue and apply political ecology in my research, Adriana was fascinated with the urban environmental history component in the "blue infrastructures" of Kolkata. I took the bold and brave step of combining environmental history and political ecology through my empirical investigations and explained why and how it could be applied as a

comprehensive framework to explore and understand urban nature dynamics in my back-to-back invited lecture at the Indian Institute of Human Settlements (IIHS), Bangalore, and job talk at the Indian Institute of Technology (IIT) Kharagpur in August 2015. The IIHS architects considered the framework as breakthrough and IIT offered me the job.

The IIT job was a major and positive intervention in terms of funds (ISIRD, SRIC), exposure, and networks. The same municipal officials and engineers were now ready to talk to me on the same topic and similar questions. The Director's (Prof. Partha Pratim Chakrabarti) letter was so powerful that it allowed me immediate entry to the municipal archives and departments which I had longed for since my Ph.D. days. PPC Sir not only provided the administrative support but listened to my ideas patiently, shared his opinions, and motivated me to craft ways through which theories could be materialized into actions by collectively optimizing on existing potentials among natural and social scientists and academicians and policy makers. "But how is this possible?" Policy makers are class enemies to almost every political ecologist! That we need to have a sanitized mind and belief in the dictum of "the greatest good" for mankind (and of course urban nature) by harnessing mutual trust and collective empathy, initially appeared to be too much for me, yet I started realizing and internalizing this greatest reality after I met Anuradha, my IIT colleague, friend, and mentor. I consider this as the most fortunate moment of my life, followed by our unending exchanges on how to understand everything, from life to "blue infrastructures," by applying the "larger picture" perspective. The Indian Institute of Technology and my amazing mentors like Anuradha, PPC Sir, Manas Sir, Priyadarshi Sir, and many other supportive and friendly colleagues like Archana and Amrita played significant roles in making me tread the difficult path of translating historical urban political ecology into an "engaged praxis."

The final and the most important conjuncture in this long sojourn was the Carson Writing Fellowship, offered by the Rachel Cason Center for Environment and Society (RCC), Munich, which considered my book proposal worth funding and offered me the rarest opportunity to deeply concentrate, compile, think, and write, away from a mundane routine and tasks. The preparation for the lunchtime colloquium, the work-in-progress seminar, the best library for environmental humanities in the world, and librarians like Annika, academic exchanges with the RCC director Christof Mauch and urban environmental historians and social scientists like Robert Gioielli, Élisabeth Abergel, Ruma Chopra Julie Sze, Matthew Klingle, Rae Choi, Anne Rademacher, Gerald Aiken, Dominic Hinde, Anna Pilz, Diana Romero, Erin Ryan, Saba Pirdazeh, Astrid Bracke, Geoffrey Craig, Eva Horn, Ariane Tanner, Seth Peabody, Ronald E. Doel, Matthew Booker, and Neil Maher over the five long months of writing this book can be considered as the highest boon and blessing. Daily discussions on the different sections of the book with Rob at my RCC office and over long lunches with Élisabeth at the RCC kitchen benefited me so much. In spite of her own writing assignment deadlines, Élisabeth took the trouble and pleasure of going through my chapters and provided detailed comments and feedback on structure, content, and language. Ruma Ma'am and Saba's detailed

feedback on my introduction and conclusion helped me restructure portions and refine my arguments and frame of analysis with confident and clear strokes. Julie provided me with pertinent reading materials. Matthew spent so much time with me over coffee, imparting training on urban environmental history and motivating me with his own phenomenological experiences while writing the award-winning *Emerald City*. Anne was so kind to invite me over lunch to discuss my book project with her; she openly talked about how and why she thought this book project and my presence at the RCC was so important to narrate stories of the urban global South.

I am grateful to Dominic Regester for inviting me as the panelist at the Salzburg Global Seminar held between May 30 and June 5, 2019, on "Parks for the Planet Forum, Partnerships for Urban Wellbeing and Resilience: Harnessing Nature and Protected Areas for the SDGs," where I got the opportunity to discuss and engage with fellow participants representing different urban think tanks and institutes including Russell Galt, Director, Urban Alliance, International Union for Conservation of Nature, and Ingrid Coetzee, International Council for Local Environmental Initiatives.

I also had the opportunity to discuss the book project with Debjani Bhattacharyya (Drexel University), Rohan D'Souza (Kyoto University), Natasha Cornea (University of Birmingham), Sutapa Chatterjee Sarkar (West Bengal State University), Suchetana Chattopadhyay (Jadavpur University), Mahua Sarkar (Jadavpur University), and historian Chittabrata Palit who provided valuable insights and inputs on the different components of the book at different stages. I am grateful to Shinjini Chatterjee (Commissioning Editor, Springer Nature) for her comments on the book title and structure and also for insisting that I write this book followed by my edited volume *Sustainable Urbanization in India* (2018) published in the same book series.

I would like to acknowledge Sasidulal Ghosh (leaseholder, Jhagrashisha *bheri*), Gobinda Sardar (Baro Chaynavi Matsyabay Samiti), Bidisha Chakraborty and Sarmistha De (WBSA), Librarians (Town Hall), Antonia Moon (British Library), Asish Ghosh (Centre for Environment and Development), Nitai Kundu (IWMED), Naba Datta (Sabuj Mancha), Jayanta Basu (EnGIO), Sushovan Dhar (Manthan), Gautam Sen (Manthan), Mohit Ray (Vasundhara Foundation), Subhas Datta (environmental activist), Asit Ray (Green Circle), Abhijit Mukherjee (Department of Geology and Geophysics, IIT Kharagpur), Kalyan Ghosh (KEIP), Subhrajit Mukherjee (KEIP), Dipankar (KMDA), Kousik Mandal (I&WD), and many others including the fishers, farmers, and canal bank households who facilitated my empirical investigations. My former IDSK M.Phil. student Joy Karmakar prepared the maps and provided me with comments and feedback on my draft chapters. My junior from Jadavpur University, Basudhita Basu collected archival materials at the National Archive of India, New Delhi. My Ph.D. scholars Shreyashi Bhattacharya, Lina Bose, and Archita Chatterjee facilitated the archival research, and Shreyashi also went to the wetlands to collect some missing information that was urgent when I was away from Kolkata on the book writing fellowship. My Ph.D. scholars Saurabh Sharma, Maneesh Rawat, and Amit Kumar Das provided me technical

support by scanning materials and I will always cherish Prithwinath's good wishes and care for me.

The support and constant encouragement of my family due to which I have been able to pursue this dream project and avail this fellowship, cutting off ties from them for the time being for reaping the fruits together forever, are commendable. I am sincerely grateful and thankful to Subhadeep (my husband) who has walked this entire path with me, encouraging, loving, supporting, and trusting me and this book project through thick and thin. Jeeshu (my six-and-a-half-year-old son) has never complained of my hectic schedule and cooperated in the best way possible without which this would not have been possible. I consider Bamma's (my grandmother's) blessing and love as the strongest pillar helping me fight against all odds. Ma, Papa, Mami, Utsab, Debi, and Mona have been instrumental through their unconditional love and care since my childhood and adulthood. Debi listened to the same ideas a thousand times without complaining and getting bored, and I kept achieving clarity through this exercise. I am so grateful to her.

The comfortable stay at Uli Uncle's place in Munich and our sessions of serious exchanges every night on my book sections complemented by rounds of laughter and visits to the Alpine range provided me the peace of mind to concentrate on my work, away from family. Marcella took me to the English Garten and showed me the Eisbachs when I was about to start this writing assignment the very next day. I will remain extremely indebted to them forever.

Many names associated with this decadal journey have been lost from my field diaries; they have not been included here. But they strongly exist as eternal figures, exerting their sharp prominence through the very existence of this book.

Kharagpur, India Jenia Mukherjee

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About the Author

Jenia Mukherjee is Assistant Professor at the Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur. She is also a joint faculty at the Rekhi Centre of Excellence for the Science of Happiness. Her research interests include urban sustainability, environmental history, political ecology, and development studies. In 2013, she was awarded the World Social Science Fellowship on Sustainable Urbanization by the International Social Science Council. She has published papers and chapters in peer-reviewed journals and edited volumes, and has engaged in international projects on urban environmental issues. Her most recent book (edited) is *Sustainable Urbanization in India: Issues and Challenges* (Springer, 2018). She is the guest editor for the forthcoming (July 2020) special section 'New Epistemologies of Water in India', *Ecology, Economy and Society—The INSEE Journal*. She was awarded the prestigious Carson Writing Fellowship (2018–19) by the Rachel Carson Center for Environment and Society, Munich for completing this book project *Blue Infrastructures: Natural History, Political Ecology and Urban Development in Kolkata*.

Abbreviations

ADB	Asian Development Bank
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BDP	Basic Development Plan
CEMSAP	Calcutta Environment Management Strategy Action Plan
DoE	Department of Environment
DoF	Department of Fisheries
DPP	Development Perspective Plan
DWF	Dry weather flow
EIA	Environmental impact assessment
EIC	East India Company
EKW	East Kolkata Wetlands
EKWMA	East Kolkata Wetlands Management Authority
EM Bypass	Eastern Metropolitan Bypass
GBI	Green and blue infrastructures
GoWB	Government of West Bengal
I&WD	Irrigation and Waterways Department
ICT	Information and communications technology
IDA	International Development Association
IIT	Indian Institute of Technology
IWMED	Institute of Wetland Management and Ecological Design
IWMI	International Water Management Institute
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KEIIP	Kolkata Environmental Improvement Investment Program
KEIP	Kolkata Environment Improvement Project
KII	Key informant interview
KMC	Kolkata Municipal Corporation
KMDA	Kolkata Metropolitan Development Authority
MEA	Millennium Ecosystem Assessment
MLD	Million liters per day
MT	Metric tons

NRCD	National River Conservation Directorate
PIL	Public interest litigation
PUBLIC	People United for Better Living in Calcutta
SAFE	South Asian Forum for Environment
SDGs	Sustainable Development Goals
SFDC	State Fisheries Development Corporation
SWF	Storm water flow
T&CP Act	West Bengal Town and Country Planning Act, 1979
UBJM	Ucched Bachao Jukta Mancha
ULB	Urban local bodies
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UPE	Urban political ecology
WBHIDCO	West Bengal Housing Infrastructure Development Corporation
WHO	World Health Organization
WRR	Waste recycling region
WSP	Waste stabilization pond
WUC	Wastewater users committee

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Chapter 1
Introduction: Navigating Blue Infrastructures Along Historical and Political Ecological Realities

1.1 The Context

As I write the introduction for this book at the Rachel Carson Center for Environment and Society, Munich, 400 urban specialists from different parts of the world, including academicians, policy makers, consultants, members of NGOs, and artists, are collaborating at The Nature of Cities (TNOC) Summit in Paris in order to forge a transdisciplinary movement for green cities that are just, livable, resilient, healthy, and sustainable. At this summit, the Technical Expert Group of the International Union for Conservation of Nature (IUCN) Urban Alliance is brainstorming about what should go into the "Urban Nature Index" (UNI). The index is targeted to enabling cities to measure, value, and conserve nature within and beyond their boundaries, addressing pressing urban challenges such as flooding, heat stress, and pollution, and identifying and refining indicators at different scales: within cities (urban); in the immediate hinterland of cities (bioregion); and far beyond cities (global).

The recent flurry of events with "urban nature" as their main theme has to be contextualized within the era of the "Urbanocene," a term which signifies the contemporary rate, scale, and shifting geographies of urbanization, bringing extreme challenges like urban demographic growth, carbon emissions, greater global economic integration with growing volatility and increasing ghettoization, and the global South as the locus of urbanization (Mendieta 2019). The "environment" has now prominently entered into the urban planning discourse and praxis, with planners and experts being desperately keen to generate data on different urban environmental components such as water and air pollution, carbon emission and sequestration, and ecosystem services offered by parks, water bodies, etc. These sophisticated sets of data are enabling the development of indices to measure, test, verify, and validate the resilience of cities, preparing planners and policy makers to come up with prescriptions that can be immediately acted upon, involving huge funds and several actors. However, the crucial question in this

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regard is: how to make indices inclusive and frameworks meaningful? Though numbers have a significant appeal for investors and policy makers for the identification and rolling out of SMART (specific, measurable, attainable, relevant, and time-bound) goals and their implementation, yet they are not self-sufficient by their very definition. Numbers without stories, and data suggesting "the same size fits all" approach, are not only theoretically incomprehensive, inauthentic, and superficial, but have also been misleading, causing irreversible errors and problems in urban planning and execution. The implications of this for the huge, complex, and diverse South Asian cities remain underexplored, as this region is yet to occupy the much-required space in global urban environmental understanding, debates, policy dialogues, and initiatives.

Numbers have to be padded with stories rooted to their own contexts, encompassing dynamic elements traveling across shifting temporal scales and changing political conjunctures, connecting past, present, and posterity. Data is much more meaningful if it evolves extensively and gets informed by in-depth explorations of specific contexts, capturing micro-political processes and bringing to the forefront an "epistemology of particulars" (Castree 2005). Each city has its own narrative and "it unfolds in its own way" (Moore 2007, p. 23). It is important to capture these realities across stories and conversations, or what Moore (2007) conceptualizes as "story lines." "There are dominant, counter, and even suppressed story lines in each city that demand our attention" (Moore 2007, p. 23). And herein lies the importance of a rich ethnography dedicated to detailed and rigorous readings of particular urban environmental contexts, which are not "apolitical" spaces by any means. Ethnography complemented with archival research provides these realities with temporal edges, helping us discern their evolution and transformation, a key exercise (often ignored but gaining significant ground recently) in order to dig deep into the roots of urban sustainability. This account of Kolkata's "blue infrastructures" is crafted along similar lines and directions.

1.2 Blue Infrastructures of Kolkata

> The king of Oudh, Sagar, who was the 13th ancestor of Lord Rama and the 7th incarnation of Lord Vishnu, performed the Ashvamedha Yajna 99 times.[1] He was desperate to undertake it one more time, but Lord Indra, the king of heaven, who had already performed

[1]The Ashvamedha Yajna is a horse sacrifice ritual followed by the Śrauta tradition of the Vedic religion. It was performed by the ancient Indian kings to prove their imperial sovereignty. A horse accompanied by the king's warriors would be released to wander for a period of one year. In the territory traversed by the horse, any rival could dispute the king's authority by challenging the warriors accompanying it. After one year, if no enemy had managed to kill or capture the horse, the animal would be guided back to the king's capital. The horse would then be sacrificed, and the king would be declared as an undisputed sovereign. https://en.wikipedia.org/wiki/Ashvamedha (accessed May 23, 2019).

> it a hundred times and had thus earned the title Satamanna, was jealous of being displaced by Sagar. He subsequently stole the horse and concealed it in a subterraneous cell, where the sage Kapilmuni was meditating. The 60,000 sons of Sagar started searching for the horse and ultimately they traced it to the place where it was hidden. They assaulted Kapilmuni, believing that he had committed the theft. The sage cursed them and they were burnt to ashes. A grandson of Sagar came to Kapilmuni and begged him to redeem the souls of the dead. Kapilmuni decreed that this would only be possible if the waters of the Ganga (the aqueous form of Vishnu and Lakshmi) could be sprinkled on the ashes. Bhagirath, the great-grandson of Sagar, prayed to Brahma, the Creator, who sent Ganga to earth. Bhagirath led the way as far as Hathiagarh in the 24 Parganas, but could not show the rest of the way. Ganga, in order to make sure of reaching the place, divided herself into numerous channels, and thus formed the delta. One of the channels reached the cell, washed the ashes, and purified the souls which could then reach heaven. Ganga became the sacred stream; the sea took the name "Sagar." This junction where the river meets the sea is still worshipped by the Hindus and is a place of Hindu pilgrimage (the legend of Sagar, based on Hunter 1875, pp. 27–28).

The legend of Sagar, transmitted through oral traditions among Bengalis, encapsulates the essence of the scape: the delta, manifesting not only a rich assemblage of channels in the form of distributaries of the mighty river Ganges, but also a conscious understanding of the multiplicity and plurality of its being, blurring land–water boundaries and crafting the continuous making, unmaking, and remaking of this fluid and dynamic muddyscape. A longue durée approach to capturing the dynamicity of the delta through nuanced explorations of the constant interplay among land, water, and mud unveils how this space could determine, and in turn get determined by, political fate, economic calculations, and social livelihoods across changing temporal trajectories and shifting political-economic imperatives that carry long-term and large-scale implications for sustainability. "Blue infrastructures" is the overarching and all-encompassing story of the making and unmaking, shaping and reshaping of the space. It is a story comprising the interplay between complex narratives of continuous functioning of the natural and the cultural, the physical and the manufactured, the tamed and the untamed, where these remain enmeshed as embedded entities, infusing meanings into this integrated scape. "Blue infrastructures" has to be understood, conceptualized, and recognized as a composite whole, formed of components intricately intertwined with each other as inseparable constituents, merging with, making, and continuously influencing its evolution and unfolding over space and time.

The concept of "blue infrastructures" has entered urban planning and management discourse and praxis during recent times, and is considered fundamental to a healthy, livable, and climate-resilient urban environment. Urban green and blue infrastructures (GBI) are considered a subset of "Sustainable and Resilient Infrastructure" (SuRe), the recently developed global voluntary standard that integrates key criteria of sustainability and resilience into infrastructure development

and upgradation.[2] In February 2019, Wetlands International organized an event relating to blue-green infrastructures for urban resilience at the European Union Forum on "Cities and Regions for Development Cooperation."[3] Big projects are being funded and conducted on urban GBI, establishing a direct correlation with human well-being. In these investment-laden technical exercises, GBI design principles are formulated using infographics, providing information on the effectiveness of these eco-friendly spaces and influencing investment decisions. Emphasis is placed on rooftop rainwater harvesting in multi-storied residential and official buildings, storm water management, sustainable energy production, tree plantation, etc. Capturing benefits from blue and green is the key motto determining the effectiveness of these technical templates, as manifested in the argument that these infrastructures provide ecosystem services the extraction of which is imperative for the survival and functioning of cities.

Recent urban environmental management literature has studied the differences between GBI and grey infrastructures, the former implying biophysical ecosystems and their services, and the latter signifying engineered structures like excavated canals, drainage pipes, floodgates, storm sewers, etc. (Grimm et al. 2016; Jones et al. 2012). This scholarship argues that blue infrastructures (comprising all bodies of water—ponds, wetlands, rivers, lakes and streams, estuaries, seas and oceans) should not encounter technological interventions in order to retain their natural ecosystem service flows (Renaud et al. 2013; Sudmeier-Rieux 2013), which are also related to human psychological well-being (Gómez-Baggethun et al. 2013). However, Kabisch et al. (2017) develop the concept of "hybrid infrastructures" using the socio-ecological-technological systems (SETs) framework, demonstrating how, within today's urban environmental context, ecosystem services complemented by technological or built infrastructures can be considered as the best possible solutions.

The particular story of the "blue infrastructures" of Kolkata that this book offers is a critique of the above-mentioned approaches, which are linear, reductionist, and too technocratic. Kolkata's "blue infrastructures" story is multilayered and complex, and has been largely contextualized here within contemporary social sciences understanding of infrastructures and beyond. *The Promise of Infrastructure*, edited by Anand et al. (2018), is a recent contribution to social sciences approaches to infrastructures, offering cutting-edge research work on the subject as well as providing a detailed review of literature on the topic. Understanding infrastructures as technological expositions that require only engineering expertise abstract them from social, political, and cultural realities and meanings. Infrastructures have histories, and they grow and evolve in a dynamic temporal, spatial, and political environment

[2]Global Infrastructure Basel (GIB), http://www.gib-foundation.org/sure-standard/. (accessed June 21, 2019).

[3]"Green-Blue Infrastructures for Urban Resilience: Partnerships to Turn Policy into Urban Resilience Practice—Wetlands International Event," https://europa.eu/capacity4dev/public-urban-development/events/green-blue-infrastructures-urban-resilience-partnerships-turn-policy-urban-resilience (accessed June 21, 2019).

(Edwards et al. 2009). "Material infrastructures, including roads and water pipes, electricity lines and ports, oil pipelines and sewage systems, are dense social, material, aesthetic, and political formations that are critical both to differentiated experiences of everyday life and to expectations of the future" (Anand et al. 2018, p. 3). Graham and Marvin (2001), borrowing from Williams (1973), show that infrastructures are not merely aloof hardware networks but invoke "structures of feeling." The authors demonstrate how infrastructures "give shape to and are shaped by everyday lived experiences across sentiments of hope, inclusion, violence, and abandonment" (Anand et al. 2018, p. 11). While urban geographers have drawn attention to the material forms of infrastructure and the ways in which they differentiate and structure urban life, anthropologists have minutely explored and analyzed lived experiences of unequal provisioning and differentiated belonging in cities (Caldeira 2000; Chu 2014; Schwenkel 2015). Anthropological and, more specifically, ethnographic attention to infrastructures reveals how politics not only are formed and constrained by juridico-political practices, but also take shape within a technological terrain consisting of water pipes, grid lines, etc., providing a frame to defamiliarize and rethink the political (von Schnitzler 2015).[4]

The urban political ecology (UPE) literature, and, more specifically, literature on the political ecology of networked infrastructures (Monstadt 2009), has ingeniously fused (or rather, exposed) politics and power asymmetries ingrained in infrastructures' life span across pre-implementation, implementation, and post-implementation stages, traversing design, financing, construction, completion, maintenance, repair, breakdown, obsolescence, and ruin (being permanently dead or getting restored, facilitating the whole sequence again). Infrastructure is "politics pursued by other means" (Latour 2012, p. 38). Questioning the singularity, ubiquity, and linearity of infrastructures, Graham and Marvin (2001) unveil dynamic and congealed processes of the workings of finance, knowledge and power imbricated in them:

> When our analytical focus centers on how the wires, ducts, tunnels, conduits, streets, highways and technical networks that interlace and infuse cities are constructed and used, modern urbanism emerges as an extraordinarily complex and dynamic socio-technical process.… As capital that is literally "sunk" and embedded within and between the fabric of cities, [urban infrastructures] represent long-term accumulations of finance, technology, know-how, and organizational and geopolitical power. (Graham and Marvin 2001, p. 8)

The "blue infrastructures" of Kolkata offer the complex narrative of co-evolution and co-functioning of hard, soft, and ecological infrastructures that evolved extensively over time across tangled interactions among city, nature, and technology. It would not be an exaggeration to argue that it is in these "blue infrastructures" that the anecdote of origin, the account of functioning, and the apprehension of survival of the city are rooted. These comprise the cyclical history of ecological

[4]The relationship between infrastructure, environment, and modernity has been addressed by anthropologists since the beginnings of the discipline (Anand et al. 2018). Some of the significant works, among many others, include: Ballestero (2015), Geertz (1972), Harris (1966), Lansing (1991), Mauss (2008), Steward (1955), White (1943).

infrastructures (in the form of the river Hooghly in the west, the river Bidyadhari in the east, the saline marshes further east, and numerous channels and creeks in between) influencing the colonial selection of the site as the potential seat of the imperial capital, and the urban, in turn, crafting transformations in the environment, and the co-evolution of the urban and the environment, with changing interactions between them across shifting political trajectories, impacting urban sustainability. The account is thickly loaded with multilayered existence, encounters and exchanges among engineers, planners, municipal officials, farmers, fishers, and the citizens of Kolkata including middle-class environmental enthusiasts, grassroots activists, and squatter settlers inhabiting the banks of excavated canals circulating the city and playing key roles in urban utilities. These "blue infrastructures", in the form of natural and excavated canals, wetlands, etc., as an integrated space, chronicle the evolution of networks through the tamed interventions of technologies, incentivizing upon ecological resources, including their disruption across a succession of new technologies, and a predilection for revival and restoration, everything connected to and determined by the politico-economic imperatives of statecraft and interlinkages between global visions and local realities. Inseparable global–state, municipal–local, bureaucrat–citizen, and human–non-human interactions made way for the "blue infrastructures" to be understood as "living systems infrastructures" (Carlisle 2013), extensively evolved over time through complex interplay among an array of technical and social variables.

Why is this understanding and mapping of Kolkata's "blue infrastructures" relevant? Briefly, this endeavor is key to addressing the major question that the delta city is confronting during the "Urbanocene": Is Kolkata environmentally vulnerable or ecologically subsidized? That Kolkata is one of the delta cities most vulnerable to climate change and natural disasters has been attested by detailed scientific research pursued by international organizations (OECD 2007; World Bank 2011). However, despite these studies, opinions diverge among academics, scientists, and policy makers. Recent research by Bhattacharyya (2018) demonstrates that the contemporary urban sprawl of Kolkata, by encroaching upon its wetlands, is a colonial legacy of property-making initiatives, entirely suited to capitalist calculations of profit. The work addresses a deliberate amnesia about the soaking ecologies of the Bengal Delta by historically tracing an engaging tale of colonial property making in the marshes. The research shows how this expanding urban property market continues to shape the current landscape of the city with devastating consequences, as manifested in the Bay of Bengal's receding coastline.

> The construction boom, which began in the early decades of the twentieth century, is intricately linked with the rapidly vanishing coastline of the Bengal Delta. To this day, the annual cycle of floods that drown the low-lying parts of Bengal … manifest themselves as disasters when the river violates the human-made demarcations between land and water. (Bhattacharyya 2018, p. 40)

While Bhattacharyya (2018) contextualizes Kolkata's contemporary climate challenges within the historical transformation of the unique ecology of Bengal's littoral into solid foundations geared towards private capitalist accomplishments,

ecological engineers and urban ecologists-cum-bureaucrats like D. Ghosh and A.K. Ghosh, urban experts like Nitai Kundu, and World Wide Fund for Nature (WWF) funded researchers and project investigators like Stuart Bunting argue that Kolkata's ecological infrastructures in the form of rivers, canals, and wetlands offer multiple ecosystem services (including carbon sequestration and flood regulation), and are major incentives for keeping utility costs very low and affordable compared to other Indian metropolises. They consider Kolkata as an "ecologically subsidized" city with triple blessings: the Hooghly River managing its drinking water needs, the Kulti River acting as the outfall channel, and the wetlands in between to treat municipal wastewater and solid wastes free of costs. Hence, while on the one hand, its location on the north of the Sundarbans delta and only 1000 km from the Bay of Bengal makes Kolkata highly vulnerable to climate change (World Bank 2011), on the other hand, the same deltaic attributes serve as lifelines for the city. Addressing the intersections of these two major arguments, this book reveals that Kolkata's vulnerability and viability are not mutually exclusive. Rather, their shifting situatedness is rooted in the larger environmental template in which the emergence and expansion of Kolkata are embedded.

In this book, I argue that Kolkata's resilience depends upon optimizing on her "blue infrastructures" through a comprehensive understanding and recognition of the cyclical, mutual, and reciprocal "sustainable flows" (Mukherjee 2015) between the city and its ecological infrastructures. The book demonstrates why and how understanding "blue infrastructures" through detailed explorations of its evolution and functioning by unpacking complex entanglements among city–nature–technology dynamics across mediations among multiple actors along historical scales is the first step in this exercise. It is within this context that the application of the historical urban political ecology (HUPE) framework, combining urban environmental history and urban political ecology, appears to be the most useful way to capture the multilayered and interdependent technical and political processes, complexities, and realities comprising Kolkata's "blue infrastructures."

1.3 Historical Urban Political Ecology: What, Why and How?

There can be no single definition and conceptualization of political ecology. It is a robust and diverse field "with origins and trajectories resembling more closely a tangled evolutionary lineage than a neat family tree" (Perreault et al. 2015, p. 3). It is neither a branch of politics, nor a branch of ecology (Hayward 1994). That ecology is not apolitical or neutral, but that politics and environment are thoroughly connected on multiple scales and levels, and access to and control of natural resources are structured by power relations in human society, are the fundamental arguments of the political ecological approach. Initially influenced by Marxist agrarian studies, the early political literature of the 1970s and 1980s gave rise to a

succession of conceptualizations of nature–society interactions based on broader political-economy contextualization of resource management practices, sharply criticizing neo-Malthusian interpretations of environmental scarcity and the apolitical nature of the fields of cultural ecology and hazards studies (Wisner 1978; Watts 1983, 2013; Blaikie and Brookfield 1987; Bassett 1988; Hecht and Cockburn 1989). Political ecology has experienced a "meteoric rise" (Perreault et al. 2015, p. 3). In the second edition of *Political Ecology: A Critical Introduction* (2012), Paul Robbins reflects that between the publication of the first edition of the book in 2004 and the second edition, the field had grown dramatically and in multiple directions; it now reflected a "range of approaches" (Robbins 2012, p. vii). Opinions on the field vary, from referring to it as a diversity of theoretical and methodological approaches in academics (Bassett and Peimer 2015), to a "community of practice" (Robbins 2012, p. 5). Not only has the field of political ecology attracted scholars from academic disciplines cutting across both the social and natural sciences, but countless practitioners are also committed to this framework, applying it in their action researches.

"Third World political ecology" emerged in the 1980s against the backdrop of a pressing need for "an analytical approach integrating environmental and political understanding" in a context of intensifying environmental problems in the Third World (Bryant 1992, p. 12). While political ecology in the global North remained concerned with agrarian political economy, indigenous livelihoods, and resource governance, it emerged as a useful tool for the global South with its additional environmental justice challenges due to the colonial exploitation of nature and native and its continued legacy in contemporary times. Guha and Martinez-Alier (1997) identified the distinct variety of environmentalism for the global South, "environmentalism of the poor," demonstrating how livelihood concerns occupy the central tenet of the eco-socialist movement, struggling for sustainable development alongside social justice and ecological sustainability.

More recently, to understand the environmental dynamics of the more complex urban space, especially within the context of rapid planetary urbanization, the basic notion of the underlying interconnectedness of human and natural processes has been extended to the foreground of the "urban" through urban political ecology (Keil 2003). Urban political ecology investigates how a particular urban environment is produced, and who gains and who loses due to particular power relations influencing changes within the urban environment and in the coproduction of urban society and environment (Braun and Castree 1998; Kaika 2005; Heynen et al. 2006; Swyngedouw 1996, 1997; Swyngedouw and Heynen 2003)—in short, "who controls, who acts and who has the power" (Swyngedouw 1999, p. 461). Urban political ecology explains how urban processes shape the way in which natural resources are exploited and how urban metabolism produces both enabling and disabling social and environmental conditions (Heynen et al. 2006). It reveals how "nature in cities (and beyond) is socially produced, guided by social, economic, and political processes, and embedded within varying power relations" (Monstadt 2009, p. 1933).

Focusing on urban networks and utilities and the power equations surrounding these, the UPE of water has emerged as a robust field discerning the politics of drinking water circulation and distribution among various user groups (Swyngedouw 1997; Bakker 2003; Gandy 2004, 2008; Loftus and Lumsden 2008; Anand 2011, 2017; Ranganathan 2014). This now also includes wastewater: from waterscape, UPE has enlarged its vista to waste waterscape to establish the strong connection between waterscape and the politics of wastewater (Karpouzoglou and Zimmer 2016). Situating wastewater as part of the waterscape incorporates a full understanding of the socio-natural transformation of water as it occurs not only through production and consumption, but also through the disposal of wastewater (Gandy 2008; Jewitt 2011; McFarlane 2012). Karpouzoglou and Zimmer (2016) advance the UPE lens by demonstrating how wastewater is embedded in an arena of social relations of power. They show how different ways of knowing about wastewater exist amongst the inhabitants of an informal settlement, scientific experts, and municipal workers in Delhi. The study discloses that the systemic exposure of poorer urban citizens to untreated wastewater cannot be attributed to the shortcomings of service delivery alone, but is more fundamentally associated with how legitimacy is awarded to competing systems of knowledge about wastewater in the urban sphere (Karpouzoglou and Zimmer 2016).

The uneven geographies and unequal power hierarchies attending water access and distribution and wastewater disposal form the key component of UPE research, which mainly deals with "flowing waters." However, more recently, there has been a shift to unveiling the uncharted terrain of "many waters," and the case studies on Indian cities are noteworthy in this regard (Mukherjee 2018, p. 261). Focusing on the imaginings, appropriations, and contestations that make way for the unfolding of waterscapes, Baviskar (2011) shows how the Yamuna riverbed has changed from being a neglected non-place to prized real estate for private and public corporations by tracing the shifting visibility of the river in the social and ecological imagination of Delhi. Taking into account both material spaces (geographic territories) and environmental narratives (discursive representations), and using the Yamuna riverfront in Delhi as a case study, Follmann (2015, 2016) applies the concept of "riverscape," acknowledging the assemblage of multiple human and non-human actors and processes transforming urban rivers across space and time. Mukherjee (2016) emphasizes the shifting development perspectives that resulted in the transformation of the heritage Adi Ganga River into a pillar-ridden sewer in Kolkata. Political ecologists have explored everyday negotiations over access to composite water resources, such as lakes and ponds, that are simultaneously water, land, and public space (Cornea et al. 2016; Singh et al. 2018).

Contemporary UPE literature is overtly declensionist; the narratives and discourses are woven along a web of decline through pessimistic portrayals of environmental injustice and analysis of city–nature equations from the domination–subordination lens. Urban political ecology suffers from a reductionist mapping of power asymmetries and class hierarchies in accessing resources, where final decision making is determined and dominated by the interests of capital and powerful lobbies tied across global, national, and local scales. In the emerging situated urban

political ecology (SUPE) framework, scholars have come up with more sophisticated analyses to overcome this overgeneralization, pushing forward the "situatedness" of the place through detailed understanding and critical analysis of place-based narratives. Situated urban political ecology has evolved as a significant approach enriching UPE's theoretical base with concepts that arise from the everyday workings of the state and acknowledgement of the greater complexities of urban society in order to better understand the production of urban environments, especially within the South Asian context (Zimmer 2015). Though urban ecologies are produced in a context of "embeddedness in multiple elsewheres" (Mbembé and Nuttall 2004) and are globally "networked" (Lawhon 2013), Indian case studies have particular contributions to make in their own way (Zimmer and Cornea 2016). They work to counter the normalized assumption that the middle class always works against the poor within environmental activism, and further complicate class binaries in order to understand contemporary power dynamics in Indian cities (Follmann 2016).

This book applies historical urban political ecology (HUPE) as a methodological tool and framework by combining ethnography-based empirical investigations with archival knowledge. Through its different chapters, it shows how and why adding a temporal scale to political ecological understanding is extremely significant. A quick review of (urban) environmental history will provide further insights and directions as to how and why urban environmental history and urban political ecology can combine and converge towards the formulation and implementation of a comprehensive and robust frame of analysis, identifying both challenges and potentials within urban environmental contexts.

After the long-standing perception of cities as the antithesis of nature, urban environmental history emerged in the West during the 1990s as a major sub-field of both urban and environmental history. Research on urban technical infrastructures (utilities) developed by North American historians like Joel Tarr and Martin Melosi in the 1970s had provided the immediate backdrop and framework for the evolution of urban environmental history. However, the Rio conference on "Sustainable Development" in 1992 provided "a strong motivation for urban historians to ask to what extent cities had been 'sustainable' in the past, when and why there had been qualitative changes and ruptures in the ways cities managed their environment and used their resources" (Schott 2004, p. 520). Moreover, the "Urbanocene" created the need for urban and environmental historians to converse with each other in order to grasp from different angles the multiple meanings and significance of the "urban" and the "environment" and their overlaps, encounters, segregations, and cohabitations in very specific contexts that might resonate across or be very different from other historical and geographical conjunctures.

> The fact that many cities not only in the most developed countries of North America, Europe and East Asia but also the megacities of developing countries have a huge ecological footprint raises in historical perspective the question … how cities have been able to sustain themselves, to procure the necessary resources for their reproduction without threatening the ecological stability of their hinterlands. (Schott 2014, p. 171)

Historians started examining the place of nature in the city, and the place of the city in nature, blurring nature–culture, city–nature binaries. While Tarr and Dupuy (1988), Tarr (1996, 2002), and Melosi (1980, 2000, 2001) addressed the intersections between city, nature, and technology across historical scales, Cronon (1991) explored the intricate connections between cities and their hinterlands. European historians like Barles (2005) and Neri Serneri (2005) infused the concept of "urban metabolism" in the history of infrastructures, tracing and quantifying flows of water and waste and illustrating that pre-industrial cities like Paris and Milan had elaborate systems to cater for urban metabolism that were replaced by modern technical networks. The modern technological interventions, while solving immediate sanitary problems, created a range of collateral challenges, impacting larger questions of urban sustainability. With urban environmental challenges taking more complex turns during contemporary times, the themes and scales of explorations are taking on new dimensions. "Sprawling urbanism" in the United States and the reinvigorated environmental movement have provided fresh provocations to historians of the twenty-first century to explore multilayered complexities across class, race, and ethnic lines within the changing urban environmental scene (Rome 2001; Klingle 2007; Thrush 2007; Gioielli 2014).[5]

South Asia occupies a prominent position in terms of the emergence and expansion of environmental history; only "in India … have environmental historians attracted the attention of their fellow historians as successfully as in the U.S." (McNeill n.d.). Yet, "the biggest lacunae within the historiography on South Asia's environmental history" is "the lack of studies on urban environments" (Wilhelm 2016, p. 11). Much before Mann (2013, p. 352) pointed out this "highly neglected field which should … be put on the agenda of South Asia's environmental history," in "What Next for Environmental History?," Guha (2005) asserted that within the changing context of India's having the largest urban population in the world, Indians know far less than they "ought to about the history of ecological conditions within cities or their claims on the resources of the hinterland." Mainly since the last decade, South Asian urban environmental history has been gradually unfolding with historians' (restricted) focus on utilities and pollution (Anderson 1995; Broich 2007; Das 2007; Mann 2007; Sharan 2011, 2014, 2017; Arnold 2013; Chakrabarti 2015). Wilhelm's (2016) work on colonial sewerage technologies on the Ganges is a major contribution beyond the reductionist urban environmental history of sanitation restricted to major Indian cities like Delhi, Calcutta, and Mumbai. Highlighting the important role played by smaller cities such as Banaras and Kanpur, Wilhelm sheds light on the formation of colonial river pollution and sewage disposal policies. The author not only traces debates and policy making through the central, provincial, and municipal layers of the colonial administration with an in-depth analysis of argumentative strategies, but also captures arbitrations

[5]Shedding light on the nature and pattern of "sprawling urbanism," Culver (2014, p. 561) reflects, "Instead of bringing nature into the city, Americans took their cities out into nature, unleashing vast changes in the landscape of the nation".

among colonial and native actors, showing "how local interest groups, such as Hindu citizens and industrialist lobbies, actively influenced official policies" (Wilhelm 2016, p. 10). Bhattacharyya (2018) offers a path-breaking contribution within the emerging domain of South Asian urban environmental history, succinctly fleshing out multilayered realities surrounding power, politics, bureaucracy, speculation, and legal maneuvering in the making or reclaiming of colonial Calcutta from the Ganges swamp (delta) between the second half of the eighteenth century and the early twentieth century. She provides an engaging account of colonial property making in the marshes through legal articulations developed as a response to ecological indeterminacies in the Bengal Delta, an admixture of land–water–mud–social relations. Bhattacharyya's work justifies why and how nuanced explorations of the tangled history of infrastructures and mediations among existing and new actors (hoarders, planners, land developers, etc.) remain extremely significant for understanding contemporary environmental vulnerabilities in deltaic cities of the global South, beyond mainstream quantitative (data-centric) and technical analyses.

The urban environmental social sciences scholarship is encountering a provocative transformative context. "[E]nvironmental and urban history are now engaged in one of the richest collaborative enterprises currently underway in any historical field" (Culver 2014, p. 567). Moreover, the ever-expanding evolution and enrichment of both urban environmental history and UPE through continuous explorations and emphasis on new and very different conceptual realms enable us to comprehensively capture complexities within the more complex, contemporary urban environmental scene by recognizing both challenges and potentials through the application of multidimensional heterodox and hybrid approaches. Within this context, HUPE has been formulated to explore city–nature equations across long-term temporal scales, involving multiple actors and mediations among them, determining, and in turn getting determined by, urban environmental trajectories and transformations (Fig. 1.1).

I have formulated and applied HUPE by combining archival and qualitative research methodologies. Historical research through the implementation of archival research methodology provides temporal scale to political ecological understanding, enabling researchers to map transformations over a long period of time, exploring shifting priorities and political-economic imperatives of statecraft and arbitrations among multiple stakeholders during particular historical conjunctures. I have used qualitative research methodology based on rich and detailed ethnography to explore and capture mediations among actors over access, control, and influence vis-à-vis ecosystem resources, technology, and decision-making processes. Oral accounts facilitate historical (re-)construction through deconstruction of mainstream histories.

Cities, through intricate interactions with nature, evolve over time as situated, produced, and representational spaces. This dynamic and long-term evolution, embracing the element of "path-dependence," has been understood here through the application of HUPE. Through theoretically informed triangulation of multiple methods, I argue that HUPE can be relevant and useful for tracing not only situated

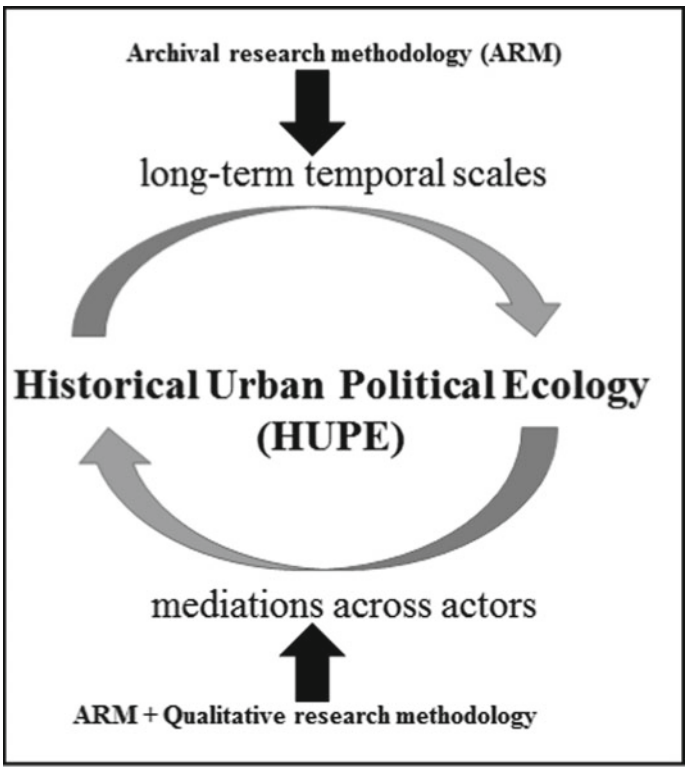

Fig. 1.1 The HUPE framework. *Source* Author

knowledges (Haraway 1988), but also situated perceptions, understandings, and practices through detailed compilation, interpretation, and dissemination of empirical investigations informed by access to archival records and field interviews, discussions, exchanges and narratives with anyone and everyone involved (including policy makers or bureaucrats, technocrats, engineers, planners, politicians, fishers, farmers, environmental activists, squatter settlers, etc.).

The HUPE framework is not altogether new. Political ecologists have drawn from a wide range of primarily field-based research methods, supplemented with in-depth archival analysis (Offen 2004; Kosek 2006; Davis 2007; Peluso 2012; Mathevet et al. 2015). In the earliest tradition in political ecology, why and how history matters is directly manifested (Watts 1983; Blaikie 1985; Blaikie and Brookfield 1987; Hecht and Cockburn 1989; Jarosz 1993; Peluso 1992). To capture the contemporary reality of marginalization and famine in Nigeria, Watts (1983) traced the historical intricacies of how African peasants were enfolded in the machinations of global capitalism. In Watts (2013), the significance of combining environmental history and political ecology is evident. Since archival documents are essentially class products, Watts warns that "the distorted optic provided by a

wholesale dependence on archival sources can, and I would argue must, be complemented by oral fieldwork" (2013, p. 34). On the other hand, Davis (2015) observes that "it is precisely the historical components of political ecology research that help to guard against 'apolitical' analyses." She claims that critical historical analysis should become more clearly articulated in the work of political ecologists (Davis 2015, pp. 263–264). Though explicitly used in very few works, historical approaches have provided an edge to UPE and strengthened it (Swyngedouw 1997, 2004; Sayre 2006; Hollander 2008).

Though environmental history in general has been criticized for the dearth of social theory (Sorlin and Warde 2007), environmental historians of the global South have more prominently embraced various forms of social theory and have been strongly informed by attention to political economy, policy, and narratives (Arnold 1996; Arnold and Guha 1998; Beinart 1984; Grove et al. 1998; Guha and Martinez-Alier 1997; Sutter 2003). However, with urban environmental history and UPE as budding domains within the context of the global South in general and South Asia (India) in particular, there is huge potential for scholars to converge historical and political ecology perspectives by looking back, in order to move forward. This involves, for example, mapping power equations, interests, and priorities among multiple actors along long-term scales. To date, very few studies addressing this crucial intersection (with varying temporal scales) can be considered as significant contributions or attempts in this direction (Coelho and Raman 2013; Mukherjee 2015; Sundaresan et al. 2017).

Drawing inspirations, insights, and directions from this literature, I have applied HUPE as a methodological tool to narrate the complex and lengthy account of the "blue infrastructures" of Kolkata to come up with findings that critically interrogate urban environmental narratives of declensionism as the only reality. With the awareness and understanding that each city has its own narrative, the "blue infrastructures" of Kolkata can at best be regarded as a case to demonstrate why and how HUPE can be a significant, relevant, and meaningful tool and frame of analysis as well as an important epistemological intervention by itself.

1.4 Book Structure and Thematic Organization

The structure of this book has an inbuilt temporal sequence: the colonial and the contemporary. But the chapters do not necessarily follow a strict chronological chain. Rather, they are organized across themes, making readers aware of the (shifting) political-economic priorities of particular historical conjunctures, crafting changing city–nature interactions with cyclical and far-flung implications for both the urban and the environment.

The first part of the book (Chaps. 2 and 3) describes the emergence and evolution of the urban (the deltaic city of Kolkata) from nature through a series of tamed interventions in the form of excavation of canals and reclamation of marshes initiated by the British colonizers. Before turning to a detailed focus on the complex

production of the scape making way for huge colonial capitalist profits (Chap. 3), untamed and non-intervened-in nature is introduced, making readers aware of the "swampy origins" and "watery roots" of present-day Kolkata. The deliberate agenda here is not only questioning the nature–culture or city–nature compartmentalization in urban social science scholarship, but also the great land–water divide which is inexorable in exploring delta cities (Chap. 2). These chapters draw heavily from archival sources and also rely on compiled sources and data available from secondary literature on the history of Kolkata's canals and wetlands. I have also consulted indigenous Bengali literature, mainly legends and folk narratives, to bring out the swampy origins and marshy roots of the scape from where the city was reclaimed. I have accessed the mainstream (colonial) archive to understand rulers' logic for selecting this particular site as the seat of the imperial capital in spite of continuous complaints about it as "wild," "unhygienic," and "unhealthy" during the initial years of settlement. Did the very ecological equations which were perceived as challenges offer economic incentives that British entrepreneurial eyes could not afford to miss? Using a wide range of colonial archival sources such as gazetteers, correspondence, extracts from diaries, medical reports, reports on period surveys of the Hooghly riverfront, etc., and also extracting information from secondary literature on colonial urban history, Chap. 2 demonstrates that the deltaic-estuarine scape, with the river Hooghly in the west, the river Bidyadhari and the Adi Ganga in the east, the saline marshes further east, and numerous distributaries of the river Ganges in its lower course, offered ecological advantages that far outweighed the disadvantages. With a detailed understanding of these incentives, mapped and validated across rigorous scientific investigations and making use of the then political situation of Bengal, the colonizers' next major target was to tame this space, facilitating its evolution as an urban site through the implementation of "modern" hydraulic technologies catering to the needs and requirements of colonial capitalism (Chap. 3). Though Chap. 2 explores deltaic dynamics as the key factor behind the imperial selection of this urban site, yet, by mapping political variables across conflicts, frictions, negotiations, and bargains between the colonizers and the local rulers, it also asserts that multiple realities, located at the complex intersections of environment, politics, and society, cannot be missed within the (urban) environmental history narrative.

Chapter 3 exposes readers to the more complex evolution of the urban, comprising tangled interactions between the urban–environmental and technical–social dimensions. While "colonial hydrology" (D'Souza 2006) instituted a new property regime through the deployment of numerous technical interventions like the construction of embankments and perennial irrigation systems in rural South Asia, to buttress imperial revenue collection strategies, urban hydraulic projects were geared towards similar objectives of profits on investments through a series of tamed interventions facilitating the evolution of networked infrastructures that performed the dual and parallel functions of trade-transportation and drainage-sewerage-sanitation. Using the perspective of UPE of networked infrastructures to better understand colonial urban environmental history, Chap. 3 employs archival research methodology (including both primary and secondary sources) to explore

debates and discussions surrounding various plans and designs relating to canal excavation and marsh reclamation among the different wings of the government including the Military Board, the Calcutta Corporation (henceforth the Corporation), the Irrigation and Waterways Department (I&WD), the Public Works Department, and different committees appointed by the government. It also traces clashing priorities between navigation needs and drainage-sewerage requirements, impacting investments in infrastructures. Using archival (administrative and revenue) records of the period between the 1770s and 1920s, the chapter weaves the complex web of city, nature, and technological history, reflecting on the colonial encounter between nature and native in a volatile, vulnerable, uncertain, "unhygienic," and "unruly" fluid scape.[6] The major moments in the ecological history of Kolkata, like the deterioration of the river Bidyadhari and its replacement by the river Kulti as the alternative outfall scheme in the 1940s, are illuminated with nuanced explanations and analyses of reasons and outcomes.

When the Kulti Outfall Scheme was implemented, there was a transformation in the ecological regime of the marshes from saline to non-saline, with the former being fed by wastewater carried by municipal canals. Moreover, an adequate water-head was raised for supplying sewage to most of these fishponds by gravity, which resulted in the extension of wastewater fishponds further east and south-east, leading to the formation of the East Kolkata Wetlands (EKW), the world's largest recycling ecosystem treating 750 million liters of wastewater generated by Kolkata per day. The city has no separate sewage treatment plant till date and entirely relies on this natural infrastructure for waste disposal and management! Municipal solid waste and wastewater are co-recycled through traditional recycling mechanisms and recovery practices pursued by fishers and farmers. Chapter 4 describes these "untamed practices" which have been recognized as locally driven, locally managed, and locally owned by fishers and farmers who, in spite of being harbingers of cost-effective waste management mechanisms, remain the worst sufferers and victims at the hands of the state. This chapter complicates the wetlands story by critically interrogating these binaries—state versus EKW, municipal versus local, urban versus rural, managerial versus environmentalist—by historically tracing the coproduction and co-evolution of the city and its peripheral wetlands.

With ethnographic work (including key informant interviews [KIIs] among irrigation officers, officers and engineers employed at the KMC (Kolkata Municipal Corporation), pump operators, lock-gate operators, project in-charges of government *bheri*s,[7] secretaries of cooperative *bheri*s, leaseholders and managers of private *bheri*s, and fishers and farmers) complemented by archival research (including consultation of drainage committee reports by I&WD, records maintained at municipal pumping stations, minutes of meetings between government departments

[6]I have consulted records preserved in the British Library (India Office Records section), the National Archives of India (New Delhi), the West Bengal State Archives (WBSA), the National Library, and the Town Hall (Kolkata).

[7]*Bheri* is a Bengali word which refers to a waste-fed pond.

and wetland inhabitants, and also local documents and participatory maps), Chaps. 3 and 4 together establish that low-cost waste management and recycling practices conducted by locals (leaseholders, fishers, and farmers) in EKW are strongly associated with the history of municipal initiatives, encouragements, and interests geared to harnessing the best possible solutions for parallel management of urban sewage, generation of local livelihoods, and establishment of a revenue regime. Chapter 4 ends with three case studies of three different types of *bheri*s: government, cooperative, and private, to demonstrate that EKW is a complex, heterogeneous space with each *bheri* marked by its own specificities in terms of geographical location, administrative status, size, ownership patterns, etc. These in turn shape special sets of challenges and potentials that require and await rigorous, detailed, and nuanced mapping and explorations towards conscious and comprehensive planning, policy formulation, and actions.

The canal network that evolved during the nineteenth century as an emblem of British hydraulic technology and as one of the most significant systems of river canals in the world in terms of its volume of traffic, connecting Kolkata with the other districts of Bengal and provinces of India (see Chap. 3), is clogged with silt today. The navigable canals have turned into mere *nullah*s.[8] This disruption finds linear explanations in scientific literature and media reports with the colonial period being projected as the "golden era" and the post-independence period explained as the stage dotted with bureaucratic reluctance, civic indifference, and overall apathy and lack of awareness with regard to protecting these former lifelines of the city. Applying HUPE, Chap. 5 contextualizes "disrupted networks" within larger temporal and political conjunctures thickly loaded with their own economic calculations and imperatives. Tracing a succession of technologies from inland boat traffic to steam navigation to the railways, the chapter illustrates how Kolkata's elaborate canal system succumbed under the pressure of emerging networked infrastructures like the railways, which appeared as a more lucrative space for investments promising huge returns. Reading "archival silence" (with sparser records and reports on the canal trade, investments, etc., from the early twentieth century) as an indicator of decreasing colonial enthusiasm for Kolkata's canals as arteries of trade, this chapter traces debates and discussions among proponents and opponents within the government and conflicts of interests among municipal officials and the state regarding the functioning of the canal system as a navigation network or as a receptacle of the city's wastewater. It traces how the shifting calculus of rule led to the transformation of the canal network from arteries of trade to drainage channels, and portrays the social and ecological costs of this disruption, complicating mainstream contemporary "development" and "encroachment" narratives.

Severe socio-ecological implications, such as the loss of ecosystem services and livelihoods, displacement, etc., have also been generated alongside the continuous march of the metropolis in the eastern periphery, consuming the wetlands since the post-independence period. Chapter 6 is an empirical illustration of when, why, and

[8] *Nullah* (used both as a Hindi and a Bengali word) means drain or sewer.

how ecological infrastructures in the form of wetlands made way for concrete estates with major short-term and long-term socio-ecological outcomes for both the city and its (transformed) surroundings. It traces the development of new townships and urban development projects from the 1950s to the present, analyzing the context behind the formulation and implementation of these projects through nuanced readings of development project reports. It demonstrates how EKW conversion is directly and rapidly causing diminishing returns from (provisioning, regulating, supporting, and cultural) services affecting both wetland dwellers and urban ecology, setting the context for why collective consolidation towards its protection has to be crafted and concretized. It argues that apart from the loss of environmental services and social livelihoods, the transformative processes are far more complex and non-linear and have to be understood by recognizing and mapping a wide spectrum of challenges and potentials including coercion, consent, negotiations, perforations, and bargains among old (existing) and new (rising) stakeholders within the story.

What is driving Kolkata's mega-urbanization at the cost of its ecological infrastructures (or subsidies)? The literature suggests that political-economic interests and aspirations of the city during the neoliberal period where Kolkata's fate is being determined by global visions and national agendas operating within the logic of "accumulation by dispossession" can explain the sprawl (Roy 2004; Bhattacharya and Sanyal 2011; Dey et al. 2013; Bose 2013, 2015). By shedding light on the partnerships between government agencies and transnational corporations, recent political-economic and political ecological works assert that Kolkata's environmental assets and infrastructures have been destroyed by the emergence of so-called "green" and "eco-friendly" townships and also the implementation of environmental restoration and beautification projects within the inner city core and periphery (Bose 2013, 2015; Dey et al. 2013). By discerning the "polemics of planning, development, and environment," Chap. 7 makes a different intervention. Although the city has encountered tremendous ecological conversion and "cleansing" drives affecting the social livelihoods of marginalized communities, a linear story of Kolkata entirely succumbing to and appropriated by global pathways and national trajectories is not strictly accurate. The argument is validated through detailed analysis of a series of elaborately developed government plans (from the 1960s to the present) that emerged out of particular historical and political contexts to address specific issues. The chapter provides clues and directions to the urban sustainability puzzle with regard to Kolkata's very own aspirations, requirements, capacity, and limits.

With Kolkata's entry into the list of its posh Indian metropolitan counterparts like Delhi, Chennai, Mumbai, and Bengaluru, embracing luxury housing complexes, information technology, business process outsourcing sectors, foreign-funded environmental and infrastructure projects, and the construction of numerous luxury amenities for the middle classes, the environmental activism that the city witnessed has also been explained in terms of "bourgeois environmentalism." The "bourgeois environmentalism" concept framed by Baviskar (2002, 2003, 2006, 2011) remains till date the most powerful paradigm to capture urban environmental

projects (restoration, beautification, and housing schemes) facilitating middle-class desires, aspirations, and perceptions of the urban environment, at the cost of squatter clearance and eviction drives in Indian metropolises. Environmental activism in Kolkata has been explained using this lens (Chatterjee 2004; Bose 2013, 2015). Chapter 8 empirically investigates, chronologically covers, and analyzes varieties of environmental activism across conflicting, negotiating, and mediating actors in two case studies: the first on the restoration of the Adi Ganga, and the second on the preservation of the EKW. The empirical findings, loaded with rich qualitative insights over a wide temporal frame of analysis, reveal that urban environmental activism comprises vibrant stories of violations and victories with long-lasting impact and future directions for the urban environmental trajectory that cannot be captured by fragmented and unilinear understandings and perspectives.

The book concludes with the "useful narrative" that a reconceptualization of urban sustainability is imperative through detailed and rigorous understanding and explorations of complex and dynamic city–nature–technology dialectics. The temporal dimension is extremely pertinent as it makes invisible feedbacks and connections visible. In the midst of the declensionism spelled out in technical reports on Kolkata's vulnerability to natural disasters or its "bourgeois" affiliations and tendencies, this book, through the application of HUPE, complicates mainstream urban narratives and provides hope and optimism by identifying potentials and converging interests among multiple actors involved at different hierarchical levels in decision making. In conclusion, I argue that Kolkata's vulnerability and viability are not mutually exclusive. Detailed explorations of Kolkata's "blue infrastructures" across temporal and political scales are an important exercise to identify avenues through which vulnerability can transcend into viability through optimizing on the existing urban environmental template. Providing concrete examples of municipal–local, bureaucrat–technocrat–citizen interactions since the unfolding of urban nature, the final chapter opines that Kolkata's ecological subsidies can be harnessed through exchanges crafted out of a common language of conversation among different stakeholders and also between activists and policy makers, enabling the city re(gain) its resilience. The "blue infrastructures" of Kolkata is an epistemological and methodological contribution to understanding complex urban nature dynamics over long-term temporal scales, ultimately geared to informing and influencing policy circles towards a just, democratic, and resilient future.

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Chapter 2
The Natural Evolution of the Urban

2.1 From Nature, with Nature

What is nature? Which nature? Whose nature? Is it "pristine," "wild," "manufactured," or "manicured"? What part of the newly constructed Eco Park in New Town, Rajarhat, Kolkata, for instance, is "natural"?[1] The answers to such questions vary and shift across particular temporal conjunctures, dotted with their own challenges and struggles, shaping how concepts, practices, and phenomenological encounters including "nature," "culture," "urban," and "technology" can be broadly explored, understood, perceived, and defined. Environmental historians around the world have dismantled the nature–culture binary by reflecting on the more complex co-evolution of environment and society across large temporal trajectories; political ecologists have coined the term "socionature" to highlight the intricate intertwinings and cyclical workings of the two.[2] The contemporary urban moment has brought together urban and environmental social scientists to study urban-environmental intersections, critically interrogating the city–nature antithesis that has long dominated both environmental and urban disciplines.

Melosi (1993) criticizes Worster (1990) for restricting the purview of environmental history within farmed landscapes. Concerned about the global (monoculture-dominated) agricultural crisis of his times, Worster argued that along with the history of climate and weather that relies upon huge data sets on tides and winds, ocean currents, geological and hydrological forces, "the living sources of the

[1]New Town Eco Park (Prakriti Tirtha) is an urban park which has been constructed by the West Bengal Housing Infrastructure Development Corporation (WBHIDCO) in New Town, Rajarhat, Kolkata. Situated on a 195 ha plot and surrounded by a 43 ha water body with an island in the middle, it is the biggest park in India. The deep blue views and the lush green scenes, however, suppress stories of displacement of farmers and fishers, and New Town's top-down mode of acquisition in the name of "development" including ecotourism.

[2]"While nature provides the foundation, the dynamics of social relations produce nature's and society's history" (Swyngedouw and Heynen 2003, p. 905).

J. Mukherjee, *Blue Infrastructures*, Exploring Urban Change in South Asia,
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earth, or the biota" which have been "more susceptible to human manipulation than non-biological factors," should occupy the primal place in environmental history (Worster 1990, p. 1089). To Melosi (1993), the city–nature schism in both urban and environmental scholarship is unscientific; he strongly advocates for the "urban" to occupy a place within environmental history.

Urban research focusing on building technology, public works and infrastructure, environmental services, parks and green space, pollution and public health, energy, environmental reform and regulation, and municipal engineering became gradually operational in the United States as early as the 1960s (Blake 1956; Mumford 1961; Warner 1962; Condit 1961; Rosenberg 1962, 1968). However, since the 1980s, there has been a strong focus on urban technical infrastructures, shedding light on how human beings utilize nature's services to meet urban utilities, accomplishing expanding urban needs, and "how man-built or anthropogenic structures ('built environment') and technologies shape and alter the natural environment of the urban site with consequent feedback to the city itself and its populations."[3] These studies, mainly emanating from the history of technology, have explored urban infrastructures like water provision, waste disposal, and other public works (Moehrin 1982; Hoy and Robinson 1982; Tarr 1984; Konvitz et al. 1990). Still restricted within the realm of urban history and the history of technology, these explorations did not devote much attention to how cities are also derived from nature, how they grow, and what role they play within the larger matrix of the physical environment.

It is only recently that urban environmental history expanded to locate the city within its wider ecological surroundings, considering "from nature, with nature" dimensions, i.e., how cities, having been derived from their natural environment, utilize nature to meet urban utilities like water-sanitation-sewerage services in the various stages of their evolution and growth, and how these urban-environmental equations in turn have consequences for both nature and the urban, shaping and determining larger questions of urban sustainability. Hence, urban ecology and urban environmental history started to focus on both internal city–nature dimensions and also "beyond the urban" dynamics, enriching both urban and environmental history scholarship (Mukherjee 2015).

Questioning the city–country binary that had strongly dominated urban and environmental researches, Cronon's work (1991) on Chicago emphasized understanding the growth of cities by considering their relationship with the vast region lying beyond the defined urban boundaries. The complexities and connections in this regard are prominently revealed in the vivid narrative of the making of the Chicago waterfront by Salzmann (2018). The author describes the power of "liquid capital" illustrated in the feats of engineering and statecraft conducive to commodity exchange, and how these facilitated the city's growth and the development of its western hinterlands. Urban environmental history has advanced from only focusing on networked infrastructures as outcomes of urban manipulation of the

[3]Joel A. Tarr to Martin V. Melosi, letter dated 6 September 1992, cited in Melosi (1993).

environment, to going beyond manufactured networks, projecting implicit urban-environmental interactions. Barles's study (2017) on Paris and her coinage of "out-infrastructures" add another dimension to this research. Demonstrating the multiple uses and extractive mechanisms deployed on the river Seine by Paris for more than three centuries, Barles explains how the institutional imprints exercised by the city of Paris were also executed on an extensive hinterland, tied up with the city through diverse commercial interests and incentives.

In spite of the recent proliferation of research in urban environmental history, Melosi's conceptualizations, provocations, and contributions to the field remain the most noteworthy. Melosi's understanding of the multiple dimensions of city–nature relationships has facilitated researchers in appreciating the complex and pervasive process of how cities and environments make and remake, shape and reshape each other over space and time. For Melosi, cities are derived from the natural world and they interact and blend with it. Hence, urban environmental history should combine "the study of the natural history of the city with the history of city building and their possible intersections," incorporating "from nature, with nature" dimensions that expose the embedded, mutual, and reciprocal correlation between the urban and the environment from the very inception of the "urban" itself (Melosi 1993, p. 2; 2001, p. 126).[4] As Gandy (2003, p. 2) puts it, "Nature has a social and cultural history that has enriched countless dimensions of the urban experience."

With rivers performing navigation and water provision roles, acting as "the ultimate sink," and connecting cities with hinterlands, city–nature interactions are revealed most prominently in urban river research, the scope of which is not limited to the urban but goes "beyond the urban" (Tarr 1996; Mukherjee 2015). For a pool of researchers currently focusing on particular case studies, "the coevolution of cities and rivers is an inextricably interwoven process, a complex assembly of human and nonhuman actors, and an arena where material and symbolic worlds merge" (Knoll et al. 2017, p. 22).[5] The fluid account of a tropical-deltaic-estuarine "muddyscape" (Lafaye de Micheaux et al. 2018) adds a further dimension by complicating the land/water separation (along with the nature/culture, city/nature divides) over a long temporal scale and unveiling multilayered, interdependent complexities and possibilities. The story of the "blue infrastructures" of Kolkata begins on such a pretext.

[4]Focusing on the interdependence between nature and technology, the various chapters in *The Illusory Boundary* (Reuss and Cutcliffe 2010) attempt to blur boundaries between nature/culture and city/nature aspects.

[5]Significant recent contributions include Castonguay and Evenden (2012, 2017) and Way (2018).

2.2 Swampy Origins, Watery Roots

Present-day Kolkata, with its lavish, swaggering skyscrapers, swarming population, and ever-increasing, sprawling boundaries, suffers from the dilemma of erasing its past—its deltaic-estuarine-marshy-aqueous origins—while being forced to face this past when pluviometer readings generate alarm and urban utilities and lives get disrupted in a few hours of continuous rainfall, leave aside catastrophic cyclones![6] In *Empire and Ecology*, Bhattacharyya (2018) addresses this "amnesia" about the soaking ecologies of the Bengal Delta, arguing that we need to develop innovative methodologies through which collective memories of reclamation of Kolkata can be recovered.[7] Bhattacharyya discusses how, beyond conventional cartography which is marked by the politics of knowledge production, almanac forms of reading space can be a meaningful exercise in reviving its multiple histories, traversing environmental, political, and cultural dimensions (Bhattacharyya 2018).[8] History, geology, palynology, and literature, deploying their own sets of scientific investigations and unraveling age-old memories ingrained in folk songs, stories, poems, beliefs, rituals, traditions, and customs, help us bring back memories which have not been permanently destroyed but temporarily suppressed under the hubris of (partial) knowledge generated and fed by "modernity."

Kolkata has been reclaimed from a tidal swamp (Murphey 1964; Bhattacharyya 2018). It is part of the Bengal Basin and the Bengal Delta, located on the edge of the Sundarbans, which is the world's largest mangrove estuary, located at the mouth of the delta. There are debates among geographers about the exact outlines of the Bengal Basin and the Bengal Delta (Lahiri-Dutt 2014). The Bengal Delta can be considered as the geomorphic unit which is part of the geologic unit, the Bengal Basin, "a large subsurface sedimentary province filled up by sediments of pre-trappean and post-trappean age" (Dasgupta 2010, p. 198). In spite of controversies about its geographical boundaries and contours, there is no doubt that the

[6]The catastrophic impact caused by the super-cyclonic storm AILA that formed over the Bay of Bengal on the Sundarbans and Kolkata in May 2009 is an insightful example.

[7]"This is a history of forgetting in the Bengal Delta, a forgetting that enabled human design in the world's largest delta and one of its most vulnerable landscapes. From the eighteenth century on, colonial law, bureaucracy and technology eclipsed and erased the 'secrets of land-making' and unmaking in Bengal's seaface, where land dissolved gradually into the vast and turbid waters of the Bay of Bengal, in order to build colonial Calcutta, the second capital of the British Empire. In the postcolonial moment, this amnesia has turned into hubris, where the aqueous and the igneous elements are now being transformed into landed concrete property" (Bhattacharyya 2018, p. 1).

[8]"Almanacs endow the place–time relation with verticality toward the cosmological, while modern geographical representations freeze spaces in time and remain essentially horizontal" (Chapman 2007, quoted in Bhattacharyya 2018, p. 16). And it is important to "begin to view spaces beyond the one-dimensional cartographic register, which fixes spaces in time" (Bhattacharyya 2018, p. 7).

entire scape is complex and exciting,[9] unleashing possibilities of attracting multiple disciplines and "undisciplined disciplines" to understand it.[10] Originating in the snowy Himalayas and flowing through the Gangetic plains, innumerable distributaries of silt-laden rivers meet here, dumping their sediments to create the largest delta in the world, before finally draining into the Bay of Bengal. Sediments, complicating land/water, physical/social, flux/fixity binaries, make this land(water) scape fascinating, inviting multilayered explorations to critically interrogate mainstream theories and paradigms of hydrological or even socio-hydrological research (Wesserlink et al. 2017). Fed by the combined flows of three major river systems, the Ganga, the Brahmaputra, and the Meghna, that bring enormous silt to the Bengal Delta, the latter is imbricated with both the technical and the social aspects that sediments entail (Lafaye de Micheaux et al. 2018).[11]

That Kolkata is part of the Bengal Basin is also corroborated by archaeological evidences. It is underlain by a considerable thickness of predominantly alluvial material of the Quaternary Age and overlain by a vast thickness of Tertiary and Mesozoic sedimentation in a subsiding trough (Biswas 1992). The alluvial swamps of Calcutta have been found to be approximately a thousand years old, an estimate supported by the discovery of the semi-fossilized bones of an antelope or a horse at Jadavpur in 1980, traces of an animal world more than 2000 years old in the village of Mochpol near Barasat, and the skeletal remains of a one-horned rhino recovered recently from Calcutta (Chakraborti 1982). The remnants of Sundri (*Heritiera fomes* Buch.-Ham) trees (from which the name "Sundarbans" derives, i.e., beautiful forest: *sundar* means "beautiful" and *ban* implies "forest") have been found here, proving that the site is on a continuum to the estuarine-deltaic scape. At places like the Curzon Park Tank (in 1815), Sealdah (1864), Dhakuria Lake (1941), and Salt Lake (1969), forests of submerged Sundris were detected in situ (Carey 1905; Blanford 1864).

[9]The complexities have been vividly captured by novelist Amitav Ghosh in his bestselling novel *The Hungry Tide*. Ghosh describes the Sundarbans as an "immense archipelago of islands" where "[t]here are no borders … to divide fresh water from salt, river from sea. The tides reach as far as three hundred kilometers inland and every day thousands of acres of forest disappear underwater only to reemerge hours later" (Ghosh 2004, p. 7).

[10]The notion of "undisciplined disciplines" implies different emerging frameworks that rely upon and implement bottom-up, unconventional sets of methods and methodologies, often borrowing these from other disciplines, and finally giving birth to some of these during or as after-effects of field experiences and exposures. The idea is to understand a problem in its all possible forms towards comprehensive solutions rather than protecting disciplinary boundaries and ethos that sometimes impose a cognitive blockade in perceiving a problem. The idea becomes further relevant for "undisciplined environments" where nature is comprehended as beyond disciplined and controlled, where it not only remains a passive victim but acts as an active agent within transformative contexts.

[11]The Ganges and the Brahmaputra together carry more sediment than any other river system, double that of the Amazon and four times as much as the Nile. During the monsoons, 13 million tons of silt are carried to the delta every day. Though most of this continues into the Bay of Bengal, some gets deposited on the riverbeds along the way (Nicholson 2007).

My detailed consultation of legends and folk narratives of Bengal allows a vivid portrayal of the aqueous roots and marshy origins of Kolkata. According to a popular legend, which finds reflection in the 16th-century text *Digbijayaprakasa* written by Kavirama, the city was born when the ocean started churning and the tortoise, Kurma, gasped while being pressed by the Mandar mountains on one side and by Ananta ("the infinite") on the other. Kurma's breath created the country of Kilkila located in the lower stretches of the Bengal Delta (Ray 1902). The oceanic origins suggested by the Kurma legend find validation in recent geological findings, which prove that the Bengal Basin is a remnant oceanic basin (Alam et al. 2003). In the *Brihat Samhita* by Barahamihira, Lower Bengal is designated as *samatata*, which means "tidal swamp," more specifically land that is level with the sea (Sen 1971). The presence of the site within the larger delta and its apparent connection with and the consciousness of belonging to the waterscape are evident in the traces of anthropogenic canals and the numerous *ghat*s (banks) of the Ganges depicted in medieval Bengali literature, like Bipradas Piplai's *Manasa Mangal Kavya* or Kavikankan Mukundaram's *Chandi Mangal Kavya*. While *Manasa Mangal Kavya*'s depiction of the river route taken by the protagonist, the merchant Chand Saudagar, includes Kalighat, *Chandi Mangal Kavya* mentions Kalikatta as one of the prosperous localities on the left bank of the river Hooghly.[12]

The Bengali nomenclature "Kolkata" itself is a reflection of its coastal and riverine topography. In Bengali, *kol* means shore or coast, and *kata* implies that which is cut open; these two words are joined to form "Kolkata," which signifies a coast or shore cut open by creeks and inlets (Biswas 1992). Other accounts by lexicographers suggest that *kol* means silted up into a shoal and *kata* denotes the open ends of alluvial formations which are formed on the banks of the rivers flowing through the delta by the deflection of river currents (Biswas 1992). Similarly, the names of places in Kolkata like Creek Row or Ultadanga (dry land close to the river) indicate its watery origins. Ray (1902), and more recently Bhattacharyya (2014) have explored the various connotations of the names of places as sites for an environmental history of the city. Some of the names of other sites in (south) Bengal also bear witness to the swampy origins and watery roots of the entire scape. Suk-sagara, Chag-daha, Naba-dwipa, Hans-khali, Nal-danga, etc., with the affixes *sagara* (sea), *daha* (abyss), *dwipa* (island), *khali* (creek), and *danga* (upland) are some examples (Chunder 1978).

The swampy, marshy, watery roots of the city have been washed out and repressed within the glorious saga of modern built infrastructures, cutting the urban site from its wider environment. This also applies to the history of people who had

[12]Kalighat is one of the oldest locations in Kolkata appearing in ancient texts. Here, on the bank of the Adi Ganga, the temple of Goddess Kali is located. It is one of the 51 *shakti peetha*s (shrines) centering round the story of the death of Goddess Sati in Hindu Shakta (worship of the Lord Shiva) tradition. When Shiva was performing the *maha-tandava* (destructive dance) carrying his wife Sati's corpse, Vishnu with his *sudarshana chakra* had to cut her body into 52 parts which fell on the earth and emerged as sacred sites of pilgrimage. Kalighat is one such site. (*Sudarshana chakra* is a disk-like weapon used by the Hindu god Vishnu to destroy the evil and the inauspicious.).

inhabited the place keeping in tune with the moods of the river (Lahiri-Dutt and Samanta 2013) and adapting their lives and livelihoods in this dynamic environment, constantly shaped and reshaped by the interplay of land-water-mud.[13] Lahiri-Dutt reflects, "The innumerable rivers and water channels intersecting each other create a moist and unstable maze that has nurtured riverine ways of life and culture for hundreds of years" (2014, p. 514). These aspects hardly appear in mainstream archives formulated by statecraft, outrageously displaying and preserving documents that cater to the development needs of the state. However, subaltern archives comprising stories and songs preserved through intergenerational oral transmission or paintings displayed on the walls of households or scrolls bear witness to the age-old existence of hydrocultural elements, where water, society, and culture not only interconnect but are enmeshed in a composite whole. The early habitation of fishers and falconers in the marshes of today's built Kolkata is evident in a small collection of songs and couplets and artisanal paintings, attesting to the city's long-forgotten watery origins (Bhattacharyya 2018).[14]

2.3 Imperial Infiltration

The selection of a colonial urban site is often the story of cautious calculations surrounding environmental and economic incentives and political equations across conflicts, frictions, negotiations, and bargains among the imperial power, the local rulers, and the people. That the selection of Kolkata as the imperial site was marked by a vacillating political climate and uncertainties confronted by the British cannot be missed within the environmental history narrative. Explorations of these multiple realities, cutting across environment, politics, and society, can provide a sharper edge to this temporal tale of the city's interactions with its environment and vice versa, unfurling what actually prompted particular decisions and choices at specific conjunctures, and why, instead of other sets of alternatives.

On August 24, 1690, Job Charnock came to Sutanuti with a contingent of 30 soldiers, and thus the first dated colonial history of Kolkata began. For a long time, until recently, Charnock's name appeared gloriously as "the founder of Kolkata" in all textbooks, public forums, pieces of architecture, etc. On May 16, 2003, the Kolkata High Court, on the basis of a report submitted by an academic committee, passed a ruling that confirmed that the site had existed since time immemorial; it

[13]Living on the edges and getting familiarized with this environment in flux, people developed a distinct subculture, different from that of the people living on the mainland (Lahiri-Dutt and Samanta 2007, 2013; Zaman 1989).

[14]Bhattacharyya argues that though artisanal productions like scroll paintings are not very traditional pieces of evidence, yet they comprise a rich repertoire of artisanal representative practices around rivers and riverbanks in the absence of archives of pre-colonial paintings of the rivers of Bengal. And unlike the "state-historical archival remains," these "portray their world in a non-realist representative index" (Bhattacharyya 2018, p. 123).

had been an important trading center long before the European infiltration.[15] "Calcutta or at any rate, that portion of Hugli, where Calcutta now stands, has a history … and the city is the growth of many centuries" (Wilson 1895, p. 127). History attests that Armenian communities were there at least 60 years before the foundation of Kolkata by Job Charnock (Wilson 1895; Seth 1937; Nair 1977). The scattered references to the site in ancient and medieval literature like the *Mangal Kavya*s further stretch back its historical existence. While vernacular literature unveils and portrays deeper ecological, cultural, and social relations in this region by depicting its rivers, *ghat*s, mercantile expeditions, social and quotidian belief systems and the practices around them, Abul Fazl's *Ain-i-Akbari* demonstrates its administrative significance by recording revenue details.[16] However, urban historian Nair's (1977) account provides a conclusive intervention in the debate about the foundation of the city and its colonial existence. Nair argues how and why the very British moment of infiltration can be considered as a watershed in the history of the site, crafting a grand new beginning cut off from its past:

> if the founding of a city be more than the mere trading with people, if it be the ownership of its soil, the armed protection of its inhabitants and the establishment of a centre where citizens may come and go without fear of rapine, then the palm for the founding of Calcutta must unhesitatingly be awarded to Job Charnock, who lies peacefully within its busy thoroughfares, while round about rise buildings upon buildings, magnificent in structure and stately in appearance, which go to make up the one-time metropolis of India, a glorious city which in the dim distant days he so heroically founded. (Nair 1977, p. 172)

As early as the 1650s, almost four decades before Charnock landed in Bengal, the Mughal rulers granted a license to the East India Company (EIC) to trade in the province. In 1651, a British factory was established in Hooghly where the Portuguese and the Dutch had already settled. Like the Portuguese, the British also used Garden Reach as an anchorage for sea-going vessels. Beyond Hooghly, a few factories at Dacca, Balasore, Kashimbazar, and Patna were possessed by the Company. The British often visited the Hooghly area via Patna and Dacca to trade in saltpeter. The EIC obtained a *firman* (order) from the Mughal emperor in 1677–78 which granted them rights and privileges to conduct free trade in Bengal. Brisk trade developed among the European powers—the British, the Dutch, the Portuguese, and the French—at Hooghly, which can be traced to the 1680 s. The need to establish an independent settlement in Bengal for the appropriate exploitation of new trading opportunities soon surfaced among the British colonizers (Roy 1982).

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[15]The academic committee consisted of some of the leading historians of the city including Dr. Nemai Sadhan Basu, Prof. Barun De, Prof. Sushil Chaudhri, Prof. Arun Dasgupta, and Prof. Pradip Sinha.

[16]The *Ain-i-Akbari*, embodying a copy of Todar Mall's *Asl-i-Jama* (rent roll) compiled in 1582, informs us that Bengal was divided into 19 *sarkar*s (districts) and 682 *mahal*s (each *mahal* comprising a village or a number of villages as the unit of revenue collection). "Kalkatta" (Kolkata) was the 35th *mahal*, which, together with the 36th and 37th *mahal*s, paid a revenue of 23,905 rupees (Blochmann 1978).

The political history of imperial penetration in Bengal is loaded with warfare and skirmishes with both the Indian rulers and the other European powers which were anxious to acquire their own spheres of influence in the oriental world. The major grounds of discontent between the British and the Mughals and the Nawab of Bengal were: defective *firman*s, illegal exactions, quarrels over customs, incitement to interlopers, and attempts to build a fortified settlement (Roberts 1958; Dasgupta 2005).[17] In 1685, violent conflicts occurred between the Bengal Nawab Shaista Khan and the EIC troops (which included a force of 10 combat vessels) under the command of Vice-Admiral Nicolson. Hooghly was bombarded by the British, following which they had to return 27 miles down the Bhagirathi-Hooghly River to Sutanuti. The incident took such a severe turn that the Mughal emperor ordered an attack on other British settlements, leading to the seizure of factories at Patna, Kashimbazar, Masulipatnam, and Visagapatam.

At this crucial juncture, in April 1686, Job Charnock appeared in Hooghly as the EIC agent after he was detained from Kashimbazar (Murshidabad) due to conflicts in trade-related matters with the Mughal emperor and also the local authorities.[18] Charnock was making preparations for the Chittagong expedition as per instructions from the London Court of Directors to resist arbitrary exactions from the Mughals: "we have no remedy left … either to desert our trade, or we must draw the sword his majesty had entrusted us with, to vindicate the rights and honours of the English nation in India" (Hedges 1887–89, p. iii). Charnock's troops were sent up the river in small vessels, some quartered at Hooghly, some at Chandernagar (Wilson 1906) to join Nicolson's expeditionary force meant to capture Chittagong. The British received a huge blow, their ships got dispersed, and rather than being able to carry out the Chittagong expedition, the troops landed in Hooghly. By then, the Nawab's troops had surrounded the Company's factory at Hooghly containing stocks of saltpeter and other goods, and they burnt it down (Hedges 1887–89).

In December 1686, Charnock left Hooghly and reached Sutanuti. Peaceful negotiations between Shaista Khan and the Company seemed to be a distant dream. The Nawab passed orders to the Bengal governors to drive out the British from Bengal. In February 1687, Shaista Khan sent his troops to Hooghly again, following which Charnock was compelled to leave Sutanuti and move to Hijli (Midnapore). This incident was followed by negotiations between the British and the Mughals leading to the signing of a treaty on August 16, 1687, granting the former the rights to build structures at Uluberia, Falta, and Budge Budge, but specifying at the same time that they would no longer have access to the Hooghly River. Charnock built docks in Uluberia.

[17]Nawabs refer to semi-autonomous Muslim rulers of the Indian princely states who were bestowed ruling power by the Mughals.

[18]The *qazi* (judge) at Kashimbazar had adjudged creditors' claims of 43,000 rupees against Charnock. When Charnock's attempts to negotiate failed, he had to set out for Hooghly to escape arrest (Dasgupta 2005).

> Your town of Ulluberreah hath, we understand, depth of water sufficient to make docks and conveniences for the repairing of any of our biggest ships and is a healthful place. We hope you may so manage that place or town of Ulluberreah, which you have articled for, that it may in time become a famous and well governed British colony, wrote the London Court of Directors. (Roy 1982, p. 17)

Meanwhile, in 1688, Captain Heath arrived from England with reinforcements, took on board all the British in Bengal with the Company's goods, bombarded and burnt Baleshwar, and sailed to conquer Chittagong. Heath's Chittagong expedition failed as well, leading to his return to Madras. Charnock lamented, "Captain Heath tripping from port to port without effecting anything, has not only rendered our Nation ridiculous, but hath unhinged all treaties, by which means the trade of Bengal will be very difficult to be ever regained" (Hedges 1887–89, p. lxxxvi). And, "the consequence of the Company's spirited war policy was the evacuation of Bengal and the loss of the result of half a century's painful toil and effort" (Roberts 1958, p. 45).

Job Charnock and other servants arrived at Fort St. George on March 3, 1689, after Captain Heath's futile expedition to Chittagong. Charnock opened a fresh set of negotiations with the Mughal emperor, asking him to grant permission to the British to return to Sutanuti. It appears from a letter dated September 30, 1689, that the Bengal Council had reasons "for the altering of our [their] opinion about Ulluberreah and pitching on Chuttanuttee [Sutanuti] as the best and fittest on the main" (O'Malley 1914, p. 40). However, Shaista Khan was not gratified by the proposition and ordered the British to move to the Hooghly area. But with the resignation of Shaista Khan and the appointment of Ibrahim Khan as the new Nawab of Bengal, the political equations transformed radically. Ibrahim Khan took steps to resettle the British trade and issued a *parwana* (charter) that assured trading rights and privileges to the EIC in Bengal. The Mughal emperor Aurangzeb's *firman* of April 23, 1690, to Ibrahim Khan says,

> It has been the good fortune of the British to repent them of all their irregular past proceedings and they have petitioned for their lives and a pardon for their faults, which out of my extraordinary favour towards them, have (been) accordingly granted. Therefore upon receipt of my *phyrmand* (*firman*) you must not create them any further trouble, but let them trade freely in your government as formerly, and this order I expect you see strictly observed. (Wilson 1895, pp. 124–125)

Charnock returned to Sutanuti with his council in August 1690. On February 10, 1691, an Indian imperial grant offered the British the right to trade in Bengal with an annual payment of only 3000 rupees, marking a new beginning of transformations for the site that is now Kolkata.

2.4 "Unhygienic" and "Wild"

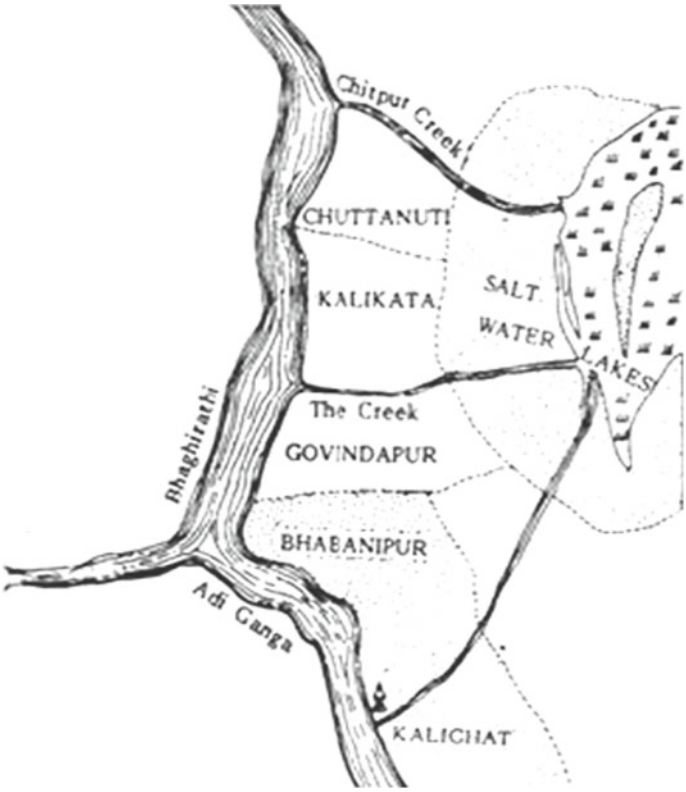
In 1698, the EIC purchased three villages at 16,000 rupees with lands adjacent to their fortified factories. These villages were Sutanuti, Kalikata, and Gobindapur, with their districts extending about 3 miles along the eastern bank of the river Hooghly and about 1 mile inland. Kalikata took precedence among the three villages; they merged into one which began to be commonly called "Calcutta" by the British. Blochmann (1978) argues that the whole settlement was called "Calcutta" because the British fort (Fort William) occupied a part of the ground of Kolkata; to its south was Gobindapur and to the north, Sutanuti (Map 2.1).[19]

Sources of the early colonial accounts of the site include gazetteers, diaries, extracts, and correspondences. In these accounts, the site was projected as "unhygienic" and "wild," provoking environmental historians to critically look into and interrogate colonial perceptions and categorizations, contributing to the debates surrounding the "wilderness" discourse. Environmental spaces and ecological systems that fell beyond the ambit of colonial mainstream knowledge, understanding, training, skill, and expertise, and hence, sites that were difficult to map, survey, and measure in order to make profits, were considered treacherous. These became sources of immediate anxiety for the early colonialists. D'Souza's (2002, p. 1264) work on the Mahanadi delta has shown how the deltaic scape appeared wild and difficult to tame for the British, to whom it appeared "to be in direct contrast to the relatively placid and docile English rivers." The tension is reflected in Hunter's comment:

> In the first stage [pre-deltaic] it [the river] runs on a lower level than the surrounding country, winding through mountain valleys and skirting the base of the hills. During this long part of its career, it receives innumerable streams and tributaries from the higher country on both banks. So far it answers to our common English idea of a river. But no sooner does it reach the delta than its whole life changes. Instead of running along the lowest ground, it gradually finds itself hoisted up until banks form ridges which rise high above the adjacent country. Instead of receiving confluents it shoots forth a hundred distributaries. In short, it enters upon its career as a deltaic river and presents a completely different set of phenomenon from those we are accustomed to in European streams. (Hunter 1875, p. 176)

Swamps and marshes in the form of land-water admixtures or soil-liquid hybrids, upsetting the linear and fixed principles of modern science and hydraulic engineering, were considered the most inhospitable and uninhabitable spaces in the colonial understanding and imagination. Along with being considered "wild," "uninhabitable," and "treacherous," swamps were perceived as dens of sickness, disease, and death. Colonial surveys and administrative documents and reports on

[19]The areas of the three villages at the time of purchase were calculated as: Kalikata—1704 *bighas* and 3 *cottahs*, Sutanuti—1861 *bighas* and 5¼ *cottas*, and Gobindapur—1044 *bighas* and 13½ *cottahs* (Holwell 1764). A *cottah* (also spelled *katha*) is an area unit in Bangladesh and India approximately equal to 1/20 of a *bigha*. In West Bengal, the *bigha* was standardized under British colonial rule at 0.3306 acre, often interpreted as being one-third of an acre.



Map 2.1 The site. *Source* Chattopadhyay (1990)

the one hand, and the medical archive on the other, consisting of fever committee reports, medical topography notes, etc., converse with each other, shedding light on how the colonial categorization (and also stigmatization) of "unhygienic" and "wild" spaces went hand in hand to describe and explain this marshy terrain.

The colonial encounter with "wilderness" at the settlement site, described as a narrow strip of land on the bank of the Hooghly River, surrounded by swampy jungles and brackish lagoons on all sides, is vividly documented in colonial settlers' accounts. This is evident in detailed portrayals of the event of British settlement in Kolkata and the environment by the EIC physician Captain Hamilton, who traveled extensively in different parts of India between 1688 and 1733:

> The English settled at Calcutta about the year 1690, after the Moghul had pardoned all the robberies and murders committed on his subjects. Mr. Job Charnock being then the Company's Agent in Bengal, he had the liberty to settle an emporium in any part on the river's side below Hughly; and for the sake of a large shady tree chose that place, though he could not have chosen a more unhealthful place on all the river; for three miles to the north-eastward, is a salt water lake that overflows in September and October, and then prodigious numbers of fish resort thither, but in November and December, when the floods

> are dissipated, these fishes are left dry, and with their putrefaction affect the air with thick stinking vapours, which the north-east winds bring with them to Fort William, that they cause a yearly mortality. One year I was there, and there was reckoned in August about twelve hundred English, some military, some servants to the Company, some private merchants residing in the town, and some seamen belonging to shipping lying at the town; and before the beginning of January there were four hundred and sixty burials registered in the clerk's book of mortality. (Quoted in Blochmann 1978, p. 57)

Hamilton added, "The Esplanade and Fort William were a complete jungle interspersed with a few huts and small pieces of grazing and arable lands. Calcutta then extended to the Chitpur Bridge, but the intervening space consisted of ground covered with jungle" (Chunder 1978, p. 41). Hamilton's depiction finds solid ground in Sterndale's description of the place and its surroundings.[20] In his *Historical Account of the Calcutta Collectorate* (1885), Sterndale mentions that less than two hundred years previously, the entire stretch was "a place of mists, alligators and wild boars" (O'Malley 1914, p. 43). Sterndale described it as follows:

> Though allowed by the Nawab to choose any site below Hooghly, he [Charnock] selected perhaps the most unhealthy site on the whole river. The Salt Water Lake on the east left masses of dead, putrid fish as water receded in the dry season, while a dense jungle ran up to where Government House now stands. The new settlement was situated about 160 miles from the sea. The south wind—the only mitigation of the fierce tropical heat which prevails from the end of March to October—blows over salt marshes and steaming rice lands on its way to the city. Its most uniform dead level, with depressions lying below the level of high water in spring tides, renders it difficult to drain properly, while the soil on which the town is built possesses every quality which the site of human habitation ought not to possess. (Quoted in O'Malley 1914, p. 43)

> [T]he jungle, the dampness of the soil, the impure air blowing from the Sundarban and the Salt Water Lake standing in its vicinity were all insanitary factors, and Calcutta in consequence was the picture of unhealthiness.… Living creatures were no less a source of danger than the forces of nature. Wild boars, crocodiles, alligators, reptiles and leopards infected the place; and man was as much a source of danger as the beast, for thieves and robbers abounded. (Quoted in Deb 1905, pp. 9–10)

The deleterious condition of the area was further justified by the fact that when in 1690 Job Charnock issued a proclamation permitting people to erect houses in any portion of the waste land that was under the possession of the Company, that type of inducement was a sine qua non for attracting a population (Ray 1978). Colonial accounts also cited medieval texts to assert and affirm the deplorable environment of the region. In the *Bengal District Gazetteer (24 Parganas)*, O'Malley referred to the *Riyaz-us-Salatin* to attest that "its air is putrid, its water salt, its soil damp" (O'Malley 1914, p. 43).

How dangerous this "wild" environment was, came out sharply in the narrative and estimates of miseries, diseases, death and pestilence. Hamilton's *A New Account of the East Indies* (1727) and Wilson's *Early Annals of the British in Bengal (1718–1722)* (1906) illustrate the miseries arising from the fever-stricken condition of the area throughout the 1690s. In 1830, Captain Herbert wrote about

[20]R.C. Sterndale was the commandant, Presidency Volunteer Rifle Battalion, Kolkata, 1888–1895.

the "malarial topography of Calcutta," pointing out that "there was not sufficient space to breathe, without inhaling disease, and that the luxurious growth of vegetation everywhere existing among the huts and villages, produced the malarious atmosphere, which not only influenced the suburbs but extended its effects to the city" (quoted in Strong 1837, p. 31).[21] F. P. Strong, the surgeon of 24 Parganas, wrote letters and submitted reports to the EIC local authorities regarding the topography and vital statistics of Kolkata, more specifically about "this city, its suburbs, the salt marshes, and the Sundarbans, south-east to the sea" (Strong 1837, p. 1). Strong's *Extracts* clearly indicate colonial anxieties and apprehensions relating to the environment of the city and its surroundings even more than a hundred years after the establishment of the colonial settlement:

> Let us look around us, and we find all the essentials necessary for the formation of malaria; beyond our city jangals, lakes, marshes, gardens crowded with trees, and woods of every description, and weeds, stagnant water, filthy pools, and low grass jangals of every kind surrounding the villagers' habitations. In these exist ample means for a constant supply of the poison, assisted as they are, by the natural heat and moisture of the climate; but when unnatural or meteoric changes of climate take place, or when unnatural inundations of sea, or river water occur, then … we find disease and death scourge the land, as was instanced by the inundation of 1833 in particular, and as shown by all the other [those of 1831, 1832, 1834] inundations also. (Strong 1837, pp. 34–35)

To Strong, it was "uncontradicted" that the saline water marshes on the eastern part of the settlement site were "highly productive of malaria—the air, when the wind is eastward of us has to find its way to our city, only over swamps, *jangals* (forests) and villages themselves highly productive of the same malaria, and therefore not calculated to dispel the evil" (Strong 1837, p. 9). The *Extracts* confirmed that the arguments offered on the saline marshes (salt water lakes) and, further downward, on the Sundarbans, were valid as these were formulated in conversation with other medical practitioners taking into account their experiences and also cross-verified through on-spot field visits and inquiries. The salinity of these marshes was held responsible for causing more pestilence, affecting the health conditions of not only those inhabiting its immediate borders, but also those residing in the neighborhood and for miles around it.[22] Cholera was also reported in the medical books and police records that specifically calculated the mortality rate among the prisoners of the Alipore Jail.

The "wild"–"unhygienic" connect finds strong reflection in Bhattacharyya's (2018, p. 19) work as well, which demonstrates how in the colonial understanding and accounts Kolkata became "the quintessential place of sickness and death, with

[21]Captain Herbert wanted to publish "Malarial Topography of Calcutta and Its Neighbourhood" in *Gleanings in Science*. But he left the work incomplete and left the Bengal Presidency (Strong 1837).

[22]The salinity was attributed to the tidal river Bidyadhari, which carried water from the Bay of Bengal and spilled it into this undulating, low-lying area from where water could not drain out, turning it into the spill basin of the river, and leading to the formation of the salt water lakes or saline marshes.

the swamps regarded as the culprit." J. R. Martin's *Notes of the Medical Topography of Calcutta* (1836) is a perfect example of how the "pestilential qualities of the marshes were turned into the medicalized terminology of 'miasma'" (Bhattacharyya 2018, p. 19).[23] Pande (2010) captures how the deltaic ecology, sanitation, race, and epidemiology came together under the rubric of "pathology," which became a central idiom of colonial liberalism. Urban history depicts how colonial urban planning schemes were determined by the "miasma" theory (Chattopadhyay 2006; Datta 2012). However, Bhattacharyya (2018) argues that though epidemiology was an important organizing principle, yet colonial economic calculations of profit making were crucial and key determinants. The next section of this chapter pushes this argument further by addressing the following question: Were the colonizers, through these categorizations of "wild" and "unhealthy," channelizing their inability to settle in such volatile environments, or should these conceptualizations be understood and studied as legitimization strategies geared to the colonial conquest of the settlement site (through the implementation of elaborate technologies, bureaucratic mechanisms, and legal architecture) that already offered ecological incentives that British entrepreneurial eyes could not have missed?

2.5 The Victory of Site Over Situation

Thus the midday halt of Charnock—more's the pity!
Grew a City.
As the fungus sprouts chaotic from its bed,
So it spread—
Chance-directed, chance-erected, laid and built
On the silt—
Palace, byre, hovel—poverty and pride—
Side by side;
And, above the packed and pestilential town,
Death looked down.

But again,

Me the sea-captain loved, the river built,
Wealth sought and kings adventured life to hold.

[23] "[O]ne would breathe thickly through the heat and miasma" (Martin 1836, p. 18).

> Hail England! I am Asia, power on silt,
>
> Death in my hands, but gold![24]

The "muddyscape" was "wild," full of risks and dangers; yet it was fluid gold, the use value of which could be nurtured and harnessed through manipulation using labor, capital, and technology. But would the experiments be worthwhile? Was it capable of delivering profits over huge sums of expenditure? That the colonial mind and enterprise was involved in this cost-benefit exercise over the settlement site and that Kolkata was not at all a "chance-directed," "chance-erected" city is palpable in the series of surveys that were conducted to measure, quantify, and identify the value of this land, some of which even predate Charnock's visit.

By 1667, the Court of Committees of the London Company had issued instructions to the East India captains to take notice of the channel and the depth of the Ganges and also to keep a journal to note the exact drafts on the river's depths, reaches, and currents and also the pattern of sand variation on its banks (Mukherjee 2009–10). Joseph Townshend was appointed the "Pilot of the Ganges" in the program of organized periodic surveys of the riverfront. In his *Diary*, William Hedges, the first governor of Bengal, reflected,

> They [the Court] … maintained something of a Pilot establishment for the conduct of the sloops, and of such larger craft as occasionally ascended the River, and with some view no doubt to the eventual realisation of their desire that their sea-going ships should habitually proceed up to the chief depots of their trade. (Hedges 1887–89, p. cxcvil)[25]

Apart from the French and Dutch riverine cartography, the British carried out extensive surveys of the land-water admixture in the Bengal Delta. These include: the land survey of Robert Barker, statistical survey of the landholdings by William Farkland, river surveys by Thomas Bowrey, a nautical survey undertaken by Marine Surveyor Captain John Ritchie and entrepreneur Benjamin Lacam, and extensive surveys by Major-General James Rennell which continued for 13 years from 1764 (Maps 2.2 and 2.3).

Siltation and the tidal currents of the Hooghly stretch where the site was located appeared to be chronic problems, yet the "advantages in terms of defensibility and serviceability were effectual to overbalance the disadvantages" (Ghosh et al. 1972, p. 9). The same riverine topography, the dense network of waterways in Bengal in the form of distributaries of the Ganges and tidal spill channels—the river Bhagirathi-Hooghly in the west, the river Bidyadhari in the east, the moribund Adi Ganga, and the presence of numerous channels, creeks, and inlets in between—and the salt water marshes to the extreme east offered ecological opportunities that could be manipulated towards economic incentives (Mukherjee 2009–10).

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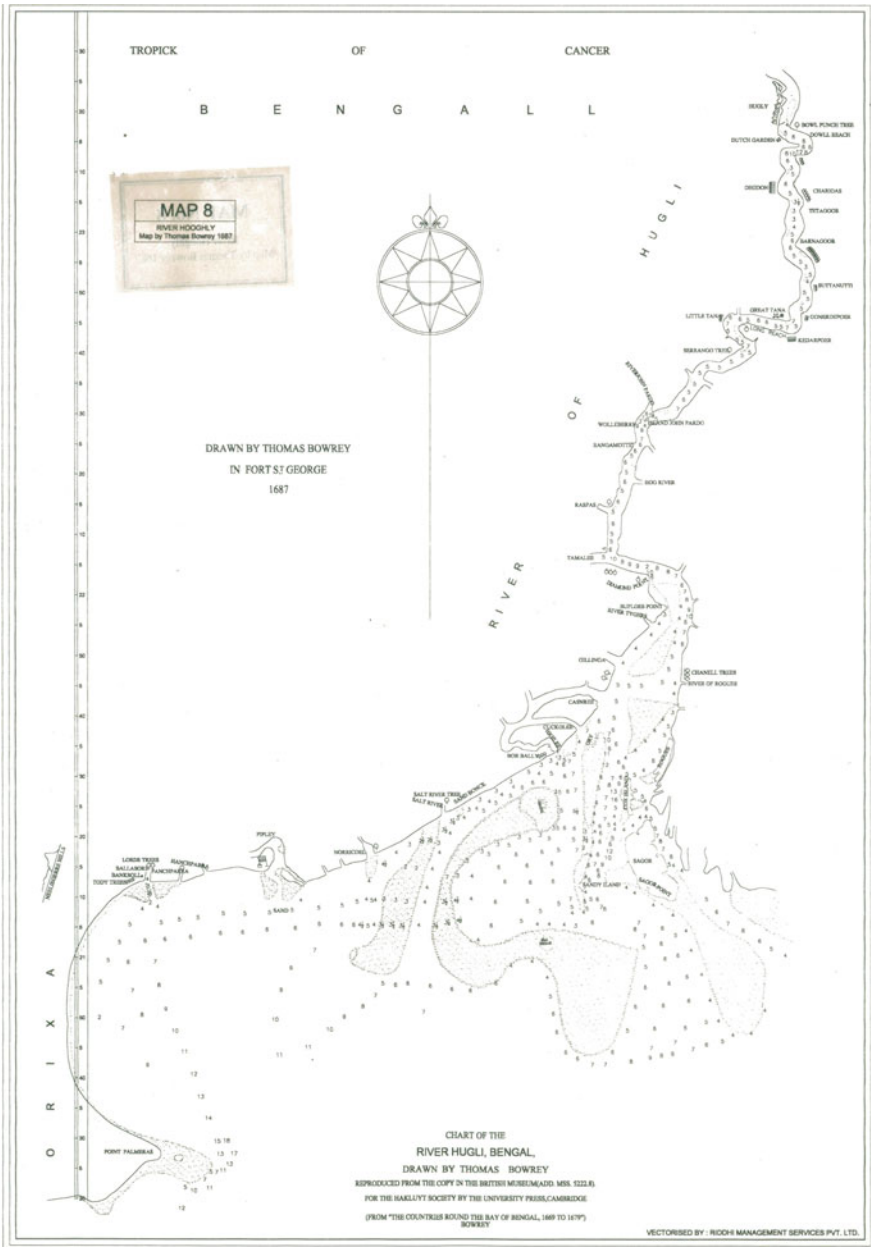
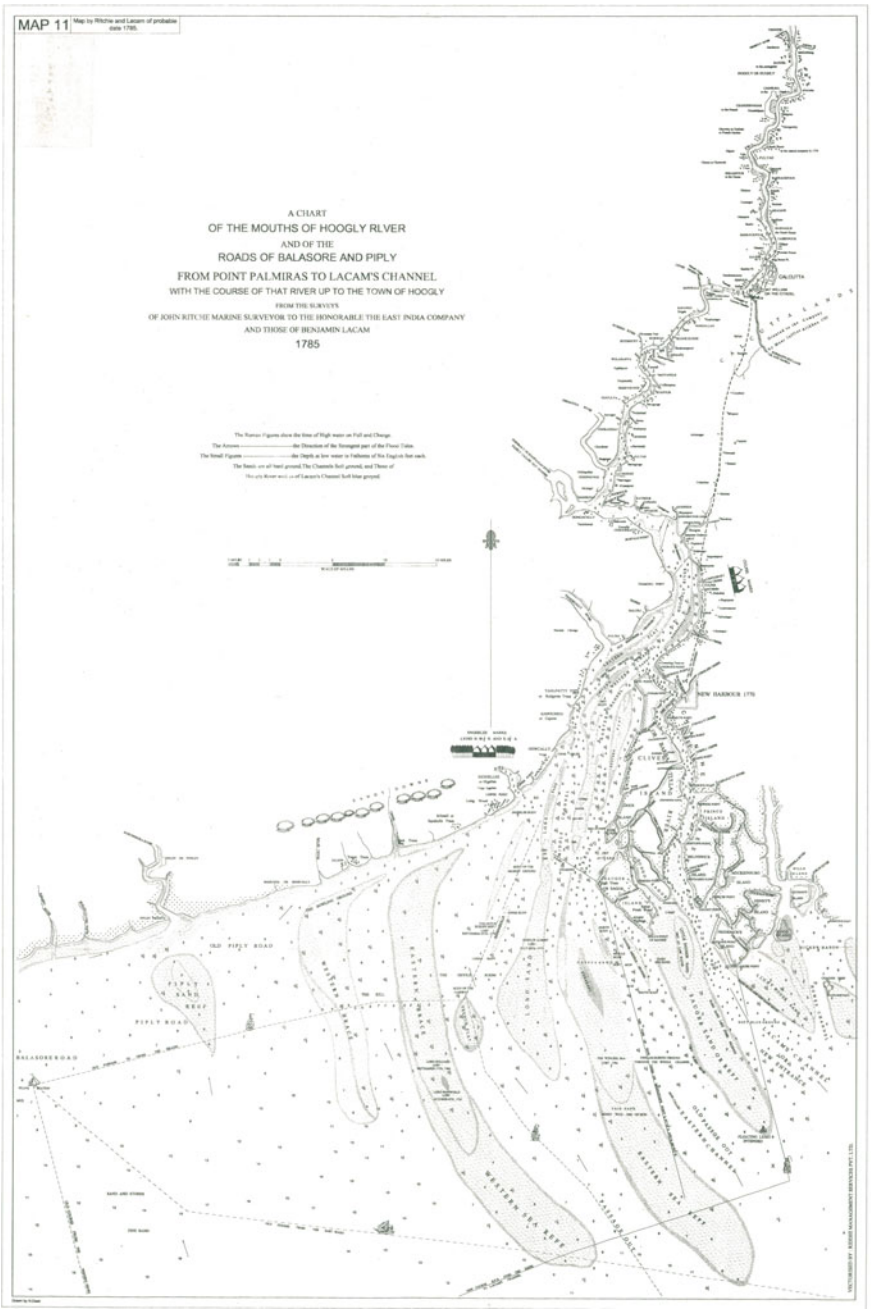
[24]Verses extracted from Rudyard Kipling (2017), "A Tale of Two Cities" and "The Song of the Cities," respectively.

[25]Part VII of volume III of Hedges' *Diary* is on the "Early Charts and Topography of the Hugli River," which includes a comparative topography of the old and the modern charts from the sea to the Hooghly River, from Hooghly Point to Kolkata and vice versa (Hedges 1887–89).



Map 2.2 River Hooghly by Thomas Bowrey, 1687. *Source* Biswas (2001, Map no. 8)



Map 2.3 Map by Ritchie and Lacam, 1785. *Source* Biswas (2001, Map no. 11)

The Hooghly (or the Bhagirathi-Hooghly) River served as the western distributary of the Ganges.[26] It was the main stream of the Ganges till the sixteenth century, when the eastward migration of the delta is assumed to have started, following which the flow of water reduced. This is noticeable if a comparative cartographic exploration is conducted considering the maps drawn by early Portuguese cartographers like Matheus Van den Brouche, De Barros of the seventeenth century, and English cartographers like James Rennell. Rennell's map clearly shows that by the eighteenth century, the eastern distributary of the Ganges, the river Padma, flowing independently to the sea and without uniting with either the Brahmaputra or the Meghna, became more active, replacing the Bhagirathi-Hooghly River as the main channel (Mukherjee 2011). The river Hooghly's upper reaches started silting up so extensively that the emergence of sandbanks completely blocked the connection with the Ganges near Kashimbazar during low water seasons.[27] However, in spite of these difficulties and hazards, there was much water in the lower reaches of the Hooghly to accommodate ocean-going ships. Once the ships had managed to ascend the lower course and escape shifting sandy shoals and strong tidal currents, at Sutanuti and immediately below it, "the river had scoured out a relatively deep pool (what is now Long Reach and Garden Reach) which made a usable anchorage" (Murphey 1964).

Other important streams that sought colonial attention were the Bidyadhari River (which was later converted into the outfall channel for the city) and the moribund Adi Ganga River (part of which was excavated by William Tolly for inland navigation).[28] The Bidyadhari was a tidal river with a wide spill area; it had a circuitous course and an average breadth of 300 yards. The river flowed from the Sundarbans in the east, northwards past Harua (taking the name of the Harua Gang), took a bend to the west and was joined by the Nona Khal. It then flowed south-westward, and then south-east to Matla, where it was joined by the Karatoya and Atharabanka Rivers, debouching into the Bay of Bengal under that name (Hunter 1875; O'Malley 1914). The Bidyadhari was one of the finest spill channels of the Ganges (Chattopadhyay 1990) and, at least till the mid-nineteenth century, it was one of the most active channels of the Gangetic delta (Mukherjee 1938). The Adi Ganga is mentioned in the *Mangal Kavya*s, from which it is apparent that it was a paleo-distributary of the Bhagirathi-Hooghly River which also performed navigational functions. In the *Chaitanya Bhagabat*, the Vaishnavite Saint Shri Chaitanya's

[26]The entire stream is named the Bhagirathi. However, since the arrival of the Europeans, the lower course has been called the Hooghly (Murphey 1964). The Bhagirathi is mentioned in the ancient Sanskrit texts like the *Matsya Purana*, and the epics *Ramayana* and *Mahabharata*. The legend of Sagar also describes how the river assumed its nomenclature from the protagonist Bhagirath (see Chap. 1).

[27]The reduced water flow in the Hooghly has to be understood as part of the larger seaward growth of the delta, leading to abandonment of once-prosperous ports on the west like Tamralipti and Gaur as the coastline advanced beyond them, causing the decay of old cities on the west and the rise of new cities in the east (Mukherjee 1938).

[28]Chapter 3 will shed light on these colonial hydraulic initiatives and engineering techniques.

journey on the Adi Ganga is illustrated. The Adi Ganga finds mention in the accounts of Holwell (1764), Sherwill (1858), Hunter (1875), O'Malley (1914), Hirst (1916), and Reaks (1919). Holwell noted that a small brook near Kalighat was deemed to be the original course of the Ganges by the local Brahmins (Holwell 1764). A hundred years after Holwell, Hunter reflected,

> The old channel is still traceable as far as Hathiagarh Fiscal Division, where it loses itself. This channel long ago dried up, and the bed now consists of a series of tanks. Many large Hindu villages are situated on the banks of the old stream, which is called the Adi, or original Ganga. The Hindus still consider the route of the channel sacred, and burn their dead on the sides of the tanks dug in its bed. (Hunter 1875, p. 10)[29]

Between the Hooghly and the Bidyadhari, about 5 miles east of Kolkata were the saline marshes or the salt water lakes. Apart from the explanations and interpretations of Alexander Hamilton, C. R. Wilson, and F. P. Strong, the salt water lakes find description in the accounts of colonial officials like H. M. S Harvich and J. H. Grose during the second half of the eighteenth century. Harvich observes,

> The soil [of Calcutta], marshy and damp, must be unwholesome particularly in the rainy season and from the vicinity of the River and *a very extensive lake*, which is about 3 or 4 miles distant and in no part above 18 inches deep, frequented by innumerable flocks of wild geese, duck, teals, etc. (Grose 1772, quoted in Chattopadhyay 1990, p. 6)[30]

Again, J. H. Grose reflects,

> The British had the Mughal's permission to settle at Calcutta in 1690; and Mr. Job Charnock, the Company's agent in Bengal, pitched upon that spot for the sake of a large shady grove which grew there; but it was the worst place he could have marked out; for three miles to the north-east there is a salt-lake which overflows in September, and when the flood retires in December, there is such a prodigious quantity of fish left behind that they putrefy and infect the air. (Quoted in Chattopadhyay 1990, p. 8)

The name of the lake provides directions as to its tidal origins. It was formed by the tidal actions of streams flowing through the district of the 24 Parganas. These streams carried volumes of saline waters of the Bay of Bengal into the district and spilled them over vast areas which led to the formation of these saline marshes (Bagchi 1944). Of the many rivers intersecting the area, the Bidyadhari was the most significant spill channel. Here, the bay waters found easy passage through the numerous water courses and estuaries of the Sundarbans. The presence of a depression along with changing silt distribution patterns due to the shifting of the river courses and the clayey and calcareous substratum created a conducive environment for marsh formation in the eastern part of Kolkata and the north of the Sundarbans (Mukherjee and Ray 2014). From colonial narratives, it becomes evident that in spite of the unhealthy, swampy, and marshy conditions of the lakes, they protected the eastern frontier of the site from invasion and provided ample

[29]There are controversies relating to the route and functional existence of the Adi Ganga, which will be discussed in Chap. 3.

[30]Chattopadhyay (1990) mentions that in 1748, Harvich anchored at Kolkata and stayed there between August and November. The journal of the ship captures his observations and opinions.

revenue generation opportunities through colonial experiments with agriculture, more specifically sewage cultivation.

With the river Hooghly on the left, the Bidyadhari and the Adi Ganga on the right, the saline marshes bordering the east, and the existence of a system of natural channels which could be interlinked and developed as the best means of communication connecting Kolkata with its hinterland—Khulna, Faridpur, Backhergunj, Barishal, etc.—and carrying the produce of East Bengal and the Brahmaputra Valley to Kolkata, the British were planning towards a deep, long-term vision. They observed that the Ganges and its tributaries and distributaries offered them opportunities to extend their trading operations inland over a wide area. No other place outside Bengal had until then covered such a vast area of influence. Thus, the economic logic of commercial development of the Ganges valley gathered momentum (Ghosh et al. 1972). In spite of its marshy, swampy, and malarial atmosphere, the site had several significant advantages (Mukherjee 2009–10). The Hooghly River tapped the trade of the Ganges valley, and Sutanuti was situated at the highest point at which the river was navigable for sea-going vessels. It was situated on the eastern bank of the river and was strategically more secure from the attacks of the Mughals and the Marathas. On the eastern side, it was protected from invasion by the presence of an extensive salt lake, the swamps and marshes of which made it invulnerable to the enemy. It had easy communication with places such as Orissa and also other parts of Bengal and Bihar. The cost of land acquisition and settlement would be cheaper due to its volatile and vulnerable topography. Yet, it was not actually an area of howling wilderness, as Sutanuti was already inhabited and supported a small village of weavers and cotton traders.[31] Five merchant families, one of the Setts and four of the Basacks, cleared the jungles and settled down near Gobindapur around the sixteenth century (Table 2.1). With the diminishing importance of the ancient port city Satgaon, due to the gradual silting up of the Saraswati River, these families migrated from there, settled in this region, and established a cotton and cloth market here on the basis of which the site came to be referred to as Sutanuti (Wilson 1895).

The wide range of ecological advantages that the site offered and the relative freedom from the official interference which had plagued the foreigners at every other place in Bengal "were considered enough to overbalance the headaches" (Murphey 1964, p. 251). The locational incentives "for the expanding trade of the Ganges valley were enough to build a metropolitan city of six million souls in and around the same swamp which attracted Hamilton's unfavourable comments" (Murphey 1964, p. 251). No wonder that eight years after the foundation of British Calcutta, i.e., in 1698, the Agents of the Company wrote, it was "The Best Money ever spent,"[32] celebrating "the victory of site over situation" (Mukherjee 2009–10).

[31]The nomenclature "Sutanuti" is indicative of cotton trade being carried on in this region. The Bengali word *suta* means "thread" and *nuti* implies "loop of yarn" (Biswas 1992; Mukherjee 2009–10; Murphey 1964).

[32]Extract from *Chutanutte Diary and Consultation*, October 3, 1698. Factory Records, Calcutta, no. 3 (Wilson 1906, p. 39).

Table 2.1 The Sett and Basack families

Names of the patriarchs	Number of generations	Name of the gotras
Makundaram Sett	21	Maudgalya
Kali Das Basack	20	Agnivesma
Siva Das Basack	19	Allodri Rishi
Barpati Basack	19	Amba Rishi
Basudeva Basack	19	Brahma Rishi

Source Biswas (1992, p. 17)

The next series of actions was targeted towards taming this natural riverine ecology for accomplishing the colonial capitalist agenda, evident in huge initiatives and investments in excavating canals and reclaiming marshes.

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Chapter 3
Tamed Interventions

3.1 Colonial Urban Hydrology

In conceptualizing a "colonial hydrology," Rohan D'Souza describes it as a broad rubric to characterize the British experience as comprising an altogether distinct paradigm for hydraulic interventions in South Asia, which involved "fundamentally realigning land and water in new sets of social, political and ecological relationships" (2006b, p. 625). The notion of "colonial hydrology" provides rigorous theoretical traction in exploring the relationship between colonialism and water, covering a wide range of subjects including floods, drainage, wetlands, lakes, inland river navigation, traditional fisheries, urban water supply, water legislation, cultures of water use, ideologies of "river improvement," and multipurpose river valley development (D'Souza 2006b). Shedding light on the broader dynamics of colonial rule, "colonial hydrology" unfolds colonial economic and political imperatives that defined and impacted South Asian fluvial endowments in specific and unprecedented ways.

Water historians have addressed the intersections of agrarian and water histories, depicting the connected and correlated histories of the institution of a new property regime and the deployment of numerous technical interventions under colonial capitalism. Historians focusing on eastern Indian deltas and floodplains like the Mahanadi, the Ganges, the Damodar, and the Kosi have demonstrated how, with the changing economic scene, from the levying of tax on the gross produce to rent on the land under colonialism, floods came to be perceived no more as blessings positively impacting soil fertility and protecting inhabitants from mosquito-borne diseases like malaria, but as a curse, interrupting with the colonial "fixed rent" regime (D'Souza 2002, 2003, 2006a; Klingensmith 2007; Mishra 1997, 2008;

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Singh 2008, 2011). "The colonial administration consequently developed the idea of flood control to buttress attempts to secure its property regime and its revenue collection strategies" (D'Souza 2002, p. 1266).[1]

Drawing from a vast bibliography of government records on agriculture, famine, finance, railways, revenue, public works, trade, law, and especially the comprehensive land revenue settlement reports, the introduction of perennial irrigation and its impact on the environment and the peasantry have been thoroughly studied within the context of north and south India. This has opened up debates on whether these hydraulic experiments should be perceived entirely as a watershed, crafting a binary between "pre-colonial equilibrium" and "colonial hydrology," the former being recognized as environmentally benign and socially accommodative against the environmentally malign and socially disruptive characteristics of the latter (Mukherjee 2018).[2]

In general, the water historiography of South Asia describes three major stages of hydraulic interventions, resulting from the more advanced colonial capitalist mode of production (tied up with the excesses of technochauvinism) causing crucial transformations in ecology and socio-economic arrangements, leading to a "metabolic rift" in nature (water)–human relations (D'Souza 2006b; Mukherjee 2018).[3] The stages include: the embankment era, when embankments were designed to insulate lands from floodwaters; the perennial irrigation epoch when excavated channels ensured a steady supply of water from rivers for agricultural and navigation purposes; and multipurpose river valley development, or the construction of dams on river courses. These subsequent stages can be read and understood as three interconnected but distinct trajectories comprising the consolidation of capitalist property, intensification

[1]The revenue acts (like the Permanent Settlement Act of 1794 implemented in the Bengal Province, i.e., Bengal, Bihar, and Orissa) introduced in India transformed the flexible revenue collection mechanism tuned to environmental fluctuations into a rigid rent regime. To ensure steady flow of extraction of agrarian surpluses, big hydraulic structures like embankments were constructed to regulate floods and floodwaters. Embankments, by confining floods within the narrow stretch of the river channel, did not allow the silt to be deposited uniformly over the floodplains, resulting instead in the deposit of silt in the riverbed itself, depriving floodplains of nutrient deposits essential for continued fertility. This was a complete departure from the pre-colonial agrarian relationships to flood, floodwaters, and sediment in the region, which drew the attention of British civil engineers such as William Willcocks who wrote extensively about the beneficial side of what he understood and categorized as "overflow irrigation" (Willcocks 1930). It was a system by which the nutrient-rich, silt-laden monsoon floodwaters from the upper regions of various rivers flowing into Bengal were distributed evenly over the delta, watering and more importantly fertilizing fields, spreading fish over the countryside, and sweeping away mosquito populations that spread malaria (Willcocks 1930; Klingensmith 2007).

[2]For the historiography of waters focusing on north India, see the works of c (1972), Stone (1984), Gilmartin (1994), and Weil (2006); for the south Indian context, significant contributions include Mosse (1997, 1999, 2003), Shah (2008, 2012), Rao (2011) and Schmitthenner (2011).

[3]Ecological Marxists like John B. Foster have elaborated on the Marxian environmental paradigm by focusing on the "metabolic rift" that establishes the connections between the two greatest contradictions of the planet: the contradiction between labor and capital and that between human beings and nature (Foster 1999, 2000).

of a hydraulic crisis, and deployment of new technical fixes to respond to the changed physical environment (D'Souza 2002). Within the colonial hydraulic conjuncture, ecological interventions determined by the politico-economic imperatives of rule had significant implications for the social apparatus, fostering changing social relations between the rulers and the ruled, the emergence of new social classes of intermediaries, and also constant chasms between different agencies and wings within the colonial bureaucracy and technocracy.[4]

The "colonial hydrology" framework has found wide application within the agrarian contexts of South Asia; it awaits exploration so far as urban settings are concerned. While within the context of contemporary urbanization, urban–rural boundaries have been gradually getting blurred in recent environmental social sciences research that emphasizes the urban–rural continuum and interface and calls for regional planning "beyond the urban" (Mukherjee 2015), yet in the same context, it is imperative to trace and map political and economic variables that determined particular patterns of urbanization and "urbanization of nature" (Swyngedouw and Kaika 2000, 2014), generating mutual and reciprocal repercussions between the city and its wider ecological infrastructures.

Tuned to the economic logic of the "calculus of rule," urban hydraulic infrastructural projects were geared to colonial capitalist objectives of revenue generation through the efflorescence of port cities as viable commercial centers of trade and transportation, connecting the city with its hinterlands. Networked infrastructures were designed and executed as important arteries of trade and urban utilities (water in, water out), meeting the expanding needs of the planned metropolises in the most cost-effective mode. The application of the "colonial urban hydrology" framework calls for rigorous explorations of urban economic history (and economic geography) and the technological history of urban infrastructures, and the possible intersections between the two.

Just as floods were perceived as a curse because they affected colonial capitalist calculations of extractions from agrarian produce, rivers connecting cities with hinterlands served as commercial arteries, guaranteeing "the steady, uninterrupted, and year-around flow of increased navigation" (Knoll et al. 2017, p. 9). Rivers supplied cities with drinking water and became the "ultimate sinks" for the disposal of waste (Tarr 1996; Melosi 2000).[5] In order to perform, "rivers needed to be

[4]In his study of the Mahanadi Delta, D'Souza (2002, 2006a) discusses the tussle between wings of the government—the revenue authorities and the military engineers. "While the former was keen on merely securing revenue interests by insulating as much rent paying lands as possible, the latter had to grapple with the hydraulic complications that had resulted from restraining rivers within embankments" (D'Souza 2002, p. 1266). Singh's (2008, 2011) studies of the Kosi River in Bihar demonstrate how, weaving complex arrangements with sections of the prosperous peasantry, railway officials, irrigation engineers, district administrators, and colonial zamindars crafted an embankment-driven flood control regime.

[5]The history of port cities shows how rivers have connected cities to hinterlands of global scale for centuries (Poussou 2014). In his study on Québec during the 19th and twentieth centuries, Castonguay (2017) highlights the "production of hinterlands" through the mediation of rivers. He unfolds the role of the river as a fundamental form of communication and integration and exhibits how hinterlands are shaped and defined across these processes.

engineered to become more reliable and much less subject to the vagaries of climate, the weather, and river morphology, to become streams uninhibited by rapids and shallow water, by floods and droughts, by narrow bends and meanders" (Knoll et al. 2017, p. 11). Rivers were straightened and shortened, and hydraulic engineers openly enjoyed "pushing rivers round," which is evident from river (water) engineering projects in the Western world and their transplantation in the colonies (Reuss 2008). These tamed interventions included an array of urban hydraulic initiatives like dissipating shoals and sandbars and draining of wetlands, facilitating the evolution of a "regulated and technicized hydraulic system" targeted to performing multiple functions at scales (Knoll et al. 2017, p. 9). The emergence of colonial port cities that evolved by tapping riverine potentials has to be contextualized within larger contexts of the establishment of European trade centers "on their own models, responding to situational advantages for trade" (Murphey 1964, p. 241). Beyond the distinct histories of land, forests, water, agriculture, and the urban, "fluid frontiers," "liminal spaces," and "amphibious histories" have caught the recent attention of historians towards rethinking and reconceptualizing the land/water binary, which was technically crafted to establish property regimes on rivers (perceived as flowing resources) and land as (fixed commodities) (D'Souza 2009; Morris 2012; Lahiri-Dutt 2014; Gillis and Torma 2015; Lafaye de Micheaux et al. 2018). Urban environmental history is now treading the path of understanding the advent of metropolises "from the shore" and reclamation of urban centers from swamps, muddying the (planned and executed) solid boundaries of separation where nature has been reduced to a resource (Bhattacharyya 2018; Schlichting 2019). Within these broad directions of research, this chapter provides an account of the tamed interventions comprising the history of colonial manipulation of a fluid scape on which the development of the port city and the delta city of Kolkata was concretized.

3.2 Networked Infrastructures

This chapter addresses the what, how, and why questions relating to networked infrastructures that evolved through a series of colonial manipulations or "tamed interventions" in the tropical-deltaic-estuarine scape. The system performed the dual functions of trade-transportation and drainage-sewerage-sanitation, accomplishing the colonial economic logic of revenue extraction from inland navigation (connecting the city with its hinterland) and cost-effective delivery of urban utilities. The networked infrastructures comprised an intricate web of rivers, canals, and (salt water) lakes along with interventions such as artificial cuts and excavations, construction of pumping stations, lock gates, sluices, mortar sewers, and elaborate projects of drainage and reclamation of marshes. The entire system evolved as an integrated apparatus to render the colonial urbanization project commercially viable.

The idea that Bengal, highly fertile and productive, crisscrossed by numerous rivers, tributaries, and distributaries of the Ganges, extensively supported lucrative trade gained ground through a huge corpus of historical writings, travelogues, and statistical surveys since ancient times. Bengal had an established history of internal (carried up the Ganges as far as Patna, and Masulipatam in the south) and foreign trade (with Ceylon and Maldives as chief importers) in rice, sugar, silk, lac, and saltpeter. The cotton textiles of Bengal, "the incredibly light muslins" produced near Dhaka, were "acknowledged to be the finest in the world and were in great demand in Europe" (Murphey 1964, p. 243). Bengal was the production paradise which mercantile European eyes could not afford to miss. Once the political climate became favorable after long-drawn attempts and negotiations, and Kolkata was selected as the potential site (port city) for colonial urbanization (see Chap. 2), the British plunged into the megalomaniac mission of muddling through the muddyscape to fulfill the increasing demands of the colonial exchequer. While on the one hand, the riverine ecology of Bengal presented the colonizers an opportunity to extend their trading operations inland over a wide and productive area, rather than remaining restricted to the west and south coasts which were "hemmed in on the west by Ghats and the interposition of the warlike Marathas," on the other hand, the "unruly waters" and "unhygienic" marshes of the delta unfurled uncertainties that the British had to navigate (Murphey 1964, p. 246).[6] However, the strategic location or physical isolation of eastern Bengal, cut off by a dense network of tidal streams and extensive swamps, was an advantage that could be harnessed to its utmost. The series of tamed interventions through the excavation of canals and reclamation of marshes manifests this continuous tussle in striking a balance between the ecological subsidies and environmental vagaries that the site offered.

The river Hooghly was the gateway to the trade of the Ganges valley. Several river "improvement" schemes including aggressive dredging operations were conducted by the Port Commission to keep the river free from siltation.[7] The crucial importance of this battle against silt is captured in the administrative reports of the Port Commissioners. Between the rivers Hooghly on the west and the Bidyadhari on the east (and further down till the Meghna estuary), an intricate network of canals was excavated, linking the city with its fertile eastern hinterlands that promoted and facilitated inland navigation. The canal system that evolved out of the deployment of colonial hydraulic engineering opened a navigation route between Kolkata and eastern Bengal, traversing the districts of 24 Parganas, Khulna, Faridpur, and Barishal. The two termini of the Eastern Canal System were Dhapa on the west and Barishal (the headquarters of the rice-growing district) on the east. The boat routes converged on Dhapa, a portion of the salt water lakes which was connected to Kolkata by the Beleghata Canal and the Circular and New Cut Canals

[6]"Navigation is treacherous, plagued not only by shifting sandbanks and tidal currents, but by continual and often very rapid change in the stream pattern" (Murphey 1964, p. 246).

[7]Founded in 1833, the Calcutta Chamber of Commerce paid attention to the maintenance and improvement of the harbor and its approaches, port facilities, and pilot service.

in the north. The portion of the Adi Ganga which was re-excavated by William Tolly was the very first and significant project executed within this context. "The Tolly's Nullah marked the beginning of modern navigation of the Sunderbans" (Bandopadhyay 2018, p. 53). Numerous cargo boats carrying rice, fish, vegetables, fruits, etc., passed through this canal every day paying regular tolls at the collection offices instituted for tollage. Tolly's Nullah tapped the rice trade by connecting Kolkata with the Sundarbans in the south, and "it was the only means of outlet for the rice traffic of the Sundarbans and the surrounding countryside" (Bandopadhyay, 2018, p. 64). Buckley, executive engineer, Calcutta and Eastern Canals, argued that the canal system of Kolkata had few competitors in the world in terms of the quantity of goods they delivered (Buckley 1883, cited in Inglis 1909).

The debates, discussions, and arguments around the implementation of various plans and designs relating to canal excavation and marsh reclamation among the different wings of the government, including the Military Board, the Calcutta Corporation, the Irrigation and Waterways Department (I&WD), the Public Works Department (PWD), and different committees appointed by the government, capture technical dilemmas (mainly surrounding siltation or tidal accumulations) and clashing priorities between navigation needs and the drainage-sewerage requirements of the city. Should a canal continue being a prominent artery of trade or function chiefly as a receptacle of the city's wastewater? What would be the financial logic, the implications and arrangements between colonial agencies? Should the salt water lakes be reclaimed and sewage farming experiments be introduced for commercial gains? Or should these lakes be primarily used as the city's outfall? Which ventures and initiatives would ensure greater returns on investments? What would be the health impacts of channelizing the city's effluent and dumping its solid wastes in these tidal marshes? Shifting development needs unfolded these questions and debates time and again, shaping the environmental trajectories of the city through the planned accomplishment of immediate, short-term objectives with long-term implications for urban sustainability. The passage of acts, most importantly the Bengal Embankment Acts, by delegating power to the government to appropriate any tract as a "public water course" for drainage requirements, further complicated the situation. The implementation, functioning, and maintenance of the technical apparatus are not only dotted with convoluted institutional dynamics of governance, but also social relations and equations between the government and local inhabitants like Seroo Ghose (employed as the superintendent of Tolly's Nullah by the government), Bhabanath Sen (leaseholder in Dhapa), and fishers whose fishery rights and compensation charges had to be taken into consideration before implementing marsh reclamation projects. These "tamed interventions" expediting the evolution of networked infrastructures offer a complex history of this continuous colonial encounter with nature and native in a volatile, vulnerable, uncertain, "unhygienic," and "unruly" fluid scape.

3.2.1 Excavation of Canals

The major canals which were excavated between the first decade of the nineteenth century and the first decade of the twentieth century together comprised the "Circular and Eastern Canals" (Inglis 1909). Inglis' accounts, reflecting on the early history of the canal system, provide an indication of how this nomenclature was derived. At the beginning of the nineteenth century, the "Eastern Canal" was the name given to a shallow channel by which country boats passed through the salt water lakes about a mile and a half east of Entally. The canal was engineered so that its use value could be optimized. In Buckley's (1883) report, the project details are illustrated:

> In 1810, the "Eastern Canal" of those days was improved, widened and lengthened; the channel was brought from the Salt Water Lakes, near the present village of Chingreehatta, nearly up to the Circular Road a little to the south of the place.… it was connected with the old Dhurrumtolla open drain, and carried a portion of the drainage of Calcutta to the Lakes. A portion of this old Eastern Canal, from the Circular Road to the site of the present sewage pumping station in Entally, was obliterated when the existing sewers of Calcutta were constructed; it was converted into a large brick tunnel, into which all the main sewers converge. (Quoted in Inglis 1909, p. 1)

The report mentions that the new "Eastern Canals" are far more important and extensive as these form a channel of communication between Kolkata and Barishal covering a distance of around 187 miles (Inglis 1909; O'Malley 1914). The artificial cuts were excavated to connect the tidal channels and rivers of the Sundarbans to this waterway. The major canals within the Eastern Canal System were: the Beleghata Canal, the Circular Canal, New Cut Canal, the Bhangar Canal, and the Krishnapur (or Kestopur) Canal (Table 3.1).

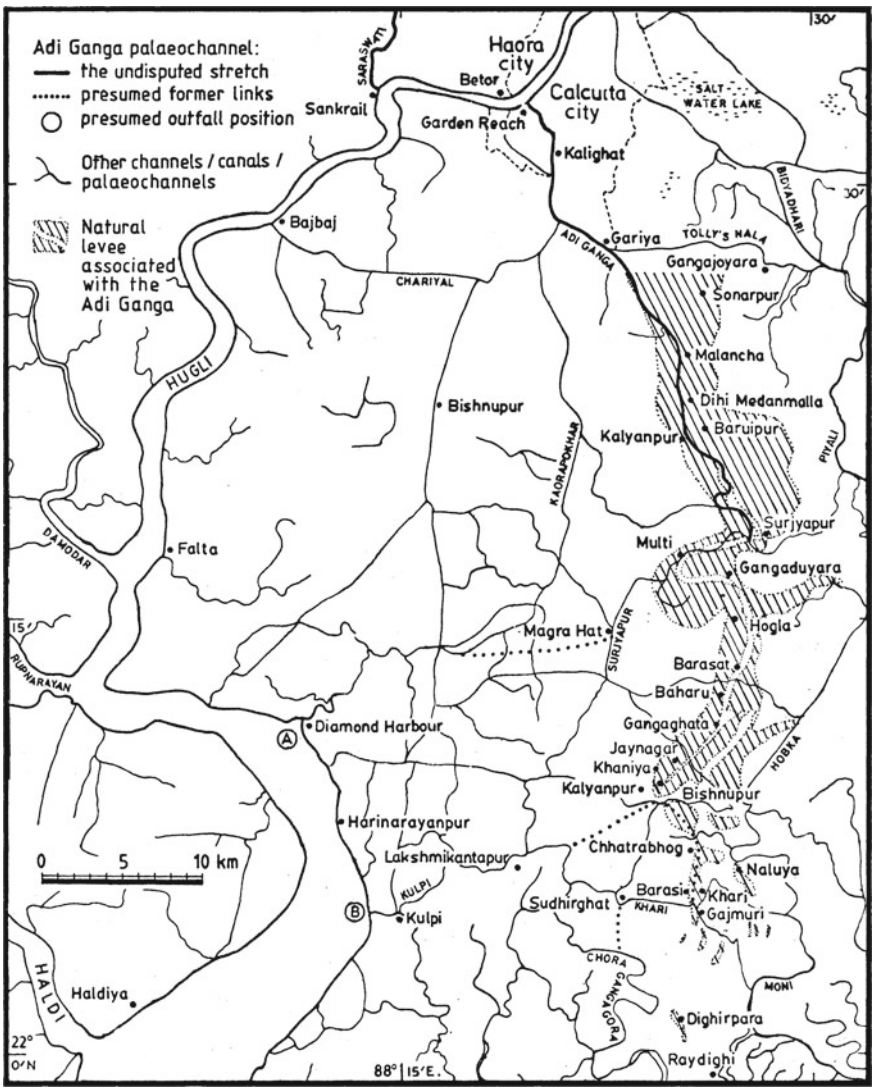
Though Tolly's Nullah does not technically fall within the Eastern Canal System, yet it was part of this intricate network and the first revolutionary step taken by the colonizers to avoid the previously existing route, which was not only "circuitous but also impracticable" for the movement of the country boats during the monsoon (O'Malley 1914, p. 205). Connecting the river Hooghly with the Bidyadhari, the 17-mile-long excavated canal followed the moribund route of the Adi Ganga in its western section up to Garia (Map 3.1).

On July 6, 1775, Major William Tolly applied for permission from the government to excavate the canal between the Hooghly and the Bidyadhari (with the

Table 3.1 The Eastern Canal System

Name of the canal	Year of execution
Beleghata Canal	1810
Circular Canal	1831
New Cut Canal	1859
Bhangar Canal (canalized)	1897
Krishnapur Canal	1910

Source Compiled from Inglis (1909); O'Malley (1914); Addams-Williams (1919)



Map 3.1 The Adi Ganga—Tolly's Nullah route. *Source* Bandopadhyay (Bandopadhyay 1996)

salt water lakes as its spill basin) at his own expense. He initially suggested two alignments, one to the north and the other to the south of Kolkata, of which the latter got the government's approval. Tolly received a temporary land grant from the government and also a loan of 100,000 rupees for 12 years and the right to levy tolls at 1 percent on the price of all goods carried by country boats that would take this route using the canal (Mukherjee 2016; Bandopadhyay 2018). In 1776, Major William Tolly canalized the old bed of the Adi Ganga from its confluence at Hastings, south-eastwards to Garia, a distance of 8 miles. Then it was further

excavated east to meet the Bidyadhari River at Samukpota, a distance of 9 miles. Tolly's Nullah (named after William Tolly) provided access to an inner route which led eastwards from Canning. The 17-mile-long canal was opened to navigation in 1777 to accommodate boats of 400 *maund*s.[8] Buckley's (1883) report provides detailed justification for the sanction of the project:

> It appears that Major Tolly proposed to connect, by a cut across the Salt Water Lake, which was then apparently much larger than now, two natural creeks, called the Tarda Nullah and Surnam's Nullah; the former of these was a creek which drained the Salt Water Lake into the Biddiadharri river near the present village of Samukpotta and the latter appears to have been a khall somewhat to the south of the site of the present nullah at the Hastings Bridge. The connecting channel appears to have been at least twelve miles in length; it was found impracticable to proceed in any other line than that by the way of Gurreah, which increases the distance by at least seven miles. (Quoted in Inglis 1909, p. 95)

After the death of Major Tolly, Mrs. Tolly was given the right to levy tolls, and to establish markets "as many bhokeys, wharfs, Custom Houses for the purpose of collecting such Tolls" free of rent from the Company.[9] On March 18, 1790, in the *Calcutta Gazette*, an advertisement was published offering the sale of the remaining term of the lease granted by Mary Anna Maria Tolly to John Wilkinson. The canal was taken over by the government in 1804, as evident from the official announcement in the *Gazette* which states that the tolls on boats and goods passing through the canal would henceforth be collected by the government—the Superintendence of the Collector of 24 Parganas. Proceedings and land title deeds preserved at the WBSA, Kolkata, provide the detailed history of purchase of lands and land transfers, management, and tax collection rights on Tolly's Nullah involving William Tolly, Mrs. Tolly, the government, and also "natives" like Seroo Ghose.[10]

The Beleghata Canal was excavated between 1806 and 1810 as a further step to improve an old channel through the salt water lakes. The canal was named after the village Ballighaut north of Dhapa. It extended a few hundred feet from the Circular Road and was spanned by a small arched bridge known as Palmer's Bridge. Addams-Williams' (1919) report recounts that a strip of 150 feet of land was acquired in 1808–10, and in all 140 *bigha*s, 4 *cottah*s, and 14 *chitak*s,[11] of which 13 *bigha*s, 12 *cottah*s, and 2 *chitak*s were composed of water courses, were brought under the implementation of canalization schemes. This project was part of the

[8] *Maund* is a unit of weight equivalent to 37 kg (approximately).

[9] Proceeding 24 dated June 8, 1804, which includes an extract from the Proceedings of the Governor General in Council in the Public Department dated October 23, 1786. The deed recites the former grant to the late Colonel William Tolley, the Will of the Deceased, and that Mrs Tolley had proved the same in the prerogative Court of the Archbishop of Canterbury and taken upon herself the sole executor thereof (WBSA, Kolkata).

[10] Proceeding 16 dated July 6, 1804 (letter to D. Macnabb, Attorney to the Executors of the late Anna Maria Tolley) (WBSA, Kolkata). Proceedings 1 and 2 dated July 24, 1804 (WBSA, Kolkata). Proceeding 35 and 36 dated February 18, 1806 (WBSA, Kolkata) specifically talk about the deputation of Seroo Ghose as the *Suzawul* (toll collector) for the collection of tolls from Tolly's Nullah.

[11] *Chitak* is the unit of land measurement prevalent in Bengal. One *chitak* is 45 square feet.

widening initiative on the Eastern Canal (Buckley 1883, cited in Inglis 1909). However, as the canal had no connection with the river Hooghly, major boat traffic still resorted to Tolly's Nullah to reach the river following the Sundarbans route. However, Tolly's Nullah seemed to be quite inadequate for navigation. During dry seasons, it remained almost choked, and many of the boats, being unable to progress further, were compelled to deposit their burdens on the bank of the Nullah. In order to relieve pressure on the canal, Major Schalch proposed to extend the Beleghata Canal up to the river Hooghly at Chitpur with lock gates at that point, parallel to the Circular Road. The project was sanctioned and completed in 1831. The entire stretch of the canal from Chitpur to Dhapa came to be known as the Circular Canal. Boat traffic in the Circular Canal started when the construction of the Chitpur lock gate was completed in 1833. The Circular Canal project, including the excavation of the canal and the construction of the Chitpur lock gate, was the brainchild of Major Schalch. Lieutenant T. Prinsep and James Prinsep took charge of the entire project after Schalch's demise. Buckley's (1883) report provides an account of how and why the idea of the construction of the Chitpur lock gate originated:

> As the water in the Salt Lakes was found to be so much below the high tides of the Hooghly in the rains, Lieutenant Schalch proposed that in the masonry of the Ooltadanga bridge grooves should be constructed for the reception of large sal or teak timbers with the space between them filled up with earth. This primitive idea was the first germ from which the present Chitpore Lock has sprung. (Quoted in Inglis 1909, p. 2)

A sum of about 65,000 rupees was spent to construct the lock gate, as this was required to regulate storm water and effluent in the Circular Canal, which was also used as a receptacle for wastewater for the city. James Prinsep proposed a lock with floodgates consisting of two chambers, each 24 feet wide, parallel with each other and separated by a pier 8 feet wide (Addams-Williams 1919). The idea was to close the floodgates during rains to prevent excessive rush of water down the canal, saving the city from flooding and waterlogging. With the opening of the Chitpur lock, it was expected that "during the rains it would be possible to send such a stream through the Circular Canal as would completely sweep away the accumulations which were attributed to the town drains" (Inglis 1909, p. 2). But though the deposits or accumulations were removed to a commendable extent, "the method did not prove to be nearly as efficacious as was expected" (Inglis 1909, p. 2). The Chitpur lock seemed to be small and less effective against the increase of traffic and challenges relating to tidal and effluent discharge, further constraining navigation. Colonial anxieties increased with the fact that "such a number of boats lined the banks on both sides that it was almost impossible to get a boat through from Dhappa to Chitpore" (Inglis 1909, p. 2).

In the early 1850s, there were proposals to cut an entirely new canal almost parallel to the Circular Canal to relieve traffic. It was to be designed as an independent outlet with a lock into the river Hooghly to the north of the Chitpur lock. However, the project did not materialize. The New Cut Canal was excavated in 1859; it was carried from Dhapa up to Ultadanga, from where it was then connected to the Circular Canal. The proposed lock plan in the initial proposal was abandoned

and the land that was already acquired for this was eventually sold to the Eastern Bengal Railway (Buckley, 1883, cited in Inglis 1909; Addams-Williams 1919). One of the reasons why Major Issac's 1854 lock-gate construction plan to abate tidal silt did not gain ground was that if the canal was always kept full, town drainage equations would have suffered with risks of floodwaters sweeping the city during monsoons (Inglis 1909). The key challenge for colonial hydraulic design, development, and implementation was striking a perfect balance between navigation interests and the drainage-sewerage requirements of the city through the integrated and intricate nexus of networked infrastructures.

During the 1850s, a parallel project on the drainage of Kolkata was prepared, sanctioned, and executed. Three storm overflows running into the Circular Canal were built. There was provision to channelize the effluent passing through the sewers and reaching the main outfall at Palmer's Bridge into the Beleghata Cut. The problem of silt accumulations became a serious hindrance to the traffic and a constant source of colonial concerns. There was obstruction to the smooth flow of traffic due to constant accumulation of silt in the canal between the margin of the salt water lakes at Dhapa and Chitpur. These silt deposits were chiefly carried in by the tidal waters of the salt water lakes and the Hooghly and the washings from the town drains. "The nuisance caused by these town drains increased; while the drains in the early days of the Circular Canal mainly discharged surface drainage, these now discharged (at times) large quantities of sewage into the Canal" (Buckley, 1883, quoted in Inglis 1909, p. 3). The implementation of the scheme by Major Clark, engineer to the Calcutta Corporation, replaced the old open drains by brick sewers "which reticulated the town in all directions and discharged their contents at times of heavy rainfall, directly into the Canal at four or five different points" (Buckley, 1883, quoted in Inglis 1909, p. 3). In 1855, Major William Clark proposed a combined system for the disposal of storm water as well as the sewerage of dry weather flow; one outlet for storm water at Manicktala into the Circular Canal and another into the Beleghata Cut from Entally. It was intended that the receiving sewers would discharge storm waters at both ends. It was accepted by this time, especially after observations made by the committee which was appointed in 1857 to examine the scheme for drainage and sewerage of Kolkata, that "due to the rise of the tides, and the noxious effluvium from the sewerage" creating "mortality among the shipping of the port," the river Hooghly on the west could not be the city's outfall (Inglis 1909, p. 29). Moreover, the natural declivity of Kolkata was in the eastern direction. The outfall selected by Clark was the salt water lakes for sewerage and for the storm water into the Beleghata Cut and Circular Canal. Clark's scheme was sanctioned in 1859 and executed between 1860 and 1875 at an estimated cost of 34,000 rupees.

> The sewers which were designed to carry off a 6″ rainfall in 24 hours over the area (then 4,600 acres) delivered their contents at Palmer Bridge where three engines capable of lifting a total amount of 91 c.ft. per second were erected to pump the sewage, etc. into their higher level sewer (leading to Tangra and falling into Rajakhal, an off-shoot of the Bidyadhari).

> They carry off the storm-water, three storm-water overflows were provided running into the Circular Canal. The ordinary discharge from sewers at that time, was ten million gallons in 24 hours or 18½ c.ft. per second.… In 1875, nearly 38 miles of brick sewers and 37 miles of pipe sewers were completed. (I&WD 1947)

There were constant clashes and negotiations between the government and the corporation over the use of canals as navigation arteries or receptacles of wastewater. The different (yet not absolutely divergent in terms of cost-effectiveness calculations and the larger needs of the city and the relationship between the two) sets of priorities and perspectives on urban development and larger economic logic came out sharply, especially within the context of the functioning of the Circular Canal. On the one hand, the canal was reported to intercept the flow eastward, and on the other, it was itself receiving a great portion of the drainage of the city. The 1857 committee pointed out that as large revenues were derived from the canal through navigation and tollage-imposed cargo boats, hence, it "should be made to pay for such injury to or interfere with the drainage, as it may be instrumental in occasioning" (*Selections from Records of Bengal Government relating to Calcutta and Eastern Canals, 1865–1904*, quoted in Inglis 1909, p. 30). It did not consider how the canal was providing services to remove storm water which would have otherwise attracted huge costs. While the committee was pushing for incurring partial costs of drainage from surplus funds generated by the canal, the corporation was desperate to exclude the Circular and Eastern Canal System from carrying Kolkata's sewage and storm water. The Bengal Government Resolution No. 570 (C) dated June 25, 1878, depicts the negative implications caused by the discharge of storm waters into the city's canal system:

> The Lieutenant-Governor is of the opinion that the Superintending Engineer of the Presidency Circle should prepare a detailed scheme for entirely relieving the Calcutta and Circular Canals of influx of storm-water and sewage from the Calcutta drainage system, and for bringing within the sewerage and drainage system of Act XV of 1876 … that portion of the environs of the town of Calcutta which lies between the town and the canal and extends from Chitpore to Baliaghatta, or beyond if considered desirable. (Quoted in Inglis 1909, p. 32)

The solution came through the approval of the construction of an intercepting sewer with flushing sewers at those points where outfall sewers flowed into the canal, so that the intercepting sewer could easily flush out from the canal whenever required. However, with these alteration and arrangements, the canal still kept offering itself as a means to drain storm water.

Similar concerns and apprehensions also surfaced so far as Tolly's Nullah was concerned, especially regarding the proposal to canalize the Nullah to materialize the Port Commissioners' scheme for wet docks at Khidirpur (Inglis 1909; Bhattacharyya 2018).[12] In his 1883 report, Buckley mentions the connection between the canal and the Kolkata sewers and argues that "it will be imperative to

[12]The proposal was to connect the docks with Tolly's Nullah by a boat canal terminating in a lock at the docks, for which canalization of the Nullah was essential to ensure "constant and pure supply of water" to pump into the docks (Inglis 1909, p. 97).

prevent the discharge of storm-water from this sewer into the nullah when the nullah is canalized" (quoted in Inglis 1909, pp. 100–101). This was significant in terms of the navigational utility of the canal; "the storm-waters discharged from the Calcutta sewers are strongly tainted with sewage; this sewage, if admitted to the canalized nullah, would be sufficiently objectionable even there, but doubly so when it came to be pumped into the Kidderpore Docks, where the water should be kept as clean as possible" (quoted in Inglis 1909, p. 101). Buckley went as far as to suggest that this canal should be closed altogether as a storm outlet. His proposal appeared to be significant and it was recognized that the canalization was a necessary step to provide the country boats with direct access to the docks.[13] It was suggested that a sluice should be constructed for passing vessels in and out for flushing out the silt, which was more cost-effective than pumping up water from Tolly's Nullah. Regarding the costs of the inlet sluice and the expenses of removing the silt, it was proposed that it could be charged against the dock scheme. The proposal did not materialize as it was contemplated that the maintenance of other canals within the Eastern Canal System was more important for the time being than the Tolly's Nullah canalization project.

A series of plans, designs, schemes, and proposals were formulated, debated, annulled or implemented to constantly address increased traffic and tidal accumulations in the canal system. Meanwhile, the lock at Dhapa as proposed and advocated by Major Issac in 1864 was approved. After initial hiccups, the revised proposal by Issac to construct a lock at Dhapa and a larger lock at Chitpur for controlling the town drainage and sewage discharged into the canal was sanctioned. The Dhapa lock was constructed in 1881 and the new Chitpur lock in 1883. The storm water outfall works intercepting sewage from the canal were also sanctioned and executed in 1881. The technical plans, experiments, and executions manifest colonial desperation to balance the trade-transportation and drainage-sewerage-sanitation requirements of the city, evident in Buckley's (1883) report:

> The execution of these works will leave the Canal between Dhapa and Chitpore in a thoroughly satisfactory condition. Instead of being muddy with the silt of the Salt Lake Channels and foul with the sewage of Calcutta, the water will be clear and clean. Instead of being frequently blocked by silt and sewage mud, until the channel was almost dry at places at low water, the Canal will have a uniform depth throughout which will never be less than eight feet and rarely less than ten. (Quoted in Inglis 1909, p. 4)

In the 1880s, further modification in the city's drainage plan was required in light of the development of the city southwards along with a marked increase in population in the northern part as well. The revised design was executed in 1896.

> It covered an area of 7.5 square miles (19.2 square kilometres) in the Town or Central area and included setting up of a drainage pumping station at Palmer's Bridge. Clark's sewerage-cum drainage system was designed to accommodate an average ¼″ (6.35 mm) of rainfall per hour with 100% run-off in addition to domestic sewage. The main sewers were

[13]Selections from Records of Bengal Government relating to Calcutta and Eastern Canals, 1865–*1904*.

> connected for flushing purposes with the river on the west wherefrom they fall eastward to the intercepting sewers on the Circular Road. The sewage was pumped up at Palmer Bridge Pump house about a mile (1.61 km) farther into a high level sewer and discharged at a distance of about 3 miles (4.83 Kms) into Rajkhal, an off-shoot of Bidyadhari river and Salt Lake. (Dasgupta 2003, pp. 3–4)

In this connection, the proposal for canalization of the Bhangar Canal at an estimate of 1,256,000 rupees by Mr. Horn, secretary and chief engineer, I&WD, was submitted. The plan included construction of locks at Bamanghata and Kulti along with a sluice and widening and deepening of the canal. In a letter dated June 2, 1884, Horn wrote,

> The tides from the Biddiadharee and Kooltee Gong meet in the 20th mile of the canal close to Bhangore hat, and the amount of silt annually deposited between the 18½ and the 20th mile is so great that it is impossible to remove it by dredging. The khal (canal) is also very narrow, and at high water spring tides there is barely 3 feet 6 inches of water which only lasts for an hour, so, considering the large number of boats that pass through the khal daily, and remembering that boats coming from both directions must pass this shallow part of the channel at the same time, it is easy to understand how the traffic is daily obstructed. (Quoted in Inglis 1909, p. 14)

The proposal was not sanctioned immediately, following which Horn again put forward the need and importance of the project. The new proposal was more detailed and comprehensive, reflecting on each and every project component including the size and sill of the locks (fixed at −3.00 + MSL [mean sea level], enabling the locks to be worked for 6 h at each tide), the volume of water (rainfall of ¾ inch in 24 h equivalent to a discharge of 20 cubic feet per second per square mile, was assumed as the quantity to be drained off the whole of the catchment area), drainage (an impounded level of 6 + MSL; when draining the lowest rice lands in November, it would be necessary to lower the canal for a few days to MSL + 4.00), and the bed of the canal (a depth of −2.50 + MSL). The project commenced in 1896 and was completed by 1897–99.

Between 1896 and 1904, to cope with the increased wastewater supply due to urban expansion and demographic pressure, it was considered necessary to further augment the drainage scheme by increasing the capacity of the Palmer Bazar Pumping Station, the setting up of the Ballygunge Pumping Station, and the construction of high-level sewers from these stations to flush points, and also using town and suburban storm water reservoirs connected to the Central Lake Channel at Bantala (I&WD 1947). In 1904, the next major proposal centering round the construction of a link between Dhapa and Bamanghata to avoid the Central Lake Channel was made, as the latter was choked due to rapid accumulation of silt.[14] In a report submitted on September 12, 1905, Horn justified the execution of the project:

[14]The Central Lake Channel ran through the salt water lakes for a distance of 6 miles (approx.) from Dhapa to Bamanghata, where it merged with the Bidyadhari and flowed for 15 miles (approx.) to meet Tolly's Nullah at Samukpota, establishing a roundabout link between the Circular Canal and Tolly's Nullah. Between 1863 and 1864, of the 145,778 boats that entered the Circular Canal, 111,396 passed through the Central Lake Channel (Bandopadhyay 2018).

> The boats which arrive too late to enter the lock (at Dhapa) are unable to anchor with safety or the next opening, any distance short of 5000 feet from the lock, when up to 1896 boats could moor within 1000 feet of Dhapa. Prior to 1896 boats and launches could anchor in a sufficient depth of water at low tide so that in a few years more the channel will have to be condemned as being insufficient sections to pass the boat traffic and there will be great loss of canal revenue. (Quoted in Bose 1947, p. 37)

However, instead of being approved, the project had to come to an abrupt halt due to exorbitant demands of compensation for fishery rights in the northern salt water lakes region. Thus, an alternative scheme was put forward leading to the construction of the Krishnapur (or Kestopur) Canal in 1910 at an estimated cost of 910,014 rupees (Inglis 1909; Bose 1947). The canal was constructed on the eastern margin of the salt water lakes. Taking off from the New Cut Canal, the Krishnapur Canal joined the Bamanghata-Kulti Canal, facilitating both navigation and drainage. The canal received sewage from the city's north and east, which entered it through a series of regulators and sluices and finally disposed it into a smaller inlet called the Paran Chaprasir Khal connected to the salt water lakes.

The city's drainage encountered a deadlock scenario with the deterioration of the Bidyadhari River, which had served as the main outfall channel. From government reports and letters exchanged between 1917 and 1924, it appears that signs of deterioration in the river were evident as early as the late nineteenth century. Remedial measures costing 2,000,000 rupees were implemented, but in vain (Calcutta Corporation 1946). The deterioration was widespread rather than local, "extending right up to Port Canning, 35 miles from Dhapa or even downwards" (Calcutta Corporation 1946, p. iii). However, though the drainage of its watershed of about 200 square miles was seriously affected from the early 1930s, the river still kept functioning as an outlet of the city's drainage till the alternative outfall became operational. When the river showed prominent signs of deterioration due to several reasons including the excavation and re-excavation of canals and reclamation of the eastern saline marshes, and it was officially declared dead for both drainage and navigation purposes in the late 1920 s, there were discussions and debates about the selection and implementation of an alternative outfall (Tables 3.2 and 3.3).

F.C. Griffins, chief engineer, Public Health Department, Bengal, and M.R. Atkins, chief engineer, Calcutta Improvement Trust (CIT), suggested the revival of the Bidyadhari River to its original state. To Atkins, the river Hooghly seemed to be a useful receptacle for the city's discharge. The viability of considering the Piali River as an alternative outfall was also considered (Calcutta Corporation 1946; I&WD 1947). However, these plans were abandoned in light of feasibility issues.

Table 3.2 Reduced cross-section of the Bidyadhari River.

Year	Cross-section of Bidyadhari River (at Bamanghata)
1829	1920 sft (178.38 m^2)
1904	13,674 sft (1270.39 m^2)
	700 sft (901.19 m^2)
1913	490 sft (602.96 m^2)
1928	1000 sft (92.91 m^2)

Source Dasgupta (2003)

Table 3.3 Reasons behind the deterioration of the Bidyadhari River

• Construction of the Dhapa lock in 1881 disturbed its equilibrium
• Canalization of the Bhangar Khal, particularly the damming up of the Kanatala Gong in 1896
• Construction of the Krishnapur Canal considerably dwindled the upland water flush
• Premature reclamation by embanking the salt lakes[a]
• Non-enforcement of Embankment Act between Dhapa and Samukpota, which the government had to abandon on a strong protest from the local zamindars[b]

[a]There was decrease in the spill of water from the river over the adjoining land and consequent silting of the riverbed due to reclamation of portions of the salt water lakes for rice cultivation
[b]The farmers were keen to utilize the marshes as rice fields; the fish owners formed *bheri*s (fishponds) by erecting embankments to prevent the spill waters of the Bidyadhari. This caused obstruction to the spilling of the waves by the tidal river in the natural spill basin. This also led to the deposition of huge amounts of silt carried on the riverbed. The accumulated silt choked the river and made it moribund
Source Compiled from Calcutta Corporation (1946), Dasgupta (2003)

So far as the Hooghly River was concerned, there was opposition and objection to disposal of sewage from both sanitary and religious points of view as the river was sacred (Chap. 1). The Piali River was a spill channel of the Matla-Bidyadhari system, which attracted higher possibilities of unmanageable tidal accumulations. It became apparent from geomorphological understandings and explorations that the head waters of the Bidyadhari were getting diverted to the Kulti River further east, which had deepened and enlarged itself considerably to become a "vigorous" river by this time. In the *Kulti versus Bidyadhari* section in the Drainage Committee Report, the then outfall engineer A.N. Banerjee explained why the Kulti was a more viable alternative to the Bidyadhari (I&WD 1947). The Bidyadhari could not survive the series of canalization initiatives, as the free spills into the salt water lakes had been curtailed naturally and artificially at an alarming rate. On the other hand, Kulti went on increasing its sections from 1894 to 1926, which has been attributed to the existence of free spill areas at her ends that remained unaffected. The Bidyadhari was purely a tidal creek for which the remedial measures that were considered for adoption came too late. The Kulti was not an old river and at the expense of the Matla series of rivers, it went on steadily increasing its sections. Banerjee urged, "Sufficient resources are still available to maintain the Kulti Gong in good condition and it is of utmost importance to tap the resources as soon as possible" (I&WD 1947, p. 69).

After a series of proposals, meetings, debates and discussions, the Kulti Outfall Scheme was developed and submitted by Dr. B.N. Dey, chief engineer, Calcutta Corporation, in May 1930 (Map 3.2). On July 16, 1935, the project was sanctioned by the government under Section 251 of the Calcutta Municipal Act of 1923.[15]

[15]For details on these debates and various proposals that came up between the 1920s and early 1940s, see *Report of the Committee to Enquire into the Drainage Condition of Calcutta and Adjoining Areas 1945* (I&WD 1947) and *Index Corporation of Calcutta Selection of Records on Dr. Dey's Kulti Outfall Scheme 1930–1945* (Calcutta Corporation 1946).

Map 3.2 The Kulti Outfall Scheme. *Source* Chattopadhyay (1990)

Dey's scheme consisted of the internal drainage scheme and the Kulti Outfall Scheme at an estimated cost of 6,500,000 rupees. The internal drainage scheme implied the execution of two parallel channels—the dry weather flow (DWF) and the storm water flow (SWF)—from Bantala to Kulti (17 miles) to carry DWF and SWF of the city separately, along with additionally draining adjoining areas into the SWF to relieve pressure during the period when the disposal of the storm water of the city was not required.[16] Five big sewers were proposed, of which two (one old and one new) from the town were designed to be controlled by the Palmer's Bridge Pumping Station, while two (one old and one new) from the suburban area were to be controlled by the Ballygunge Pumping Station, and one from the Tangra area which was to meet at Point "A." The combined discharges at this point were led by an open *pucca* sewage channel to Bantala and thereafter to the new outfall river Kulti. The entire scheme was massive; apart from the excavation of DWF and SWF, it also incorporated construction of sluices, cross-drainage works of adequate ventages, roads, bridges, lagoons, drying beds, sedimentation tanks, etc. The justification for this expensive project and the reasons behind its approval are reflected in Dey's very own remark:

> It will thus be possible to drain in addition to the city's 30 square miles of urban areas adjoining Calcutta and a still further rural area of 50 square miles in the neighbourhood of the city's Outfall Drainage Channels. The difficult problem of drainage disposal over a hundred square miles of Calcutta and its environs is, therefore, solved. I understand the committee is unanimous on this point, viz. utilizing Calcutta's New Drainage Outfall Channels and the New Outfall on the Kulti river to the utmost limit. (I&WD 1947, p. 55)

[16]This implied the widening and deepening of the existing SWF and DWF with excess sluice capacity.

3.2.2 *Reclamation of Marshes*

The 24 Parganas, like other deltaic districts, are studded with large marshes and swamps, situated between the elevated tracts which mark the course of the rivers (Hunter 1875). The extensive saline marshes in the eastern part of the city are a component of this tidal geomorphological continuum. The Bidyadhari River was the most significant spill channel that fed these marshes with saline water from the Bay of Bengal leading to the formation of the salt water lakes. These lakes were spread across the eastern part of the city, north of the Sundarbans delta. In the north, the edge of the lakes extended up to "the foot of a 9-m-high mound known as Dumduma, near which the Burmese and Mug traders, arriving in boats, used to anchor" (Chattopadhyay 1990, p. 3). Chapter 2 shed light on the geomorphological origins of these tidal saline marshes and colonial perceptions and anxieties about its contribution towards the "unhygienic" environment. Though the salt water lakes provided a strategic locational advantage by making these "wild" swamps impenetrable for enemies, its reclamation seemed necessary for different reasons which can be clubbed together within the larger logic of the colonial capitalist project of urbanization.

Colonial accounts (Martin 1836; Strong 1837) portraying the malarial atmosphere of the marshes ensured that reclamation schemes and projects were guided by apprehensions surrounding "miasma," which played a strong role in the implementation of networked infrastructures (water provisions) in different Western cities followed by colonial urban centers (Melosi 2000; Schott 2004).[17] The colonial urbanization project of Kolkata is loaded with numerous debates about sanitation, epidemiology, and cholera throughout the nineteenth century (Smith 1869, pp. 9–12). Writing epidemiological histories of Kolkata, Chattopadhyay (2006) argues that malaria, cholera, and other diseases were the basis for a colonial pathologization of the urban space, resulting in the ascendancy of the "environmentalist paradigm of disease" and the "climatic difference" between India and Europe as "central in understanding India's environment" (Chattopadhyay 2006, pp. 62–63). These studies on colonial urbanization, demonstrating how miasma and epidemiology had shaped early colonial urban planning, fail to "account for the cornucopia of other factors: economic, ecological and legal" (Bhattacharyya 2018, p. 21). Hence, the miasmatic paradigm ignores how colonial infrastructure was

[17]To Strong, draining the marshes was necessary to ensure the healthiness of the city and its suburbs, "when we know from well authenticated records that the mortality was frightfully great, and we find the Salt-water Lake recorded as the most prominent of the causes. Should cleanliness ever obtain in these eastern suburbs and the Salt Lake become drained and cultivated, I entertain no doubt whatever of great healthiness being the result; and one great advantage attending the drainage of the lake would be, that the country between it and the city would immediately improve, become more valuable, and be the resort of a more respectable population" (Strong 1837, p. 9).

"entangled in ecological interventions into nature and economic ordering of spaces" (Bhattacharyya 2018, p. 146).[18]

"The native dwelling there (near Salt Lakes) are subject to constant low fevers, spleen, dropsy and mesenteric disease."[19] "The plague spots, viz. the Salt Lakes should be reclaimed" (I&WD 1947, p. 14).[20] While there is no doubt over colonial anxieties from the public health and hygiene perspectives, yet, the fact that expanding urbanizing needs of the city, especially relating to drainage-sewerage services, also captured major attention is evident from the series of reclamation plans, proposals, schemes, and designs preserved in the colonial archive.

Drainage woes and worries of the eighteenth century figure repeatedly in the *Fort William Consultations and Correspondence* records. At the onset of the nineteenth century, it was understood that the natural slope and declivity of the city was towards its eastern side. In a minute of 1803, Lord Wellesley pointed out the defects of colonial engineering by draining the city to the west against its natural slope.

> The construction of the Public Drains and Water Course of the Town is extremely defective. In their present state, they neither answer the purpose of cleansing the Town nor of discharging the annual inundations occasioned by the rise of the river or by excessive fall of rain during the South-West monsoon.… An opinion is generally entertained that an original error has been committed in draining the Town towards the River Hugli. (Martin 1836, p. 672)

For the effective drainage needs of the city and its suburbs, reclamation of the chain of swamps in the north and the east comprising the salt water lakes was suggested time and again. In a minute dated February 2, 1830, Lord William Bentinck, the then governor-general of India, emphasized the implementation of the reclamation project on sanitary grounds and strongly recommended that the marshes, comprising "eighteen and a half square miles or about 12,000 acres," should be "embanked and drained" (I&WD 1947, p. 14). Bentinck connected this project with that of the construction of the Circular Canal between the river Hooghly and the salt water lakes. He proposed a change in the design of the Circular Canal plan which had been formulated by Major Schalch and was being pursued by Captain Prinsep. He suggested that "the New Circular Canal instead of terminating at the Entally Canal shall be continued round the Lake and shall enter the creek at deep water below Bamanghata"; "the Lake shall be drained and subsequently warped up"

[18]Bhattacharyya (2018, p. 145) argues that using epidemiology as the only lens is problematic as it fails to capture "market-driven aspects of infrastructure, and how they in turn created forms of market governance." Bhattacharyya's work establishes the distinct link between the "hydrological urbanization" of Kolkata and economizing urban spaces, even prior to the consolidation of the British rule in 1857. Pande's (2010) work on British Bengal also addresses the intersections across colonial commercial, civilizing, and epidemiological interests that came together in the production of a sanitary city.

[19]*Selections from Records of Bengal Government relating to Calcutta and Eastern Canals, 1865–1904*, p. 5.

[20]"The proper draining of these areas should be taken up by the Government with the least possible delay if Calcutta is to be saved from malarial epidemic" (I&WD I1947, p. 42).

(quoted in Chattopadhyay 1990, pp. 92–93). To Bentinck, it seemed that the project could optimize itself by clubbing canal excavation (improvement) and marsh reclamation components together. Though the importance of the proposal was accepted by the Court of Directors, yet it was not immediately executed against "more pressing demands of other schemes and to the difficulty of providing the necessary funds" (I&WD 1947, p. 14). In 1835, T.H. Maddock, secretary to the Government of India, submitted a proposal to the Court of Directors which mentioned that the best mode of executing the drainage work would be

> by banking out the Salt Water and by providing sluices for the discharge, at ebb-tide, of rain water or of alluvion-charged water admitted by the canal, and by a feeder to be constructed so as to join the Hooghly and the upper end of the Lakes, for the purposes of irrigation, of ameliorating the soil, and of raising the level of the bed of the Lake by warping it. (Quoted in Chattopadhyay 1990, pp. 92–93)

Apart from the miasmatic paradigm and tackling the drainage needs of the evolving urban center, the salt water lakes reclamation project should also be contextualized within the larger colonial property-making and revenue generation initiatives of "draining the delta" and "drying the land" (Bhattacharyya 2018). Bunding and embanking salt water lakes seemed significant to introduce sewage irrigation and agrarian experiments in the marshes to accomplish colonial economic incentives. It was demonstrated that with proper draining and sewage irrigation, a variety of crops could be cultivated; "even if nothing else but mere guinea-grass were grown, the returns would be such as to secure shareholders a fair percentage on the invested capital" (quoted in Inglis 1909, p. 259).

In 1865, the government accorded the task of salt water lakes reclamation to a company (the Salt Water Lakes Reclamation and Irrigation Company Limited) which was supposed to reclaim 44 square miles of the area by raising embankments, draining the marshes, and clearing the jungles at an estimated cost of 3,000,000 rupees. The feasibility of the scheme was assessed from different dimensions, like sewage cultivation practices and continued functioning of the lakes as outfall (especially required during the rains). While according to Colonel Beadle the project was practicable, achievable, and meaningful in terms of high crop yield, to Clark, the value of the salt water lakes outlet in absorbing the city's sewage and storm waters was not to be compromised and given due importance within the project design (Inglis 1909, pp. 260–262). The range of tides from the Hooghly and the bed level of the salt water lakes were evaluated time and again using previous records and contemporary estimates to decide on the execution of the project. However, a controversy ensued on questions of reclamation and utilization of sewage; further correspondence on the scheme remains untraceable.[21]

[21]The company's original scheme contemplated two distinct concessions on the part of the government and the Calcutta Corporation: a grant of the government space to be reclaimed and a free grant in perpetuity of all the sewage of Kolkata. There were doubts about whether the application of the sewage to the reclaimed land would prove injurious to health or would be great in terms of generating exemplary pecuniary value.

Within this context, during the 1860s, a portion of the salt water lakes (1 square mile area) was acquired by the government and transferred to the Justices of Peace (the predecessor of the Calcutta Corporation) under the project design formulated by Major Clark to dump the waste of the city.[22] This came to be known as the "Dhapa square mile" which was purchased at 93,225 rupees as the city's dumping yard (Goode 1916; Chattopadhyay 1990; Ghosh 2017). Embankments were constructed to protect Dhapa from all sides against tidal waters, and a sewage channel was excavated intersecting it in continuation to the sewer.

In 1882–83, Buckley designed a reclamation proposal in connection to the canalization of the Bhangar Canal. The plan advocated exclusion of tidal waters from the northern as well as southern portions of the lake to the canal. He proposed excavation of new canals for discharging the city's sewage and construction of sluices to regulate the discharge. The navigation function of the canal through the maintenance of its still-water reach seemed more important to Buckley than the waterway being converted into a mere receptacle of sewage and storm waters from the city. He argued,

> It is not improbable that when the Southern Lake is reclaimed the whole of the sewage of Calcutta might be utilised in the cultivation of the bed of the Lake. But as it must be years before this can occur, it is essential to provide a satisfactory channel which will carry the sewage to the Biddiadharee without contaminating the proposed still-water reach of the canal. (Quoted in Inglis 1909, p. 274)

Buckley's scheme was not sanctioned on the ground that it was costly and undesirable. In 1902, Horn's scheme of connecting the Circular Canal and Bhangar Canal echoed Buckley's proposal in lieu of excluding tidal water from the northern salt water lakes. Horn proposed to make the link from Dhapa to Bamanghatta across the channel which fed the northern lakes. He realized that "[b]y the exclusion of tidal water from the North Lake, no further silting of the drainage channels would be possible." He also proposed to make "the new canal the main drainage channel of the country" (quoted in Inglis 1909, p. 278).[23] However, the proposal was not successful due to several reasons including the deterioration of the Central Lake Channel (which would be encroached upon by the proposed canal and get choked) and the huge sums of money to be paid as compensation to the proprietors of fishing rights in the lakes against stoppage of tidal flows.

After a gap of almost four decades, two other major reclamation proposals by Gurner (in 1943) and Hora (in 1944) unfurled further set of debates, discussions, and decision making among the municipal engineers. By this time, with the deterioration of the Bidyadhari and the implementation of B.N. Dey's alternative Kulti Outfall Scheme, there was a major transformation in the aquatic regime of the salt

[22]There is a minor controversy about the exact date of acquisition. While an administrative report of the Calcutta Corporation mentions 1865 as the year of acquisition, records available in the land acquisition collector's office consider it as 1864 (Chattopadhyay 1990).

[23]Letter to the Superintending Engineer, South-Western Circle (letter no. 24T.-I, dated April 20, 1902).

water lakes. With the decline of salinity due to the decay of the river which had spilled salt water in these lakes, tidal saline-fed marshes gave way to sewage-fed marshes with implications for piscicultural practices in the area.[24]

A committee (the Salt Water Lakes Reclamation Committee) headed by Gurner was appointed by the government in September 1943, consisting of members from the Calcutta Improvement Trust, Calcutta Corporation, I&WD, and Public Health Department. In the report submitted by the committee in 1943, the existing size of the salt water lakes was ascertained to be 70 square miles, out of which it was suggested that 18 square miles of the northern salt lakes should be reclaimed for the expansion of the city. Demographic pressure, health hazards, and post-war employment, among shifting urban development needs, gave rise to the proposal of transforming the marshes into estate. During the same time, the 1944 reclamation scheme of Hora, Director of Fisheries, Bengal, shed light on how to manage and improve the extensive sewage-irrigated fisheries in the spill area of the defunct Bidyadhari River. This was considered significant "in view of the short supply of fish in the Calcutta markets and the proximity of the fisheries to Calcutta" (I&WD 1947, p. 52). Hora's scheme addressed all major aspects relating to salt water reclamation that had been discussed and debated for more than a decade: piscicultural requirements and profits, tackling health hazards, improvement of drainage and conversion of unproductive land into agricultural farms, and utilization of the sewage "which is now being criminally wasted" (I&WD 1947, p. 52). After detailed scrutiny of these two schemes, the Committee to Enquire into the Drainage Condition of Calcutta and Adjoining Area, 1945, reported that immediate steps should be taken by the government to acquire full rights of occupation of the entire area of the northern salt lakes at an early date and that a separate and independent authority should be set up to undertake reclamation works followed by detailed surveys (contours, topographical surveys, etc.). The committee recommended that the major part of the northern salt lakes should be reclaimed as per Gurner's scheme and most of the southern salt lake should be devoted to fisheries or fishery-cum-agriculture (I&WD 1947, pp. 14–15).[25]

3.3 "Calculus of Rule"

"Tamed interventions" were tied up with colonial capitalist calculations of surplus over expenditure, profits on investments.[26] A series of plans, designs, schemes, and debates among colonial agencies and institutions like the military board, Calcutta

[24]This will be covered in detail in Chap. 4, "Untamed Practices".

[25]The committee emphasized that the topographical surveys available till date were obsolete; for the appropriate plotting of contours, an accurate and up-to-date survey was necessary, as during the last few decades, changes in this area had been considerable.

[26]The idea of "calculus of rule" has been borrowed from D'Souza (2002).

Corporation, I&WD, Port Commissioners, Public Health Department, Public Works Department, etc., on river "improvement" and execution and maintenance of infrastructural projects to excavate canals and reclaim marshes (that also included the setting up of pumping stations, construction of lock gates, sluices, etc.) explain how these were important to the colonial exchequer. Information available on trade and transportation through the Hooghly River and the canal system and the tollage collected demonstrate the economic viability of these projects. Government approvals for particular projects (over other sets of proposals) were determined by their feasibility in terms of the greatest cost-effectiveness, which was assessed using detailed quantitative calculations of financial investments and returns. Moreover, delivery of other urban ecosystem services like discharge of the city's drainage and agricultural and piscicultural practices using sewage added to the economic incentives that the colonizers were desperate and anxious to extract. Property-making experiments in the Dhapa dump yard side were in vogue as is evident from colonial accounts of revenue extraction from the zamindars or leaseholders who were provided with land (on lease or contract tenures) to pursue sewage cultivation experiments.

The river Hooghly was the gateway to the foreign trade of Bengal, and a series of "improvements" were designed and implemented in the greater interests of maritime commerce. The Stevenson-Moore Committee (1916–19) made systematic observations of changes in the navigable channels and feeders for the lower Hooghly stretch (Biswas 1998). For ascertaining the condition of the river from Kolkata to the sea, periodic surveys were conducted, prominent among which were surveys carried under Major Hirst, Director of Surveys, Bengal and Assam, and the river surveyor H.G. Reaks who was a specialist on the Hooghly river regime (Biswas 1998, p. 3).

The following remarks by Frederick Dumaye, vice-chairman, Commissioners for the Port of Calcutta, capture the commercial importance of the Hooghly, colonial anxieties about the health of the river, continuous systematic surveys, and implementation of hydraulic engineering (dredging operations, etc.) to increase revenue earnings by augmenting the tonnage capacity of vessels through the river:

> The cry that the Hooghly is deteriorating is raised every now and then. Sixty years ago it was stated that the river threatened at no distant date to render access to Calcutta altogether impracticable for any but vessels of the smallest tonnage; that several vessels had no prospects of getting to sea for over a month, and that the serious impediments in the river were progressive and inevitable and beyond the reach of removal by any engineering skill. Ten years later there was a scare that the trade of Europe with Calcutta was in danger of immediate and prolonged suspension. The calamity which had overhung the city for years, … and the fear of which had at intervals strained and baffled the ingenuity of half the engineers of Bengal, was officially stated to be already at hand.… In 1830 pilots were prohibited from moving vessels of greater draft than 20 feet in any part of the river, even with the aid of tugs. In 1857 the permissible draft was only 22 feet. The average size of the largest vessels in the world was then about 2500 tons burden, with a length of about 300 feet. The draft allowed has since been steadily increasing, until at the present time the river

> is navigated by vessels drawing up to 29 feet, of a length exceeding 500 feet, and carrying as much as 12,500 tons of cargo. The advent of steam, the great skill of the members of the Bengal Pilot Service, the elaboration of the system of surveying the river, were all factors in obtaining these results. Satisfactory as they were, further effort was demanded. Nature required assistance. The dredging of the river was undertaken in 1907.… The dredging operations are now about to be extended, and contacts have been placed, in shipyards on the Cycle, for additional dredging plant that will cost £220,000, which include two very powerful dredgers, one of which will be employed on the improvement of the river within the port, and the other in dredging the bars in the lower reaches. The Commissioners confidently expect to obtain by dredging as good results in the lower as in the upper reaches, and ultimately to maintain throughout the year a clear channel from Calcutta to the sea for any vessel that can pass through the Suez Canal. The tonnage of vessels entering the port 50 years ago was 668,000 tons. Last year the tonnage was 6¼ million tons, or ten times as much. The growth has been most rapid in the last 15 years, when the increase was 3 million tons, or a yearly expansion of 200,000 tons. The value of the trade of the port of Calcutta from imports by all routes has reached 104½ millions sterling, and from exports 107½ millions, altogether 212 millions, an increase of 77½ millions in the last eight years. (Quoted in O'Malley 1914, pp. 8–9)

The colonial archive sheds light on the various proposals regarding the maintenance of Tolly's Nullah and eastern canals, as these facilitated revenue earnings through trade as evident in the increase in boat traffic through the canals (Table 3.4). The tollage data and detailed accounts of collections, charges, and net receipts, which were systematically documented, show good returns on investments which should be correlated to frequent and aggressive maintenance schemes implemented on the canal system. Between the early 19th and the early twentieth centuries, proposals were submitted by collectors like Ince and engineers like John May, Buckley, and Lees for canalization of Tolly's Nullah, as "material interruptions to the navigation of Tolly's Nullah will be a serious inconvenience to the public and occasion a less of Revenue."[27] Tolls were collected from cargo boats carrying different commodities while passing Tolly's Nullah at three *chowkey*s: Samukpota, Russa, and Khidirpur (Table 3.5).[28] Between 1791 and 1794, average toll collections from the canal amounted to 56,829 rupees. Secretary to the Government Holt Mackenzie's (1826) account provides annual estimates of tolls levied between 1818–19 and 1824–25 (Table 3.6).[29] Toll rates were continuously revised to retain the commercial viability of projects.[30] Buckley's (1883) report mentions that though there were constant challenges of silt accumulation in the

[27]Proceeding 31 dated April 25, 1826 (WBSA, Kolkata).

[28]*Chowkey* in the local dialect means toll collection center.

[29]Proceeding 58 dated January 6, 1826 (WBSA, Kolkata).

[30]Proceeding 30–32 dated July 26, 1831 (WBSA, Kolkata), provides statements and petitions regarding the revision of toll rates levied on Tolly's Nullah.

Table 3.4 Boat traffic through Circular Canal and Tolly's Nullah, 1855–56 to 1864–65

Years	Boats passing through Circular Canal	Boats passing through Tolly's Nullah	Total
1855–56	87,780	84,215	171,995
1856–57	92,475	73,776	166,251
1857–58	97,095	77,139	174,234
1858–59	106,200	72,063	178,263
1859–60	91,133	96,579	187,712
1860–61	135,410	8365	143,775
1861–62	41,953	93,794	235,747
1862–63	145,727	68,737	214,464
1863–64	145,778	87,274	233,052
1864–65	154,909	81,153	236,062

Source Bandopadhyay (2018, p. 72)

Table 3.5 Boat traffic through Tolly's Nullah

Articles	Name of chowkey	Number of boats	Mundage by canal measurement	Mundage of cargo by estimate
Coal	Samookpota	…	…	…
	Russah	…	…	…
	Kidderpore	203	212,000	123,550
Imported Fabrics	Do	…	…	…
		…	…	…
		4	900	300
Rice	Do	4361	1,363,300	640,975
		3623	102,275	75,725
		132	56,225	29,250
Jute	Do	14	33,050	15,700
		…	…	…
		…	…	…
Indigo	Do	…	…	…
		…	…	…
		5	1150	1023
Salt	Do	…	…	…
		…	…	…
		967	539,100	277,900
Castor Oil	Do	…	…	…
		…	…	…
		2	025	475

Source Administrative Report on Calcutta and Eastern Canals and Nuddea Rivers, 1868—69 (Calcutta: Bengal Secretariat Press 1869)

Table 3.6 Collections, charges and net receipts from Tolly's Nullah, 1818–19 to 1824–25

Years	Collections	Charges	Net receipts
1818/19	89,596	7705	81,891
1819/20	88,401	8214	80,187
1820/21	78,495	9621	68,874
1821/22	76,010	7447	68,563
1822/23	67,739	17,477	50,262
1823/24	67,351	7475	59,876
1824/25	68,708	529	62,179

Source Proceeding 58 dated January 6, 1826 (WBSA, Kolkata)

canal calling for costly engineering solutions, yet the local traffic was on the rise as it was the only waterway through which "the rice traffic of the Sundarbans and the surrounding countryside … was conveyed to the Chetla rice market" (Bandopadhyay 2018, p. 64). The canalization of Tolly's Nullah gathered momentum when the proposal by the Port Commissioners of Calcutta to connect the canal with the wet-docks at Khidirpur was formulated; the canal was to act as the feeder to the wet-docks to render easy access of boats to the dock (Bandopadhyay 2018; Bhattacharyya 2018).

The colonial archive of reports of proceedings between 1806 and 1826 provides estimates of tolls levied on the Beleghata Canal with detailed information on receipts and disbursements (Tables 3.7 and 3.8).[31]

With the completion of the Chitpur lock in 1833 with which the Circular Canal was opened for traffic, a second outlet to the Hooghly was provided which attracted a large number of country boats from the eastern districts of Kolkata. Chitpur (on the upper stretch at the junction with the Hooghly), Bamanghata (near the salt water lakes), and Raja Khal (connected to the Central Lake Channel) were the three *chowkey*s where tolls were collected. By the mid-nineteenth century, there was a sharp increase in the number of boats, their tonnage capacity, and tollage (Table 3.9) with commendable returns (net collections) on expenditures (Table 3.10). Different proposals, including those by Galloway, Wood, and others to maintain the canal, pertaining to its delivery of navigation and drainage services were submitted and considered (Inglis 1909). Within this context, the clashing priorities between the Government of Bengal and Calcutta Corporation regarding whether weightage to navigation or delivery of drainage services should supersede is noteworthy. In 1876, the revenue from the canal increased to 3,09,657 rupees with a 60 percent increase in boat traffic (Bandopadhyay 2018). Between 1887–88

[31]The information between 1815 and 1817 could not be traced. Proceeding 15–17 dated March 1, 1816 (WBSA, Kolkata), is a letter to R. Rocke, Acting President & Member of the Board of Revenue from C. Doyly, Acting Collector, that discusses a petition by Mohischunder Ghose, Tasildar of the New (Beleghata) Canal, requesting the deepening of a part of the canal, near Bytuckanna, which had become unnavigable for 600 yards, as a result of increasing deposition of sediments. The vast utility of the duct serving the purpose of clearing the town of filth, detrimental to the health and comfort of the inhabitants, finds mention in the petition.

Table 3.7 Tollage on the Beleghata Canal, September 1810 to April 1811

Month	Commission (in rupees)
September	105
October	261
November	335
December	367
January	477
February	457
March	503
April	403

Source Proceeding 10 dated June 10, 1811 (WBSA, Kolkata)

Table 3.8 Collections, charges, and net receipts on the Beleghata Canal, 1810–13

Year	Collections	Charges	Net receipts
1810–11	2901	862	2039
1811–12	6075	729	4346
1812–13	11,394	2484	8910
1813–14	11,436	1560	9876
1818–19	17,191	2164	15,027
1819–20	18,107	3106	15,001
1820–21	17,686	2302	15,384
1821–22	17,674	3156	14,518
1822–23	17,622	2281	15,341
1823–24	16,546	2277	14,269
1824–25	16,896	2225	14,671

Source Compiled from Proceeding 22 dated September 13, 1811 (WBSA, Kolkata); Proceeding 4 dated October 23, 1812 (WBSA, Kolkata); Proceeding 4 dated September 7, 1813 (WBSA, Kolkata); Proceeding 24 dated May 13, 1814 (WBSA, Kolkata); Proceeding 58 dated January 6, 1826 (WBSA, Kolkata)

Table 3.9 Comparative statement of boat traffic, tonnage, and tollage through the Circular Canal

Years	Number of boats	Tonnage	Tollage (in rupees)
1839–40	22,731	24,322,600	71,613
1851–52	139,494	38,555,200	192,776

Sourc Bandopadhyay (2018, p. 59)

Table 3.10 Estimates of gross collections, expenses, and net collections on the Circular Canal

Years	Gross collections (in rupees)	Expenses (in rupees)	Net collections (in rupees)
1846–47	195,374	27,822	167,552
1847–48	172,350	27,041	145,309
1848–49	76,654	31,119	145,535
1849–50	82,989	21,767	61,222

Source Bandopadhyay (2018, p. 75)

and 1891–92, the tonnage and the tollage increased further. While 132,292 rupees were earned from Tolly's Nullah alone, 422,869 rupees were collected from the Circular and Eastern Canal System during 1888–89 (Bandopadhyay 2018).

The marsh reclamation projects, apart from addressing the insanitary and unhygienic conditions of the city and its suburbs, were tied up with pecuniary incentives. Colonel Beadle reflects:

> There can be no question of the feasibility of raising, reclaiming, and draining the greater part, if not the whole, of the Salt Water Lakes, and of bringing them under high cultivation. Such lands, without help from manure, would be fertile as paddy lands. The low reclaimed lands of the 24-Parganas on the left bank and of Doroo Dumnun on the right bank of the Hooghly afford the best rice crops in Bengal, the rice being small in grain like that of Bareilly and Patna and selling at a very high price. (Quoted in Inglis 1909, p. 261)

Experiments were conducted in agriculture and pisciculture utilizing the city's sewage as early as the 1860s. With the formation of the Salt Water Lakes Reclamation and Irrigation Company Limited in 1865, sewage farming experiments to produce rice, vegetable, cotton, and also cattle fodder were conducted between 1868 and 1869 by Health Officer Fabre Tonnerre. Sewage-fed piscicultural activities began in the salt water lakes and sewage (garbage) farming in the city's dumping yard Dhapa where cultivation of maize, brinjal, cauliflower, and corn remained successful. Lands reclaimed by the Salt Water Lakes Reclamation and Irrigation Company in Dhapa were leased to leaseholders for pursuing sewage cultivation and fisheries. The lessee had to pay an annual rent to the Calcutta Corporation which became another important source of revenue collection for them. The data on annual rent collected from one of the prominent leaseholders, Bhabanath Sen, by the Calcutta Corporation demonstrates how cess collection progressively increased over the years (Table 3.11).

Hora's (1944) report sheds light on the importance of sewage-fed fisheries in the northern and southern portions of the salt water lakes. That Kolkata sewage possessed high nutritional value for fish and manurial value for crops was well recognized by the colonizers. It was observed that the "the growth of fish in Salt Lake areas and extensive cultivation in Dhappa now surpass all other records of production of these two staple articles of food all over Bengal" (I&WD 1947, p. 7). And, "if properly manipulated, the yield may be much more" (I&WD 1947, p. 7).

Table 3.11 Annual rent payable by the leaseholder

Year	Amount (in rupees)	Year	Amount (in rupees)
1908–09	250	1919–20	4750
1909–10	500	1920–21	250
1910–11	750	1921–22	750
1911–12	1000	1922–23	6250
1912–13	1250	1923–24	6750
1913–14	1750	1924–25	7250
1914–15	2250	1925–26	7750
1915–16	2750	1926–27	8250
1916–17	250	1927–28	8750
1917–18	750	1928–29	9250
1918–19	4250	1929–30	9750
Total: 101,500			

Source Chattopadhyay (1990, p. 38)

3.4 Blurring Boundaries

My analysis of the colonial archive shows how the selected site was gradually tamed, controlled, and interfered with, keeping pace with the development of the universal laws of colonial hydraulics. This led to the evolution of networked infrastructures in the form of an extensive (eastern) canal system that simultaneously facilitated both trade and transportation, and drainage, sewerage, and sanitation. By shedding light on the history of the construction of lock gates, sewers, pumping stations, etc., here, I have demonstrated how and why networked infrastructures should be understood as an intricate web and an integrated apparatus to render the colonial urbanization project commercially viable. This understanding is missing in contemporary policy circles leading to the development of incomplete and sporadic solution strategies that only impact a particular stretch of the canal or a sluice with limited benefits for the functioning of the entire system.

The British project of urbanization implied the evolution and successful management of this complex hydraulic scheme, evident in colonial reports and correspondence regarding maintenance and management of the system between the late 18th and early twentieth century. Reclamation of the eastern salt marshes went parallel with canal excavation as part of the colonial large-scale technological design to maximize capitalist profits. Revenue and administrative reports vividly project how the economic logic that provoked the British to select Kolkata as the seat of the colonial capital proved successful positively impacting the colonial exchequer. By incorporating the urban context, this chapter has provided empirical insights to the "colonial hydrology" framework prevailing in South Asian water history and opened up avenues for further research exploring the intersections between economic history and technological history of urban infrastructures.

Moreover, by contextualizing the colonial technological interventions through which the fluid scape of the site was manipulated and transformed into a port city, within the larger context of European trading interests, this chapter provided the provocation for going beyond methodological cityism and studying urbanization as a process in relation to wider translocal political and economic forces.

Apart from the workings of the technical apparatus, the chapter has also shed light on social aspects and arrangements, unpacking debates, discussions, and arguments about the implementation of various designs among the different government agencies, mainly focusing on clashing priorities between navigation and drainage-sewerage lobbies finally leaving its mark on the future of canals as arteries of trade or as mere receptacles of the city's wastewater. Similar debates prevailed about the utility of marshes in terms of serving as the urban outfall or space for lucrative sewage farming and fishing experiments. The reclamation initiatives remained further complicated as they involved colonial encounter with the native, especially fishers affected by the series of tamed interventions in the marshes. Finally, Chap. 3 provides significant entry points to Chaps. 4 and 5, bringing out the emergence of untamed practices as far-reaching implications of colonial tamed initiatives complicating municipal–local binaries and offering scientific insights behind the deterioration of the canal system in the post-independence era, critically interrogating the mainstream narrative of "colonial heyday" versus "contemporary neglect."

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Chapter 4
Untamed Practices

4.1 Beyond Binaries

In an informal exchange with Dr. Dhrubajyoti Ghosh, he mentioned that the local fishers and farmers of the EKW are the ecological stewards who have been protecting Kolkata for a long time.[1] They are committed to fish and crop production using the city's wastewater and solid waste. He often hinted at the ideological ethos of the poor wetland dwellers: "Give us wastewater and solid waste and we give you back food and fish at very cheap prices."[2] But in spite of being harbingers of cost-effective and popular waste management and recycling mechanisms, Ghosh lamented, they remain the worst sufferers and victims at the hands of the state (in alliance with transnational development agencies), and their knowledge is not even recognized in mainstream science which arrogantly suffers from "cognitive apartheid."[3] His radical ideas about the importance of popular ecosystem management are reflected in his remark on "the paradigm of ecology and ecosystem management," which he claimed "will have to come down from its eminent domain and embrace the vulnerable.… Ecosystem management will have to be a pedagogy of the vulnerable, as much as for the vulnerable" (Ghosh 2014, p. 4). In scientific literature and also popular (and protest) discourse on the EKW, this ecosystem resource has been

[1]I had the opportunity to work closely with Dr. Dhrubajyoti Ghosh as his research assistant between 2008 and 2009. Our exchanges and debates on the EKW continued till 2018. I have learnt the fundamental principles of functioning of the EKW from him. He was my teacher and mentor.

[2]"The fishermen of the wetlands are the forerunners of a contemporary worldview of waste as resource pursued by leaders and thinkers of the modern-day environment movement" (Dhrubajyoti Ghosh, quoted in Anand 2008, p. 18).

[3]In his 2014 book, Ghosh elaborated on the concept of "cognitive apartheid." He argued that while the local wetland dwellers have been managing the ecosystem using their cognitive abilities and innovative instincts, mainstream science suffers from "cognitive apartheid," i.e., "the glaring inability to respect the 'outsiders' (farmers, fishers, forest dwellers, for example) even to locate any benchmark of ideas in the high and mighty platforms of licensed knowledge" (Ghosh 2014, p. 25).

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projected as a locally driven, locally managed system entirely run by local wisdom, passion, and expertise through intergenerational transmission of knowledge (Ghosh and Sen 1987; Ghosh 1999, 2005, 2014; Banerjee 2012; Bose 2013, 2015; Kundu and Chakraborty 2017). Within this pretext, this chapter complicates the wetlands story by critically interrogating these binaries: state versus the EKW; municipal versus local; tamed versus untamed; urban versus rural; and managerial versus environmentalist (Furedy 1985) and also draws attention to the heterogeneity within the EKW. Applying the historical lens and through a quick recapitulation and elaboration of the origin of the EKW, it explores complex interactions between the government and these wetlands (and, more specifically, the corporation and the leaseholders), and the municipal canals, inlet canals, and waste stabilization ponds (WSPs) in the coproduction of this space and its functioning across historical and political conjectures. Connecting "tamed interventions" (Chap. 3) with "untamed practices," it reveals how tamed–untamed are entrapped, entangled, and enmeshed as a complex and composite whole across cyclical, mutual, and reciprocal interactions and equations between the urban and its wider ecological infrastructures.[4]

The origin and evolution of the eastern marshes from saline to sewage-fed wetlands was the outcome of the internal drainage scheme and the Kulti Outfall Scheme implemented by the Calcutta Corporation, discussed in the previous chapter. Sewage fishing experiments were conducted even before the implementation of Dey's scheme in the early 1940s. During the second half of the nineteenth century, informal attempts at sewage agriculture and aquaculture were made by local fishers. In 1872, a fish *ghat* was established at the Dhapa Square Mile Area and a channel was excavated from Raja Khal (which existed at that time), followed by the establishment of a flourishing fish market at the *ghat*.[5] The channel connected the market to the city reservoir. This entire arrangement facilitated fish supply to the municipal market (Chattopadhyay 1990; Kundu et al. 2008). Oral history from fishery owners practicing aquaculture across generations attests to the fact that the earliest attempt at formal wastewater-fed aquaculture was by conducted by Bidhu Bhusan Sarkar in 1918. While Sarkar's venture was affected by the construction of the SWF canal that disrupted the land and the inlet canal which were being used by his fishery, the discharge of sewage carried by the canal led to the reduction of salinity in the marshes. With the implementation of the Kulti Outfall Scheme, sewage-fed aquaculture received momentum when the salinity of the

[4]I am aware that from the chapter titles "Tamed Interventions" (Chap. 3) and "Untamed Practices" (Chap. 4), it might appear that the study continues to evoke the binary or bifurcation of "tamed" and "untamed." However, the contents of the chapters elaborate the intertwining of tamed–untamed in the course of the long history of coevolution, coproduction, and co-management of the urban environmental trajectory across complex interconnections among city, nature, and technology. The idea of "untamed practices" is used here to elaborate on the successful, low-cost waste management and recycling practices implemented and conducted by locals (leaseholders, fishers, and farmers) in the sewage-fed wetlands, practices also associated with the history of municipal initiatives and incentives to harness the best solutions for parallel management of urban sewage, generation of local livelihoods, and the establishment of a revenue regime.

[5]*Ghat* is a Bengali word which means the bank of a river, canal, or pond.

wetlands dwindled to a great extent; the area expanded and the locals adopted wastewater-fed aquaculture at scales.

The Corporation and the Department of Fisheries (DoF), Government of West Bengal (GoWB), were enthusiastic about these developments, as is evident from the series of plans and initiatives regarding the utilization of Kolkata's sewage to harness the best possible solutions for managing urban waste and wastewater, through which the generation of local livelihoods and the establishment of a sustainable revenue regime could be successfully facilitated (Calcutta Corporation 1946; I&WD 1947). In order to promote fisheries, the Calcutta Corporation's (Dey's) drainage scheme of the 1940s included the construction of sedimentation tanks at Bantala to ensure that the effluent going out of municipal canals would be free of suspended solids to the extent of 85% (Calcutta Corporation 1946). The tanks were commissioned in 1945. With their foundation more than 40 feet deep, these seemed to be "the biggest of [their] kind ever constructed anywhere in the world" (Calcutta Corporation 1946, p. 83). In the Corporation reports, it was emphasized that through the introduction of suitable regulating works in the Corporation canals, pisciculture would flourish and yield profitable returns with the pre-settled sewage being processed by these sedimentation tanks. In the report submitted by the committee which was entrusted by the government in 1945 with enquiring into the drainage condition of Kolkata and adjoining areas, the utilities of the Kolkata sewage were observed for both piscicultural practices in the salt lake area and sewage irrigation in Dhapa. It was recognized that Kolkata sewage possessed high food value for fish and manurial value for crops. The committee recommended that with further manipulations the yield could be increased. Hence, "this procedure, therefore, should not be stopped," and it was advised that "a regular system of control" with the advice of the DoF should be introduced (I&WD 1947, p. 7). The DoF by then had already expressed the importance of this sewage and explained why and how it should not be "criminally wasted" (I&WD 1947, p. 52). In a symposium on the utilization of sewage for pisciculture, the extensive sewage-irrigated fisheries in the spill area of the defunct Bidyadhari River drew major attention.[6]

The Corporation gave portions of the eastern wetlands and the Dhapa Square Mile Area to leaseholders on a short-term lease system, where the latter were encouraged to practice sewage-fed aquaculture and farming using their own capital, labor, knowledge, and skills. In the late 1870s, the Corporation granted land lease and the lease of fisheries and the fish *ghat* to Nandalal Das and Durgacharan Kundu, respectively. The longest term of lease was granted by the Corporation to Bhabanath Sen followed by Durgacharan Kundu in 1880 for a period of 19 years.[7] To optimize on this property, including land, fisheries, and the fish *ghat*, Sen

[6] *Proceedings of National Institute of Science* (1944), 10(4), 441–467.

[7] The history of the lease followed a sequence of events where legal cases were fought between the Corporation and the families of leaseholders. In the late 1980s, the Corporation became the exclusive title-holder of the Dhapa Square Mile Area after paying a compensation of 1,200,000 rupees to the leaseholding Sen family. For a detailed history of land lease in Dhapa, see H. Chattopadhyay (1990, Chap. 3: "The Dhapa Square Mile").

opened numerous inlet canals connecting the main canal with *bheri*s and cultivable plots.[8] Ghosh and Sen (1987, p. 223) reflect that the "improvement in efficiency was obtained entirely through experiments carried out by the operators, using local and indigenous methods and resources."[9]

The apparent schism between mainstream science and local or popular scientific practices is an exaggeration, as is the fact that these sewage-fed fisheries in the city's eastern part (more specifically the EKW) did not receive official recognition, since these were grounded in municipal interests and encouragements for the enterprise from the very beginning. The notion that "[l]ittle or nothing was known about east Kolkata till the eighties" (Anand 2008, p. 17) is not true. The then director, DoF, S.L. Hora, emphasized the extensive utilization of sewage for aquaculture for increasing the supply of fish in Kolkata markets at a cheap price. He laid out a scheme of 1.36 crore rupees for the improvement of sewage-fed fisheries targeted to huge profit returns. He claimed that if the scheme was executed properly, "I have the least doubt that the capital expenditure would be paid back in 20–25 years' time and there will be a substantial annual revenue to Government thereafter" (I&WD 1947, p. 52). The DoF wanted to scale up this initiative, forging a "uniform and impartial distribution pattern" for the city's sewage and not against the sporadic "demand of individual and influential fishery-owners" (I&WD 1947, p. 53). The department also identified the "short-term system of lease" and "exorbitant rent" as "the greatest obstacle" as this caused "the bunds, drainage and the feeding channels" to be "left totally uncared for" (I&WD 1947, p. 53). A remark by K.C. Saha, director, DoF, in post-independence West Bengal manifests the appraisal of sewage-fed fisheries and their safety quotient. Pointing out the overall novelty of this recent venture, he commented:

> In India, West Bengal is perhaps the only state where Calcutta city-sewage is being extensively utilized for fishery purpose. Extensive investigations and researches carried out by the State Fisheries Agency in this important branch of pisciculture have shown that the present rate of indigenous production of fish can be increased at least three-fold if the stocking, exploitation, and management are carried out on a scientific basis. Fish culture in sewage-fed fisheries has its obvious advantages because sewage contains manure nutrients like nitrogen, phosphorus, calcium, potassium, etc. and hence it has a high nutritive value as fish-pond fertilizer. (Saha 1970)

Most of the literature on the EKW has highlighted the ecosystem services generated by these wetlands, which has an implied subordination-domination framework rooted in it; here, the wetlands are understood to be operating both as an output and an input, produced and required by the city (Chattopadhyay 2000;

[8] *Water Works, Drainage,* etc. *Previous History and Enquiry Committee Report,* etc. *628 COR. Superintendent's Copy*, Calcutta Corporation, cited in Chattopadhyay (1990).

[9] "Untamed practices" refers to the application of this "low-cost folk technology" by the locals. However, this conceptualization does not romanticize these practices or weave an illusory worldview surrounding them that opposes them to a statist worldview. Rather, the term addresses complex state–wetlands, municipal–local intersections in the making, unmaking, and remaking of Kolkata's environment.

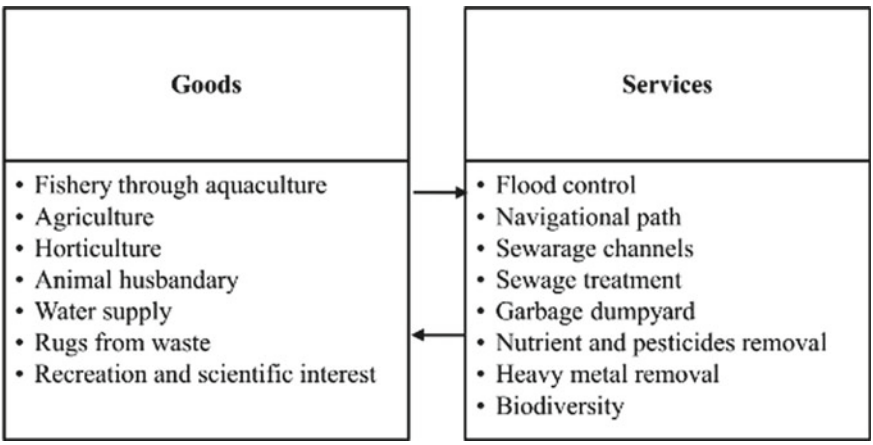


Fig. 4.1 Ecosystem goods and services being provided by EKW. *Source* Kundu and Chakraborty (2017, p. 385)

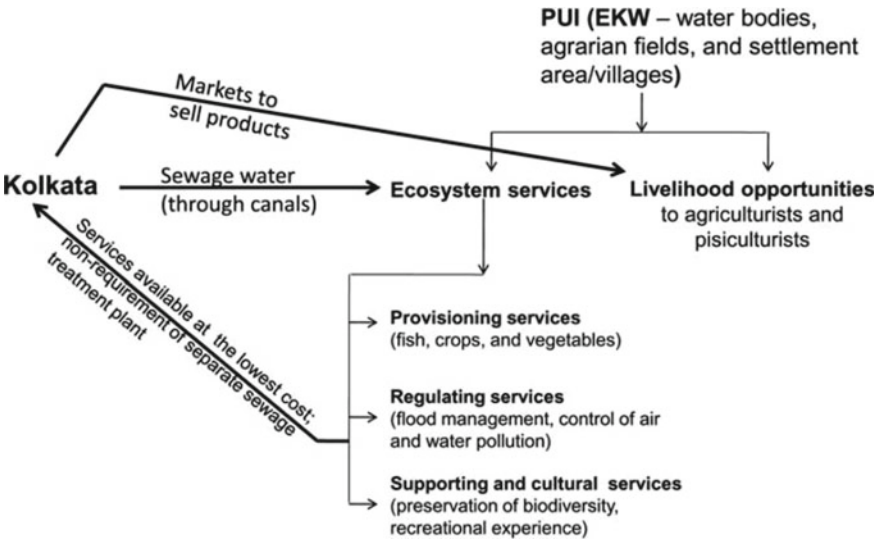


Fig. 4.2 Sustainable flows between Kolkata and EKW. *Source* Mukherjee (2015a, p. 36)

Banerjee 2012; Banerjee and Dey 2017; Kundu and Chakraborty 2017) (Fig. 4.1).[10] However, it is important to recognize that EKW is "tightly bound to urban fabric

[10]Banerjee (2012, p. 101) ridicules the nomenclature of the wetlands: "The government's choice of nomenclature for these wetlands—East Kolkata Wetlands—conveniently ties up with the 'peri-urbanity' officially ascribed to them; as if the wetlands derive their fundamental identity from being 'peripheral' to Kolkata!".

and performance" and the functioning of both the city and its wetlands depends on the mutually reinforcing sustainable flows between these two interdependent, interconnected, and embedded entities (Carlisle 2013; Mukherjee 2015a, b; Mukherjee and Ghosh 2015) (Fig. 4.2).

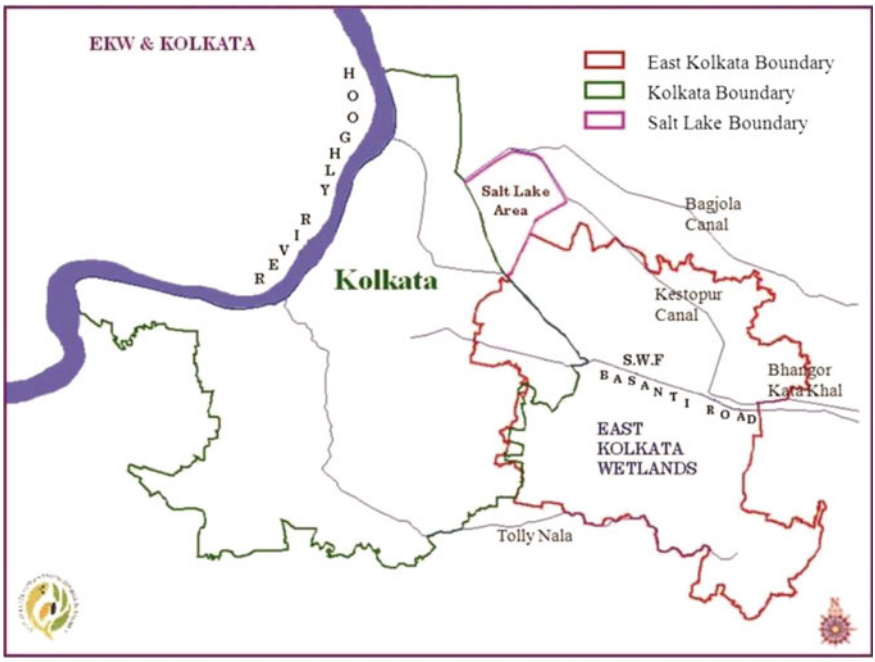
4.2 "East Kolkata Wetlands" or "Wetlands to the East of Kolkata"?

The "contemporary" wetlands consist of an expanse of around 254 water bodies forming the peri-urban interface of the city (Map 4.1).[11] Are these "East Kolkata Wetlands" or the "wetlands to the east of Kolkata"? The nomenclature "EKW" is owed to the ecological engineer and wetland expert Dr. Dhrubajyoti Ghosh, who drew the attention of both the state and the civil society to the existing wise use recovery practices in the wetlands and dedicated a lifetime of research to understanding the socio-ecological dynamics surrounding it. However, Banerjee (2012, p. 93) postulates that perceiving this space as the EKW disentangles it from the "entire sub-continental watershed," i.e., the wide and vast network of Bidyadhari wetlands connected to the deltaic Sundarbans of which it is part and parcel (Map 4.2). Hence, EKW is a misnomer and the wetlands should be described as the "Bidyadhari wetlands," as the Bidyadhari River constituted the main conduit that carried and spilled saline water from the Bay of Bengal, leading to the formation of the salt water lakes (Chap. 2). These wetlands are an integral part of the great chain of brackish marshes stretching from the vicinity of Kolkata to Barishal in Bangladesh (De 1994; Banerjee 2012).[12] Banerjee further explains that the official naming and delineation of "EKW" "is the conscious production of an official

[11]By "contemporary" I mean the present; the present not cut off from but connected to the past, carrying the legacy and residues of the past, but also prominently projecting what and how it is now.

Banerjee (2012) points out that categorizing these wetlands as Kolkata's peri-urban fringe is loaded with the exclusionary politics of not acknowledging the vast expanse of eastern marshes and restricting them to the waste recycling region (WRR) of the Ramsar-designated EKW. Though Banerjee also argues that the connotation "peri-urban" itself is a debatable category, and "definitions of 'peri-urban interface' are thin and inconsistent" (2012, p. 101), yet it is a strong categorization capturing the contemporary urban sprawl in the global South (Allen 2009; Marshall et al. 2009). The *bheri*s (and this is especially applicable to *bheri*s and not so much to other land use patterns and practices within the EKW) underwent administrative (jurisdictional) transformation from being governed by the panchayat (i.e., the lowest village unit of administration) to the municipal corporation (specifically the Bidhannagar Municipal Corporation [BMC]) during recent times.

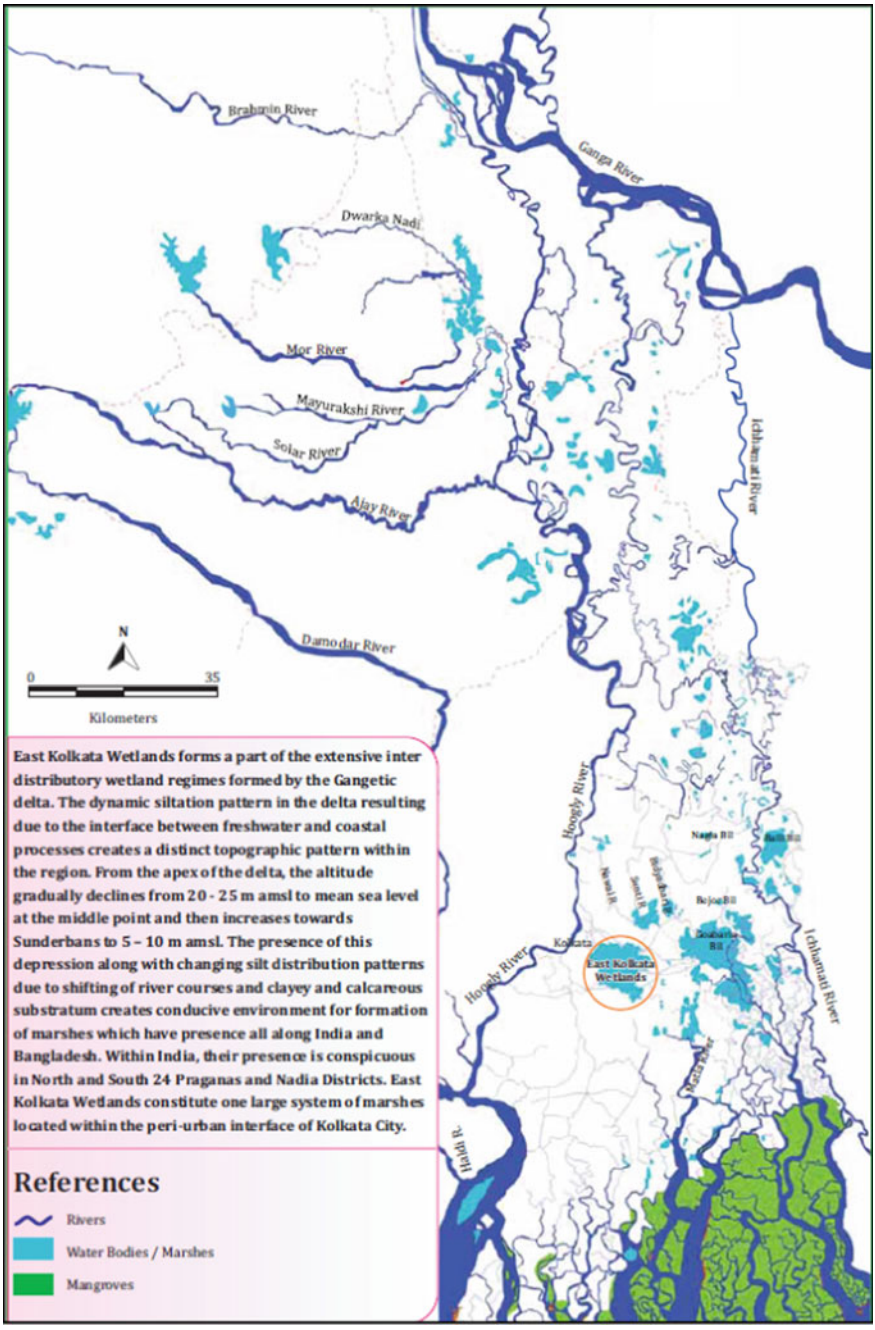
[12]With the partition of India in 1947, the distribution of districts and states followed the principle of a contiguous Hindu majority for India and Muslim majority for Pakistan; districts within the eastern part of Bengal became part of the newly formed country of Pakistan. The eastern districts of Bengal constituted Bangladesh when Bangladesh was formed out of Pakistan in 1971, the (Bengali) language (and not religion) being the determining variable.



Map 4.1 Kolkata and the EKW. *Source* http://www.ekwma.com (accessed March 22, 2019)

representation of the wetlands for public consumption; this representation cartographically truncates the expanse of the wetlands and silences the natural history and geomorphology of the Bidyadhari spill basin" (Banerjee 2012, p. 100).

This debate regarding whether wetlands on the periphery of Kolkata should be designated as "East Kolkata Wetlands" or understood as part of the larger chain of tidal Bidyadhari swamps and Sundarbans marshes unfolds multiple questions across geographical, geomorphological, regional, and political lines, provoking us to think about nomenclatures and conceptual categories which are outcomes of particular historical and political conjunctures. This also brings us to research that problematizes the concept of "wetland" and offers a critique of the notion of wetland in common usage. In her history of nomenclature (specifically focused on America's wetlands), Vilesis (1997, p. 7) notes how in the 1950s the term "wetland" was coined by ecologists to replace "the imprecise and value-laden swamp." While for centuries the understanding and conviction that natural marshes and swamps were treacherous went hand in hand with people's actions and government policies which were troublesome, equally problematic is the fact that with the emergence and growth of environmentalism and its impacts, overall values towards wetlands have shifted; now these are perceived only as a resource to be preserved through the application of an (over) protectionist prism. In his study on America's largest river basin, the Atchafalalaya, Keul (2015) pushes forward this argument and slashes the obvious declensionist narrative associated with this space. "Though



Map 4.2 The EKW as part of the vast network of tidal swamps. *Source* EKWMA (2010, p. 9)

the material context of this fluid frontier between social land-space and ecological nature-space still covers thousands of acres of coastal peripheries, by depicting the swamp as a wetland and conceptually over-broadening it, ecologists and historians have reified its decline" (Keul 2015, p. 15). In his case study of the Atchafalalaya Basin, Keul uses the word "swamp" and not "wetland," arguing that the term "wetland" itself has become value-laden because "it carries with it an imaginary of a threatened space, a space without culture, a space of objective reality" (2015, p. 25). Calling for a paradigm shift, Keul advocates bringing "the swamp back to life" (2015, p. 16).

Detailed historical explorations across the geographical terrain of the eastern marshes and wetlands surrounding Kolkata will unravel the logic and truth grounded in the arguments put forward by both Banerjee (2012) and Ghosh (1999, 2005, 2014), as there are "the natural history of the wetlands" and also "the recent history of sewage recycling" (Banerjee 2012, p. 107). While Chap. 2 has provided an overview of the geomorphology of the Bengal Delta comprising vast saline marshes fed by tidal rivers like the Bidyadhari, Chap. 3 captured complex intersections among city, nature, and technology where a series of tamed interventions manipulated the fluid scape with considerable ecological and social implications. The evolution of the EKW from the tidal saline swamps as a somewhat "unique" ecological space and opportunity treating the city's sewage through low-cost, popular recycling resource recovery techniques implemented by fishers and farmers (referred to as "untamed practices" here), providing livelihoods to these marginalized communities, is an outcome of these tamed interventions which were in tune with the politico-economic imperatives of statecraft (Chap. 2).

The wetlands to the east of Kolkata are "a fundamentally locked natural annexe of the Sundarbans" (Banerjee 2012, p. 104), and the river Bidyadhari flowing through Deganga, Haroa, Rajarhat, Bhangar, and Sonarpur to meet Matla in Canning is "a river of the Sundarbans" (Mondal 2006, pp. 67–69). These wetlands, functioning as the low-lying spill basin shaped by the tidal activity of the Bidyadhari-Piali-Matla river system and embedded in the wider ecosystem of the Ganga-Brahmaputra delta, are a biological and geomorphic continuum with the estuarine-deltaic Sundarbans to the south and east. During the sixteenth century, the eastern subsidence of the Ganga-Brahmaputra delta delinked the Bidyadhari from the Ganga and made it a tidal river. The Bidyadhari, along with its distributary the Piali, and accompanied by numerous creeks, channels, inlets, and canals, is the main channel through which saline tides from the Bay of Bengal found an easy passage inland through the Sundarbans estuaries. Carried northwards by the river Matla, the Bidyadhari used to spill the saline water in this low-lying area, giving rise to the eastern saline water marshes or the "salt water lakes." Thus, the environmental and geomorphological characteristics and fundamentals of this vast marshy terrain have been shaped by the fluvial dynamics of the Bidyadhari-Piali-Matla system with the Bidyadhari playing the key role in it. "[I]f this wetlands terrain is inextricably tied to the Sundarbans in an intimate biogeochemical relationship it is because of the riparian connectivity that Bidyadhari ensured" (Banerjee 2012, p. 95).

The Bidyadhari River became the major outfall channel for the disposal of storm water and sewage of the city when the natural declivity of Kolkata was identified on the eastern side in the beginning of the nineteenth century.[13] Since late nineteenth century, the river started showing prominent signs of deterioration and decay due to both natural reasons and the series of interventions that it encountered, including excavation and re-excavation of canals and cuts and reclamation of the salt water lakes (Chap. 3). The river also decayed when free tidal flushing was interfered with by the construction of embankments and tank fisheries which encroached upon and reduced the size of the spill areas and subsequently caused deposition of silt on the riverbed. Furthermore, the farmers engaged in utilizing the marshes as paddy fields also raised embankments like the fishery owners (Calcutta Corporation 1946; I&WD 1947). In the 1930s, Lt. Col. R.B. Sewell reflected,

> Most of the spill channels are kept closed with cross dams, so that water in the river is almost entirely prevented from spilling in the lakes. If the free spill had not been cut off, a vast volume of water would return on the ebb-tide and would prevent the deterioration of the river, advancing at so rapid a rate. (Quoted in Chattopadhyay 1990, p. 25)

When the Bidyadhari River became completely defunct for use as the city's outfall channel and was officially declared dead in 1928 after a series of proposals, arguments, debates, and feasibility assessments, B. N. Dey's Kulti Outfall Scheme was implemented (Chap. 3). With the deterioration of the Bidyadhari and the diversion of the city's outfall to the Kulti, towards the further east, there was a transformation of the aquatic environment of the wetlands from tidal-fed to sewage-fed. This has been attributed as "the big change"; "what had been a saline marshy area behind the city of Calcutta thus changed gradually into a waste-recycling region bereft of salinity" (Ghosh and Sen 1987, p. 222). With this diversion in the discharge of the city, the salinity of the salt water lakes dwindled from 800 to 1200 parts per million to 500–600 parts per million (Chattopadhyay 1990). Thus, "salt-water fishery gave way to sewage-fed fishery," crafting a change in the pattern of pisciculture in the region (Chattopadhyay 1990, p. 30). In Sewell's data on the salinity of different parts of the salt water lakes in 1928, the reduction of salinity is attested (Table 4.1).[14] In 1945, out of 9000 ha (approx.) of wetland, 4700 ha (approx.) were sewage-fed with a production rate of 838 kg per hectare per year.[15]

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[13]In 1803, urban drainage was directed to the Hooghly River. But it was a decisional misfire on the part of the colonial masters as the natural elevation of Kolkata is 26 m (approx.) to the east and only 6–7 m to the west, i.e., along the levee of the Hooghly. Thus, right at the initial stage, the scheme was annulled and replaced by a viable drainage scheme that followed the natural slope of the land towards the south-east through the Bidyadhari and the Matla Rivers (Chap. 3).

[14]Though Sewell pointed out the overall dwindling of salinity following the decay of the Bidyadhari, it is to be noted that he also specified that the highest salinity occurred during April and May before the onset of monsoons and the lowest salinity occurred during the monsoons or at the end of monsoons when the rains diluted the water. Table 4.1 captures these details.

[15]*Summary of the Report of Dr S.L. Hora, DoF, GoWB on Fishery Development-cum-Mosquito Control Scheme for the Reclamation of the Salt Lakes, Calcutta*, Appendix VII (I&WD 1947).

Table 4.1 Reduction in salinity in the salt water lakes

Area	April 1928 (in mg)	July 1928 (in mg)
Paran Chaprasir Khal	15.48	5.97
Salt Lakes proper	14.99	4.87
Bidyadhari River	13.73	5.17
Dhapa Lock	13.53	4.67

Source Chattopadhyay (1990, p. 30)

When the Kulti Outfall Scheme was commissioned, an adequate water-head was also raised for supplying sewage to most of these fishponds by gravity, and this "resulted in the extension of wastewater fishponds further east and south-east for about 8000 ha" (Dasgupta 2003, p. 32). A striking feature of the whole undertaking by the Calcutta Corporation was that huge sedimentation tanks were constructed at Bantala, 5 miles to the east of Topsia where the sewage from Ballygunge and Palmer Bazar Pumping Stations met. Thus, "East Kolkata Wetlands" is the nomenclature given specifically to designate these sewage-fed wetlands in the eastern part of Kolkata. Ghosh clarifies the exact location of these wetlands:

> Between the levee of the River Hugli on the west and the Kulti Gong on the east lie the East Calcutta Wetlands, distributed nearly equally on the two sides of the Dry Weather Flow Channel that reaches the Kulti Gong to the east. The wetland area lies approximately between latitudes 22°25″ to 22°40″ north and longitudes 88°20″ to 88°35″ east. (Ghosh 2005, p. 43)

4.3 "Low-Cost Folk Technology"[16]

With core Kolkata having no separate sewage treatment plant, the eastern wetlands are responsible for treating almost 80% of the city's effluents and waste.[17] They absorb approximately 750 million liters of wastewater that are generated by Kolkata per day.[18] Being one of the finest examples of socio-ecological metabolism and manifesting the reciprocal-cyclic relationship between generated ecosystem services and livelihood needs and opportunities, EKW was designated a "wetland of

[16]I have borrowed this idea and phrase from Dhrubajyoti Ghosh, who was a crusader fighting for the rights of fishers and farmers in the EKW. He has written extensively on popular cost-effective resource recovery techniques pursued by local fishers and farmers to sustain this ecosystem.

[17]The city has no sewage treatment plants within municipal boundaries. There are three small plants located outside the municipal limits at Bangur, Garden Reach, and Bagha Jatin and these too have very little capacity: 45 million liters per day (MLD), 48 MLD, and 2 MLD, respectively.

[18]There is difference of opinion regarding this figure, which varies between 600 and 810 MLD, as reflected in scientific literature on the EKW.

Table 4.2 Land use status in the EKW

Land use	Area (in ha)
Bheris	5852.14
Agricultural area	4718.56
Urban, rural settlements	1326.52
Total	12.500

Source Kundu et al. (2008, p. 869)

international importance" under the Ramsar Convention on August 19, 2002.[19] Ramsar identified the EKW as "one of the rare examples of environmental protection and development management where a complex ecological process has been adopted by the local farmers (*fishers*) for mastering the resource recovery activities" (Kundu et al. 2008). The EKW nurtures the world's largest wastewater-fed aquaculture system, which drew international recognition and appreciation for the "low-cost folk technology" through which wastewater is treated by fishers and fish is supplied to the city at an extremely affordable cost as the sewage-fed wetlands exist in the "backyard of Kolkata."[20] Along with the approximately 254 sewage-fed fisheries or *bheri*s and spanning the districts of North and South 24 Parganas, the EKW also consists of agricultural plots and solid waste farms ensuring three major eco-environmental practices being pursued in these wetlands using the city's effluent and solid waste (Table 4.2).[21] The Ramsar-designated 12,500 ha include 37 *mouza*s comprising the *bheri*s, agricultural land, horticultural plots, and residential areas (Tables 4.2 and 4.3, Map 4.3).[22]

The most striking feature of the wetlands is how the locals treat wastewater in natural ways using nature's services like sunshine, algae, coliform bacteria, water hyacinth, etc., in the *bheri*s, which again consist of a series of ponds known as WSPs through which step-by-step sewage-fed fish production is ensured. This turns

[19]The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

[20]This epithet for the wetlands was given by Ashok Mitra, a Marxist economist who was the finance minister of West Bengal between 1977 and 1987. This came up in an exchange with Asish Ghosh, former director of the Zoological Survey of India, who was deeply involved in environmental activism to save the wetlands against conversions. Furedy and Ghosh (1984) and Furedy (1985) have cited the article published by Mitra (1984) in the *Statesman*, where he used the term "Calcutta's backyard" while discussing "health and wealth from garbage.".

[21]In the study conducted by Ghosh and Das Gupta (2015), it has been estimated that only 200 *bheri*s exist today.

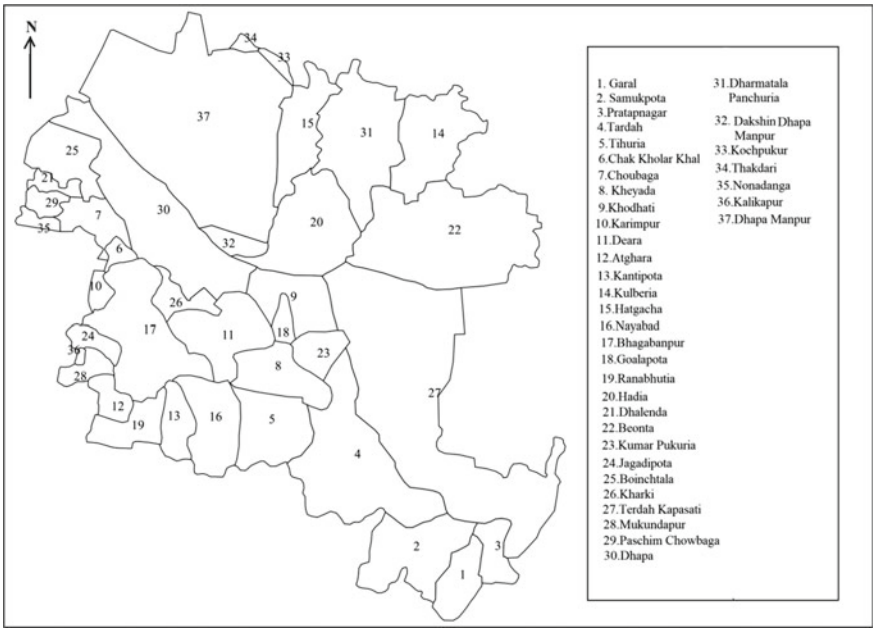
[22]*Mouza* refers to administrative units, corresponding to a specific land area within which there may be one or more village settlements.

This land use has encountered significant changes during the post-Ramsar period with areas within the Ramsar-declared protected site facing rampant conversion (see Chap. 6). Though the DoF, West Bengal, and PAN Network have recently prepared the present land use map by applying GIS techniques, their accuracies are yet to be verified across technical and cartographic ethnography parameters; these are not yet available for public dissemination.

Table 4.3 Geographical details of Ramsar-designated EKW

District	Police Station	Sl. No.	Name of the mouza	Status
South 24 Parganas	Tiljola	1.	Dhapa	Part
		2.	Chowbhaga	Full
		3.	Bonchtala	Part
		4.	Dhalenda	Full
		5.	Paschim Chowbhaga	Full
	Sonarpur	6.	Chak Kolar Khal	Full
		7.	Karimpur	Full
		8.	Jagatipota	Full
		9.	Mukundapur	Full
		10.	Atghara	Full
		11.	Ranabhutia	Full
		12.	Kantipota	Full
		13.	Bhagabanpur	Full
		14.	Kharki	Full
		15.	Deara	Full
		16.	Kheadaha	Full
		17.	Khodahati	Full
		18.	Goalpota	Full
		19.	Kumarpukuria	Full
		20.	Tardaha	Full
		21.	Tihuria	Full
		22.	Nayabad	Full
		23.	Samukpota	Full
		24.	Pratapnagar	Full
		25.	Garal	Full
	Kolkata Leather Complex	26.	Hatgaccha	Full
		27.	Hadia	Full
		28.	Dharmatala Pachuria	Full
		29.	Kulberia	Full
		30.	Beonta	Full
		31.	Tardaha Kapashati	Full
North 24 Parganas	South Bidhannagar	32.	Dhapa Manpur	Part
South 24 Parganas	Purva Jadavpur	33.	Kalikapur	Part
	Kolkata Leather Complex	34.	Dakshin Dhapa Manpur	Full
		35.	Kochpukur	Part
	Tiljola	36.	Nonadanga	Part
North 24 Parganas	Rajarhat	37.	Thakdari	Part

Source Kundu et al. (2008, p. 880); Mukherjee (2015a, p. 43)



Map 4.3 *Mouza*s within the EKW. *Source* Author

the EKW into a "remarkable example of living systems infrastructure" and "a high-performance, engineered and managed ecological system" (Carlisle 2013) where the fishers have "outshone every available stock of knowledge in wastewater recycling anywhere in the world" (Ghosh 2014, p. 179).

Waste stabilization ponds retain the sewage. Through sedimentation or settling of sewage that is carried out by successive primary and secondary stages, the biochemical oxygen demand level gets reduced. While during the primary stage heavier solids settle, the secondary stage involves the provision of an additional period during which variations in flow get mixed and homogenized. During this stage, the natural purification process starts and accelerates. Three types of WSPs are functional in the EKW: anaerobic ponds, facultative ponds, and maturation ponds. There is retention of sewage in an anaerobic pond followed by more days of retention in a facultative pond before the partially treated effluent enters the maturation fish pond (Fig. 4.3). Natural sewage treatment in WSPs moves through the five distinct phases of pond preparation, primary fertilization, fish stocking, secondary fertilization, and fish harvesting (Table 4.4).

The significance of the system lies in the traditional knowledge, skills, and wisdom of the fishers which Ghosh categorized as "low-cost folk technology," its scale of application being commendable within the country and also in the world (Fig. 4.4).

Fig. 4.3 Facultative (left) and maturation (right) ponds. *Source* South Asian Forum for Environment (SAFE), included in Carlisle (2013)

Table 4.4 The five stages of natural sewage treatment in WSPs

Stage	Major activities
1. Pond preparation	• Ponds are drained, desilted, tilled, and dried in the sun • Sewage from the city canal is drawn into the pond and allowed to stabilize for 15–20 days • To control soil alkalinity and destroy pathogens, lime is applied • Pond dykes are constructed • Aquatic weeds, water hyacinth, algae, etc., are grown in the ponds to save the dykes from waves, provide shelter to fish species against high temperature (Box 4.1). Hyacinth roots absorb metal ions and facilitate leaching of heavy metals out of water • For raising carps (seeds), ponds are dewatered. Otherwise, *mohua* oil cake is used as a natural pesticide[a] • The oil cake turns the water black; after a few days the water becomes clear • A bamboo sluice gate is used to prevent the entry of wild and the escape of cultured fish species (Fig. 4.4)
2. Primary fertilization	• Sewage is allowed from the feeder canal through the bamboo sluice • Sewage is left for 15–20 days to get stabilized • Sewage is purified in the presence of atmospheric oxygen and sunlight • When the water turns green, the pond is considered ready for stocking
3. Fish stocking	• Pilot testing with a small quantity of species is done • With positive outcomes, large-scale stocking is undertaken • As the sewage contains a high content of nutrients, the farmers keep a very high stocking density, i.e., 40,000 to 50,000 fingerlings/ha • Species are carefully chosen; exotic carps are not stocked in large quantities, *Pangasius hypophthalmus* is stocked to control mollusks
4. Secondary fertilization	• Sewage enters the ponds throughout the culture period at regular intervals of 1–10% of the total water volume of the pond • In bigger ponds, water level is maintained by continuous inflow and outflow • The requirement of sewage quantity is determined by observing the water color, transparency, temperature, and depth

(continued)

Table 4.4 (continued)

Stage	Major activities
	• The sewage, partly or fully decomposed, contains a high percentage of nitrogen, phosphorus, Ca, K, etc. • These nutrients together with adequate alkalinity contribute to high production
5. Fish harvesting	• Periodical stocking and regular harvesting are practiced. Followed by the first phase of stocking, species are restocked at 1 kg fingerlings per 5 kg harvested fish • This is followed by the subsequent harvest phase that starts after 15 days of restocking. • Drag nets are used for harvesting and encircling technique is followed

[a]The pesticide is prepared by distilling the residue of *Manileara indica*, locally called *mohua*

Note Solar radiation remains adequate for photosynthesis. The fish population maintains a proper balance of plankton in the ponds and additionally converts the available nutrients in the wastewater into readily consumable form, ensuring the safety quotient of fish consumption for fish growing on municipal sewage. However, with the change in the nature of sewage from organic to inorganic and multiple other factors across changing times, there are now increasing apprehensions about the same

Source Compiled from secondary literature: Ghosh (2005, 2014), Suutari (2006), Kundu et al. (2008), Paul (2015), Mukherjee (2015a), and field findings. Key informant interviews, focus group discussions, informal onsite conversations, transect walks, and case studies were conducted in two sets between July and August 2016 and September and April 2019

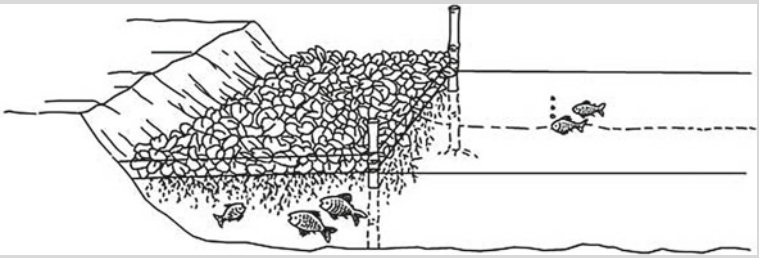
Fig. 4.4 Natural sluice gate made of bamboo. *Source* Author

> They know exactly how to excavate the ponds to the correct depth, clean the water by spraying kerosene, lime and oil cakes (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. (Dey and Banerjee 2018, p. 190)

In his 2014 book, Ghosh explains why the EKW should be considered as a "tutorial ecosystem," and brings out how local knowledge and specificities play a pivotal role in the sustenance of this ecosystem. For Ghosh, the locals are not trained in mainstream scientific theories and applications, yet their local knowledge, wisdom, and expertise surpass the precision of a hydrodynamics expert or a civil engineer. This can be illustrated by small yet significant examples that constitute part and parcel of the natural recycling and resource recovery mechanism in these wetlands (see Boxes 4.1 and 4.2).

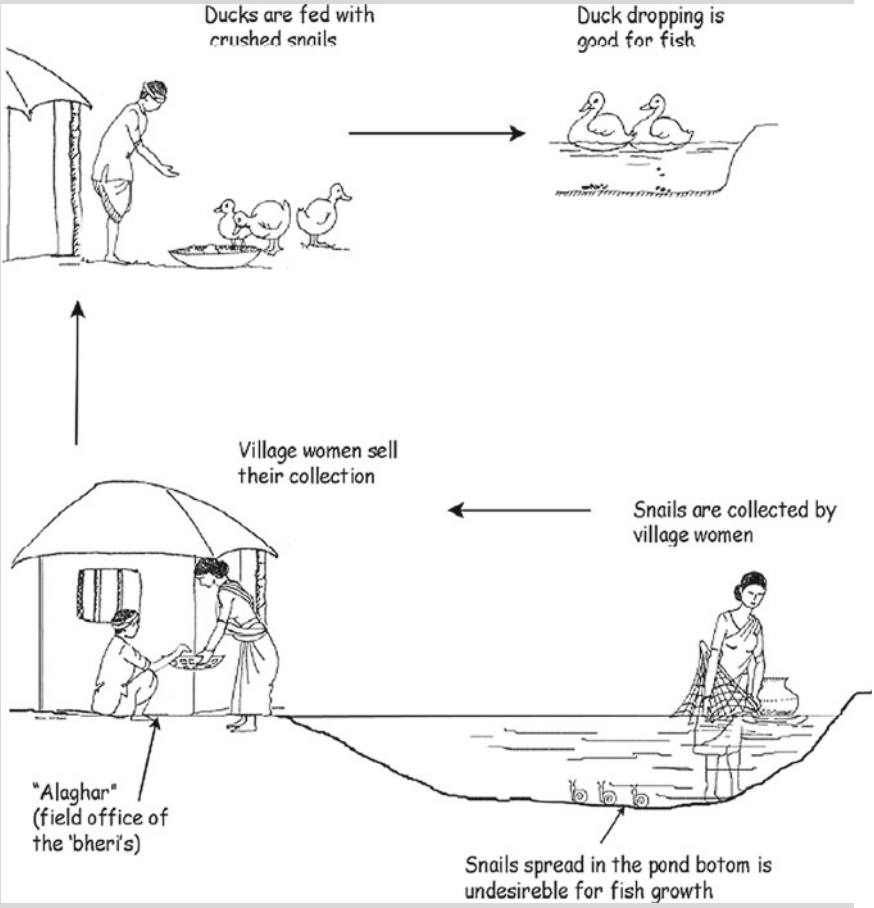
Box 4.1 The EKW as a "Tutorial Ecosystem" for Traditional Natural Recycling Mechanisms: Lessons from Embankment Maintenance Using Water Hyacinth

Bank erosion was becoming a common phenomenon, mainly in the large *bheri*s of 20 ha or more as the waves dislodged the embedded soil from its natural grip along the embankment. The locals understood that the surface waves had to be dismantled before these could reach the shore. Along the margin of the water bodies, the fishers retained a 3-m-wide skirt of water hyacinth. Poles at an interval of about 3–4 m were secured firmly to the bottom of the pond and along the embankment. A galvanized iron wire (of 2–4 mm thickness) was tied to the poles to set up a fence to stop the water hyacinth from leaving the demarcated boundary. The waves broke upon the hyacinth skirt and lost their energy. The embankments have not eroded over the last eight decades. *Source* Ghosh (2014, pp. 183–184)



Box 4.2 The EKW as a "Tutorial Ecosystem" for Traditional Natural Recycling Mechanisms: Lessons from Traditional Snail Collection by Elderly Women

Around noon, groups of elderly women wade through the shallow ponds for an hour or two. "The task they take upon themselves is far more interesting than their countenance" (Ghosh 2014, p. 185). They collect snails in their pot from the bottom of the pond. They sell these snails to someone waiting for them in the bank-side offices locally called *alaghar*. The collection of snails ensures smooth and rapid fish growth as the species require a clean pond bottom. The women on the other hand get a satisfactory payback by selling snails. The snails purchased from them are crushed and used as feed for the paddling of ducks whose droppings in the pond are a valuable source of fish feed. *Source* Ghosh (2013, 2014)



Through these comprehensive waste recovery principles and practices, the EKW produces different varieties of fish species that occupy different ecological niches of the pond system, including the Indian major carp, minor and exotic carp, non-native tilapia, etc. (Suutari 2006) (Table 4.5). Fish yield in the EKW is two–four times higher than that of ordinary fish ponds. With the transformation in the aquatic regime of the wetlands from saline (*nona*) to sewage-fed *bheri*s, aquaculture came to be dominated by the production of indigenous Indian major carp, specifically a polyculture of rohu (*Labeo rohita*), catla (*Catla catla*), and mrigal (*Cirrhinus mrigala*), and also the indigenous minor carp bata (*Labeo bata*). As early as the 1960s, exotic fish species like common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and Mozambique tilapia (*Oreochromis mossambicus*) were introduced into the polyculture. More recently the Nile tilapia (*Oreochromis niloticus*) has replaced Mozambique tilapia with a trend towards culturing mainly Nile tilapia usually in polyculture with Indian major carp, but sometimes in monoculture. Walking catfish (*Clarias batrachus*) and striped catfish (*Pangasianodon hypophthalmus*) are also produced, although in limited quantities. More recently, new species are gradually being introduced; trials with seabass (*Lates calcarifer*), locally called bhetki, and other native species are being experimented with to enhance incomes from *bheri*s (EKWMA 2010; Bunting et al. 2010; KIIs).[23]

When the nutrient-rich effluent moves through the system, it is progressively cleaned and nutrients are redirected to the growth of algae or agricultural products grown along the pond edges. Solids are removed, composted, and used to fertilize the surrounding fields. Algae and other aquatic plants are used to feed several fish species, which in turn create nitrogen and phosphorus-rich water to irrigate the adjacent rice fields (Jana 1998). The major forms of cultivation prevalent in the region are sewage-fed agriculture, garbage farming, i.e., growing crops on composted or decaying garbage, and sewage-fed aquaculture. In more peripheral rural areas, paddy farming dominates production. Two varieties of paddy, *aman* and *boro*, are cultivated during monsoon and winter, respectively. Approximately 4700 hectares of agricultural lands devoted to raising paddy use effluent water from the *bheri*s for irrigation (Table 4.2). The cultivation of rice is made possible because of the persistent supply of effluent running through the wetland canals.[24] A 2011 study by Mukherjee and Gupta shows that plots using wastewater containing organic nutrients earn higher profits than those using groundwater. Though the research also observes

[23]Key informant interviews were conducted with private *bheri* owners, project in-charges of government *bheri*s, cooperative members, and fishers in two sets between July and August 2016 and September and April 2019.

[24]It should be noted here that in the late 1960s, there was a large-scale conversion of sewage-fed fisheries when about 2500 ha (approx.) were drained and converted into paddy lands, "essentially as a consequence of the unsettled land questions and the anarchy of holding pattern in this region" (Premtosh Ghosh, unpublished records, 1987, cited in Ghosh and Sen 1987, p. 223). This was followed by the land reforms movement in the 1970s and the subsequent cooperativization of *bheri*s and acquisition of *bheri*s by the state in the 1990s.

Table 4.5 Fish fauna in the EKW

Scientific name	Common name	Abundance
Cultured fish varieties		
Catla catla	Catla	Common
Labeo rohita	Rui	Common
Cirrhinus mrigala	Marigel	Common
Labeo bata	Bata	Common
Labeo calbasu	Kalbos	Rare
Hypothalmicthyes molithrix	Silver carp	Sporadic
Crenopharyngodon idelea	Grass carp	Rare
Aristichthysnobills nobilis	American rui	Sporadic
Oreochromis mossambica	Tilapia	Common
Oreochromis nilotica	Nilotica	Common
Lates calcarifer	Bhetki	Rare
Liza parsia	Parse	Rare
Wild fish varieties		
Puntius chila	Punti	Rare
Puntius guganio	Punti	Rare
Amblypharyngodon mola	Murala	Rare
Glossogotius giuris	Belay	Sporadic
Salmostomabacaila	Chala	Rare
Aploeheilus panchax	Techoka	Common
Mystus vittatus	Tangra	Rare
Mystus	Tangra	Sporadic
Channa striatius	Sol	Rare
Channa gachua	Chang	Rare
Channa punctatus	Lata	Rare
Clarias batrachus	Magur	Rare
Heteroneustes fossilis	Singhi	Rare
Mastacembetus panalus	Pankal	Sporadic
Mastacembetus armatus	Ban	Sporadic
Pisodonophis boro	Kucho	Rare
Chanda nama	Chanda	Rare
Chanda ranga	Ranga Chanda	Rare
Notopterus notopterus	Falui	Rare
Anabas testudineus	Koi	Sporadic
Badis badis	Banda	Rare

Source Adapted from Kundu et al. (2008)

that the profitability of plots using wastewater is negatively affected by the presence of heavy metals like chromium, lead, and mercury, yet it affirms that the positive effects of organic nutrients outweigh the negative effects of heavy metal toxicity.

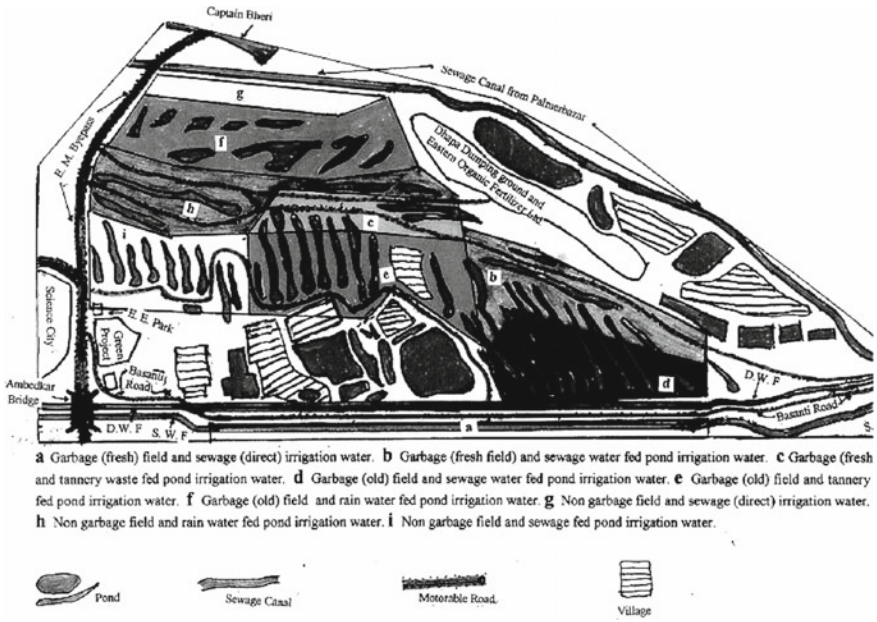


Fig. 4.5 Garbage farming practices in Dhapa based on use patterns of solid waste and wastewater. *Source* IWMED (1999)

"Fishing and vegetable farming are the lynch pins of production in this resource-conserving environment" (Furedy and Ghosh 1984). The combination of solid organic waste and wastewater used by producers in the main vegetable farming region was captured by the Institute of Wetland Management and Ecological Design (IWMED 1999). The report describes nine distinct combinations of waste resources and their use patterns of solid waste and wastewater (Fig. 4.5). Ghosh (2014, p. 175) explains the system as "co-recycling of solid waste and wastewater" (Fig. 4.6).[25] And this is what makes this ecosystem, nurturing fish in the *bheri*s and growing vegetables in alternate strips of garbage and wastewater channels, a unique example of waste recycling (Furedy and Ghosh 1984). Garbage farming is confined to Dhapa which is owned by the Corporation (Chap. 3). The farmers working as tenants or sub-tenants under the aegis of the Corporation are responsible for the entirety of the farming operations and also marketing of produce. At present some 325 ha of garbage farms are located within the EKW, and particularly in and around Dhapa. There are around 3000 farm plots in Dhapa, ranging between 5 and 30 *cottah*s (Mukherjee and Ghosh 2015). Farmers produce

[25]In Ghosh and Sen (1987, p. 4), Ghosh drew attention to the fact that "disposal of solid waste has also resulted in the reclamation of wetlands. Unlike urban conversion, however, wetlands that have lost to garbage fill are not always of a permanent nature, this landfill having produced an economically viable natural biological system to recycle waste which is inseparably linked with the water-bodies of the area."

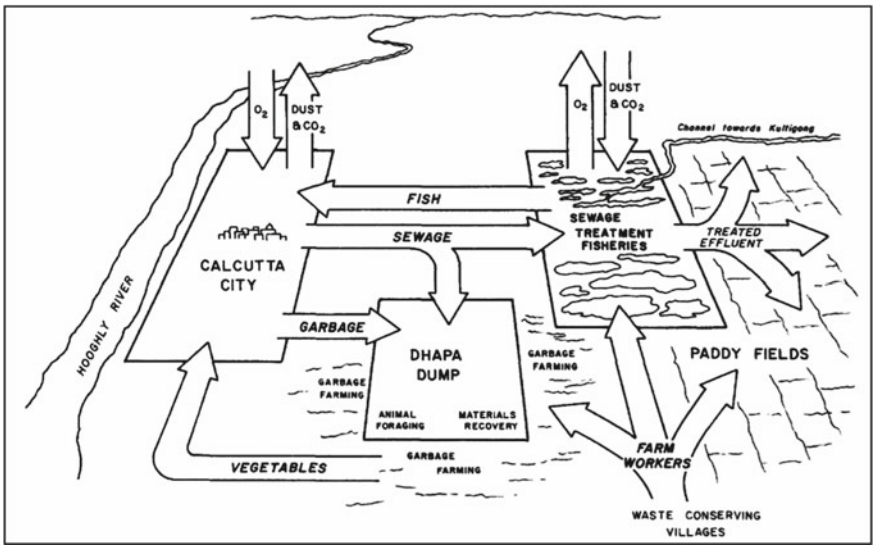


Fig. 4.6 The co-recycling mechanism for fish and crop production. *Source* Furedy and Ghosh (1984, p. 163)

11–16 different varieties of crops and vegetables with wastewater from the *bheri*s used to irrigate the farms (Table 4.6). Due to prevailing soil conditions, it is also a common practice for farmers to simultaneously crop 3–5 different varieties of vegetables on the same land. These farms are reported to produce 1500 quintals of vegetables per half hectare per annum, providing employment to 2.5 persons per half hectare, excluding the additional employment required for ploughing and irrigation. The rich soil makes it possible to grow several varieties of vegetables simultaneously. In its detailed report and findings on "sound practices" in composting across "industrialized, transition and developing countries," the United Nations Environmental Programme (UNEP) recognizes that "the best known example of garbage farming is at Calcutta's Dhapa dump" (UNEP n.d.) (Figure 4.7). Emphasizing how garbage farming relies totally on nature's services and also touching upon the co-recycling mechanism, UNEP mentions, "The combination of dirt, dust, organics, human and animal feces, and ash in Calcutta's garbage produces a fertile growing medium that requires no additives; the dump is in a wetland and there are numerous ponds between the ridges of garbage that provide water" (UNEP n.d.).

Fishermen and farmers live on wetland produce and sell the surplus to city markets. Seventy-four percent of the working population draws its sustenance from fish farming, agriculture, and horticulture (EKWMA 2010). Fisheries being the major economic produce from the wetlands have a well-established market chain from the producer to the buyer through a system of traders or auctioneers. Fish is sold through four wholesale markets at Bantala, Bamanghata, Chowbhaga, and

Table 4.6 Vegetables grown at Dhapa

Vegetable	Yield
Cauliflower	15,000 heads
Ridge Gourd	45 quintals
Maize	45 quintals
Radish	45 quintals
Yam	70 quintals
Brinjal	90 quintals
Bottle Gourd	240 quintals
Bottle Gourd Plant	126 quintals
Pumpkin	180 quintals
Pumpkin Plant	30 quintals
Bitter Gourd	9 quintals
Spinach	90 quintals
Pui	108 quintals
Danta	90 quintals

Source Mukherjee and Ghosh (2015)

Fig. 4.7 Farmers engaged in garbage farming in Dhapa. *Source* Author

Chingrighata located in the wetlands. From these four points, fish is distributed to retail markets scattered in different parts of core Kolkata. There is also increasing evidence that fish is increasingly being transported out and marketed in provincial towns. The city receives nearly one-third of its daily fish and vegetable requirements from the EKW at cheap prices due to the proximity of the wetlands. These low-cost and indigenous practices referred to here as "low-cost folk technology" have allowed fishers and farmers to recycle waste to wealth, making waste recycling in the city extremely cost-effective, as well as generating cheaper vegetables and crops to the benefit of lower-income groups.

Time and again questions relating to the safety of consuming fish and vegetables from EKW have been raised. In their recent work, Vicziany et al. (2017) have pointed out the limits of traditional knowledge against the heavy metal pollution that EKW is exposed to, especially from the tanneries. The article argues that fish from EKW is not safe for consumption anymore as sewage that enters the *bheri*s includes toxic waste and a range of heavy metals. Vicziany et al. (2017, p. 621) criticize Bunting et al.'s (2010) resilience argument about the wetlands, pointing out that it is an "optimistic presumption" as it does not factor heavy metal contamination into the assessment of sustainability. Several studies have shed light on the increasing heavy metal pollution in the EKW and strategies through which it can be regulated (Sahu and Sikdar 2008; Chakraborty et al. 2013; Saha et al. 2015). Interviews conducted with fishers, managers, and government officials during a series of field visits for this study, however, confirm that though there have been changes in the nature of effluent which is now affected by inorganic, toxic waste, yet it is still safe to consume fish produced from these wetlands. The interviewees mentioned that till now no single case has been reported of skin problems among fish producers or catchers or other laborers who work in sewage ponds. Several assessments conducted by the Central Inland Fisheries Research Institute (CIFRI) do not project negative findings. The secretary of Baro Chaynavi Matsyabay Samiti, during an interview, drew attention to the fact that big corporate fish lobbies were mediatizing against sewage-fed fish production in EKW arguing that it was unsafe and could be carcinogenic. To many of the fishers, the safety question is being deliberately raised to discourage fisheries which give tough competition to corporate fish lobbies.[26]

4.4 Each *Bheri* Has Its Own Narrative

The EKW is not a homogeneous scape. Each *bheri* has its own specificities in terms of geographical location, administrative status, size, ownership patterns, etc., which in turn shape its specific sets of challenges and potentials that await rigorous, detailed, and nuanced mapping and exploration towards conscious and

[26]Interviews conducted between July and September 2016.

comprehensive planning, policy formulation, and actions. This section will shed light on the heterogeneity of the EKW by focusing on the above parameters, like location, institutional dynamics, etc., contextualizing these within larger historical and political dimensions across which the EKW has evolved and encountered transformations. This "living systems infrastructure" is a dynamic ecosystem, and hence, it is important to map the drivers and dynamics of change that determine its functioning (Carlisle 2013; Bunting et al. 2010). This section will also provide case studies from three different types of *bheri*s (based on different ownership patterns) to validate the argument of heterogeneity in this dynamic ecosystem (see Boxes 4.3, 4.4, and 4.5).

Three major types of *bheri*s constitute the EKW: government, cooperatives, and private. Out of 3900 ha of sewage-fed fisheries, as per a 2002 study, 72% were privately owned, 27% were under cooperatives, and 1% were state-owned (including the two largest government *bheri*s: Nalban and Goltala) (Mukherjee and Maity 2002). However, this pattern has undergone transformation as some cooperatives have made way for private ownership. Presently, 93% remain private-owned *bheri*s across shareholding, partnership, and leaseholding bases (Mukherjee and Ghosh 2015) with only 6% under cooperative ownership across registered and unregistered categories (Kundu et al. 2005) (Table 4.7). In another more recent study on water and sanitation arrangements in peri-urban Kolkata, Mukherjee and Ghosh (2015, p. 19) capture this changing trend: "Cooperative fisheries are increasingly becoming privatized, selling *bheri*s to commercial companies operating in the region." Again, within these major varieties in ownership patterns, there are sub-varieties based on institutional dynamics and management and functioning strategies that had evolved over time (Table 4.8).

For understanding different ownership patterns, it is important to trace the political history of West Bengal in the post-independence period and especially

Table 4.7 Types of *bheri*s based on ownership patterns

Type of bheri	Sub-categories	Details
Government or state-owned	–	Managed and run by the DoF, GoWB
Cooperative	Registered	Run by cooperative members, registered under and supported by the DoF, GoWB
	Unregistered	Run by cooperative members in an informal way, not registered under or supported by the DoF, GoWB
Private	Shareholding basis	Where profit is divided among shareholders; owner takes 40% of the profit
	Partnership	*Bheri* owner is paid a rent; he may participate in decision making and take a share of profits
	Leaseholding basis	Taken on lease usually by 5–10 people; owner pays an annual rent; profit is shared in proportion to the financial contribution of each leaseholder

Source Adapted from Mukherjee and Ghosh (2015)

Table 4.8 Type of *bheri*s and their different modes of operation

Ownership type/management strategy	Form of operation
Government undertakings	Maintained by the State Fisheries Development Corporation, GoWB
Vested KMC (Kolkata Municipal Corporation) land	The KMC provides water bodies under its ownership to farmers
Registered cooperative	Groups of fishermen holding the required land deeds may approach the DoF to form registered cooperatives; following registration, cooperatives are eligible for government support in the form of seed inputs or loans
Fishermen's group or non-registered cooperative	Land vested by the state government is distributed to a group of landless people residing locally and assistance is provided by the DoF in managing the fishery
Owner managed	Farms managed by the owner who engages labor as required; according to local knowledge this type of management practice is declining
Own land with joint management	Land or ponds with multiple owners are developed for fish culture and the owners share investment and operating costs, as well as profits
Owner-worker participatory	Although individually owned, the workers take responsibility for investment, management, and marketing, giving a fixed portion of the production to the owner
Leased	Leases are arranged for various periods. The owner makes a single payment to the leaseholder after which he has the right to culture fish for the term of the lease
Leased with joint management	Several leaseholders share responsibility for decision making and profits are distributed according to individual shareholdings
Private companies	Fisheries of this type function as commercial businesse

Source Adapted from Bunting et al. (2002, p. 19)

since the 1970s, when the land reform movement crafted far-flung implications in the then communist state of West Bengal. The previously uniform pattern of ownership where the existing form was marked only by private holdings under zamindars (more specifically leaseholders) underwent transformations under wider socio-political forces and legal restructuring in West Bengal during the post-independence period. The West Bengal Estates Acquisition Act and West Bengal Land Reforms Act were implemented in 1953 and 1955, respectively, to abolish the zamindari ownership of land. However, these acts contained exemptions covering tea gardens, orchards, and fisheries; individual fish farms in peri-urban Kolkata largely remained intact until recently. In 1995, the Land Reforms Amendment was passed during which the fisheries were covered. This led to the cooperativization of a number of *bheri*s when private holdings were wrested from their owners by the state and transferred to fisheries groups and cooperatives. This in turn led to the decline of large privately owned fisheries. However, numerous

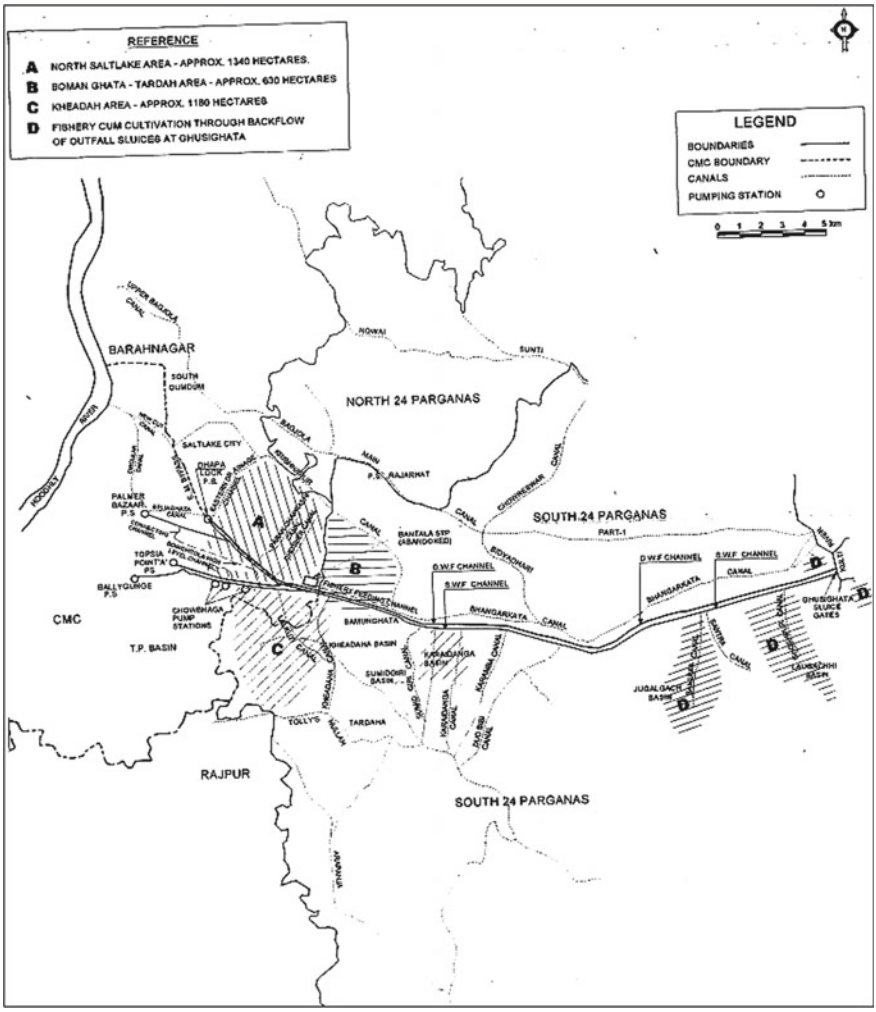
smaller, household-managed ponds continued to exist. During this time two of the largest fisheries (Nalban and Goltala) were also directly acquired by the government, through the State Fisheries Development Corporation (SFDC).[27]

The location of a *bheri*, i.e., its distance from the main or primary (DWF) canal, is also a key variable determining the functioning of the *bheri* in relation to other *bheri*s in terms of productivity and profit returns. With the implementation of the Kulti Outfall Scheme, two parallel canals were put into operation to carry DWF and SWF of the city separately from Bantala to Kulti, a distance of 17 miles. The wastewater is led to the channels through the six terminal pumping stations—Palmer Bazar, Ballygunge, Bagjola, Topsia, Chowbhaga, and Dhapa, which are connected to underground sewers.[28] The *bheri*s receive the pre-settled sewage from the DWF through an intricate network of locally excavated secondary and tertiary channels including Paran Chaprashir Khal, Fishery Feed Canal, Lalkhuti Khal, Ghosher Khal, etc. (Map 4.4). Key informant interviews with private *bheri* owners, cooperative members, and project in-charges employed in the two government *bheri*s captured the fact that the distance between the primary canal and the location of the *bheri* is a key variable in the distribution of and access to wastewater. While the location nearest the primary canal receives the maximum supply of wastewater, the *bheri*s located at the secondary canals get a lower quantity of wastewater and those situated at the tertiary canals suffer from inadequate quantity of wastewater supply and distribution. The correlation between the locational incentive (or disincentive) and ownership pattern also came out sharply during field research (Table 4.9). The government *bheri*s enjoy the locational advantage of the least possible distance from the main canal. This explains the government acquirement strategy followed by detailed scenario analyses exercises. The same is true so far as some of the government registered cooperative *bheri*s like the Captain *bheri*, Sukantanagar *bheri*, etc., are concerned. On the other hand, most of the small-sized private *bheri*s receiving wastewater from secondary and (more specifically) tertiary canals keep complaining about inadequacy in supply throughout the year, which is crucial for fish production.

The drainage network consisting of the intricate web of primary, secondary, and tertiary canals was engineered in such a way that it could distribute wastewater using gravity to the majority of fisheries. However, due to siltation and other related problems in the drainage infrastructure, an increasing proportion of fishers have had to pump wastewater from the canals during recent times. And this is more applicable to *bheri*s located far away from the main canal. "[T]he considerable cost of pumping wastewater from the feeder canals to the fishponds, constitutes a significant indirect subsidy supporting the managed disposal of wastewater from the city" (Bunting et al. 2002, p. 22). Moreover, "employing diesel pumps represents a

[27]For a detailed list of *bheri*s based on ownership types, please refer to Ghosh and Das Gupta (2015).

[28]Though technically and ideally only the DWF channel is expected to receive wastewater, yet wastewater is also pumped to the SWF, creating tensions between the municipal agencies and fishers.



Map 4.4 The intricate web of canals and the wetlands basin. *Source* KEIP, *EGIS Report*, TA No. 3089-IND, 3–38

Table 4.9 The main canal and some inlet canals carrying wastewater to some *bheri*s and their types

Name of the canal	Name of bheris and their ownership type/pattern
Paran Chaprashir Khal	Boroparesh (private)
	Chotoparesh (private)
	Naskarer Bheri (private)
	Patrabad (private)
	Gopeshwar (private)

(continued)

Table 4.9 (continued)

Name of the canal	Name of bheris and their ownership type/pattern
Ghosher Khal	Darir Bheri (private)
	Hara Singh (cooperative)
	Jhagrashisha (private)
	Har Hare (private)
	Rani Jheel (private)
Fishery Feed Canal	Saheb Bheri (private)
	Rajnagar (private)
Lalkuthi Khal	Prafulla Naskar (private)
	Sudhir Mandal (private)
	Mohan Patra (private)
	Heder Bheri (private)
	Fishermen's Cooperative Society (cooperative)
Main Canal (DWF)	Nalban (government)
	Sukanta Nagar Bheri (cooperative)
	4 No. Fishermen's Cooperative Society (cooperative)
	Guniner Bheri (private)
	Panch Kapati (private)
Paran Chaprashir Khal	Boroparesh (private)
	Chotoparesh (private)
	Naskarer Bheri (private)
	Patrabad (private)
	Gopeshwar (private)
Ghosher Khal	Darir Bheri (private)
	Hara Singh (cooperative)
	Jhagrashisha (private)
	Har Hare (private)
	Rani Jheel (private)
Fishery Feed Canal	Saheb Bheri (private)
	Rajnagar (private)
Lalkuthi Khal	Prafulla Naskar (private)
	Sudhir Mandal (private)
	Mohan Patra (private)
	Heder Bheri (private)
	Fishermen's Cooperative Society (cooperative)
Main Canal (DWF)	Nalban (government)
	Sukanta Nagar Bheri (cooperative)
	4 No. Fishermen's Cooperative Society (cooperative)
	Guniner Bheri (private)
	Panch Kapati (private)

Source Compiled from primary documents collected from the leaseholder of the Jhagrashisha Bheri; interviews with project in-charge, Nalban Fisheries Project

capital and operating cost to producers, and also brings into question the environmental credentials of the system" (Bunting et al. 2002, p. 23). Again, while government and registered cooperatives with ensured flow of capital and funds from the state remain in a better position to buy and use fish feed, fertilizers, etc. (if and when required) to enhance the production process, the private *bheri*s already deprived of wastewater and in dire need of relying on these external mechanisms lack funds to support and implement these on their fish farms.

The size of *bheri*s ranges roughly between 5 and 50 ha. There are some *bheri*s that are less than 2 ha, sometimes resulting from subinfeudation, i.e., division of *bheri*s among family members.[29] The disproportionate size of *bheri*s in the WRR and its relation to fish production was captured in a 1997 study conducted by the Calcutta Research Group (CRG). Assessing the distribution of *bheri*s based on location, the study identified that smaller fisheries under 2 ha exist mainly in Sonarpur and Tiljala, while large fisheries over 40 ha predominate in Bidhannagar; Bhangar is characterized by a mixture of small to medium sized fisheries (Table 4.10). Although roughly over 80 percent of the 254 commercial fisheries are under 20 ha in size, occupying approximately 30–40% of the total fishery area, the remaining 20% of fisheries over 20 ha account for a disproportionately large fishery area of 60–70%. The two state-owned fisheries, Nalban and Goltala, are the largest, comprising approximately 165 ha and 115 ha, respectively.[30] Ghosh (1999) calculated that the yield per hectare increased steadily with increase in the *bheri* size, and was the highest at 6.48 metric tons (MT) in fish farms where the effective area of the water body was above 70 ha (Table 4.11). The performance efficiency of large *bheri*s is also high, as these remain the most organized in terms of operations, planning through efficient management of production schedules, manpower utilization, sewage management, better procurement planning, water quality, fish health monitoring, and efficient personnel management. And all these "combine to provide the right synergy for achieving better production performance and per hectare yield" (Ghosh 1999, p. 10). The large size of farms enables the fishers to purchase both fry and fingerlings as fish feed. The large fisheries can afford to buy costly fry because, with more space available for separate nursery ponds, the fish species can be grown prior to stocking. Only fingerlings are purchased by *bheri*s that are smaller in size, hence with no scope for on-growing. On the basis of GIS maps of the EKW developed by the PAN Network, Banerjee and Dey (2017) have identified three types of land conversion in favor of urban settlements: from water body to urban settlement, from agricultural field to urban settlement, and from open space to urban settlement. The study confirms that "most of the changes have taken

[29]The issue of subinfeudation and its impact on fish production came out in an interview conducted in December 2018 with the leaseholder of Munshir Bheri located in the Dhapa Manpur *mouza*. The interviewee emphasized the increasing costs of production or capital investment with parcelization of *bheri*s, making the fish production business more competitive and less profitable for *bheri*s that are small in size and located in remote areas, away from the main canal.

[30]SFDC website, http://wbsfdc.com/fishery-projects/ (accessed March 26, 2019).

Table 4.10 Frequency distribution for aquaculture operations with respect to size and location of *bheri*s

Farm size (in ha)	Area/region				Frequency (%)
	Bidhannagar	Bhangor	Sonarpur	Tiljala	
< 2			41	32	28.8
2–10	21	3	51	32	47.3
10–20	7	21	10	9	12.9
20–30	6	8	2	3	5
30–40		2		1	1
40–50	1	2			0.4
50–60	3				1
60–70	4	1			2
> 70	4				1.5
Total	46	37	104	77	

Source Bunting et al. (2002, p. 16)

Table 4.11 Yield in relation to size of *bheri*s

Area range (in hectares)	No. of bheris	Total production (in MT)	Yield/ha (in MT)
Up to 2	76	318.72	3.94
Above 2–10	125	2443.50	4.01
Above 10–20	34	1850.99	4.12
Above 20–30	13	1100.25	3.48
Above 30–40	3	270.95	2.89
Above 40–50	1	180.00	3.90
Above 50–60	3	760.00	4.46
Above 60–70	5	1496.85	4.51
Above 70	4	2493.89	6.48
Total	264	10915.15	–

Note These are general estimates. There are rare exceptions to this. For example, the Baro Chaynavi Matsyabay Samiti with an area of 30 ha produces 6–7 MT/ha/year
Source Ghosh (1999)

place in *mouzas* where the average sizes of the water bodies are either small or at most medium and is definitely below 8000 m^2" (Banerjee and Dey 2017, p. 14) (Table 4.12; Map 4.5).[31]

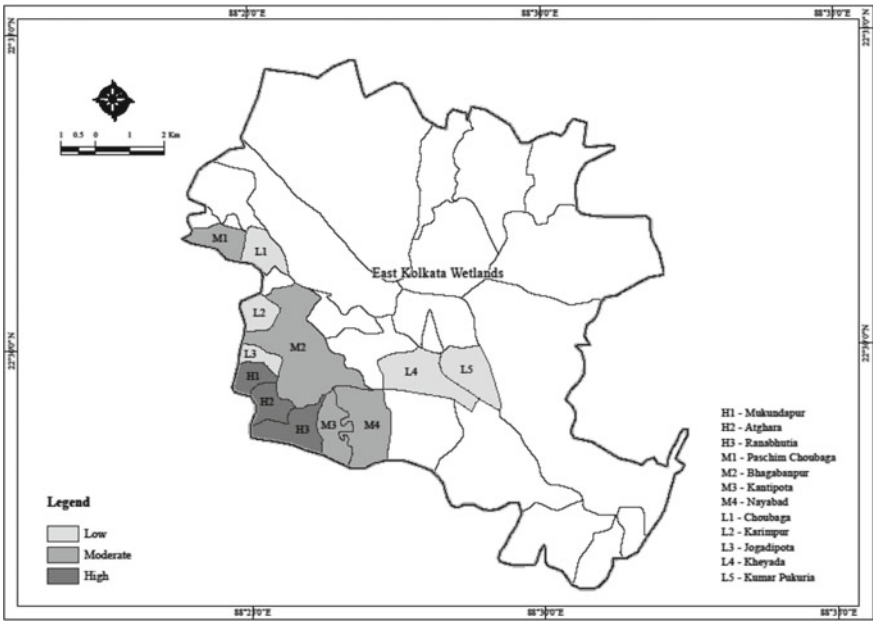
[31]The *mouzas* in the "high" group experience all three types of changes and those in the "low" group experience change on only one count. The "moderate" group lies in between. The changes are mostly concentrated in the western and the south-western parts that share a common border with the city of Kolkata.

Table 4.12 Size of water bodies and conversion threat

Conversion of Wetland into urban settlement	Dimension(s) of change[a]	Average size of the water body		
		Small ≤30,000 m^2	Medium (30,000 – 80,000) m^2	Large >80,000 m^2
	All three (High)	- Atghara - Ranabhutia	- Mukundapur	
	Only two (Moderate)	- Kantipota - Nayabad - Bhagabanpur	- PaschimChoubaga	
	Only one (Low)	- Karimpur - Choubaga - Kheyada	- Jogadipota - Kumar Pukuria	

[a]Three dimensions of changes are: (i) from water body to urban settlement, (ii) from agriculture to urban settlement and (iii) from open space to urban settlement

Source Banerjee and Dey (2017, p. 14)



Map 4.5 Pattern of land use change in the EKW. *Source* Banerjee and Dey (2017, p. 15)

Box 4.3 Field Insights from a Government *bheri*: Case Study 1—Nalban

Nalban is located in Dhapa Manpur of the South Bidhannagar Police Station, spanning 165 ha (approx.) out of which 130 ha (approx.) are used for pisciculture. It has the advantage of on-grown fish stocking as it includes nursery ponds occupying 10 ha (approx.) of the total area. The *bheri* receives wastewater from the DWF through the Dhapa lock-gate pumping station. The quantity of wastewater is not a challenge encountered by the Nalban Bheri; rather, if more water enters it during summers, there is a significant rise in the biochemical oxygen demand level, affecting productivity and growth.

The fishery mainly produces silver carp (*Hypothalmichthyes molitrix*), Indian major carp (*Labeo rohita*), grass carp (*Ctenopharyngodon idella*), tilapia (*Oreochromis mossambicus*), lylantica (*Oreochromis niloticus*), and black carp. Monosex tilapia has been a recent addition. Only natural fish feed is used, i.e., rice bran mixed with paddy husk. The average output (in this decade) has been roughly between 4.4 and 6 MT/ha/year with an average 25 million/year turnover. Fish is sold at nearby municipal markets at a fixed rate decided by the DoF. Surplus is sold in Chingrighata and Chowbhaga auction markets.

The fishery does not suffer from shortage of labor either. There are government-recruited permanent departmental fishing staff including 14 persons for netting and harvesting, 10 night guards, and 15–20 project management staff. The permanent employees enjoy a good, secure salary between 6000 and 8000 rupees per month against insecure and fluctuating incomes of fishers and workers working for private *bheri*s.

Being completely state-owned, this fishery is entitled to additional advantages and incentives which other *bheri*s cannot afford. The DoF has introduced air-conditioned mobile vending cars that carry fish for sale to the auction markets of Chingrighata and Chowbhaga. Fish production from the *bheri* is marketed to parallel initiatives by the DoF. For example, fish is provided at a subsidized rate to the Nalban Food Park, an eco-friendly DoF tourism project with restaurants and amenities like luxury boating, etc., developed on the waterfront of Nalban Fisheries Project. With generous government funding, from 2016, the *bheri* has also developed its own hatchery, prior to which it had to depend on spawns coming from Bankura, Naihati, and Bishnupur districts of West Bengal.

The common problem of siltation in the main canal and change in the nature of waste from organic to inorganic during the present time is a major problem reported here. Moreover, reduction in the nutrient status of wastewater due to the removal of cattle sheds in Kolkata deprives fish of adequate nutrients and negatively affects the growth of species.

Source Interviews conducted with the project in-charge, Nalban Fishery Project, at the project site in December 2018.

Box 4.4 Field Insights from a Cooperative *bheri*: Case Study 2—Baro Chaynavi Matsyabay Samiti

This *bheri* is located in Bidhannagar ward no. 36 within the jurisdiction of the South Bidhannagar Police Station, and constitutes 30 ha (approx.). It is a government-registered cooperative which was wrested from the zamindar when the EKW encountered a wave of cooperativization during the 1990s. Baro Chaynavi practices integrated aquaculture and horticulture, cattle rearing, poultry, etc., using municipal wastewater and biodegradable solid waste.

It consists of 67 members who are involved in different activities in fish production. During peak season, share catchers are hired on a temporary, contractual basis. The average production is 6–7 MT/ha/year with an annual turnover of 10 million. Silver carp, Indian major carp, tilapia, and lylantica are the major species grown here. Vietnam *koi* is a variety that has been added to the list since mid-2015. Fish is sold at the Bantala, Chowbhaga, and Chingrighata auction markets. Natural fish feed without additives or antibiotics is used. However, during the pond preparation stage, along with lime, potassium permanganate is used on rare occasions, especially during the winter when some fish varieties are affected by diseases.

It is one of the most active *bheri*s in the EKW which initiates its own plans and activities for holistic development of the cooperative with fish production as the core pursuit. It engages in distributive schemes like allocation of funds to members for welfare measures such as the construction of pit latrines, or other community and household goods. There are four cooperatives in the Bidhannagar no. 36 ward: 4 no. *bheri* (300 members), Chaker *bheri* (300 members), 1 no. Patrabad Samabay Samiti (100 members), and Baro Chaynavi with the lowest member strength of 67. Yet, its annual production rate remains the highest most of the time, sometimes even surpassing the state-owned *bheri*s.

The SFDC provides nets and fish feed to producers. It has also constructed roads and bridges for easy communication with auction and retail markets. Recently, SFDC has also encouraged Baro Chaynavi to produce big fish varieties so that Kolkata does not have to depend on fish coming from Andhra Pradesh.

The *bheri* suffers from challenges relating to quantity, quality, and access to sewage. Siltation in the inlet canal and ponds is a perennial problem. Yet, at its own initiative, with its own funds and labor, every year Baro Chaynavi pursues desiltation activities to increase the depth of the pond bed by 3–4 feet and the pond lines (side of pond) by 20 feet to retain and enhance production.

Source Interviews conducted with the project in-charge, Nalban Fishery Project, at the project site in December 2018.

Box 4.5 Field Insights from a Private *bheri*: Case Study 3—Jhagrashisha

Jhagrashisha is located within the South Bidhannagar Police Station and has an area of 80 hectares (approx.). It is under a leaseholder, and managed by a project manager employed by the leaseholder. It consists of three large ponds which draw sewage from Ghosher Khal (Table 4.9). As per the local system (i.e., decisions taken in WUC [wastewater users committee] meetings), wastewater distributed by the secondary canal is shared among *bheri*s in relation to their size. Jhagrashisha receives wastewater for three days a week, after which the *kapat* (locally constructed shutters or lock gate) is closed to ensure wastewater supply in other *bheri*s in the shared system.

The Jhagrashisha *bheri* uses multiple stocking and harvesting strategies and nurtures fingerlings in a nursery pond. Fish feed is obtained from local hatcheries. Common carp, silver carp, grass carp, and tilapia are the major species cultured here with 2.5 MT/ha/year as the average rate of production. Due to the large size of the farm, around 140–150 workers are employed here, ranging from permanent fishers to contractual laborers employed for specific activities within stipulated timelines. It employs 1 manager, 5 supervisors, and 33 netting men, each of whom earns 250 rupees and 250 grams of fish per day. Nine nursery workers are engaged in rearing and drying the pond, repairing dykes, and adding *mohua* cake oil and lime during the pond preparation stage. Jhagrashisha employs 3 net repairing persons who earn 250 rupees and 4 kilograms of fish per day, 6 bamboo repairing and maintenance persons taking care of the dykes, 6 evening guards and 30 night guards operating from the *alaghar* and boats, 14 women to clean the water hyacinth, and 35 fish carriers, carrying fish for sale to auction markets like Chingrighata, Chowbhaga, and Bantala.

The major challenge for this *bheri* (which has become aggravated during recent times) is lack of wastewater access, as it is located quite far from the main canal. The secondary canal (Ghosher Khal) from which it draws wastewater suffers from siltation. During monsoons, sewage gets diluted and consists of 75% rainwater which is insufficient for fish production and growth. Though no internal strife is reported among *bheri*s sharing wastewater from the secondary canal, as these strictly follow principles and guidelines decided at WUC meetings, getting a good quantity and quality of wastewater from the inlet canal is a big challenge affecting annual turnover. Moreover, due to prominence of labor unions, layoffs are also not encouraged. Hence, the entire burden falls on the leaseholder who sometimes has to incur losses that cannot be easily recovered.

Source Rounds of interviews (onsite and offsite) conducted with the leaseholder and manager, Jhagrashisha, between May and December 2018; informal onsite conversations with fishers in July 2016 and January 2019.

4.5 Networked Infrastructures and Beyond

This chapter has complicated the tamed–untamed binary by demonstrating how the implementation of municipal drainage interventions led to the sprouting of sewage-fed fisheries when the salinity of the marshes dwindled due to the deterioration of the tide-fed Bidyadhari River. The initial section of the chapter also addressed the debate on whether these sewage-fed wetlands should be perceived as EKW or "wetlands to the east of Kolkata," providing a scientific answer by considering valid arguments on both sides of the debate.

The detailed exploration and description of the functioning of sewage-fed ponds clearly portrays their inherent interlinkage with the networked infrastructures, an outcome of the colonial tamed interventions discussed in the preceding chapter. Chapter 4 has established the fundamental pretext for why and how Kolkata's blue infrastructures should consist of the history of the evolution and working of canals and wetlands, municipal initiatives and local practices, weaved together as an intricate web and a composite whole. Using this non-reductionist approach and non-compartmentalized perspective, this chapter has captured how tamed and untamed are entrapped, entangled, and enmeshed as a complex system, with changes in any particular component generating feedback loops and reciprocal responses.

The field narratives project the contemporary challenges and potentials in these wetlands in terms of material production ensuring ecosystem services and also the social base facilitating the same. The case studies of three different *bheri*s in terms of ownership patterns reveal the need to understand and explore these wetlands as a rich, heterogeneous scape seeking divergent sets of interventions. Numerous works on EKW address both their natural (technical) and social aspects; Chapter 4 has sought to make an epistemological contribution to the study of the wetlands by elaborating on the element of heterogeneity.

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Chapter 5
Disrupted Networks

5.1 Shifting Development Perspectives

The rivers–cities relationship in modernity has been understood, explained, and projected as an unequal one, where the former, or "many waters" in the form of rivers, canals, inlets, creeks, wetlands, marshes, ponds, etc., remain subordinate, exploited by cities to meet accelerating urbanizing needs and interests. Rivers came to be subjected to a new era of modern engineering and rationalization; water supply and sewage needs of urban centers altered the flow and ecology of urban rivers as well as distant sources (Castonguay and Evenden 2012). Rivers became "thoroughly conquered" and "denatured" (Castonguay and Evenden 2012, p. 2). Recent European and North American case studies on urban rivers have emanated from this research direction (Neri Serneri 2005; Deligne 2012; Bagle 2012; Barles 2012, 2017; Haidvogl 2012; Lübken 2012; Smout 2012; Castonguay 2017; Massard-Guilbaud 2017; Stradling 2017). Here, rivers are also perceived as amenities and objects "rather than as active agents in urban formation" (Way 2018, p. 1), which might be the outcome of contemporary riparian design projects like the re-creation of Cheonggyecheon River in Seoul, the Bilbao waterfront on the river Nervión as a regional civic center, Chicago's new waterfront promenade, etc., which represent riverscapes first and foremost as city attractions rather than as parts of a larger urban landscape (Yocom et al. 2016). However, some recent studies transcend this declensionist narrative and subordination/domination paradigm of transformed and commodified riverscapes and blue lines receding from city maps, shedding light on optimism and hope, activism and awareness, bringing rivers back to life (Platt 2017; Döring and Jochum 2017; Di Palma and Robinson 2018).

Within the Indian context, urban political ecology (UPE) studies have focused on the intricate relationship between the urban and many waters, mainly depicting how the latter are ruthlessly used as dumping and disposal sites, arteries to be filled up, converted entities (from rivers to real estate, from clay to concrete), scapes visualizing the sprouting of squatters (involving complex bargains between the

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state, party cadres, and the squatting population), and also spaces attracting beautification project investments (Baviskar 2011; Coelho and Raman 2013; Mukherjee 2016; Singh et al. 2018). While most of these contemporary case studies using the urban political ecology of water framework explore unequal power dynamics across the functioning of technical apparatuses and social arrangements affecting the powerless and the marginalized, the environment and the urban poor, historians have sketched the roots of this hierarchical struggle and the (mis-)use of urban rivers within the context of colonial capitalism (Wilhelm 2016; Sharan 2017).

The two volumes published in 2012 by the Centre for Science and Environment, New Delhi, provide detailed surveys of 71 Indian cities, portraying and projecting how urban India is soaking up water, polluting rivers, and drowning in its own waste (CSE 2012). The *Water Justice City Profile: Kolkata* report from the Bartlett Development and Planning Unit, University College London, validates CSE's findings by zooming into the Kolkata case study as part of a larger project traversing three cities of the global South: Cochabamba (Bolivia), Dar es Salaam (Tanzania), and Kolkata (Mukherjee and Ghosh 2015; Zegada et al. 2015; Kombe et al. 2015; Allen et al. 2017).

"Clogged with silt, today, it [Tolly's Nullah] is no more than a shallow, fetid wastewater canal" (Sengupta 2018). Disruptions in Kolkata's canal network as per media coverage, reports by (environmental) NGOs and grassroots organizations, technical reports and policy papers find linear explanations and analyses, with the colonial period being projected as the "golden era" and the post-independence period explained as the stage dotted with bureaucratic reluctance, civic indifference, and overall apathy and lack of awareness with regard to protecting these canals, once meant to be lifelines of the city. "The canal network used to serve for small boat traffic till 1960s, but gradually due to sheer neglect, canals got silted and thus the waterway was lost" (Ghosh 2010, p. 5). But can the complex dynamics and dialectics embedded in Kolkata's "disrupted networks" be explained only in terms of "sheer neglect"? "Sheer neglect" at best can be the symptom and not the cause. Applying the framework of historical urban political ecology (HUPE), this chapter drills deep to unfurl the causes and reasons culminating in the degradation and disruption of Kolkata's canal network which once drew major colonial attention and investments. The HUPE approach enables the contextualization of disruption within larger temporal and political conjunctures thickly loaded with their own economic calculations and imperatives that can be understood by capturing the "shifting development perspectives" of statecraft across time.

The canals of Kolkata designated as the Circular and Eastern Canal System (301 km approx.) were a link and a significant component of the larger Eastern Canal System, a more elaborate network of 1343 km (approx.), consisting of the inner, outer, and the steamer route connecting Kolkata with the other districts of Bengal and provinces of India. With a million tons per year volume of traffic, the canal network facilitated the emergence of Kolkata as an international port city of repute. Kolkata became the nerve center of imperial commerce, the steamer and boat traffic connecting the vast hinterland abetting imports into and exports from Kolkata. This was "an intricate system of a tangled network of inland water-routes,"

the water-borne trade of Kolkata with eastern and northern Bengal, the twin valleys of the Brahmaputra and Surma and (when the Bhagirathi remained non-navigable) Bihar, the upper and North-Western Provinces, and western Bengal (Bandopadhyay 2018, p. 48). The Kolkata canals were the most important route through which the produce of eastern India (specifically Bengal and Bihar), the North-Western Frontier Provinces, and also the Brahmaputra Valley was carried.

In 1813, Robert Fulton suggested the introduction of steam boats on the Ganges from Kolkata to Patna for transportation of troops, produce, passengers, and merchandise. In 1817–1818, the first steam engine reached Kolkata from Birmingham. The *Calcutta Gazette* dated August 14, 1823, says, "The steam vessel may now be daily seen in active operation on the Hooghly and group of wondering natives, attracted by the novelty of the exhibition, crowd both banks of the river to witness its surprising maneuvers" (quoted in Bandopadhyay 2018, p. 146). After initial experiments during the late 1820s, the tropical banks and coasts of Bengal witnessed inventions and innovations in steam engine navigation. Mechanized boats plied along the Bhagirathi and its various tributaries and distributaries and the channels of the Sundarbans. Gradually, this lessened the importance of the inland canal boat traffic which came to be considered as expensive, hazardous, insecure, and slow. Though the networks and technologies (inland canal and steam engine navigation) acted in complementarity for some time, yet, when the added advantages of steam engine navigation were charted out in terms of its speed, security, and uncertainty in a deltaic terrain and tropical climate with torrential rains, it drew state attention and the interest of private capital at an irreversible cost to the old network.[1]

Though the network of rivers in Bengal played a more significant role in "opening up the interior of Bengal which provided the routes for steamboats to penetrate as far as possible" (Bandopadhyay 2018, p. 219), yet it eventually succumbed to and was replaced by the new networked infrastructure and technology: the railways. Unlike Great Britain, Bengal experienced the absence of rival capitalist interest from (boat or steam engine) navigation lobbies.[2] Transit was the official who is credited with including the railway network in the lower Ganges Valley, criticizing Stephenson's plan which had suggested that Kolkata be the

[1]While steamers plied along the steamer route close to the bay to Khulna, Goalundo, Chandpur, and Barishal down the Hooghly to Mud Point and turned eastward by the Bartala Creek between the Sagar Island and the mainland, the main brunt of the local trade in rice, vegetables, forest products, etc., was borne by boat traffic (Bandopadhyay 2018). Boats also "served well as feeders to the steamboat traffic by linking the interior villages with the main-line river traffic" (Bandopadhyay 2018, p. 220).

[2]R. Cort revealed that the amount of capital invested in the internal navigation of Britain was no less than £30,000,000 and he demanded that in the unavoidable case of expansion of the railways, the canal interests should be protected by a legislation of Parliament (Cort 1835). On the other hand, in Bengal, "there was hardly any question of private investment in maintaining canals and similar waterways," which led to the infiltration and permeation of railways as the "sole arbiter" (Iqbal 2007, p. 336).

easternmost terminal excluding regions east of the city, i.e., eastern Bengal and Assam, from its immediate purview. Transit remarked as early as 1848,

> The Ganges Valley is your manufactory—your trading ground—your source of wealth. I look not to towns, to provinces, to districts, or to individuals; I look not to transporting sepoys, or cannon, or gunpowder, or arms … not to Manchester twist, or Welsh iron, or Swansea copper, or French brandy, or Burton ale; I look not to Purneah indigo, Patna opium, Benares sugar, or Chuppar saltpeter, Mirzapore cotton, or the grain of the chete; but on the broad principle of the greatest benefit of the greatest number, I say, that by the Ganges you catch the whole. (Transit 1848, p. 8)

Transit compared the lower Ganga Valley to a funnel whose apex was the starting point of the delta; Calcutta was a bottle which would draw the trade of the Ganges Valley through the funnel where the proposed railways would work like a pipe (Transit 1848; Iqbal 2007). Transit wanted the railways to tap the resources of the delta, but not hindering its water regime "which ensured enormous raw materials, trade and commerce" (Iqbal 2007, p. 332). "[T]he railways were supposed to have a complementary rather than confrontational relationship with the lower Ganga or eastern Bengal Delta" in Transit's scheme (Iqbal 2007, p. 332). "The best results would have been if the alignment was made in conjunction with the available water-borne traffic and not in opposing it" (Bandopadhyay 2018, p. 226). But there were opponents who considered the Ganges to be the competitor to the railways. In his study on the links between the railways and the water regime of the Bengal Delta, Iqbal (2007, p. 333) laments, "The root of the problem appears to lie not in the erection of the railway itself but in the fact that the government and different railway companies, while encouraging the construction of the railways, failed to appreciate the relative importance of inland waterways." Waterways were perceived as rivals to railways. The government was so enthusiastic about the railways project in eastern Bengal that the Eastern Bengal Railways received about two-thirds of the total sum asked for in the period 1925–1930, while other lines received less than half their demand.[3] That this enthusiasm of the state was determined by the calculus of enormous profits on investments is evident in the fact that when the implementation of the Eastern Bengal Railways project was laid out, "the computations concerning the amount of tonnage it was likely to carry were based on the returns of the Eastern Canals" (Iqbal 2007, p. 335). The railway bias is reflected in the Bengal government legislation allowing the lieutenant governor of Bengal to order the blocking of any navigable channel:

> It shall be lawfull for the Lieutenant Governor of Bengal … to authorize … to make and open any navigable channels, or to clear and deepen any navigable channel and to stop any navigable channel.… no action or suit shall be brought against the State in respect to any injuries or damage caused by or resulting from any act done. (Act V of 1864, quoted in Mitra 1954)

[3]N. Pearce, Agent, Eastern Bengal Railway, to G. G. Day, Chief Engineer to the Government of Bengal, Communication, Building and Irrigation Dept. (Railway), October 30, 1928, bundle 1, unrecorded files, file 7, National Archives of Bangladesh, Dhaka; cited in Iqbal (2007).

5.2 From Navigable Canals to *Nullah*s[4]

The Circular and Eastern Canal System and Tolly's Nullah that carried the produce of Eastern Bengal, Bihar, the North-Western Frontier Provinces, and the Brahmaputra Valley to and from Kolkata, were one of the most significant systems of river canals in the world in terms of the volume of its traffic. It witnessed its heyday during the 19th century, specifically between the 1800s and 1880s, following which it lost its vigor and rigor, the canals being transformed from noteworthy arteries of trade to mere receptacles of urban storm water and wastewater. The decrease in boat traffic and thenceforth the decline in tollage occurred from the 1890s, as is evident from a comparison of country boat statistics and toll collection between 1888–1889 and 1898–1899 (Tables 5.1 and 5.2).[5]

The canal system started losing its prominence as an inland water route due to rivalry with the Eastern Bengal Railways. Apart from the railway lobby, the country boat traffic also faced sharp competition from inland river steamer navigation. Bandopadhyay (2018), tracing the efflorescence of inland river steamer navigation in Bengal and providing detailed empirical accounts across the different districts of Bengal (including districts of the eastern part that now belong to Bangladesh like Pabna, Rangpur, Rajshahi, Barishal, Chittagong, Noakhali, Mymensingh, etc.), draws attention to this fact. Though the canal system still functioned as inland navigation in terms of local traffic, yet its golden era comprising laudable colonial projects of excavation and maintenance, proposals manifesting colonial interests and initiatives, debates and discussions, and most importantly, returns on investments came to an end.[6] From the last decade of the 19th century, except for rice and salt, country boats were cut out by inland steamer navigation "as means of transport for all the more important articles of merchandise" (Bandopadhyay 2018, p. 66). With the increasing momentum of commerce in the Ganges Valley, canal boat traffic in general and canal navigation in Bengal in particular, connecting Kolkata with its eastern hinterland, seemed to be meager, slow, insecure, and hazardous. H. T. Prinsep's remark in *Note on the Introduction of Steam Navigation in Bengal* dated August 10, 1828, offers the lucrative aspect of introducing steamer navigation in the Ganges which the British could not afford to ignore:

[4]This section captures the role of canals in Kolkata's drainage system as part of the intricate network of rivers, canals, branch channels, sewers, lock gates, and pumping stations, which it is crucial to trace and understand as a composite system.

[5]Archival records attest that there had been fluctuations in boat traffic and tollage during some years between the 1800s and 1880s, but the uniform and steady statistics of decline from the 1890s confirm that neither could the system recover, nor could the colonial administration retain its interests and enthusiasm in the venture.

[6]This declining importance also becomes apparent from the absence of more frequent year-wise records in the archive.

Table 5.1 Boat traffic in Circular and Eastern Canals system and Tolly's Nullah

Canal route	1888–1889	1898–1899
Calcutta and Circular Canal	90,090	65,030
Tolly's Nullah	78,219	48,356

Source Bandopadhyay (2018, p. 65)

Table 5.2 Tollage in Circular and Eastern Canal System and Tolly's Nullah

Canal route	1888–1889 (in rupees)	1898–1899 (in rupees)
Calcutta and Circular Canal	4,22,869	2,82,636
Tolly's Nullah	1,32,292	71,785

Source Bandopadhyay (2018, p. 65)

> There is no river in the world, unless those of China be exceptions, on which there is so large a navigation as on the Ganges and its tributary streams.… No attempt has been made to take a census of the class, or even to count the number of boats on the different rivers. Every body, however, that has lived on the banks of the great Ganges, has been struck by the constant succession of boats moving up or down, the river never appearing for a minute altogether clear; and this is nearly the same at all seasons and in all places, it leaves an impression of *the extent to which this magnificent stream subministers to the wants of commerce* and of the traveller, such as defies the attempt at computation.[7]

The proponents of the canal system like O. C. Lees and R. B. Buckley made attempts to draw the attention of the government to revive and revitalize the network which suffered from siltation, degradation, and non-maintenance. Like Lord Dalhousie, these supporters and sympathizers of canal networks emphasized the role of canals as feeders or links to railways, especially during monsoons when huge parts of the delta remained inundated. Moreover, the overhead costs of canal maintenance were lower than costs pertaining to heavy infrastructures like roads and railways. As the venture had proved to be immensely productive in terms of revenue returns, it had the potential to be rejuvenated.[8] Keeping in mind the role of the canal system and boat routes in facilitating water-borne trade in Bengal, the note of O. C. Lees, superintending engineer, on the improvement of the provincial steamer route included the canalization of Tolly's Nullah to act as the link artery in the steamer navigation and commerce connecting Kolkata with the eastern districts of Bengal and Assam. But on the ground of prohibitive costs and also increasing competition from the Eastern Bengal Railways, the proposal was not approved by the government. Lees kept foregrounding the significance of the canal system and

[7] *Parliamentary Papers* (1832), Great Britain: H.M. Stationary Office, 10(2): 677 (italics added).

[8] Archival records confirm that between 1804 (when the Government of Bengal levied tax on boat traffic or water carriage) and 1850, a profit of more than 40,00,000 rupees could be extracted as canal revenue. That the returns were commendable can be assessed by the fact that with "the exception of some of the Madras irrigation works, no other public works in India had been more really productive than the Calcutta and Eastern Canals" (Bandopadhyay 2018, p. 95).

also highlighted the complementarity between canals and railways to augment the commercial potentials of Kolkata and the Bengal Province. During the 1880s, when the deterioration of inland navigation through the canal system became imminent, R. B. Buckley observed that it should be restored as it had few competitors in the world in terms of the quantity of goods that it had delivered. However, the shifting calculus of rule by then had crafted an alternative future for this network that led to its transformation from arteries of trade to drainage channels. From performing the dual roles of trade-transportation and drainage-sewerage and sanitation, the canals were converted into mere conduits of storm water and effluent. Lees lamented, "We have been so intent upon obtaining a direct and immediate return upon our capital outlay that we have nearly killed our golden goose and have scarcely given a thought to the indirect benefits likely to be conferred by good waterways and cheap transport" (quoted in Bandopadhyay 2018, p. 96). Bandopadhyay (2018, p. 97) adds, "The 'golden' goose is now almost dead. Putrid smell it now exudes is not only prejudicial to public health and hygiene but also a disgrace to municipal administration."

In post-independence Kolkata, the canal system is used only for sewage disposal. There is no recorded history that traces the specific time period (or the exact years) from when these canals stopped functioning as waterways for boat traffic. Oral interviews with older persons inhabiting the banks of Tolly's Nullah attest that till the 1970s, boats plied in the canal and marginal trade (especially export of bricks) continued with Bangladesh. The same is true for the Beleghata Canal which functioned as a navigable waterway even after 1947. Families that had stayed on the banks of the canal for generations mentioned that it was active, bringing rice, fish, timber, vegetables, bamboo, and other commodities from Barishal and Khulna districts in (East) Pakistan via the Ichamati River route.[9] Various trade centers that had flourished on the canal bank, such as oil in Ultadanga, rice in Beleghata proper, lime in Chunapatti, and wood in the Manicktala-Bagmari area, continued thriving till the late 1940s. However, in 1953, when the use of a legal permit (passport) was made mandatory between India and Pakistan, the water trade was severely hampered.

Connected to the entire drainage mechanism of Kolkata that has altered time and again with spatial expansion, demographic spurt, and also shifting politico-economic calculations, the once navigable canals now function as mere *nullah*s! These are now part of the intricate urban drainage web or network (drains > sewers > pumping stations > trunk sewers > canals > rivers [Hooghly or Kulti through EKW]) disposing sewage and acting as arteries to channelize rainwater. The present Kolkata Municipal Corporation (KMC) area is 200.71 km^2 distributed within 144 wards and 16 boroughs. The KMC is the densest agglomeration within the Kolkata Metropolitan Area comprising 4.4 million people as per Census 2011, with an average population density of 24,760 persons per square

[9]These informal exchanges and non-structured interviews following the storytelling mode were conducted in 2008 during my Ph.D.

kilometer, and accounting for 31% of the Kolkata Metropolitan Area's total population against only 10% of its area.

The city has two major outfall river systems: the Hooghly River on the west and the Kulti River on the east. On the north, the drainage of Bagjola basin is connected to and drains into the Kulti River. Excavated in 1957, the Bagjola Canal is a major drainage artery for the northern part of Kolkata and New Town, Rajarhat (CEMSAP 1997). The KMC comprises major drainage basins and systems, each with an independent sewer network and a terminal pumping station (Tables 5.3 and 5.4, Map 5.1).[10] When the KMC expanded in 1983 to include wards from the municipalities of South Suburban, Garden Reach, and Jadavpur, the Manikhali basin, the Manikhali Canal and its branch channels were incorporated within its jurisdiction. Together with Tolly's Nullah and Churial Canal, the Manikhali Canal caters to the drainage requirements of roughly 66 km^2 within KMC and also adjoining municipalities (like Maheshtala and Sonarpur-Rajpur) and discharges into the Hooghly. The integrated circuit of the Circular–Beleghata–New Cut–Krishnapur–Bhangarkata canals connects the western riparian basin with the east. The Circular Canal gets bifurcated: while one section connects with the Beleghata Canal forming the Circular–Beleghata Canal, the other section meets the New Cut–Kestopur–Bhangarkata network, finally draining into the Kulti River.

The combined sewerage system of Kolkata consisting of the "town system" and the "suburban system" is connected to the SWF and DWF channels, finally discharging the city's storm water and dry weather flow into the Kulti River. The "town system," designed during the 1870s and put into effective implementation since the 1900s, draining the northern parts of the city (from Bagbazar to the Lower Circular Road), was implemented to accommodate 6.35 mm (1/4 in.) rainfall per hour at 100% runoff in addition to dry weather flow. It consists of town sewers discharging by gravity in an easterly direction from relatively high ground in the immediate vicinity of the Hooghly to a system of intercepting town sewers. These intercepting sewers discharge into the Palmer Bridge Pumping Station, where sewage is pumped to high-level sewers, and the Town Head Cut (THC) Channel, the primary component of the "town system," discharging into the DWF at the Topsia point (Map 5.1). During rains, storm water coming through the same network of sewers is lifted at the Palmer Bridge Pumping Station and is discharged into the THC Channel. The southern network known as the "suburban system" (1890s) catered to the sewerage needs of the southern part of the city. It was constructed to accommodate 4.23 mm (1/6 in.) rainfall per hour at 100% runoff in addition to the DWF. It consists of trunk sewers discharging by gravity in the easterly or south-easterly direction to the Ballygunge Pumping Station. At this pumping station, sewage is lifted to two high-level gravity sewers leading to Topsia

[10]A drainage basin is designated on the basis of geomorphological characteristics of the land and assumes significance in terms of precipitation absorption and the amount of rainwater being drained and discharged into a common outlet point, in this case within the KMC. Drainage system refers to an engineered arrangement designed and derived to discharge rainwater and sewage that are accumulated and carried from numerous source points to canals or drainage channels.

Table 5.3 Major drainage basins and canal networks within KMC

Major drainage basins	Canals and branch channels	Boroughs covered
Manicktala basin	*Circular channel* *Beleghata channel* *New cut channel* *Kestopur canal* Eastern drainage channel	III
Calcutta basin	*Dry weather flow channel* *Storm water flow channel* *Central lake channel*	II, IV, V, VI, VII, VIII, and XII (part)
Hooghly basin	*Hooghly river*	I (part) and XV (part)
Tollygunge Panchannagram basin	Tollygunge Panchannagram Main canal Intercepting channel Lead channels Guniagachi branch channel Suti canal	XI (part) and XII (part)
Tolly's Nullah basin	*Tolly's Nullah* Boat canal Keorapukur canal Western channel Renia canal	IX (part), X, XI (part), and XIII (part)
Manikhali basin	*Manikhali canal* Begore canal Parnasree canal CPT canal Santoshpur canal Jinjira canal	IX (part), XIV (part), and XV (part)
Churial basin	*Churial canal* Churial canal extension Kalagachia canal Suti canal	XII (part) and XIV (part)

Note The major canal(s) for each basin have been marked in bold in order to differentiate between these and their branch channels or tributaries
Source Adapted from Paul (2009) and Mukhopadhyay (2004)

point A, where high-level sewers from Palmer's Bridge Pumping Station also meet. The Suburban Head Cut (SHC) Channel (7.32 km long) carries the sewage from the Ballygunge Pumping Station till Bantala (Map 5.1). During monsoons, storm water is lifted at the Ballygunge Pumping Station for discharge into the SHC Channel. Downstream of the Bantala lock gate, the THC meets the SHC and combines as the SWF which then flows down to Ghusighata to the outfall, a stretch of approximately 27 km, finally discharging into the Kulti River (Map 5.1).

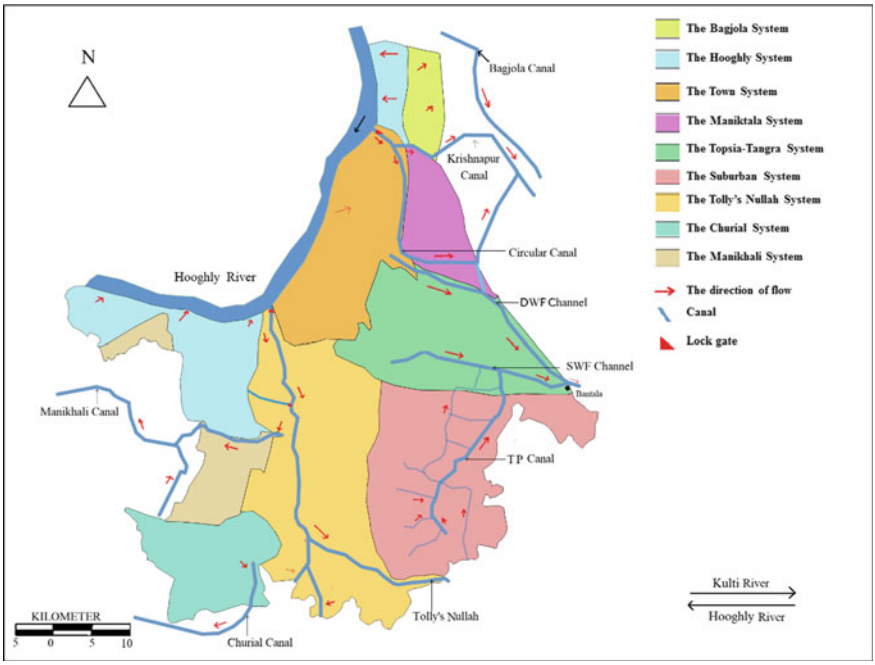
Table 5.4 Major drainage systems and area coverage within KMC

System	Wards covered		Areas served
	Full	Part	
Town	7–12, 15–28, 36–53, 61, and 62	6, and 63	Bagbazar, Shyambazar, Sovabazar, Taltala, Barabazar, etc.
Suburban	54, 55, 60, 64, and 68	65, 69, 86, 90, 92, and 93	Beniapukur, Entally, Ballygunge, etc.
Manicktala	13, 29–35, and 41	5	Ultadanga, Kankurgachi, Phoolbagan, Beleghata, etc.
Tolly's Nullah	70–78, 81–85, 87–89, 97, 111–118, and 120–121	69, 79, 86, 90, 93–95, 98, 100, 119, 122, and 123	Bhawanipore, Alipore, Chetla, Kalighat, etc.
Bagjola	2, 3, and 4	5	Cossipore
Topsia–Tangra	56, 57, and 59	58, and 66	Topsia, Tangra, Chingrighata
Tollygunge–Panchannagram	67, 91, 96, 99, and 101–110	65, 66, 92–95, 98, and 100	Jadavpur, Kasba, Garia, etc.
Hooghly	1, 134, and 141	6, 79, 80, 133, 135, 137, 138, and 140	Chitpore, part of Garden Reach
Manikhali	128–132, 136, and 139	133, 135, 137, 138, and 140	Behala, Taratala, Garden Reach
Churial	124–127	80, 119, 122, and 123	Sarsuna, Barisha, Thakurpukur, Haridebpur

Source KMC (2005), cited in Mukhopadhyay (2004, p. 183)

The discharge into the rivers through the outfall channels takes place either through gravitational flow or pumping. The lock gates, pumping stations, and sub-stations play major roles in flushing water to the sewers and outfall channels connected to the system. Pumping becomes imperative to flush sewage and storm waters due to the "bowl-shaped" feature of Kolkata; as "the centre of the city is somewhat in lower elevation and as such every drop of waste water/storm water requires pumping to relieve water-logging" (Chatterjee 2017). The main pumping stations which dispose of the major part of the drainage flow are located at Palmer Bazar, Dhapa, Ballygunge, and Chowbhaga. Apart from these main stations, there are small ones including Birpara, Duttabagan, Lake Town, Topsia, Kulia, Tangra, Chingrighata, Pagladanga, etc., which discharge directly into different outfall channels.[11] There are also boosting pumping stations at Manicktala, Mominpur, Chetla, and Nimakmahal. These belong to the colonial period and were constructed with the logic of giving "the sewage necessary lift so that the same may gravitate to

[11]For an exhaustive list of the major and minor pumping stations within KMC, see the official KMC website: https://www.kmcgov.in/KMCPortal/jsp/PumpingStation.jsp (accessed April 2, 2019).



Map 5.1 Major drainage systems of Kolkata. *Source* Author

principal pumping stations at Palmer's Bridge and Ballygunge" (I&WD 1947, p. 39). The lock gates remain functional to regulate discharge. The two major lock gates are the Chitpur and the Dhapa lock gates. Located at the head of the offtake point of the Circular Canal and connected to the river Hooghly, the discharging capacity of the Chitpur lock gate is estimated to be 28 cumecs (or 1,000 cusecs) at the high tide level. The Dhapa lock gate regulates and controls municipal wastewater.

5.3 Degradation, Disruption and Demise

The intricate network dedicated to Kolkata's drainage suffers from multiple insurmountable challenges affecting the city and aggravating its vulnerability quotient. "Kolkata's old *khal* or canal system, which acted as an effective drainage system for some three centuries, is in disrepair" (Banerjee and Chaudhuri 2012, p. 396). The network, especially the surface canals, are projected as degraded and disrupted, gasping for immediate desiltation drives. "Heavy siltation and inadequate maintenance of the channel outfall structures have resulted in a significant reduction in the hydraulic capacity of the sewerage system" (World Bank 2011, p. 17). But this is just a small part of the whole story of degradation, disruption, and demise. The problems are manifold and spill beyond linear causes categorized under

"natural," "developmental," and "climate change" factors, with rippling ramifications dispersed over the entire network impacting its functioning and performance. While some issues are ingrained in the geographical, geomorphological fabric of this delta city, others are rooted in the historical drainage schemes and initiatives that were implemented to address immediate urbanizing needs following detailed and rigorous economic viability and feasibility assessments. And these challenges have multiplied within the contemporary contexts of urban sprawl, pollution, unplanned dumping of waste, non-maintenance (or absence of regular and comprehensive maintenance of the entire system, and sporadic desiltation and dredging efforts within particular canal stretches), canal bank encroachments, "development" interventions, and the dynamic dialectics among all these.[12] The drainage pumping stations appear inadequate to tackle the situation due to malfunctioning of pumps or reduction in the pumping capacity (Ghosh, 2010). Moreover, the unplanned diversion of surface runoff from one sub-basin to another is one of the reasons for overloading of the existing drains, resulting in flash floods..

The continued expansion of the KMC through the incorporation of adjoining municipalities and panchayats with inadequate development and maintenance of the drainage network is a major challenge for the city.[13] With the expansion of the city and the surge in its population, the drainage-sewerage service coverage remains inadequate. Officially only 50% of the population has access to sewerage services (Banerjee and Chaudhuri 2012; Mukherjee and Ghosh 2015).

> So, if truth be told, no one in the benighted and much-insulted Kolkata Municipal Corporation (KMC) knows exactly where the drains, between beginning and ending, take the turns they do, and where they merge with or peel away from each other. The glum fact is that the city's sewerage network's original blueprint has been repeatedly papered over by the palimpsest of history. What is known as Old Calcutta (which was the capital of India) encompassed only Sutanuti-Chitpur, Baghbazar, Sobhabazar, Hatkhola, Dharmatala, Bowbazar, Simla, Janbazar, Gobindapur-Hastings, Maidan and Bhowanipur. The New Calcutta (the capital of West Bengal) encloses in the north Sinthi, Cossipore and Gughudanga, in the south Tollygunge, Khidderpore and Behala, in the east Salt Lake, Beliaghata and Topsia and in the west the river Hooghly.… The drainage system halted—and began backing up, for all practical purposes—when New Calcutta attached itself like a succubus to Old Calcutta. (Basu 2008)

Geography and the fluvial dynamics of this deltaic terrain have determined the sewage disposal of the city to a great extent, leading to prolonged debates and discussions relating to execution of plans, proposals, and designs. Situated in one of the world's largest deltaic regions, Kolkata stands about 27 feet (approx.) over the mean sea level. It is located below the high water levels of the neighboring rivers

[12]In an interview conducted in November 2019, the former secretary, I&WD, confirmed setbacks associated with scattered and patchy desiltation initiatives of short and targeted canal stretches against comprehensive maintenance of the entire system for which detailed planning and timelines need to be arrived at.

[13]Panchayat refers to the lowest village administrative unit in India. With the incorporation of erstwhile Joka-I & Joka-II gram panchayats in September 2012 under the jurisdiction of KMC, it has now become 200.71 km^2.

and the drainage depends upon the lower water levels obtained during the ebb (I&WD 1947). Kolkata's drainage problem is aggravated due to the ground configuration and tidal nature of the rivers and streams surrounding it. The Hooghly is "a very powerful tidal river" with a maximum tidal range of 22 feet (approx.) near Khidirpur (I&WD 1947, p. 43). As the city is saucer shaped, i.e., its central part is less elevated compared to the other parts, pumping becomes imperative for flushing out wastewater and storm water in almost 80% of core Kolkata. Eleven sluice gates on the Hooghly River are responsible for preventing tidal ingress into the sewer system during heavy storms and high tide. However, the central part of the KMC sewer network system, i.e., the "town system," is almost 140 years old. Heavy siltation and inadequate maintenance of the channel outfall structures have resulted in a significant reduction in the hydraulic capacity of this system. The canals connected to the rivers encounter the rise and fall of tidal waters every day, the variation amounting to between 10 and 15 feet during monsoons. Sewage backflow is a major concern for the KMC authorities, especially during the rains.

A greater part of the core city of Kolkata is served by the underground drainage system of the combined type in which both sewage and storm water flow through the same conduit. This has resulted in siltation of major and minor underground trunk sewer lines, the problem getting intensified by the absence of frequent desiltation drives leading to the reduction in the carrying capacity of both DWF and SWF. The canal network suffers from irregular maintenance; the DWF canal was last maintained in 1999 and the SWF in 2003–2004 (World Bank 2011). "The combined underground sewerage system, which discharges both rain and dry weather flow, is at the verge of a near total collapse. It cannot handle rainfall intensities crossing the 6 mm per hour mark, as a result of which large areas remain under water during monsoons" (Banerjee and Chaudhuri 2012, p. 395). Moreover, the SWF also caters to the needs of the suburban areas and contiguous rural areas en route to the outfall into the Kulti at Ghusighata. But again, due to the tidal nature of the Kulti River, the SWF can perform effective drainage only for 5.5–6 h on an average in every 12-h cycle (Chatterjee 2017). "[I]f we consider the tide lock-age period of 12 h, the accumulated water will make the channel capacity inadequate" (Chatterjee 2017). The wastewater is also channelized through the SWF to keep the DWF free, resulting in clashing claims and interests between fishery owners in EKW and KMC, with the I&WD mediating between the two. Though the crisis seems to be of recent origin, drawing media attention and positioning the KMC and I&WD against the "local" fishers and farmers of EKW, yet archival records on Kolkata's drainage suggest otherwise (Niyogi 2015; Mukherjee and Ghosh 2015).[14] Examining the drainage system of Kolkata with the aim of suggesting improvements, the Drainage Enquiry Committee in its 1945 report reflected that the

[14]"The flow of sewage into the fish farms or bheris has been deliberately reduced in an attempt to snuff out fishery and farming and make way for conversion of the land into real estate" (Niyogi, 2015).

The nitty-gritty of the wastewater supply and distribution challenges, clashes and collaborations among the multiple actors will be discussed in Chap. 9.

> silting (of SWF) appeared to be attributable to some extent to the creep of sludge from the unexcavated portion of the silted up reservoirs and mostly due to the utilization of the Storm Water Channel as a carrier of Dry Weather Flow of city for which it was never designed. (I&WD 1947, p. 8)

The problem continues till date, creating inadequate wastewater supply in EKW on which it thrives. A survey carried out by the Creative Research Group in 1997 indicated that nearly 57% of active fisheries were complaining about severe shortage of sewage flow throughout the year and another 24% considered it inadequate for most of the year; only 234 MLD sewage is available for aquaculture against the requirement of 869 MLD (Dey and Banerjee 2017). The lack of wastewater supply is attributed to two major causes: siltation in the main canal and existing channels and wastewater flow, and distribution being controlled at a level which is problematic and non-recommendable for ensuring sewage intake by *bheri*s through existing channels. Traditionally, the lock-gate control at Bantala which regulates the distribution of sewage should be maintained at a maximum Grand Trigonometric Survey (GTS) of 9 points, which is lowered to 4.5 during monsoons. This arrangement ensures that there is an appropriate amount of sewage water flowing into the *bheri*s during peak fish cultivation season. At the Bantala point, however, I&WD has been diverting water into the Kulti River after an accumulation of just 7.5 rather than the regulated 9. This has generated two significant problems. First, it has impeded the flow of nutrients to the fish in the sewage-fed ponds, impacting the livelihoods of the fishers working in the *bheri*s. Second, the water flowing into the Kulti River is untreated, affecting the ecology of the river as well as the health and well-being of more than 20,000 people residing in the Sundarbans (Mukherjee and Ghosh 2015).

Apart from the quantity of wastewater, the *bheri*s also suffer from quality issues not only because of the change in the nature of urban waste with the predominance of chemical and inorganic constituents, but also because of the defunct sedimentation tanks at Bantala, an important component within Dey's internal drainage scheme which lived a very short span of life; repeated plans for revitalization never materialized. The tanks were constructed at Bantala, 5 miles to the east of Topsia where the sewage from Ballygunge and Palmer Bazar Pumping Stations met. The mechanism ensured processing of pre-settled sewage before it entered the *bheri*s through the inlet canals. The supernatant effluent combined with 20–30% of sludge went into EKW and the rest drained into the SWF meeting the Kulti connected to the estuary. Initially, risks of metallic pollution were lower, which is confirmed by the list of industries documented in Census 1951 (West Bengal chapter) (Mitra 1954). The spurt of new industries since the 1960s, especially untreated waste from tanneries located in eastern Kolkata (Tangra, Topsia, and Tiljala) and the defunct sedimentation tanks were a huge blow to the canals and wetlands as an integrated system.[15]

[15]Ray (1993) makes the correlation between the pollution problem in municipal canals and the growing numbers of industries in Kolkata since the 1960s.

The eastern canals including the Bhangar Canal are affected by toxic waste from tanneries. At the sluice gate the chemical-laced water is churned up and turns into foam (Gallagher 2013). In 1995, the Supreme Court ordered 538 polluting tanneries, operating in the heart of the city, to relocate to the eastern outskirts by 1997.[16] The Supreme Court also laid down detailed guidelines for the tanneries to treat waste.[17] After the Court's decision, the vast majority of tanneries were still operating in the Tangra, Topsia, and Tiljala areas, defying the Supreme Court's decision (Dembowski 2001, p. 119). In 2005, the Kolkata Leather Complex shifted from Tangra, Topsia, and Tiljala to Bantala, "the centre of the Waste Recycling Region" (Dembowski 2001, p. 119). However, the relocation verdict, instead of lessening woes, has intensified them. Common effluent treatment plants have been installed to treat wastewater, but the arrangement is inadequate in terms of the number of tanneries operating in the area. Moreover, a host of illegal units process leather shavings outside the Kolkata Leather Complex next to EKW. "The smell of chemicals used to treat leather hangs heavy; the storm water canals are choked with rotting animal hair and fat; and the omnipresent plastic. At places where the canal water is visible, it is either dull red with blood, dyes or chromium, or shines in grimy bubbles" (Bera 2015). And, in addition to all this, the treated effluent that is channelized in the combined channels (SWF and DWF), located opposite to the complex, is already choked, the inadequacy at times resulting in backflow.

One of the major contemporary challenges encountered by Kolkata canals is encroachment on canal banks. The officials, especially executive engineers, explain that desiltation or dredging initiatives are difficult to pursue due to the thick squatter population inhabiting canal banks. This "illegal" squatting is a major impediment during pre-implementation, implementation, and post-implementation of dredging and rejuvenation of canal stretches. Shedding light on the eastern part of the city and more particularly the Tollygunge-Panchannagram Canal System, Roy (2016) reports, "Encroachment on the banks of these canals is a problem.… hundreds of huts on either side of the canal have made this natural drainage system ineffective by dumping waste, reducing the channel's water-carrying capacity." "The politicized nature of the problem relating to displacement and eviction of squatters adds fuel to fire."[18] Though this might appear logical, deeper probing into Kolkata's urban development trajectories in the last four decades and, more significantly, since the beginning of the present century, discloses major disruptions in the city's drainage network (especially the canals and EKW) at scales and with greater intensity against contemporary "development" drives and interventions. Over the years, unplanned growth and construction over the drainage outlets and wetlands have accelerated Kolkata's exposure to floods and sewage backflows. The rise of

[16]This move has to be contextualized within the larger issue of the case on the pollution of the Ganges filed by environmental lawyer M. C. Mehta in 1985 (Mehta 1996; Dembowski 2001).

[17]Further monitoring of development related to relocation was referred to the Green Bench of the Kolkata High Court, which was established in 1996 within the context of urban environmentalism surrounding EKW (Chap. 8).

[18]Key informant interview with executive engineer, Canal Division, I&WD, in November 2018.

new townships on the east, on the one hand, has badly affected the drainage arteries, outfalls, and sink (the wetlands), and, on the other, has heavily contributed to adding sewage to the existing sewage generated by the city. The mismatch between the requirement of adequate and appropriate functioning of the drainage-sewerage network and additional pressure from the expansion of urban space and population looms large over this Indian metropolis. Metro rail construction over Tolly's Nullah is an appropriate example that complicates linear understanding and perspectives on "encroachment" and "development," fleshing out nuances in the interconnections and dialogues between the two (Box 5.1).

Box 5.1 Tolly's Nullah case: Development or demise?

Siltation and pollution of the canal and the rise of its bed level to alarming proportions ranging from 6 to 12 feet due to untreated sewage being disposed of in it drew the attention of the West Bengal Pollution Control Board during the 1990s. It was observed that raw sewage and solid waste from unauthorized settlers on its banks were dumped into the canal. A study conducted by an environmental NGO, Vasundhara Foundation, pointed out that the increasing pollution load was a major hindrance as the insufficient cross-sections of the canal did not allow flushing of the pollutants by the tidal waters. In view of this serious situation, CEMSAP (Calcutta Environment Management Strategy Action Plan) launched its report in 1997 with detailed insights for the management of EKW and the canal system (CEMSAP 1997). The report emphasized the revitalization of Tolly's Nullah by joining it with the Piali River and also through the construction of lock gates to control and regulate flow and discharge of wastewater. In a report published in *Ananda Bazar Patrika* (December 21, 2000), the plan of the Urban Development Department, GoWB, for renovation of the 15.5-km stretch of the canal between Hastings and Garia was projected. But all these hopes were in disarray with the implementation of the metro railway extension (from Tollygunge to Garia) over the canal, dissecting it. Three hundred pillars, each at a distance of 20 m from the next, were dug into the canal bed (Mukherjee 2016). The metro rail project was sanctioned in spite of protests, petitions, and litigations from different rungs of society and in spite of violation of the Environmental Protection Act (EPA), 1986, and Environmental Impact Assessment (EIA) Notification, 1994. No environmental clearance was sought by the railway authorities. The strongest weapon to facilitate the implementation of the project against tremendous socio-ecological cost was the archaic Section 11 of the Railways Act, 1989, a remnant of the colonial revised edition of the act of 1890 that allowed the railways to construct, "upon, across, under or over any land, any rivers, canals, brooks, streams or other waters." "The outcome was the transformation of our heritage river into a pillar-ridden sewer" (Mukherjee 2010, p. 138) (Fig. 5.1).

Fig. 5.1 The pillar-ridden Tolly's Canal. *Source* Author

5.4 Costs of Disruptions

> I'll have to take wading through muck as de rigueur for every coming season of Nor'westers and skies opening their bellies like a thousand Lancaster bombers on a blitz run.
>
> —Kajal Basu, "The Nordoma Culture" (2008)

The degradation and disruption of the drainage-sewerage network have had a profound impact on this delta city in terms of increasing vulnerability and decreasing resilience to floods and prolonged waterlogging against a few hours of rainfall. The recent study conducted by the environmental NGO South Asian Forum for Environment (SAFE), Kolkata, in collaboration with the International Water Management Institute (IWMI), Colombo, points out that the only remaining flood relief line for water-level resilience in the municipal area is the Adi-Ganga–Tolly's Nullah stretch and the EKW. The SAFE–IWMI findings confirm that between 2005 and 2015, 53% of the eastern wetlands and 86 percent of the Tolly's Nullah stretch (dissected by metro pillars) flow below the average environmental flow volume; this degradation and disruptions have decreased the flood-resilience efficacy of the city and its wetlands by 65% (Chakraborti 2017).

"The efficiency and adequacy of a drainage system is intimately related to the quantum or volume of drainage from an area and the ability of the system to cope with such volumes" (Das Gupta 1991, p. 303). Archival records attest that the drainage-sewerage system that had evolved historically with the implementation of the combined sewerage system designed by Major William Clark during the 1890s and B. N. Dey's internal drainage scheme as landmark initiatives had an adequate effluent and rainfall (or storm water) carrying and discharge capacity. The pumping stations also functioned well and were put into immediate commission during monsoons. In September 1945, P. C. Bose, chief engineer, Calcutta Corporation, remarked, "Every precaution, has, therefore, been taken to fight against street flooding as can be reasonably expected, keeping in view the capital and recurring expenditure which the community can afford without detriment to other vital

municipal services like water-supply, conservancy, etc." (quoted in I&WD 1947, p. 44). Moreover, the total lifting capacity of the pumping stations for lifting sewage and surface drainage provided "a clear margin of over forty percent of actual requirement" (I&WD 1947, p. 39). The pumping plants could cope with the normal rainfall and also moderately heavy rainfall up to ½ inch per hour through "six storm-water escapes into the Hooghly and Tolly's Nullah" (I&WD 1947, p. 39). Though during heavy downpours the Corporation authorities faced challenges pertaining to the shape and geomorphology of the terrain, and though storm water took a long time to reach the pumping stations, yet the city usually did not encounter a deadlock scenario as, during the years of heavy rainfall, the period and duration of flooding remained small.[19] In his *Note on Rainfall of the City of Calcutta and in Adjoining Areas* (dated December 7, 1945), the then outfall engineer A. N. Banerjee provided a detailed account of deluges and inundations recorded in 1738, 1888, 1893, 1913, 1916, 1922, 1941, and 1945 with economic and social casualties when "exceptionally heavy monsoon rain" occurred and the vicissitudes were "impossible to be controlled by human power" (cited in I&WD 1947, pp. 73–74).

Effective functioning and performance of a drainage system depends on adequate structures (appurtenances) to allow quick entry of all drainage at its peak rate of flow into the conveyance or transportation system, a network of surface channels and/or underground conduits, each section having adequate hydraulic capacity to carry away the peak drainage flow reaching it, and an effective and adequate disposal system to dissipate such drainage flows. Constraints or inadequacy in any of these elements hamper proper drainage disposal leading to "drainage-congestion with its associated disruptions in civic life and hazards to life and property" (Das Gupta 1991, p. 304). The primary requisites of a good drainage system are losing ground in Kolkata, suffering from consequences of choked canals, silted inlets, and encroached wetlands that give way to the contemporary disrupted network.

The acute siltation load in the canals, rampant east-centric urban sprawl, development interventions over canals (including metro rail construction on Tolly's Nullah, expansion of the Canal West Road affecting the Beleghata Canal, and the canal bank squatting population), and the expansion of the city and its population also through the incorporation of new areas within the KMC—everything combined has added to the pressure on Kolkata's drainage situation, which is crying out for

[19]The difficulty in the draining of rainwater due to the "saucer-shaped" feature of Kolkata finds repeated mention in drainage reports. The 1945 Drainage Committee Report specified, "Calcutta is a saucer-shaped city with a steep fall of nearly 4 feet to the mile from Strand Road to Cornwallis Street (24.0 at Strand Road to 19.5 at Falitola and Bidyasagar Street). The level then gradually rises upwards to about 20.7 at Circular Road and 23.0 at the bank of the Circular Canal… it will be apparent … flood after heavy rainfall occurs in low pockets mostly below 22.0 contour. Water from higher areas collects in the low-lying areas quickly before it can enter the sewers through the street gully pits" (I&WD 1947, p. 40).

urgent revival and rejuvenation.[20] In the 1970s, attempts were made to augment the capacity of the drainage system to ½ in. rainfall per hour, but the target could not be achieved "due to various technical and financial constraints" (Chatterjee 2017). Time and again plans were laid out and initiatives were designed and implemented to increase the adequacy of the drainage network, including laudable programs like the Calcutta Urban Development Programme (CUDP) and the more recent Kolkata Environment Improvement Project (KEIP) and Kolkata Environmental Improvement Investment Program (KEIIP). Though these have achieved some of their targets with beneficial implications for the drainage system and urban ecology as a whole, yet detailed and nuanced analysis of these programs within the larger context of the (political) history of Kolkata's planning and development (incorporating "environment" in it) could be a commendable exercise for exploring the challenges and potentials within these schemes, plans, and programs.[21]

Kolkata's average annual rainfall is 1200 mm (approx.). While the total downpour is not excessive, its distribution is irregular as more than 80% of the annual rainfall (900 mm approx.) occurs during about 90 days between June and September with 300 mm (approx.) for the rest of the year. The high rainfall intensities associated with irregular annual distribution produce large runoffs leading to severe drainage congestion (Das Gupta 1991). This problem has also been emphasized in the recent SAFE–IWMI study revealing the biophysical aspects of flood risks in Kolkata. The spatial, geological, and geomorphological configurations of this delta city, including the "tidal bore" phenomenon in the Hooghly that pushes the tidal water rapidly into the river causing high tidal waves between 2 and 5 m high, aggravate flood challenges.[22] Moreover, with risks of climate change looming large, the dangers of flooding and inundation have accelerated during recent times. According to the 2007 report published by the Organisation for Economic Cooperation and Development, Kolkata is projected to have more people exposed to coastal flooding than any other city in the world. The first global assessment of the exposure of port cities lists Kolkata and Mumbai in India among the top 10 cities that have high exposure to flooding under the current climate change forecasts (OECD 2007). Amit Ghosh from the Department of

[20]Though the capacity of the combined outfall channels was in tune with the generated effluent and storm water, the addition of southern and eastern areas like Jadavpur, EM Bypass, and other new townships with additional effluent has made the system deficient.

The east-centric urban sprawl of the city consuming its peri-urban wetlands, transforming these ecological infrastructures into estates, is covered in the next chapter (Chap. 6).

[21]This will be discussed in Chap. 7.

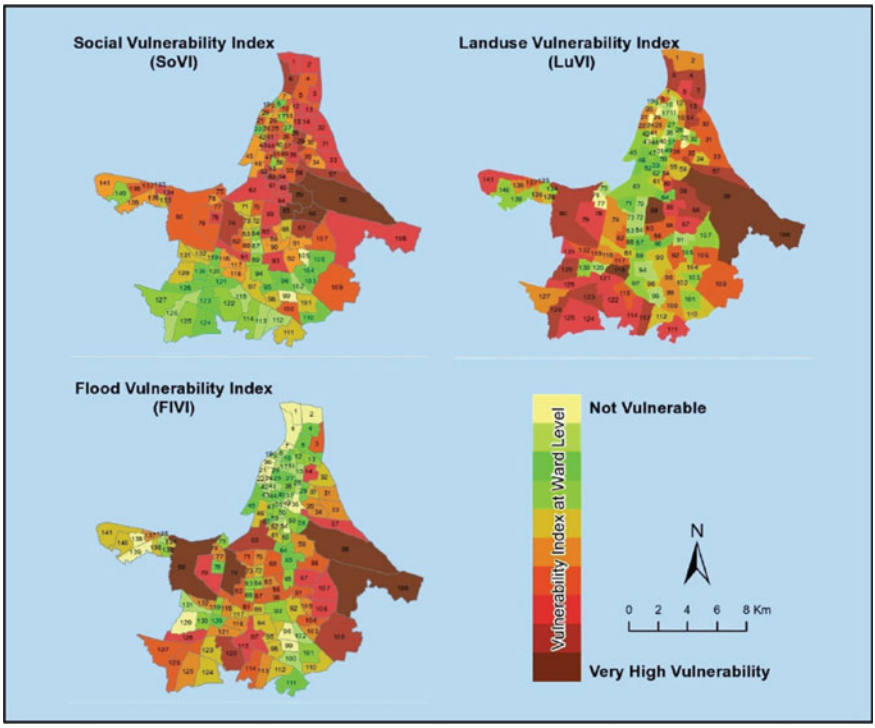
[22]The lock-gate operator at the Chitpur lock gate confirmed this phenomenon during an interview (conducted in January 2019) mentioning that during full moon, with high tides in full swing, the lock gates face risks of damage due to tidal currents if these are not properly controlled with advanced preparedness. The shift from a manual to machine-based lock-gate operation system has made the task convenient and safe.

Oceanography, Jadavpur University, notes that between 1955 and 2015, the city recorded three times as many cloudburst days, when it rained more than 4 in. a day, compared to the first half of the 20th century. Following the Census 2001 data, Ghosh's Climate Change Policy Paper on Kolkata (Ghosh 2010, p. 3) depicts "a disturbing trend" in the last three decades in the rainfall pattern, which has been unevenly distributed, very often with no rainfall for several weeks and then changing into sudden downpour towards the end of the monsoons causing flooding in the city.

After the disastrous flood of 1978, Kolkata faced the next severe waterlogging problem following the rains of September 1999, when water did not recede in several areas for up to 10 days. "Anger against apathetic officials ran high. Residents put up barricades in protest, triggering tension with the police who resorted to firing in one instance to control the crowd" (Biswas 1999). The Krishnapur Canal which drains the north is 50–70% choked and Tolly's Nullah which is responsible for the drainage of the south, has lost its vitality. In September 2006 when *Sarasari Ban*, the highest tide of the year (6.59 m high) hit coastal West Bengal, it flooded several low-lying areas in south Kolkata. The inundation was accentuated by the rains, causing waterlogging in many places in and around the city (Sengupta 2007). During the July rains of 2007 when within three days (July 3–5) 410 mm rainfall was recorded, against an annual total of 1600 mm as per previous records, tidal upsurges caused backflow in the canals, heavily disrupting the flushing-out mechanism of sewerage water. The hazard turned into a disaster due to unprecedented heavy rain combined with the failure of the sewerage system, compounded by the ill-preparedness of the civic authorities and unregulated urban growth at the cost of disaster risk management principles (Sengupta 2007). In spite of the implementation of projects to tackle the crisis, like Project Nikashi and the Asian Development Bank (ADB) funded KEIP, the waterlogging woes of the city continue.[23]

To validate the OECD (2007) findings, the World Bank in collaboration with the ADB and the Japan International Cooperation Agency undertook country-level studies including Kolkata as a case study. It identified vulnerable areas by developing hydrological, hydraulic, and storm drainage models and also compiled a database with past weather–related information and damage caused by extreme weather–related episodes (World Bank 2011). The study identified 14, 57, 58, 63, 66, 67, 74, 80, and 108 as the most vulnerable wards within KMC, bringing out the correlation between vulnerability and inadequate infrastructure, unplanned land use, and poor socio-economic and environmental conditions (Map 5.2). The heavy rainfall events are disastrous for an already flood-prone city "where nearly a third of the population lives in slums, or worse, on the sidewalks under the open sky"

[23]For *Times of India* coverage of flooding and waterlogging in Kolkata, see https://timesofindia.indiatimes.com/topic/Waterlogging-in-Kolkata (accessed April 8, 2019).



Map 5.2 Vulnerability indices in KMC wards. Note: This is based on 141 and not 144 KMC wards as the number of wards increased thereafter. *Source* World Bank (2011, p. 36)

(Sengupta 2018). The World Bank report specified that wards 63 and 80 have been identified as highly vulnerable as "the capacity of the sewerage systems have not kept pace with the changes in population as the city has evolved" (World Bank 2011, p. xii). The report also pointed out the inadequate maintenance of the system and siltation of the existing sewer networks that have considerably reduced its carrying capacity; especially in terms of carrying storm weather flow, "they prove highly inadequate for carrying the storm weather flow even with normal precipitation during the rainy season" (World Bank 2011, p. xii).

People living on the lowest rung of the social order with least access to physical infrastructures, i.e., squatters, have encountered, apart from the natural hazards, direct displacement and evictions due to development interventions carried out on Kolkata canals. The eviction drives in Tolly's Nullah during the metro rail extension project and Beleghata Canal as part of the larger project of city beautification are prominent examples of the social costs of disrupted infrastructures that complicate "encroachment," "development," and "displacement" narratives, fleshing out the direct relation between irreversible disruptions in these networks through the implementation of statist development and the displacement of squatters, the

displacement drives being officially legitimized on the grounds of "illegality" attached to the squatting population.[24]

The Tolly's Nullah eviction drive occurred in two phases. On September 22, 2001, on either side of Tolly's Nullah from the Garia station to Kudghat, a stretch of 2.5 km, 400 hutments were demolished and 2000 people were evicted (*Times of India* 2001). Although it was announced that there would be no objection if the evicted moved to other areas leaving 20 feet along the Nullah and settled at their own cost (*Statesman* 2001), yet during the five-hour operation, even shanties located 200 feet beyond the Nullah were demolished and the entire area was fenced in such a manner that nobody could enter and settle there (Sen 2002). On February 22, 2002, another 2.5-km stretch from Kudghat was cleared, followed by yet another demolition drive along the remaining 6.5 km. On December 10, 2002, "it was darkness at dawn for the squatters on the International Human Rights Day making the conception of human rights a mere mockery for the people residing at the margins" when more than 130 families inhabiting the banks of the Beleghata Canal were displaced (Mukherjee 2010, p. 203). No compensation package was arranged for the evicted. Some coupons of a meager Rs. 2000 were distributed by the administration to a few families, and there is no official record of whether the families received the token sum of money or not.

5.5 Debating Disruption, Development and Displacement

Critically interrogating the linear projection of deterioration of Kolkata's canal network during the post-independence period, this chapter has depicted why and how the degradation and decline have to be seen in the context of a succession of technologies, from inland boat traffic to steam navigation to the railways, introduced during the colonial period itself. The chapter has sought to historically establish the transformation of canals from significant arteries of trade to mere receptacles of wastewater, by sensing the gradual absence of archival records on the canal trade since the early 20th century on the one hand; and tracing conflicts of interest among municipal officials and the state regarding multiple usages of the canal system.

The contemporary disruption of the canal network is a continued legacy of the late colonial period, with the additional dimensions of demographic pressure, nature of effluent, and development interventions insensitive to ecological and social costs. I have traced the entire trajectory of the transformation of these once-navigable

[24]There is an official distinction between "slums" and "squatters." Squatters are unregistered settlements sprouting up in inhospitable areas like canal banks, railway tracks, etc. Most of the squatting population are issued with voters' cards by the state (winning party cadres being more influential or specific parties historically and politically having more power in specific wards) to enlarge vote banks. However, they lack land deeds, which makes them the most vulnerable to displacement against statist development projects.

canals into *nullah*s across a long-term temporal scale, discussing debates and deliberations among government officials about the revitalization of the canal network given the massive siltation, degradation, and lack of maintenance. The chapter has provided detailed coverage of the social and ecological implications of degradation of Kolkata's canals and discussed why and how Kolkata's climate vulnerability has a direct correlation with the appropriate functioning of its canal network connected to the wetlands. Finally, it has complicated the "degradation due to encroachment on canal banks" narrative by bringing into the discussion the entire demise of part of the network (Tolly's Nullah and Beleghata Canal) and the displacement of squatters due to statist development interventions including metro rail extension and road expansion projects.

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Chapter 6
Transformed Infrastructures

6.1 Consumption Cities

> In the developing world, the last two decades have seen a serious loss of agricultural and forest land on the urban fringes, occasioned by the tremendous growth of cities.… Maintaining food production on lands around urban areas is essential to the long term survival of cities. Protecting these lands from housing and industrial development and guaranteeing landless urban dwellers access to cultivable land are essential components in the development of successful strategies for urban food production. (Wade 1983: 27)

Wade's remark gains stronger grounds within the contemporary patterns, processes, rate, scale, and shifting geographies of planetary urbanization. The global South is undergoing very high urban demographic growth, changing meanings, definitions, and equations in the relationship between the "urban" and its wider ecological infrastructures in the "frontiers." Asian cities are expanding incessantly and engulfing arable lands, wetlands, and orchards on the frontiers. The process is variously categorized as "urban sprawl," "mega-urbanization," "super-urbanization," etc. This consumption drive is driven by the rationale that lands at the urban frontiers or peripheries are cheap and often suffer from ambiguities of clear demarcation and definition of property rights. The conversion and consumption processes continue relentlessly as "cities need the continuous existence of regions and lands as frontiers, and every instance of expansion of a city would also necessitate finding new areas to fulfil the functions of frontier land" (Sangameswaran 2018, p. 4).

Drawing attention to the hierarchical relationship between the city and its frontiers or the peri-urban interface in terms of inputs (raw materials such as crops, fish, vegetables, etc.) and outputs (sink for disposal of sewage) consumed and required by the city, while emerging urban planning studies emphasize the need to consider the urban-rural gradient paradigm, breaking and blurring the great "urban" and "rural" (theoretical) boundary, UPE literature explores complex ecological and social realities generated in this process of the mega march of consumption cities. There are studies on land use change in Asia within contemporary contexts of

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urbanization and their ecological consequences (Zhao et al. 2006; Wan and Wang 2014). The emerging UPE research focusing on Indian cities offers comprehensive and nuanced insights on the patterns and processes of urbanization, investigates multilayered interdependent eventualities across city–nature equations and entanglements, and explores mediations among various groups and stakeholders who experience and encounter these (Nair 2005; Baviskar 2011; Coelho and Raman 2013; Mukherjee 2015a, b; Sundaresan et al. 2017; Chatterjee and Parthasarathy 2018; Singh et al. 2018). It also focuses on peri-urbanization processes and the spatial, social, and physical infrastructural complexities that they entail. "Urban frontier" and the recent conceptualization of the "peri-urban" capture contemporary spatial dynamicity in areas surrounding immediate core city boundaries, signifying that these are "not quite urban" but seem to carry "the possibility of becoming urban" so that these are "not just rural either" (Sangameswaran 2018, p. 3) or these are zones of transition where "urban and rural features coexist" (Allen 2010, p. 35) or are characterized by either the loss of "rural" values (loss of fertile soil, natural landscape, etc.) or the deficit of "urban" attributes (low density, lack of accessibility, lack of services and infrastructure, etc.) (Allen et al. 1999). Succinctly perceived as "urbanization without infrastructures" (Allen et al. 2016) (that in turn results in "infrastructural archipelagos" [Bakker 2003]), peri-urbanization leads to transformation of lands, disrupting existing ecological infrastructures around metropolitan cities from rural to urban uses, the process remaining "incomplete and fraught with multiple claims and counterclaims over land, livelihoods, resources and identities" (Kundu 2016a, p. 93).

The research on peri-urban dynamics and dialectics focuses on the role of the state and the market (and their overlapping motives and interests) in large-scale displacement and dispossession of farmers and fishers within new modes of capital accumulation in the neoliberal urban development regime. Bhattacharya and Sanyal (2011) shed light on commodification of peripheral lands where new forms of globalized, knowledge-based economy exert hegemony over a transformed landscape and informalized labor. There have been studies on acts of expropriation of agricultural land, and changes in land uses in the process of conversion of rural settlements making way for the urban due to the mega march of cities (Shaw 2004; Shah 2012; Kumar 2015). In-depth explorations of transformed infrastructures manifest interconnected environmental and social realities generated in the process. Confronting fuzzy boundaries, lack of network coverage, administrative uncertainties, and social and economic insecurities (or at least transformations), these spaces remain detached and disparate, isolated and excluded from the ambit of the mainstream and formal planned city on the one hand, and the surrounding villages on the other, the latter also wrestling with the fear and threat of subsequent conversion. How do the people (villagers, new residents occupying flats, rising intermediaries, etc.) cope? Srivastava's work (2014) on Gurgaon demonstrates how gated communities have led to the formation of new middle-class identity and therefore pave the way for a new politics of engaging with the urban. Cowan (2015) traces how residual urban villages and gated communities are coproduced through circuits of capital accumulation that fragment and splinter the frontier into spaces of

inclusion and exclusion, planned and unauthorized, across manifold conflicting governance mechanisms. Kundu's (2016a) research on New Town Rajarhat focuses on everyday life realities and politics and new social equations that emerge from these quotidian practices, animating these spaces with new meanings and contestations. Within this context, this chapter is an empirical illustration of when, why, and how ecological infrastructures on the (eastern) periphery of Kolkata made way for concrete estates with major short-term and long-term socio-ecological implications for the city and its (transformed) surroundings.

6.2 New Townships and Urban Development Projects

Dhrubajyoti Ghosh's remark regarding EKW as "real estate in waiting" captures the past, present, and future of wetland conversion followed by the mega march of Kolkata in the post-independence period.[1] Series of new townships and urban development projects have come up on the eastern periphery of the city, crafting massive transformations in ecological infrastructures with rippling social repercussions and reactions. The drive started with the construction of Salt Lake City in the 1960s followed by small satellite townships like Baishnabghata Patuli and East Calcutta Township in the 1970s and the coming up of New Town Rajarhat in the 1990s, epitomizing "a saga of space, capital and people in the vortex of globalised time" (Dey et al. 2013, p. 8). The construction of the Eastern Metropolitan (EM) Bypass through the wetlands in the 1980s as a 29-km major artery connecting the city's east, north, and south was a major trigger that boosted this development drive with rampant real-estate speculation on both its sides. Giant skyscrapers now line the Bypass symbolizing the snobbish turn of the city, ensuring its entry into the list of its posh metropolitan counterparts in India like Delhi, Chennai, Mumbai, and Bengaluru. This includes the recently constructed "Atmosphere," the global "residential sky-sculpture" "in the clouds," and the megalomaniac JW Marriott and ITC hotels, apart from the existing Science City, Spring Club (Silver Sarcade), and other big hotels, restaurants, and building complexes that have erased the fluid history of the delta city, its swampy, marshy roots, and provided fuel to the new aspirations and desires of the urban gentry at the cost of the survival needs of the multitude who once drew their sustenance from it and also nurtured it.[2]

The official justification of the conversion process is the manifestation of clashing realities between official announcements and proclamations about the need to pursue these projects to meet housing needs, create better environment (with the

[1]Ghosh is quoted in Sarkar (2016) and Bhattacharyya (2018, p. 2).

[2]"These seemingly solid structures are standing on liquid land. Even thirty years ago much of this terrain was wetlands and served as the home to fishermen and farmers. Nineteenth-century colonial officials, but also today's commuters, travelers and inhabitants of the city, are never far from the smell of the salty bogs that flank the deltaic city of Calcutta. Yet the citizens and city's planners too often forget the delta and its salt marshes" (Bhattacharyya 2018, p. 2).

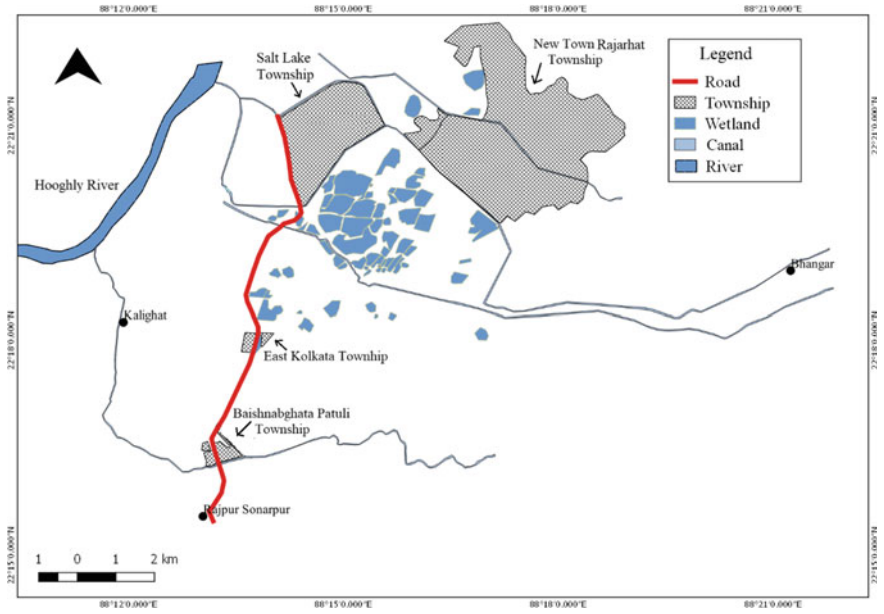
new townships being projected as "environment friendly") and urban infrastructures, generate more employment opportunities on the one hand, and the actualities evident in ecological losses, livelihood uncertainties, and changing institutional and social dynamics making the process of transformation more complex and challenging, on the other. Moreover, lands which were acquired for development purposes, in most cases, were depicted as "vacant," "fallow," and "low yielding," legitimizing policy decisions and processes of annexation that combined "legal instruments, policy-making and physical muscle-flexing in a dispersed way in order to make the 'great transformation' possible" (Dey et al. 2013, p. 116).

While Banerjee (2012, p. 100) is critical of applying the epithet "peri-urban" for the eastern wetlands of Kolkata, arguing that it is deliberately used in official literature in order to be silent on the "kindred ecological relationship between the Bidyadhari wetlands and the Sundarbans ecosystem" and reduce the significance of the vast expanse of these wetlands by concentrating only on the WRR (waste recycling region) so that non-WRR can be ruthlessly converted, yet even within the Ramsar-designated WRR, constant conversions are in vogue. This can be validated from physical observations of land use change in the wetlands in the post-Ramsar (2002) period, different reports and coverage, and protests against these conversions within WRR.[3] A *Times of India* report mentions that

> [t]hough the wetlands enjoy the protection of court orders, legislations and international conventions, there is no real shield on the ground. In the past 10 years, nearly 10 per cent of EKW has been converted into concrete. Another quarter of the wetlands are under threat. Land sharks use an old but ruthlessly effective method of walling up a part of the wetland and dumping tonnes of fly ash, concrete and garbage in the dead of night. Within weeks what was once a thriving *bheri* (fish pond) turns into dry land and the site for the next multi-storey. (Niyogi and Ray 2013)

Out of the 37 *mouza*s, the most threatened *mouza*s are Paschim Chowbhaga, Chowbhaga, Chak Kolar Khal, Kharki, Bhagabanpur, Karimpur, Jagatipota, Ranabhutia, Atghara, Mukundapur, and Thakdari (Mukherjee 2015a). Sector VI or Bantala, comprising offices of IT industries and the Kolkata Leather Complex, has come up entirely on the EKW. The prospect of pursuing other projects is discussed time and again, including the controversy over the recent proposal of flyover construction connecting Sector V and Sector VI. The proposal aimed at reducing travel time and hence arresting the carbon footprint, but at the same time planned the construction of the flyover through the heart of the wetlands. This section sheds light on the four major township projects on Kolkata's eastern periphery and discusses phase-wise execution of these projects, reflecting on the official rationale behind their implementation against the pressing needs of time (Map 6.1).

[3]There is no detailed cartography of land use change in the EKW for public dissemination yet. This is considered by local and Ramsar experts as the most urgent requirement for its protection.



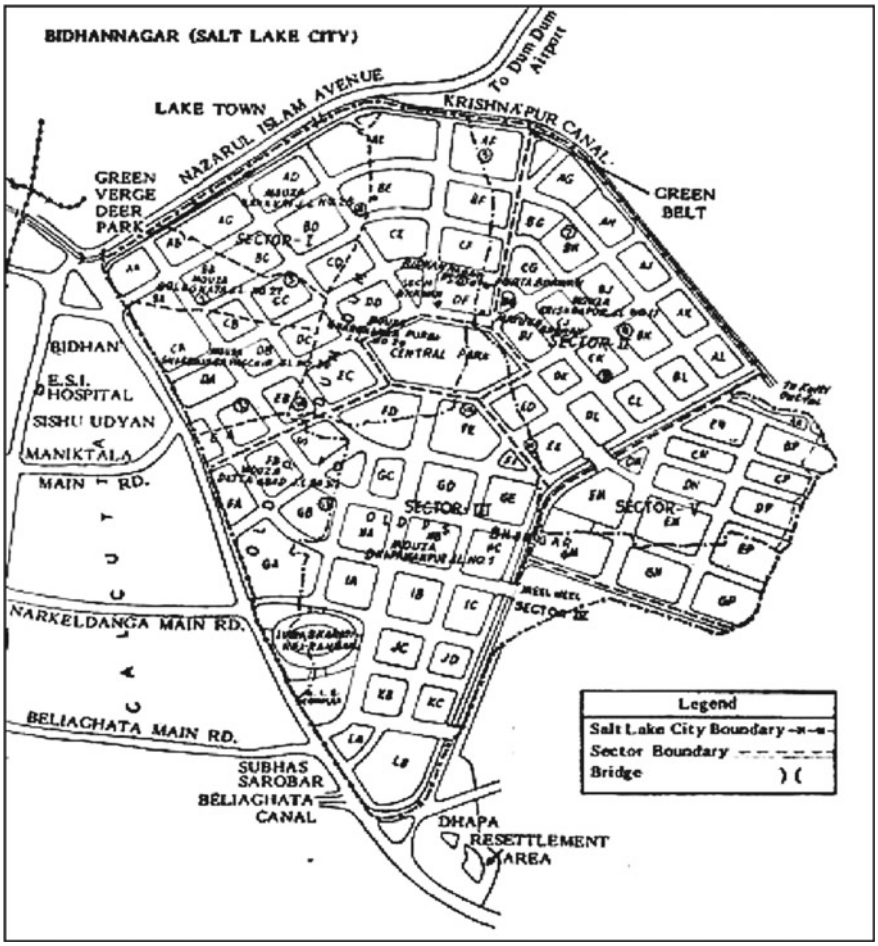
Map 6.1 The four township projects. *Source* Author

6.2.1 Salt Lake Township

The salt water lakes were converted to "neither salt, nor water, nor lake" (Chattopadhyay 1990, p. 108). These saline lakes which never escaped colonial attention, whether in terms of miasma, or as a lucrative space for sewage farming experiments generating pecuniary profits, first witnessed rapid change in their ecological regime from saline to non-saline, making way for EKW in the 1940s. This was followed by complete transformation of the wetlands into estate with the rise of the Salt Lake Township in the 1960s under the aegis of the then chief minister of West Bengal, Dr. Bidhan Chandra Roy (Map 6.2).[4]

"Dr. B. C. Roy dreamed of a 'wonderland,' a cynosure, east of Calcutta. In fulfillment of his dream, he conceived of a project to build a new township" (Chattopadhya 1990, p. 78). But the project execution was more an imminent necessity than a dream, as is evident from the area development strategic plan for this township (KMDA 1976a. The long-drawn discussions around epidemiological issues and drainage questions since the planning and enforcement of the colonial venture of urbanization of Kolkata and the additional and crucial requirements of the immediate post-independence period channelized the materialization of this "dream" project.

[4]The township is also known as Bidhannagar to commemorate Bidhan Chandra Roy.



Map 6.2 The Salt Lake Township. Note: The township is bounded by the EM Bypass in the west, Lake Town in the north, Nazrul Islam Road, the Krishnapur Canal running north-east and north-west, and Dhapa in the south. *Source* KMDA (1976a)

A World Health Organization (WHO) report in 1960 described the outbreak of cholera in the city and its outskirts between 1948 and 1958 (Table 6.1). Along with cholera there were frequent epidemics of dysentery, diarrhea, enteric fevers, etc., with high mortality rates. The insalubrity of the city was attributed to "the thick, stinking vapours of putrefying fish left stranded in the Lake on the dissipation of floods" (Chattopadhyay 1990, p. 87). Moreover, the "effects of the noxious miasma arising from the Lake often proved deadly, it was held to the Calcuttans as well as to the villagers inhabiting the adjoining rural areas" (Chattopadhyay 1990, p. 87).

The post-independence era threw up manifold challenges for the city. Indian independence was accomplished at the cost of partition when the sub-continent was

Table 6.1 Annual cholera attacks and deaths per thousand in Kolkata, 1948–58

Year	Attacks	Deaths
1948	7,947	2,478
1949	5,532	1,482
1950	9,531	4,216
1951	5,694	1,654
1952	3,553	1,356
1953	6,322	2,152
1954	1,524	654
1955	2,650	1,028
1956	2,213	845
1957	1,405	678
1958	4,866	1,747

Source WHO Assignment Report on Water Supply and Sewage Disposal, Greater Calcutta (January 1960), p. 74, cited in Chattopadhyay (1990, p. 87)

divided between India and Pakistan on the basis of contiguous Hindu and Muslim majority populations. It led to the largest influxes of migrants and "left Calcutta reeling as it tried to absorb increasing numbers of refugees" (Bose 2015, p. 80) while it was already struggling to cope with the massive migration triggered by the Bengal famine of 1943 (Sen 1983; Greenough 1983).[5] The city faced an acute housing crisis with the immigrants being forced to settle in "squalid slums, squatter camps, or on any scrap of available pavement" (Rumbach 2014, p. 119). The population of Kolkata skyrocketed between the 1930s and 1960s (Table 6.2). Within this context, the Salt Lake Township was planned to cater to the residential requirements of high-income and middle-income groups (KMDA 1976a). Again, multi-storied structures for sale on a subsidized basis to the lower-income population were also prioritized in the plan.[6] The linear expansion of the city since its inception following the north–south axis seemed to be worrisome for town planners and experts who apprehended increasing service costs like water supply, sanitation, etc., in a city whose length was disproportionate to its width. Thus, Kolkata expanded breadth-wise towards its east by reclaiming its saline marshes "and building a new Calcutta on the reclaimed area" which was intended to be integrated with the existing city (Chattopadhyay 1990, p. 85).

On a diplomatic trip to the Netherlands in 1949, Bidhan Roy was impressed by how the Dutch were able to build cities along the Rhine despite geographical challenges similar to those in Kolkata (Chattopadhyay 1990). With this newfound

[5]In 1943, during the World War II period, Bengal suffered from one of the worst famines where three million people (approx.) lost their lives. War, natural disasters, and exploitative British policies led to the outbreak of this famine.

[6]A certain percentage of plots was earmarked for the high-income group for which a few plots accounting for 7–10 *cottah*s of land was allotted (*Report of the Estimates Committee, 1965–66*, 6th Report, Salt Lake Reclamation, City Extension Project, cited in Chattopadhyay 1990).

Table 6.2 Decadal demographic growth rate of Kolkata, 1911–2011

Year	Demographic growth rate
1911	10.62
1921	3.56
1931	11.35
1941	83.72
1951	25.71
1961	13.57
1971	12.39
1981	11.04
1991	6.61
2001	4.1

Source Compiled from censuses for the relevant years

inspiration and motivation, he returned home and proposed that Kolkata should build a new town on land recovered from the wetlands east of the city (Rumbach 2014) (Map 6.3). In 1951, Ray invited NEDECO (Netherlands Engineering Consultants) to investigate the possibility of drawing up detailed projects for certain zones within the area targeted to be reclaimed (Map 6.3). In 1953, NEDECO visited Kolkata and after studying the feasibility of the project submitted its plan. On January 30, 1953, NEDECO formulated outlines of the reclamation and drainage of northern and southern salt lakes. This preliminary report had seven components: reclaiming about 4 square miles of the northern salt lakes for settlement, reclaiming about 14 square miles of the northern salt lakes by drainage, improvement of Tolly's Nullah, excavation of the water supply reservoir in the southern salt lakes, reclaiming about 12 square miles of the southern salt lakes, raising a part of Tollygunge-Panchannagram and Boichintala, and reclaiming the remaining part of the area (Chattopadhyay 1990).

Though it was fixed that reclamation required massive filling-up mechanisms to raise the elevation of the wetlands up to the level of Kolkata, there was controversy regarding the selection of the method for the filling-up procedure: "cut and fill" or "filling by dredging" from the bed of the Hooghly River. The second hydraulic method was adopted as it seemed cost-effective and less time-consuming. The 3.75 square mile area, i.e., the north-west of the northern part of the salt water lakes, was filled up with sand mixed with water obtained by dredging from the bed of the Hooghly River and pumped into the reclamation area through a 24-in. pipeline via a number of pumping stations. So far as the second part of the project was concerned, i.e., reclamation of the remaining 14.25 square miles, NEDECO proposed the usage of the "polder method" and drainage for reclamation.[7] This area which came to be known as the North Salt Lake Polder was planned for cultivation and horticultural experiments and ventures. In addition, NEDECO proposed the development of

[7]"Polder" implies an area surrounded by an embankment to protect it from higher levels of water outside.

Map 6.3 Reclamation plan for the new Salt Lake Township. *Source* Rumbach (2014, p. 119)

fisheries to be carried out in the southern part of the salt lakes, covering an area of 15 square miles. The detailed proposal was followed by the selection of a Yugoslavian firm (Messrs. Invest Import) which was contracted to reclaim the wetlands "by draining ponds, filling them with sand, and then compacting the soil" (Bose 2015, p. 95). The project execution continued for around seven years and the township was divided along five sectors (Sector I, Sector II, Sector III, Sector IV and Sector V): the first three being earmarked as residential and the last two assigned for industrial and service sectors, the township land being apportioned to serve different purposes (Table 6.3) (KMDA 1976a). The "planned" township rose at the cost of conversion of *bheri*s provoking critical interrogation of the concept of "planning" itself generating urban-environmental repercussions.

6.2.2 *Baishnabghata Patuli and East Calcutta Township*

The Baishnabghata Patuli Township project was undertaken by the Kolkata Metropolitan Development Authority (KMDA) as part of the International Development Association (IDA)-I program in 1973 (KMDA 1978).[8] The KMDA, under its Shelter, Urban Renewal, and Area Development Programme, was responsible for the project execution (KMDA 1976b). One of the official reasons for the implementation of the project was that the land was not very low and required only 1 m of filling. Though the area had a fast demographic growth rate, yet it had very low population density. In order to make "optimal use of land resources" and

[8]The International Development Association (IDA) is a soft loan associate of the World Bank that provides financial assistance (or credit) to developing countries.

Table 6.3 Land use pattern for the planned township

Purpose	Percentage
Residential	50.0
Roads and car parks	23.0
Main greenery (town park 5.1%)	12.1
Education, scientific	2.4
Government, administrative uses	1.3
Social uses	1.9
Trade and business uses	1.2
Industrial uses	3.4
Cooperative developments	2.3
For special uses	0.9

Source KMDA (1976a, Annexure II)

"provide necessary infrastructure facilities," the township project was designed, developed, and executed (KMDA 1976c, p. 1). The housing needs of the people, most importantly from the middle- and lower-income groups, were considered. Hence, along with providing housing facilities, commercial ventures, and industrial units, the project also had provision for group housing sites for cooperatives. Its location on the outskirts, while being well connected to the city, was a major impetus behind the selection of the project site, as is evident in the official records. However, due to "problems of land acquisition and other difficulties," the work was halted for some time (KMDA 1978, p. 1). In 1977, it was suggested that the project should be developed adhering "to the same philosophy as adopted in case of East Calcutta" (KMDA 1978, p. 1). The revised layout plan was discussed with the World Bank Mission in early 1978 with agreed-upon project costs and estimates. In April 1978, a subsequent report based on the preliminary report of January 1976 was prepared by the Planning Directorate and the scheme was formulated (KMDA 1981). Finally, a Housing and Urban Development Corporation (HUDCO) loan was obtained for 104 ha (approx.) and 35 ha (approx.) for pursuing phase I and phase II, respectively, of the project in three major *mouza*s: Briji, Baishnabghata, and Patuli, located within South 24 Parganas. The township spanning 15 km (approx.), surrounded by the railway network of the suburban section of Eastern Railway on the east and Tolly's Nullah on the south, was added to KMC and absorbed under parts of the 101st and 110th municipal wards at the southern fringe of the city. The EM Bypass cuts through the middle of the project area. The area plan had to take cognizance of its presence and attempted to plan the rest of the area in an integrated fashion. The plan was to keep the Baishnabghata Patuli Township and the EM Bypass area functionally integrated but physically separate (KMDA 1976c).

The area development plans proclaimed that the township was expected to grow at a very fast pace "in the vacant fringe" (KMDA 1978, p. 2), "being within easy access from the central business district, with good communication facilities and all necessary infrastructures" (KMDA 1976b, p. 2). Academic research emphasizes its beneficial aspects, pointing out how this "self-contained" township has created a decentralized environment that possesses all the economic and technological

dynamism which is generally associated with the city (Sen 2006). The costs of urban expansion in the form of transformation of infrastructures from wetlands to estates and its multifaceted and interconnected implications for ecology and society do not find any mention either in official documents or in scientific research.[9]

The development plan for East Calcutta was laid out by the Directorate of Planning, KMDA, and presented to the World Bank Mission for inclusion in IDA-II (KMDA 1976d). After brainstorming and exchanges among experts from the World Bank and central and state government officials, the final plan was designed and implemented. The selection of the project area occurred on the ground of providing relief for overcrowding and traffic congestion in core Kolkata, for which planned townships like East Calcutta were the legitimate solution (KMDA 1976d). The selected area stretched from the Beleghata Canal to Garia, surrounded by the EM Bypass on the east and the south suburban section of Eastern Railway on the west and south. It comprised seven wards of KMC (either in part or in full), five non-municipal urban units, and also some *mouza*s of the Jadavpur Police Station and three *mouza*s of the Sonarpur Police Station. The total project area was planned on 3,321.77 ha, 1,266.40 ha falling within KMC. The project implementation followed in two phases: first on the east, and subsequently on the west of the EM Bypass. That the EM Bypass was to be aligned through this area was made clear in the KMDA report (1976d). Low-lying marshy lands were perceived as constraints by KMDA planners who blatantly asserted: "Given the opportunity to overcome these initial constraints, the possibilities of the area are tremendous" (KMDA 1976d, p. 1). Unlike area development plans for Salt Lake Township or Baishnabghata Patuli, the East Calcutta Report clearly unconcealed that the purpose of the project was not only providing housing to low-income groups and middle-income groups, facilitating a socially accommodative mega-urbanization drive, but also to cater to the higher-income groups to whom "land can be sold at high profit margin" (KMDA 1976d, p. 4). Though the report mentioned that existing water bodies were not converted, rather they had been protected for recreational facilities, yet there has been no post-project implementation evaluation and no systematic analyses and interpretations of the nature of "vacant land" that has been converted to make way for the East Calcutta Township.

6.2.3 New Town Rajarhat

The complex processes including land acquisition, politics, and protests that converted the "on the whole a self-reliant 'developed' area" (Dey et al. 2013, p. 6) of

[9]Banerjee (2012), Bose (2015), Mukherjee (2015a), and other works focusing on Kolkata's east-centric urban sprawl mention that townships like East Calcutta and Baishnabghata Patuli have been built on wetlands. Yet, there is no systematic and robust research generating quantitative data and qualitative analysis on the small satellite townships, unlike Salt Lake Township (Chattopadhyay 1990) and New Town Rajarhat (Dey et al. 2013; Kundu 2016b; Karmakar 2013).

Rajarhat into the New Town Rajarhat Township is a colossal chapter in the history of east-centric mega-urbanization of Kolkata, unfolding controversies and catastrophes and provoking questions on urban (environmental) planning adopted within the neoliberal context.

Rajarhat finds mention in the *Bengal District Gazetteer—24 Parganas* as land comprising vast water bodies, saline marshes, and the river Bidyadhari stretching between the sea and the city (O'Malley 1914). It used to be a fertile agricultural area thickly dotted with villages with long histories of settlements, orchards, flower nurseries, and substantial water bodies in the form of wetlands. It had 55 *mouza*s: 15 constituted a municipality and 40 were under the jurisdiction of six panchayats. As per the 2001 Census, while the Rajarhat panchayat area had a population of 1,45,381, the Rajarhat-Gopalpur municipality consisted of 2,71,811 people. The villages were inhabited by farmers and fishers, two-thirds of whom represented marginalized socio-economic groups, either Muslims or Dalits. Though projected as an extension of Kolkata (as all other township projects are understood), "Rajarhat is not connected with Kolkata in any sense" (Dey et al. 2013, p. 9). It is connected with the Salt Lake Township (Sector V) on one side, the Bhangar Rajarhat Area Development Authority (BRADA), another notified area, on the other, and edged by the North 24 Parganas, the estuarine areas of South 24 Parganas (more specifically Bhangar and Haroa), and the Sundarbans. However, the connection between Kolkata and Rajarhat continued in the form of exchange of fresh produce, goods, and services.

Out of these 55 *mouza*s, 25 *mouza*s (amounting to more than 3,500 ha of arable land and fisheries) were notified for acquisition by the West Bengal Housing Infrastructure Development Corporation (WBHIDCO) in 1998 under the Land Acquisition Act of 1894 and the West Bengal Land Requisition and Acquisition Act of 1948. The New Town Project, almost three times the size of the Salt Lake Township, was implemented.[10] Land acquisition was not limited to 25 *mouza*s; 34 *mouza*s across North and South 24 Parganas made way for the development of New Town Rajarhat. Why was the land (which was otherwise "self-reliant") acquired? Dey et al. (2013, p. 8) ask in addition: "Was this the way to break the poverty cycle?… Who would gain and who would lose?" Using rare archival records, Dey et al. unveil that the Rajarhat project fits within the 1960s statist agenda of removing "any buffer between the sea and the metropolis and the villages and metropolis and eat away the entire wetlands on the east" (2013, p. 8), while Kundu (2010, 2016a) and Bose (2013, 2015) in their research show that the making of New Town Rajarhat has to be historically contextualized within the moment of Kolkata's urban transition: the economic decline of the city during the post-independence period and its subsequent attempt at revival during the 1990s as a powerful center in eastern India (Bose 2013, 2015; see also Wang et al. 2010; Kundu 2016a). Like a series of other new towns in developing cities, the New Town Project was also "conceived either as a new residential enclave with job

[10]WBHIDCO is the public sector undertaking that executes planning and development for the project site. It has prepared the Land Use Development Control Plan for the area.

opportunities to create an economic growth pole of IT industry and to ease the increasing pressure of urbanization in megacities or planned as a large-scale gated community with global standard housing and amenities to attract high-income and upwardly mobile population" (Wang et al. 2010, p. 323). It was projected as West Bengal's first "green," "eco-friendly," "self-sufficient," and "smart city" intended for decongesting Kolkata through the creation of a satellite city which would provide housing and planned urban infrastructure across different socio-economic segments of the population (WBHIDCO 1999).

By the early 1990s, the official initiative to create this township was launched. In 1993, while the Department of Housing, GoWB, set up a technical committee to prepare a report on the project, the housing directorate designed a preliminary base map for project execution. This was followed by the preparation of a concept plan by the KMDA in 1994. The task force set up by the housing department, consisting of technical officers of different departments and other experts, advised the modification of the KMDA concept plan. The Department of Architecture and Town Planning, Bengal Engineering Science University, and the director, School of Planning and Architecture, New Delhi, took part in the revision of the plan. Finally, based on this, the Indian Institute of Technology (IIT) Kharagpur developed a plan that made way for the preparation of the first project report. The aim was to come up with an "eco-friendly" city stretching across 2,750 ha including residential areas, industries, commercial areas, and open spaces in the form of green land, water bodies, parks, etc. (Table 6.4). However, this land use plan changed significantly and in the Master Land Use Plan of 1999, the 2,750 ha were increased to 3,075 ha (Table 6.5). A re-revised land use plan increased the area of conversion further to 3,779 ha (Table 6.6) (WBHIDCO 2010). These changing land use plans clearly demonstrate how the provision for large open spaces drastically went down and the residential and related use areas including IT (which were not present in the previous plans at all) went up, manifesting how "the environment-friendly part took a bit of a beating, while the housing rationale was strengthened" (Dey et al. 2013, p. 31).

It was suggested that mixed use patterns instead of exclusive zoning would be followed to encourage coexistence of neighborhoods across divergent income groups. The township heralded the promise of amenities like parks, schools, shopping centers, hospitals, libraries, gyms, etc., for each neighborhood, and access to mass transportation facilities and robust infrastructures and utilities like water sanitation, power supply, gas grid, etc. "This was the ultra-modern imagination that the Left Front government and all those associated with the conceptualization of the New Town brought to bear on Rajarhat project" (Dey et al. 2013, p. 32).

The greatest irony of the project lies in the fact that from the very beginning the state kept claiming that the township was being built on low-lying, marshy land not conducive to agriculture (with a few hectares having low yields). Hence, it would claim neither fertile arable lands nor wetlands, comprising both paddy lands and fisheries (WBHIDCO 1999, 2010). The official claim was made on the basis of the original project report submitted by IIT Kharagpur (considering the inputs of other institutes) that made the astonishing claim that "the project area had no fisheries or *bheris* within its ambit" (GoWB 1995, p. 5). The report mentioned that the "Project

Table 6.4 Land use plan and zoning in Rajarhat as per the first project report

Land use category	Area (ha)	Percentage
Open spaces	1,310	47.6
Residential areas (including internal access roads and local open spaces)	840	30.5
Industries	200	7.3
Commercial areas (including the new business district)	150	5.5
Regional, cultural, educational, and health facilities	30	1.1
Major roads and other transportation facilities (including railway lines and transport terminals)	220	8

Source Compiled from GoWB (1995, pp. 11–18); Dey et al. (2013, p. 30)

Table 6.5 Land use plan and zoning in Rajarhat as per the master land use plan, 1999

Land use category	Area (ha)	Percentage
Large open spaces	860	28
Residential areas	1,555	50.6
Industrial areas	200	6.75
Commercial areas	140	4.6
Educational and cultural institutional areas	20	0.7
Transportation facilities	300	9.8

Source Compiled from WBHIDCO (2010); Dey et al. (2013, p. 30)

Table 6.6 Land use plan and zoning in Rajarhat as per the latest report

Land use category	Area (ha)	Percentage
Large open spaces	903	24
Residential areas	1,466	38
Industrial areas	212	6
Commercial areas	369	10
Educational and cultural institutions	306	8
Transport networks	408	11
Information Technology (IT) hubs	135	4

Source Compiled from FICCI (2006, p. 26); Dey et al. (2013, p. 30)

Area covers 2750 ha of vacant low-yield agricultural land. There is no existing fishery or 'Bhery' or permanent wetland in the Project Area. This is outside the Calcutta Wetland and Waste Recycling Region" (quoted in Dey et al. 2013, pp. 48–49). That this projection was wrong came out sharply through field findings compiled by the Indian Statistical Institute (ISI), Kolkata. Moreover, according to the Geological Survey of India, the geographical coordinates for EKW are 22° 40′ N/22° 25′ N (latitude) and 88° 22′ E/88° 35′ E (longitude), while the coordinates of New Town Rajarhat are 22° 38′ N/22° 34′ N (latitude) and 88° 26′ E/88° 30′ E

(longitude), clearly showing that the project area fell within the circumference of the EKW.[11]

The ISI report exemplified that the areas in and around Rajarhat like Tiljala, Sonarpur, etc., were strongly marked by fishing activities consisting of 60 *bheri*s spread over 653.4 ha. This was also corroborated by the findings of Chaudhuri (1998) based on data from the DoF, GoWB. Chattopadhyay and Majumdar (2002) show that some *mouza*s of Rajarhat—Ghuni, Jatragachi, Thandari, Rekjuani, Mahishbathan, and Mahishgote—conform to wetlands characteristics. They lament that in spite of possessing similar attributes of WRR, some *mouza*s had been left out from the official map (Chattopadhyay and Majumdar 2002). The erasure is deliberate and it "is not an accident if maps of the area (prior to the new town development) are either unavailable or else these maps simply persuade one into thinking that the land was *tabula rasa*," devoid of human settlements and occupational activities (Kundu 2016a, p. 96). The act of "unmapping" enables planners to plan exceptions through the logic of territorial flexibility (Roy 2003). The project received environmental clearance from the Department of Environment (DoE), GoWB. Relaxation of the provisions of the West Bengal Inland Fisheries Act, 1984, and West Bengal Inland Fisheries (Amendment) Act, 1993, was also sought by WBHIDCO for filling up of water bodies for implementing the township project.[12]

6.3 Socio-ecological Implications

The east-centric mega-urbanization drive of the city occurred at the cost of its ecological infrastructures, in the form of wetlands (*bheri*s) and other substantial ecosystem resources like agricultural lands, ponds, orchards, etc. There is no detailed compilation of the exact amount of wetland conversion due to the development of these new townships and development projects on Kolkata's eastern periphery. Yet, studies focusing on particular urban projects like the Salt Lake Township (Chattopadhyay 1990), New Town Rajarhat (Dey et al. 2013), and researches using environmental valuation techniques (Chattopadhyay 2000; Dey and Banerjee 2018) have come up with data, statistics, figures, and interpretations regarding wetland conversions due to the contemporary urban sprawl.

Chattopadhyay (1990, pp. 80–83) provides a detailed list of names and other information about landowners whose lands (including *bheri*s and paddy lands) above 4.5 ha were acquired for constructing the Salt Lake Township. The city extension scheme on the eastern periphery proved to be prejudicial to fish culture, unleashing multilayered interdependent and cyclical socio-ecological repercussions

[11]The project area estimate is available from a report of a technical committee constituted by the state housing department in May 1994 (Basu 2011a).

[12]The clearance occurred in phases: in 1999, 622 ha were granted for project implementation (Action Area I), followed by 740 ha (Action Area II), finally followed by 1,715 ha for part of the remaining land conceived as part of the township in 2003 (Dey et al. 2013).

in the form of reduced ecosystem services and loss of livelihoods. Against these massive implications which were not well chalked out or deliberately not paid much attention, could "Salt Lake Township fulfill the dream of Dr. Roy?" (Chattopadhyay 1990, p. 119). Moreover, the execution of this township project in the 1960s not only "disturbed the ecological balance on both sides of the Eastern By-pass," but also opened avenues for influential land speculators to rapidly urbanize on the entire stretch (Chattopadhyay 1990, p. 111). The Baishnabghata Patuli Township, the East Calcutta Township, and the EM Bypass claimed hectares of wetlands as exposed in different fact-finding studies and academic researches (Chattopadhyay 2002; Gupta 2005).

Chattopadhyay and Majumdar's (2002) study shows that a substantial part of the eastern wetlands were converted, affecting the occupational and livelihood needs of around 17,000 people depending on fishing and vegetable cultivation. On the point of denial of conversion of wetlands in the making of Rajarhat by official authorities, K. Chattopadhyay attests,

> We examined in detail different studies and maps of ECW of the local governments and other agencies. Going through the available reports of various organizations like Ministry of Environment, government of West Bengal; Institute of Wetland Management and Ecological Design (IWMED), we noted certain ambiguities. Most of these ambiguities originated from the very definition of wetlands. (2000, p. 12)

With the coming up of this new township, it was recognized that the waste recycling system would be disrupted leading to entangled challenges like waterlogging in suburbs, economic rehabilitation of the displaced and dispossessed, social unrest, and the lack of supply of fish, vegetables, and crops to the city. But the false official proclamation that no wetlands existed within the project not only disclosed data on wetland conversion (an issue that drew large-scale attention on the part of environmentalists in the 1990s), but was also a deliberate strategy to avoid legal complications. If a piece of land/water is classified as a water body, there are various legislations that can be used to prevent it from being filled up, including the West Bengal Inland Fisheries Act, 1984, the West Bengal Town and Country (Planning and Development) Act, 1979, the Water (Prevention and Control of Pollution) Act, 1974, and the West Bengal Land Reforms Act, 1955.[13] The tenuousness of land–water classification expedites the filling up of water bodies and the creation of new land for the city in urban frontiers and fringes (Roy 2003; Sangameswaran 2018). These changes in the form of loss of ecosystem services and livelihoods were irreversible, and could be addressed but not altered by radical environmental mobilizations and movements.

Today, even within the Ramsar site, rampant unauthorized constructions and commercial ventures continue (Mukherjee 2015a; Mukherjee and Chakraborty 2016), the process being facilitated by definitional ambiguities and porosities surrounding wetlands (land or water bodies) on the one hand, complicating legal

[13]"A Guide to Water Body," *Telegraph*, July 4, 2013, cited in Sangameswaran (2018, p. 15).

enforcement, and a strong nexus among politicians, goons, promoters, *bheri* owners, and real-estate developers on the other (Niyogi and Ray 2014; Sangameswaran 2018).

Though there is an emerging literature on the limits of environmental valuation exercises with researchers critically interrogating the Millennium Ecosystem Assessment (MEA) (2005) framework in general, and ecosystem assessment (including livelihoods provision) in EKW in particular (Sangameswaran 2018), yet, the "environmentalism of the poor" logic still holds the ground for political mobilization to usher in a protectionist regime conducive to both the city and its wider ecological infrastructures in the form of wetlands.[14] That EKW conversion is directly and rapidly causing diminishing returns of (provisioning, regulating, supporting, and cultural) services affecting both wetland dwellers and urban ecology is the major reason why collective consolidation towards its protection has to be crafted and concretized. However, socio-ecological implications of transformed infrastructures on the urban fringe entail complexities and non-linearities evident in diminishing flows and shifting social scenes due to dwindling wetlands, unfolding a wide spectrum of challenges and potentials across coercion and consent with negotiations, perforations, and bargains among old (existing) and new (emerging) stakeholders within the story.[15]

6.3.1 *Dwindling Wetlands, Diminishing Flows*

The EKW provides rich ecosystem services across all four varieties of services categorized under MEA (2005)—provisioning, regulating, supporting, and cultural services—as rigorously compiled by Chattopadhyay (2000) followed by other subsequent researches (Mukherjee and Chattopadhyay 2002; Kundu et al. 2008; Majumdar and Kait 2014; Dey and Banerjee 2018) and the latest reports on the significance of these wetlands in determining Kolkata's climate change (Pal et al. 2016, 2018; Chakraborti 2017). There is ample literature on waste recycling mechanisms prevalent in the EKW that remain the unique selling point for these wetlands, unfolding an array of interconnected ecological and social activities

[14]Dhrubajyoti Ghosh asserts, "Preserving natural resources and ecosystem services can never be a function of economic valuation. The way a mother saves her child, Kolkata residents should save the east Kolkata wetlands" (quoted in Sarkar 2017).

The "environmentalism of the poor" concept was developed by Guha and Martinez-Alier (1997) to show how livelihoods needs are interconnected with ecological protection in the global South as against the "ecology of affluence" paradigm that explains the attitude of the global North towards environmental preservation where nature is perceived as "pristine."

[15]Dey et al.'s (2013, p. 24) argument about Rajarhat, that it is "a surface that is made of miles of wasteland, destroyed topsoil of earth … filled-in ponds, other water bodies, pilfered and acquired land that was previously tilled, vegetable gardens and farms, wetlands, and small village hamlets," holds for the entire stretch of the eastern periphery of the city dotted with township and urban development projects.

surrounding them. By collating official documents on the costs of installation of sewage treatment plants in Garden Reach, Bagha Jatin, etc., Dey and Banerjee (2018) have estimated that the EKW is providing an annual ecological subsidy of INR 4,680.06 million to Kolkata by extending opportunities of natural sewage treatment. The study, on the basis of consideration of the budgetary allocation of KMC on sewerage and drainage in 2012–13 (which was INR 1,693.9 million), clearly establishes that, "In the absence of this support service from EKW, the financial provisions appear utterly inadequate and the opportunity cost of this decay of EKW would be enormous for the city" (Dey and Banerjee 2018, p. 203). Shrinkage in size of the EKW is directly affecting the ecosystem services being offered by this resource with both short-term and sustainable implications for the ecological and economic requirements of the city and the wetlands at large.

In 1960, when 3.75 square miles of the northern salt lakes were acquired, out of 58 *bheri*s, 44 were converted of which 26 were taken over by the Salt Lake City Housing Complex alone (KMDA 1976a). Chattopadhyay (1990) explains that the reduction in number of *bheri*s produced serious repercussions in the fish markets of Kolkata when these were deprived of the required supply of fish at a cheaper rate. There was continuous correspondence and exchanges between WBHIDCO and DoF, DoE, GoWB where the former sought approval to fill wetlands for the construction of New Town Rajarhat. It is recorded that in response to a query from the deputy director, DoF, GoWB, the assistant director of the same department clarified that destabilizing the Rajarhat area would involve risks as the "vast wetlands abound with thousands of tanks,… jheels, bils … swamps, dead river beds, low lying area, doba, etc."[16] Though denied in official plans, there is little doubt about the fact that Rajarhat was in the center of the EKW; the construction of the township converted 60 water farms and 53 kinds of fish fauna including both cultivated and wild varieties (Nandi et al. 1993; Chaudhuri 1998). This is also attested by field findings conducted by the then deputy director, DoF, GoWB, Dr. Madhumita Mukherjee. Mukherjee confirms, "When I joined the department as deputy director, I started a survey in Rajarhat area. The area had a very unique ecosystem with 53 species of fish that bred there naturally" (quoted in Basu 2011a). Thirty-three water bodies were illegally filled up by WBHIDCO without permission from the DoF, GoWB, ranging between 6.05 and 114.95 *cottah*s (Basu 2011b). The average productivity of *bheri*s in Rajarhat has been estimated at 1,982 kilograms per hectare with profit returns of INR 3,900 per 0.5 hectare (approx.) per year. Apart from fish varieties, paddy production expenditure and profitability from the EKW belonging within the project area have been calculated to be INR 7,306 per hectare per year (Chattopadhyay 2000). The loss in terms of vegetable production (including potatoes, cauliflower, carrots, radish, spinach, okra, etc.) is also huge. Annual profitability has been quantified at INR 55,000 for a 1-ha farm (Chattopadhyay 2000). The average annual expenditure, value, and return from a

[16]Memo no. 774 (August 26, 1999) in response to Memo no. 122 (August 26, 1999), cited in Dey et al. (2013, p. 93).

1-ha farm in the EKW in general has been estimated (Table 6.7) along with gross and net revenues from these primary activities (Table 6.8). The EKW biodiversity and faunal diversity are so rich and diverse with manifold utilities that a robust quantitative dataset on the percentage of loss of these services due to wetland conversion is yet to be developed. This becomes more challenging and complicated due to archival silence and cartographic ambiguities overshadowing ground realities.

Apart from fundamental service provisions, other vital regulating and supporting services generated by the wetlands are also at stake due to its continuous shrinkage. There has been a significant loss of avian diversity. Of the 271 species of birds recorded from the wetlands, only 162 species have been variably noted during the last 30 years and out of 109 species of birds that have become locally extinct, the majority fall under the category of aquatic birds (Majumdar and Kait 2014). The most striking is the fall in the population of birds of prey, the top predator in the food chain. K. Chattopadhyay argues that due to the absence of reed beds and loss of plant diversity and biomass, the avian diversity has drastically reduced as "birds are deprived of shelters, nesting site, roosting site and food" (2000, p. 56). Conversely, using data on water birds as a biological indicator, change in wetland habitat has been recently assessed (Bhattacharyya et al. 2008).

As early as the execution of Salt Lake City, it was estimated jointly by KMC officials and environmentalists that while wetlands had generated 99,000 L of oxygen per minute before the coming up of the city, dwindling wetlands resulted in the reduction of oxygen generation to 12,000 L per minute (Mitra 1988). The link between Kolkata's climate future and wetland preservation has come out sharply in the SAFE–IWMI report, which confirms that 53% of the eastern wetlands within the Ramsar area were converted between 2005 and 2015 (Chakraborti 2017). Recent studies conducted by a team of the Chemical Engineering Department, Jadavpur University, revealed that the EKW locks in over 60 percent of carbon

Table 6.7 Average annual expenditure, value, and return from a 1-ha farm at EKW

Item	Total expenditure (in rupees)	Value of produce	Return (in rupees)
Paddy	12,989	20,295	7,306
Fish	35,385	47,180	11,795
Vegetables	70,000	1,25,000	55,000

Source Chattopadhyay (2000, p. 41)

Table 6.8 Generation of gross and net revenues from primary activities at EKW

Item	Gross revenue (in millions of rupees)	Net revenue (in millions of rupees)
Paddy	178.05	17.53
Fish	48.70	44.51
Vegetables	40.00	17.60
Total	266.75	79.64

Source Chattopadhyay (2000, p. 42)

from the wastewater that it receives and, hence, acts as a carbon sink for the city (Pal et al. 2016, 2018). Hence, though protection of the EKW as source of immense ecosystem services is perceived as reductionist, it is significant to explore and quantify these services to concretize the pro-protectionist arguments against tangible outcomes, an approach that is understood by policy makers.

6.3.2 *Shifting Social Scenes*

These township and urban development projects have caused massive displacement and loss of livelihoods, and in most cases with meager to no compensation and rehabilitation packages. The Salt Lake Township displaced 5,000 fishers; though some of the displaced families were given alternative accommodation, yet they were not provided with promised alternative employment opportunities (Chattopadhyay 1990). The New Town Rajarhat Township alone deprived 1,30,000 people of their livelihoods including 17,000 people (approx.) specifically drawing their sustenance from agriculture and piscicultural activities in the wetlands falling within the project area (RJBC 2010; Chattopadhyay 2000). With the continuous conversion of this ecosystem resource, ecosystem-based livelihood practices are under threat. Chattopadhyay and Majumdar (2002) have estimated that in Rajarhat, 47% of people have shifted from fishing and agriculture to informal service sector opportunities. In its master plan, WBHIDCO developed the concept of "service villages" through which residual village pockets were "discursively reinscribed into the new urban landscape … through the trope of integration" (Kundu 2016a, p. 96). Not that every uprooted person could be absorbed in the new services (servants, housekeepers, drivers, cleaners, cooks, etc.), and these also gave them little dignity (Basak 2013; Kundu 2016a). "The farmers, fishermen, vegetable growers and sellers, boatmen, and agricultural labour now robbed of livelihoods all roam around these marginal places, if they are not already serving the newcomers of Rajarhat with domestic labour, transportation, vegetable supply or serving tea and sundry snacks" (Dey et al. 2013, p. 9).

Even within the WRR, vocational switch is prevalent. Following the "time diary method," Dey and Banerjee (2016) have analyzed and assessed the nature and extent of vocational transition in the core wetlands area due to urban growth in the vicinity by identifying the demographic cohort who are still closely attached with these age-old practices.[17] The findings generated from the application of regression techniques expose that due to urban invasion in the fringe of the EKW, newer occupational opportunities have emerged; wetland dwellers no longer perceive

[17]The method involves extraction of relevant information from the "daily account of time" recorded through a time diary.

traditional wetland-dependent vocations as rewarding enough in the long run. The findings also suggest that though changes in the physical topography of the area (like the extent of land use change, the average size of the *bheri*, etc.) triggered vocational switching, socio-demographic factors like age, sex, and the education level of persons play crucial roles in vocational choices (Dey and Banerjee 2016).

Apart from this linear saga of dispossessions, displacement, and loss of livelihoods of existing communities who have been unsettled by this mega march of the urban, the complex production of space has also generated sets of beneficiaries, created new institutional dynamics, and crafted an array of relationships and mediations between different (existing and new) groups inhabiting the newly emerged spaces. Kundu (2016a, b) has studied the relationships, everyday practices, contestations and negotiations that have impinged on the future of peripheries as viable and livable places. Her qualitative analyses through detailed ethnographic research reveal that "villages and gated communities are not bounded spatial entities"; rather, these are "fluid and dynamic places, imbued with heterogeneity and inherent conflicts" (Kundu 2016a, p. 94). New residents occupying flats in New Town Rajarhat perceive it as an untamed frontier, generating both hope and fear, and they have little or no attachment to it. Its unfinished roads, lack of public transport, utilities, and markets appear as confusing and fragmented; the new townships also appear as avenues when newcomers rely on service villagers including service from rag pickers, waste collectors, rickshaw pullers, drinking water providers, etc. Transformed infrastructures have created social infrastructures "capable of facilitating the intersection of socialities so that expanded spaces of economic and cultural operation become available to residents of limited means" (Simone 2004, p. 407). Some evicted families have received compensation with which they have remodeled their houses (often with the purpose of renting these to migrants), opened up grocery shops, other ancillary shops (cable TV, mobile repair, tea, etc.) that have led to changes in the village economy. But as the numbers of beneficiaries are few and as many have received paltry compensation because of owning small landholdings and other political reasons, social and spatial inequalities in the villages have been deepened (Kundu 2016a).

Other emerging social dynamics include the rise of parastatals like WBHIDCO, New Town Kolkata Development Authority, etc., at the cost of panchayati authority and power over decision making relating to land acquisition, construction of infrastructures, and so on. "[T]he entry of new actors and the cobbling together of new constellations of state and non-state actors, bypassing of existing government bodies as well as established networks of local leadership and governments" occupy shifting social scenes in the transforming eastern urban frontier of Kolkata (Kundu 2016b). Young men joining the land transfer and sale market, accompanying the market intermediaries as land scouts, is a common phenomenon along with the prevalence of the politician–promoter nexus and the "syndicate raj" in the EKW, making legal enforcement and monitoring almost impossible against the use of

mafia and muscle power.[18] With the functioning of these goons and scouts, within WRR, new houses have come up where households are engaged in tanning and segregation of waste, etc., and have nothing to do with wastewater ecology, facilitating step-by-step wetland encroachment and conversion. Field investigations demonstrated that most of these households consist of the Muslim population making the issue more complicated as they are potential vote banks for the current party in West Bengal; an eviction drive through demolition of these houses can be projected as violation and infringement of minority rights working against the party's electoral interests.[19]

In the eastern periphery of Kolkata, "fallow lands" have been acquired but not built upon; several residential flats remain unoccupied. The superficial glitter of Kolkata, ostentatiously exhibited through a series of skyscrapers lining the EM Bypass and the giant high-rises in New Town Rajarhat, is gloomy on the inside, not only suffocating from under-coverage of network but also aggressively attracting customers.[20] Moreover, those who live in these high-rises are disconnected from both Kolkata and the adjoining villages, constantly grappling with the threat of conversion by the consumptive city. The "new inner city" remains exterior, looks like a wasteland, and combines virtual production with a new kind of consumption ethic, symbolized by mega malls and colossal industrial and residential complexes where meticulously cultivated social contacts do not seem to be the order of the day. "The simultaneous processes of erasure, displacement and dispossession, of fragmentation and splintering, and integration, imbue spaces with multiple and contradictory meanings that make it difficult to build stable and coherent attachment to place" (Kundu 2016a, pp. 97–98). Transforming infrastructures encapsulate these multilayered realities bearing the irony of constituting "a utopia to financiers and speculators and a dystopia for the urban imagination" (Dey et al. 2013, p. 11).[21]

[18]"Syndicate raj" implies the working of syndicates and influential men (in terms of wealth, political positions, etc.) consisting of a combination of politicians, administrators, police, and criminal strongmen, who have inflicted violence against farmers, fishers, and sharecroppers to exert control over territories, dispense their own justice, and make decisions with respect to life and death (Kundu 2016b).

[19]Field visits and informal onsite conversations conducted in January 2019. The information was later validated through KIIs with *bheri* owners.

[20]Families living in and around Rajarhat face acute drinking water scarcity due to indiscriminate sinking of deep tube-wells and submersible pumps that is also causing rapid ground water depletion. The same is true for the residential complexes and hotels lining the EM Bypass, which was supposed to be covered by the Dhapa Water Treatment Plant. The plant has been inaugurated, but it is yet to become functional with its promised potential and service delivery. The huge extraction of ground water on the delta city's east is a major risk considering its location on the tectonic plate.

[21]Drawing from Benjamin (2008), Kundu (2016b) applies the concept of "perforations" in her study on Rajarhat to analyze the way in which top-down master-planned spaces are challenged and resisted by "occupancy urbanism," a political process through which planned spaces are appropriated in parts by the marginal for their own purposes and interests.

6.4 Coupled Socio-ecological Transformations Concretized

In this chapter, I have chronologically illustrated the emergence and development of development projects in the eastern periphery of Kolkata in the post-independence period, focusing on the four township projects: Salt Lake, Baishnabghata Patuli, East Calcutta Township, and New Town Rajarhat. I have analyzed the official impetus behind the design and execution of these projects by minutely examining area development plans and development project reports. The chapter has also demonstrated how this official rationale is far from the actual reality which is rooted within the larger logic of the consumption city of (neoliberal) capitalist times. While I have described the township projects by accessing the municipal archive, I conducted both archival (and secondary literature) review and ethnography to capture complex social and ecological implications generated by the mega-urbanization process. This chapter has highlighted the diminishing ecosystem flows due to the dwindling of wetlands since 1960s and the social repercussions fostered by the rise of new townships. The narrative is not linear, with a situated political ecological perspective enabling explorations of conflicts, collaborations, negotiations, and bargains among the wide spectrum of beneficiaries and non-beneficiaries who emerged during the urban transition, crafting coupled socio-ecological transformations.

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Chapter 7
Polemics of Planning, Development and Environment

7.1 Incorporating the "Environment" in Urban Planning and Development

Perceptions on "environment" in urban planning have traveled and shifted across changing historical and political realities, as manifested in ideas and designs from "environmental cleanliness" to arrest diseases and death by flushing out filth in 19th-century (Western and colonial) cities, to the pursuit of a "pleasing environment" to restore, beautify, and recreate natural environment in urban spaces in a post-materialist society, to "(urban) environmental planning and management" with urban policy makers desperately trying to incorporate "sustainability" in development programs for the greater good of planet earth and its (urban) inhabitants. Understanding and exploration across spatial scales and lenses—with marked differences and connections between the global North and the global South, the latter aspiring (or being compelled) to adhere to global visions of (urban) "development"—complicate the story altogether with major implications for planetary urbanization at large and local urban contexts loaded with their own specificities.

It was clear by the 1990s that suburbanization and the proliferation of "edge cities" confined to the specific legacies of old-style capitalist industrialization and the cultural predilections of the anti-urban Anglo-Saxon way of life (Harvey 2000) had generated deeper ecological complexities and injustices in terms of increasing ecological footprints and racial discrimination and gentrification rooted in the elitist search for "sanitized" environments (Sugrue 1996; Kruse 2005; Jones and Kammen 2013; Gioielli 2014). However, imposition of the "development" discourse facilitating rapid urbanization (Escobar 1995) in the global South was marked by numerous problems and challenges, including the swelling of slums and squatter settlements, lack of citywide infrastructures for services such as housing, health,

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and sanitation, privatization and commercialization of infrastructures, widening gap between the rich and the poor, and the changing nature of the rural–urban divide (Allen et al. 1999; Davis 2004; Mukherjee 2015).[1]

As a response to the Anthropocene, "sustainability" in general and the concept of "sustainable cities" in particular entered the contemporary urban scene. The Brundtland Report (1987) on "sustainable development" and more specifically Agenda 21 (1992) discussed cities at length, covering a wide range of issues from poverty to consumption patterns and sustainable development to waste (Satterthwaite 1999). Since the late 1980s, several global agencies have been born, prioritizing environmental aspects in urban decision making and management. By the end of the 1990s, the concept of "sustainability" had traveled to the cities of the South under the aegis of development assistance agencies and international–national municipal collaborations.

The constraints in the import of the concept of "sustainability" for urban development in Southern cities became evident immediately. Critics pointed out the limits of these techno-managerial approaches (Hardoy et al. 1992; Satterthwaite 1996, 1999; Mahadevia 2001). While Satterthwaite (1998) has discussed the overall challenges making us aware of the element of greenwashing in these sustainable urban development programs, Mahadevia (2001) has specifically shed light on their negative implications for Indian mega-cities like Chennai, Mumbai, and Kolkata.[2] Recently, "sustainable urbanization" was launched as the post-2015 development agenda of the UN and Sustainable Development Goals (SDGs) were formulated by the United Nations Development Programme (UNDP) in 2016.[3] While "sustainable

[1]"[A]ll of these problems of the advanced capitalist world pale into insignificance compared to the extraordinary dilemmas of developing countries, with the wildly uncontrolled pace of urbanization in Sao Paulo, Mexico City, Cairo, Lagos, Mumbai, Calcutta, Seoul, and now Shanghai and Beijing. On the surface there seems to be something different going on here, even more than just that qualitative shift that comes with the quantitative rapidity and mass of urban growth that has Mexico City or Sao Paulo experiencing in just one generation what London went through in ten and Chicago in three" (Harvey 2000, p. 16). Sachs (1999, p. 92) further elaborates, "After forty years of development … [t]he gap between frontrunners and stragglers has not been bridged; on the contrary it has widened …. The aspiration of catching up has ended in a blunder of planetary proportions. Since 1960, according to the 1996 Human Development Report, the distance between industrial and developing countries with regard to per capita income has tripled …. The world might have developed—but in two opposite directions."

[2]These programs emphasized reduction of resource consumption, local waste absorption, and the use of renewable resources, but did not discuss improvement in service delivery of basic utilities, the most crucial need of developing cities.

[3]Also known as "Global Goals," SDGs succeeded the Millennium Development Goals (including new areas such as climate change, economic inequality, innovation, sustainable consumption, etc.) as a universal call to action to meet the urgent environmental, political, and economic challenges facing the planet. The 17 goals laid out by the UNDP are interconnected, whereby the successful implementation of one will have chain implications for others. https://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html (accessed June 10, 2019); https://www.undp.org/content/undp/en/home/sustainable-development-goals.html (accessed June 10, 2019).

urbanization" considers the urban moment as both imminent and pregnant with opportunities and recognizes cities as the axes for the new global change, as economic forces for entire nations, and as central players on the world stage (UN-Habitat 2012), SDGs echo "sustainable urbanization" in terms of highlighting the significant economic role of cities as they generate about 80% of the global gross domestic product. Like the preceding global discourses and policy prescriptions to make urbanization environment-friendly, SDGs recommend effective investment in and the creation of green public spaces towards improved and inclusive urban planning and management. The UNDP will provide support to governments through partnership with public and private sectors and civil society to integrate the SDGs into the national development plans and policies of particular countries.

The imposition of these global visions, discourses, and models on the Southern nations and the national adherence to these "hi-tech" and "smart" missions manifest their strong political-economic entanglements within the globalized world order. India's urban environmental agendas, plans, and initiatives since independence, during the 1990s, and more importantly contemporary initiatives like Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and the "Smart City Mission," have to be explored and analyzed within this larger global context.

Kolkata's urban fate to a great extent is also being determined by these global visions and national agendas. However, its urban trajectory is also being largely decided by local political aspirations and realities. Bose (2013) traces trends of "bourgeois environmentalism" in Kolkata's contemporary economic and ecological restructuring, arguing,

> Luxury housing complexes, industrial parks devoted to the IT and business process outsourcing sectors, foreign-funded environmental and infrastructure projects and the construction of numerous luxury amenities for the middle classes and elites hold the promise of reintegrating Kolkata into transnational circuits of economy and culture after decades of apparent stagnation. (Bose 2013, p. 127)

Roy (2004, p. 153) claims that more recently the city has engaged in a strategy of urban developmentalism through a "territorial rewriting of the city's edges" in the form of the vast expanse of wetlands. By shedding light on the partnerships between government agencies and transnational corporations, I discuss how Kolkata's environmental infrastructures have been destroyed by the sprouting up of "green" and "eco-friendly" townships on the one hand, the implementation of environmental restoration and beautification projects on the other, and the possible intersections between the two. However, the city's urban environmental conjuncture does not consist of the linear narrative of blind appropriation and imitation of global pathways to "sustainability," as will be validated through the deeper analysis of several plans implemented in the post-independence period that this chapter offers.

7.2 Global Visions

Within the Western context, nuanced explorations of complex equations among urban planning, development, and environment from the mid-19th century to contemporary times have unfurled the evolution of the urban from preoccupations with the "sanitary" to the "sustainable," across compulsions emerging in particular historical conjunctures. Elaborate networks of utilities were designed and implemented as historical responses to specific constructions of problems (Schott 2004). The urban networks which were constructed by manipulating ecological resources portray the imperatives of particular contexts that drove urban planners and engineers to plan and execute accordingly. Responses to considerations of poor environment, like pollution, shaped 19th-century Western urban planning discourses and actions. Epidemiological reasons, explained in terms of the "miasma" theory that provided a direct link between inadequate access to utilities and urban mortality, were instrumental in offering urban planning solutions on piped potable water networks and sewage systems in the European capitals and major cities of the mid-19th century (Hamlin 1998). In this drive towards "sanitary" cities, the latter was conceived as a quasi-organism where "water pipes and sewage systems would act like the body's blood circulation to keep the city functioning and prevent it from being poisoned through its own products" (Schott 2004, p. 522). In the late 19th century, "miasma" was replaced by "bacteriology"; however, the clean urban environmental expedition continued to take material shape in the form of public utilities in the Euro-American world (Melosi 2000). Urban planners, architects, and reformers like Olmstead, Haussmann, Geddes, Ebenezer Howard, Daniel Burnham, Camillo Sitte, Otto Wagner, Garnier, and Raymond Unwin suggested means to reshape cities according to the needs of efficiency and cleanliness (Harvey 2000).

The changing interactions between the urban and the environment from the late 19th to the early 20th century can be explained by the scale of waste generation in rapidly growing urban centers, leading to the collapse of traditional systems of recycling and recovering (domestic and mostly organic) waste on farmlands and gardens near cities. Though these robust water works and sewage systems could conquer diseases, arrest epidemics, and hinder urban mortality rates, the implications for the natural environment were underestimated. The effects on both the input side (water abstraction) and the output side (waste and effluent disposal) were hardly considered, at least for the time being (Luckin 1986). Moreover, consumption was stimulated by urban planners and managers by digressive tariffs, which implied that the more the services were consumed by households, the less the price they had to pay per unit, with severe consequences for urban environment sustainability (Hughes 1983; Schott 2004).

The search for "sustainability" in the post–World War II period can be partly understood as a pursuit of the post-materialist Western society, forging marked differences between the developed global North and the decolonized global South. In the tremendous urge to thrive in better environments, the sprawling Western megalopolises or "edge cities" not only spearheaded endless suburbanization, but

also activated the retreat of the rural with severe socio-economic and ecological implications (Harvey 2000; Gioielli 2014). While the population of Western cities fell remarkably between the 1960s and the 1990s, the world witnessed shifting geographies of urbanization with Asia, Latin America, and Africa as the loci.

The 1990s were a watershed in terms of emphasizing "environment" in the "development" agenda, as evident in the formulation of the "sustainable development" concept in the Brundtland Report of the World Commission on Environment and Development, United Nations, and Agenda 21, the agreement that came out of the Earth Summit held in Rio de Janeiro, Brazil, in 1992 (WCED 1987; UNCED 1992), and the subsequent concept of "sustainable cities" derived from it (Mahadevia 2001; Mukherjee 2018).[4] Urban environmental issues were addressed by global organizations and initiatives like the Urban Environment Forum (UEF), ICLEI (International Council for Local Environmental Initiatives), LIFE (Local Initiative Facility for the Environment), the Sustainable Cities Programme (SCP), the Urban Management Programme, and UN-Habitat II.[5] At the first session of the World Urban Forum convened at the headquarters of the United Nations Human Settlements Programme (UN-Habitat) in 2002 in Nairobi, an in-depth discussion was held on urbanization and sustainable development (UN-Habitat 2002). The ideas were concretized and reaffirmed at the World Summit on Sustainable Development, held in Johannesburg in 2002. These global visions surrounding the conceptualization and popularization of "sustainable cities" focused on the economic and environmental costs of urbanization and urban development, self-reliance in terms of resource production and waste absorption, compact and energy-efficient urban spaces, etc. (Haughton 1997). These entailed the integration of four pillars: social development, economic development, environmental management, and urban governance (Fig. 7.1).

In the meanwhile, various other global visions and urban discourses and models flooded the scene, ranging from "compact cities" to "ubiquitous (U)-eco-cities" to "smart cities." Glaesarian "high density cities" (Glaesar 2008) can be understood as an advanced version of the "compact cities" concept formulated by George Dantzig and Thomas Saaty in 1973, which became popular in the 1990s backlash against post-war urban planning, negatively impacting economy and ecology. Scheurer (2007) summarizes the criteria for "compact cities": these should encompass a minimum density ranging from 40 to 80 residential units per net hectare and promote multifunctional land use to forge and retain compactness, ensuring social

[4]The most substantive international document relating to sustainable cities was formally endorsed by all the government officials attending the Rio Earth Summit. Many of its 40 chapters were highly relevant to cities, especially those covering themes from poverty to consumption patterns, sustainable development to waste (Satterthwaite 1999, p. 15).

[5]The Habitat Agenda, adopted by the United Nations Conference on Human Settlements (Habitat II), held in Istanbul from June 3 to 14, 1996, echoed the concerns expressed in Agenda 21 with respect to the multidimensionality of development, and discussed urban sustainability as requiring a harmonious integration of economic, social, and environmental issues. https://www.un.org/en/events/pastevents/pdfs/habitat_agenda.pdf (accessed June 19, 2019).

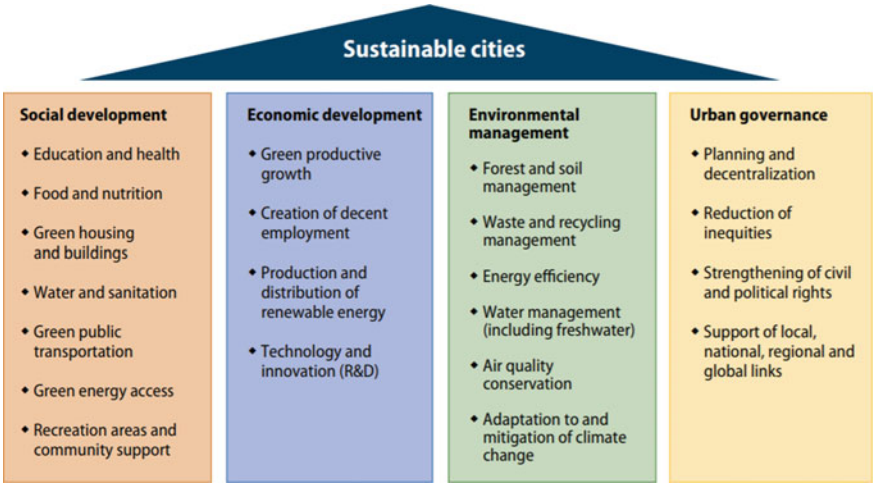

Fig. 7.1 The four pillars to make cities "sustainable". *Source* UN WESS (2013)

cohesion through decreased motorization. The aim of the "compact city" is to shorten the car trip by increasing the densities and employing mixed use in urban patterns (Dujardin et al. 2014; Howley et al. 2009; Lau 2013). Similarly, "smart cities" superseded the "U-eco-city" concept based on the idea of a built environment where any citizen can use any service anywhere and anytime through ICT (information and communications technology) devices. The "cyborg city" is another example of urban development in response to the spread of new information technologies. Michael Burke, director of the film *Cyborg City* (1998), describes a humming mass of technology beneath the glass and concrete of the future city acting as a central nervous system, constantly monitoring and controlling both its own functions and those of its citizens (Burke 1998).

While the plethora of exciting ideas and initiatives attempted to spearhead innovative solutions, yet, in terms of actual outcomes against the scale and urgency of contemporary urbanization challenges, the triumphant tale of global urban environmental paradigms and policies appeared to be a bubble. This was sharply manifested in the remark made by UN Secretary General Ban Ki Moon in the Foreword to the 2009 UN-Habitat report: "*Planning Sustainable Cities: Global Report on Human Settlements 2009* looks at the widespread failure to meet the needs of the majority of urban inhabitants, especially those in the rapidly growing and predominantly poor cities of the developing world, and identifies ways to reform urban planning" (UN-Habitat 2009). The limitations ingrained in technocratic prescriptions surrounding "hi-tech," "green," and "eco-friendly" cities were soon realized within both "developed" and "developing" contexts (Hassan and Lee 2015).

7.3 National Agendas

Planning Indian cities during the immediate post-independence period (1947–1960s) appeared to be on the priority list of the national agenda as part of the larger drive to achieve "development" in the decolonized context. The importance of "environment" followed by its incorporation in urban planning and development projects was not yet prominent as (nationalist) economic priorities deciding "continuity" or "discontinuity" from the previous long era of colonial bondage occupied the scene. During the 1950s, India focused on the construction of "planned cities" where city master plans and regional planning were accorded prime importance. "Planned cities" like Bhubaneswar (Orissa), Chandigarh (Punjab), and Gandhinagar (Gujarat) emerged as symbols of modern India and icons of India's freedom, unfettered by traditions of the past (Shaw 2009; Das and Choudhary 2019).[6] By 1971, 112 new towns had been built, a large number of which came up in the 1950s and early 1960s, coinciding with the period of India's early and rapid industrialization (Sivaramakrishnan 1976–77). The construction of several cities was linked to the location of heavy industries and power projects, including the steel towns of Bhailainagar-Drug, Bhadravati, Durgapur, and Rourkela (Manickam et al. 1962). Again, townships like Kalyani (West Bengal) were planned to relieve the core city (Kolkata) from its unmanageably increasing population determined by different factors including post-partition refugee influx and migration of people from the hinterland in search of employment opportunities in the era of economic and political tussle and turmoil. Though Shaw (2009, pp. 876–877) considers the immediate post-colonial phase of urban planning noteworthy as it left behind a "rich legacy of new towns and urban developmental institutions" where newly emerging cities were built fairly rapidly "to absorb some of the burden of the refugee crisis and the mushrooming urban population," for Das and Choudhary (2019, p. 225), Nehruvian urban planning could not cope with the increasing social, political, and economic complexities of the nation and its growing population leading to "a lack of planning ideals, infrastructure improvements, and development of more planned cities." The city-centric policies adopted during the 1950s and 1960s seemed problematic due to the deteriorating conditions of existing cities and ascending number of slums and squatter settlements.

The focus on high modernism continued. The National Commission on Urbanization in 1988 identified 320 cities as generators of economic momentum that were further categorized into state and national priority centers. During the 1990s, the Indian city-centric economy got hooked to global visions, initiatives, and enterprises with neoliberal economic reforms and cultural agendas empowering cities, ostensibly facilitating an influx of technocratic designs and transnational capital. With the notion of "sustainability" gaining ground, cities had to strike the

[6]Bhubaneswar was one of the first of the new capitals in independent India with Nehru laying its foundation on April 13, 1948.

balance between rapid economic growth and ecological considerations. The National Institute of Urban Affairs (NIUA) report (1998, p. xiii) observed,

> In the era of economic reforms, liberalization and globalization, cities and towns are emerging as centres of domestic and international investment. Within this framework, urban development policy calls for an approach that aims to optimize the productive advantages of cities and towns, while at the same time minimize or mitigate the negative impacts of urbanization.

India began implementing its structural adjustment programs in 1991, leading to privatization of urban infrastructures with cities vying to attract global investments. The opening of the Mumbai–Pune Expressway in 1993, and the ascription to Hyderabad of the nickname "Cyberabad" in the late 1990s, can be considered as instances of the process (Mahadevia 2001; Das and Choudhary 2019). Chennai, Hyderabad, Bengaluru, Delhi, and Kolkata joined the Sustainable Cities Programme initiative involving the efforts of city governments to produce "economically efficient, socially equitable and environmentally sustainable" cities (NIUA 1998, p. xiii). As part of the sustainable cities umbrella program, "environmental planning and management" exercises were carried out in the metropolises for city-level infrastructures. It is within this context of Kolkata's being a member of the Urban Environment Forum that the Calcutta Environment Management Strategy Action Plan (CEMSAP) was prepared with financial support from the British Overseas Development Agency. The World Bank has been a leading provider of loans in promoting urban infrastructure projects since the 1970s; the Asian Development Bank (ADB) made its entry in the 1990s to provide financial support and technical assistance.

In 2005, the Ministry of Urban Development under the regime of the then United Progressive Alliance (UPA) government launched JNNURM to improve quality of life and environment in cities. Though the 74th constitutional amendment adopted by the Indian Parliament in 1992 provided greater autonomy to urban local bodies (ULBs) which were expected to generate funds, prioritize needs, and take action on the basis of local needs within the neoliberal context of being global, yet several ULBs lacked financial resources to perform these tasks (Roy and Ong 2011; Choudhary 2019). The JNNURM initiative was introduced to provide financial support to ULBs to enable cities to renew services like water and sanitation. In the first phase, 63 cities were selected for support to be routed through existing ULBs. Critics have identified the substantial gap between official claims and the actual realities achieved under the mission, recognizing it as an instrument to promote a completely market-driven urban development process (Batra 2007) with provisions for the rich to invest (Searle 2010; Choudhary 2019). Private investments and the real-estate market received a fresh lease of life with the 2005 special economic zone policy that made large tracts of land available for real-estate projects by providing considerable incentives to both developers and industry.

At the stage of design of JNNURM itself, there was strong apprehension that it would lead to exclusion of the poor and capture of urban space by urban elite (Mahadevia 2006). Focusing on Mumbai, Banerjee-Guha (2009) argues that the

JNNURM had become an official carrier of the neoliberal agenda. Plans under JNNURM offered same-size-fits-all solutions with absolute disregard for local needs. The program not only failed to study variations in the existing infrastructure of different cities, but categories identified for land use classification were uniform across the cities covered under it. "The assumption that all these cities, located in different geographies, would have the same geographical conditions is preposterous" (Choudhary 2019, p. 2). It paved the way for what Choudhary (2019) calls "project-based urbanism" giving rise to the creation of an "exclusionary city."

With the threat of climate change looming large, specific programs and institutions were launched by the Indian government to strategize adaptation. The National Mission for Sustainable Habitat (2010), one of the eight missions under the National Action Plan for Climate Change, was approved to integrate adaptation into urban planning processes at the national, regional, and city levels, finally reorienting urban planning in the light of climate change. Its major objectives included improving disaster responsiveness, bringing together multiple stakeholders from national to local levels for coordinated and systematic responses to climate change vulnerabilities, and promoting and strengthening efforts aimed at awareness generation related to climate change. However, though the mission proposed specific adaptation interventions organized sectorally (water resource management, urban storm water management, coastal zone management, etc.), yet more robust planning frameworks are required to articulate the institutional linkages between sectoral agencies such as water, transport, sanitation, and housing (Sharma and Tomar 2010).

In 2012, the government announced that "smart cities" shall be a part of JNNURM Phase II. However, with JNNURM taking a back seat after the replacement of the UPA by the National Democratic Alliance (NDA) government, the latter made a fresh announcement in 2014 of creating 100 smart cities in the country as one of its flagship projects, for which it laid out an amount of INR 480 billion to be disbursed to the ULBs at frequent intervals in the five years between 2015 and 2020. The INR 70.6 billion earmarked in the 2014 budget was dramatically enhanced to INR 480 billion in the budget of 2015 (Shaw 2018). The AMRUT initiative was also floated with well-laid-out urban environmental plans like ensuring water-sanitation-sewerage facilities for all, construction and maintenance of open, green spaces, encouragement of non-motorized transport, etc. The Smart Cities Mission, AMRUT, and Housing for All were launched together to optimize overlapping urban environmental requirements. During the same time, in January 2015, the National Heritage City Development and Augmentation Yojana (HRIDAY) scheme was also launched by the Ministry of Housing and Urban Affairs, Government of India, which identified 12 heritage cities for development against a total outlay of INR 500 crore.

The ICT industry and corporate giants have identified "smart cities" as a promising new line, and invested in intra-industry advocacy by building platforms like the Smart Cities Council and spun new slogans like "smart is the new green," i.e., smart is sustainable (Burte 2014; Smart Cities Council 2014). But a stormy upsurge has swept Indian academic circles and experts are rigorously questioning

the relevance, feasibility, and sustainability of the mission. Opponents warn that with the implementation of this "21st century utopian urban experiment" of India, the competition it would entail among cities would be severe in economic terms and social polarization across Indian cities would accentuate with far greater intensity than has been estimated (Datta 2014). "Smart cities are proposed as isolated satellite cities of the 'neo-middle class,'" which implies clearly "a class-based spatial categorisation of populations: world class urbanism of smart cities for the upper classes and the creaky old urbanism of existing cities for the creaky old middle and lower classes" (Burte 2014, p. 24). Many experts also fear that these smart cities would not only prove dystopic and inequitable, but may turn into social apartheid. Having islands of well-serviced smart cities amidst a vast sea of poorly serviced and impoverished villages would lead to the juxtaposition of the citadel and ghetto, and these visible forms of spatial inequalities would engender social mistrust and violence (Ravindran 2015).

The current context provokes us to move beyond the binary analysis surrounding urbanization challenges and opportunities across the global North and global South towards a more polycentric approach of delving deep into local realities and micro-political urban planning processes and development designs across particular Indian cities. This can then enable us to unpack the embeddedness of the global, national, and local dynamics in which the city-specific stories of urban sustainability are rooted.

7.4 Local Realities

Like its other Indian counterparts, the megacity of Kolkata is "simultaneously global and intensely local" (Bose 2015, p. 109). "[D]evelopment and evictions, reclamations and resistance, planning and politics are as old as the city itself. It has been undergoing periodic bursts of 'renewal' and 'revitalization' almost from the moment of its inception as a British colonial site" (Bose 2013, p. 130). Reflecting on the characteristics of colonial urbanization in Kolkata, Raza and Habeeb (1991, p. 49) reiterate the point, arguing:

> The patterns and processes of urbanization in the developing world have been so strongly stamped by their colonial history that the contemporary reality cannot be properly understood without an analysis of the factors that were induced in the system during the colonial period to meet the requirements of imperialist exploitation.

A three-stage model has been suggested for the economic and urban development of Kolkata (and also some other cities of India), characterized by distinct modes and relations of production and investment, policy and goals, and also distinct spatial forms. The stages are: colonial economy during the first global period, a post-colonial (or command) economy during the nationalist period, and a post-command/reform economy during the second global period (Chakravorty 2000, pp. 56–77). Like many other port cities, Kolkata was created and colonized

for colonial extraction and profit, to act as a point of trans-shipment of commodities and a market for processed goods, and as a seat of administration. The urban layout and structure absolutely suited colonial needs and interests. As the main basis of the city was export trade, it was elaborately and inextricably connected and linked with Bengal and other parts of eastern India by arteries of communication including canals and railways. Urbanization was externally imposed to meet the needs of the colonial economy, "delinked from the developments in the rural areas"; a "colonially-induced urbanization … without roots" (Dasgupta 1987, p. 278). While Kolkata grew as a port city and administrative center, the rest of Bengal remained backward, agrarian based, and neglected. The population remained highly concentrated in Kolkata and its periphery (Dasgupta 1987, p. 279). In the immediate post-colonial nationalist phase, "development" as opposed to exploitation and extraction became predominant, with key ideas like import substitution, infant industry protection, balanced growth, and self-sufficiency dominating the scene. In the present stage, like most of its "developing" counterparts, Kolkata has been reconnected to the global market following the failure of imports-substituting industrialization in the South and the demand for new markets and production centers in the North (Chakravorty 2000, pp. 56–77).

That urban planning and development goals directly connected to economic regeneration and rejuvenation were vital for Kolkata during the post-independence period came out prominently in the remark made by Nehru: "Calcutta is the biggest city in the country. Its problems are national problems—quite apart from problems of West Bengal, and it is necessary that something special should be done. If the whole city went to pieces, it would be a tremendous tragedy" (cited in CMPO 1966, p. ix). Urbanization came to be recognized as an important aspect of economic and social development processes "for the first time" in the Third Five Year Plan 1961–66.[7] The Basic Development Plan (BDP) (1966) for Kolkata can be considered as the first comprehensive metropolitan plan that laid out a 20-year perspective, taking into account the significance of the metropolis for the region in which it was located, the demands on civic services, and the existing state of utilities: water-sanitation services, shelter, etc. In view of the outbreak of the cholera epidemic in 1958, tackling the insalubrious environment shaped the urban planning discourse and the development vision, as manifested in measures suggested in the BDP but also previously by a WHO team. Augmenting continuous filtered water supply, stopping the supply of unfiltered water, cleaning of the river Hooghly to check pollution load, and extension of the main sewerage collection up to the points of final treatment and disposal were considered as urgent requirements to be immediately executed. In 1960, the World Bank also suggested recommendations

[7]Five-year plans are centralized national economic programs which Nehru launched in 1951 under the socialist influence of Soviet Russia.

Earlier attempts involving state agencies in urban development include the formation of the Delhi Development Authority in 1955 followed by the formation of the Delhi Master Plan in 1962 which was "no more than a blueprint for land use along with some prescriptions for 'zoning and sub-division regulation' to control land use" (Bagchi 1987, p. 597).

on similar lines that concretized the need for the design and implementation of a master plan for water supply, sewerage, and drainage on a priority basis. Within this context, the Ford Foundation on the request and under the aegis of GoWB, came up with the first blueprint for Kolkata's development during the post-independence period. The Calcutta Metropolitan Planning Organization (CMPO) was also set up "to present a coherent and carefully thought out prospectus for the regeneration and development of the Calcutta Metropolitan District" (CMPO 1966, Foreword). The BDP consisted of two comprehensive plans: the master plan for water supply, sewerage, drainage, and sanitation (1966–2001) prepared for the WHO by consultants from the UN Special Fund, and the Traffic and Transportation Plan for the Calcutta Metropolitan District 1966–86 prepared by the CMPO.

The BDP advocated a bi-nodal strategy for the development of the Calcutta Metropolitan District by focusing on governmental actions on the two centers—Kolkata–Howrah and Kalyani–Bansberia—where the latter would act as a counter-magnet to Kolkata. The linear model of growth was considered appropriate as it discouraged daily commuting between the planned area and the metropolitan center; the load thrust on the center's roads, utilities, and other infrastructure was expected to be considerably less if growth was to be encouraged on the immediate outskirts of the center (CMPO 1966). The BDP not only highlighted the urgency of getting access to adequate and safe potable water, sewerage, drainage, and refuse disposal, but also incorporated detailed action plans for providing shelter to pavement dwellers, improvement of slums, arresting deterioration in traffic and transportation, better use of existing capacity in manufacturing, metropolitan street traffic, and water supply systems. Still it suffered from the dilemma of an "all or nothing" approach and attempts to investigate the viability of low-cost alternatives and solutions especially relating to utilities were not made. Unfortunately, though the plan was launched in 1969, it did not see the light of day due to an economic emergency prevailing throughout the country (Mukherjee 2010), and it was unmistakably "finance which hogged the progress of BDP right from its inception" (Bagchi 1987, p. 599). However, one notable development on the BDP recommendation was the creation of the Calcutta Metropolitan Water and Sanitation Authority in 1966 which functioned as the project implementing agency of the state government at the beginning and of the KMDA thereafter.

Bose (2013) has identified elements of "proto-neoliberalism" in BDP, echoing Banerjee's (2005) apprehension that the decision to bring in Ford Foundation experts was (at least in part) to forestall the rising power of the communist (CPI[M]) government. However, while doing a detailed post-mortem of the plan on its 20th anniversary, Bagchi (1987, p. 597) argues that what

> distinguished the BDP from a "master plan" was its approach to planning for urban development as a positive, integrated package designed to strengthen not only the civic infrastructure but also the economic base of the city rather than viewing the task as a "single shot exercise" confined to working out the contours of future land use with only a regulatory role for the local government.

The BDP identified the existence of perennial marshes and swamps on the eastern part of the city as a constraint on large-scale urban development on the eastern periphery. However, it was optimistic about the emergence of the Salt Lake Township and the functions that would be performed by the EM Bypass once it was completed. According to the BDP, "The cost of providing utilities and the cost of land improvements (on the east) are relatively high but this is outweighed by the area's advantages. It is appropriate for low-income housing and open-plot development" (CMPO 1966, p. 65). A series of urban plans since the 1970s have violated and replaced the BDP-advocated bi-nodal (north–south axial expansion of the city) strategy with polycentric development that spearheaded mega-development and township projects reclaiming Kolkata's ecological infrastructures on the east with severe socio-ecological costs and implications.

In September 1970, the Calcutta (now Kolkata) Metropolitan Development Authority was formed with an allocation of INR 150 crore for the programs under it for the next five years, followed by the setting up of the KMDA Directorate of Planning. In 1976, under the initiative of the Directorate of Planning, the Development Perspective Plan (DPP) was published focusing on crucial issues like urban expansion, economic activities, and employment infrastructures, and the evident overlaps among these. The DPP initially came up with a five-year investment plan covering the period from 1977 to 1982 (revised to 1979–1983) with a fiscal outlay of INR 278 crore (KMDA 1976). Recommending the polycentric development of Kolkata, DPP emphasized east–west spatial growth with major area development projects including East Kolkata, Baishnabghata Patuli, and West Howrah. It attracted private investments for implementing these projects capitalizing on the development of commercial complexes, heavy investment laden housing infrastructures, and markets facilitating commodification of Kolkata's eastern wetlands (Mukherjee 2010). The KMDA explored the possibility of obtaining financial assistance from HUDCO, Government of India, and other transnational agencies. In 1973, the IDA provided financial assistance for 44 out of 100 ongoing schemes under KMDA over a three-to-four year period (KMDA 1976). The credit package amounted to US$35 million; IDA-I marked the beginning of a series of such credits for the development of Kolkata (Roy and Roy 1990). The KMDA outlay also covered the World Bank assistance of US$87 million for the execution of a package of projects under IDA-II (Roy and Roy 1990). Though in the subsequent period, out of a total outlay of INR 278 crore, central assistance was no more than INR 17.55 crore, yet the certainty of financial assurance and flows increased compared to before, and also a semblance of capital budget appeared on the scene to meet the IDA requirements (Bagchi 1987).

The DPP was followed by the Perspective Structure Plan in 1981, formulated under the West Bengal Urban Development Strategy Committee set up in 1980. It was a continuation of the DPP, promoting a decentralized system for urban development in order to lighten the pressures on core Kolkata. Meanwhile, the Calcutta Urban Development Programmes (CUDP I, II, and III) were launched to

implement projects pursuing the sectoral components of the BDP following the creation of the Calcutta Urban Development Project as a separate head in the plan budget of the state during the early 1970s.

The prominence of the "environment" and its more direct incorporation in urban planning are evident in a series of government plans and reports since the 1990s. Meanwhile, in 1982, the West Bengal Town and Country Planning (T&CP) Act, 1979, became effective. As per its provisions, KMDA was statutorily obliged to prepare land use maps and registers and a Land Use Development Control Plan for carrying out development control functions. The Perspective Plan for Calcutta 2011 was clearly vocal about the impact of urbanization on environment, and was optimistic about the passage of the T&CP Act as it provided the opportunity for developing and executing "specific development programmes for orderly growth of any area with legal support" (KMDA 1990, p. 197). Chapter 5 of the plan dedicated to "Environment" reflected that the present land use pattern "appears to be most crucial and to be properly identified before embarking upon any definite policy model" (KMDA 1990, p. 197). That urban development should not violate but abide by the central government acts relating to environmental management and ecological balance was emphasized.[8] Pollution abatement in the river Hooghly drew the planners' concern and the plan assured that the importance of wetlands existing in the metropolitan region had been "recognised partially and awareness [had] already been created amongst the scientists and planners while designing urban framework" (KMDA 1990, p. 203). Not only was the importance of proper identification of wetlands emphasized, but additional areas within the metropolitan region of Kolkata bearing wetlands characteristics and attributes were recognized.[9] The plan finally suggested a series of recommendations for environmental protection of the urban, including the preparation of a land use map projecting detailed geographical and geotechnical data and information, formation of an Environmental Planning Authority for the entire metropolitan region at the earliest, and augmentation of sewerage and drainage pumping stations and repair, renovation, and maintenance of existing drainage canals and conduits.

Meanwhile, the Urban Development Strategy for West Bengal was prepared in 1994 and the Calcutta Megacity Programme (1994) evolved as an integral part of this report. This program also laid emphasis on "Environment and Conservation" and indicated that "development projects should be environmentally sound, otherwise it will not be possible to sustain the development" (KMDA 1994, p. 4). The plan had provisions for the conservation of nature, the wetland, and wild life to maintain ecological balance, conservation of greeneries, parks and public open spaces and waterfronts along the river, canals and lakes, etc. It highlighted the need

[8]The acts include: the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Indian Forest Act, 1983, and the Environment (Protection) Act, 1986.

[9]These included: Garden Reach (2.5 ha approx.), Santragachi (2.5 ha approx.), Barati Beel (325 ha approx.), Dankuni (12 ha approx.), Beel-Baba-Chandi (300 ha approx.), and Sonarpur-Samunkpota (78 ha approx.).

for systematic exploration of "environmental impact assessment with environmental mapping ascertaining the cases of conflict and thereafter designing the alternative measures for remedy along with determination of priorities" (KMDA 1994, p. 14). The drainage and sanitation projects included in the program comprised a new separate outfall channel leading to the Kulti River and restoration of existing outfall channels (Bagjola-Krishnapur-Bhangarkata, Circular and Beleghata, Tolly's Nullah, Manikhali, and Churial) to increase their hydraulic capacity and also construction of a new pumping station at Manicktala and renovation of existing pumping stations and old sewers. The plan clearly stated that in the development control regulation, filling up of wetlands all over the metropolitan area was strictly prohibited (KMDA 1994).

With the argument and realization that unplanned urban expansion may cause permanent damage to the environment, the Plan for Metropolitan Development, 1990–2015, advocated for the conservation of nature to maintain ecological balance and prevent environmental degradation (KMDA 1990). It specified that conservation of nature implied wetlands, marshes, swamps, orchards, and agricultural lands "which are required from planning point of view to be maintained as green areas" along with the riverfront areas, canal banks, and community open spaces (KMDA 1990, pp. 6–4). In its "Future Land Use" section, the plan clearly demonstrated that wetlands and large water bodies should be preserved and no change of use of such land would be permitted (KMDA 1990). A shift in emphasis from employment opportunities and survival needs especially to address urban poverty and equity to environment (and ecological luxury pursuits) is discernible in the 1990 plan: "The development on existing water fronts, along the river Hooghly, canals and lakes, shall be controlled so that these areas may provide recreation facilities for the people and may offer environmentally pleasing areas" (KMDA 1990, pp. 6–7).

The DoE, GoWB, assisted by ODA, UK, launched CEMSAP in 1997 "to present the current status, threats and weaknesses, potentials and options on one of the vital component of Natural Resources of Calcutta Metropolitan Area" (CEMSAP 1997, Foreword). It aimed at supporting institutional strengthening and coordination across all sectors relevant to environmental management to reconcile pro-development and pro-environment goals and develop the means to introduce stronger environmental decision-making processes at all levels.[10] Emerging out of pressures for change by NGOs and activists, CEMSAP created a window of opportunity for new civic and commercial partnerships surrounding environmental improvement (Mukherjee 2010).[11] Recognizing planning weaknesses, lack of willingness and ability to enforce regulation, and service deficiencies due to inadequate mobilization of resources, CEMSAP identified that environmental problems emerge not simply because of environmental pressures but crucially, how

[10]CEMSAP, http://wbenvironment.nic.in/html/CEMSEP/index.htm (accessed August 23, 2009).

[11]The origins of the program can also be traced in the national policy agenda outlined in the Environmental Action Programme (1993), Government of India, and planning priorities identified by the Ministry of Urban Affairs and Employment, Department of Urban Development, and Ministry of Environment and Forests.

these are managed by the responsible institutions.[12] It had a great vision, a naive mission, and a hopeful promise for the city's ecological renewal through the creation of the right incentive structure and investment program to encourage enhanced wealth creation, social justice, and sound environmental management (Mukherjee 2010).

In March 1997, CEMSAP published the *Management of East Calcutta Wetland and Canal System* report, where it projected the importance of understanding the city and its hinterland as an integrated and interdependent scape of associated riverine systems. The committee also assessed the impact of changing land use and demographic profile with larger implications for urban sustainability. The canal systems of the city and its wetlands were studied as a composite system to suggest mitigation measures and actions. Though the committee reflected that the "multi-functional canals present a picture of tragedy of commons," it was optimistic that these also "offer great potentials" (CEMSAP 1997, Foreword). The participatory planning approach involving citizens at large was followed where CEMSAP could mobilize NGO participation in preparing its report. Relevant information and data from various organizations, like the National Atlas and Thematic Mapping Organization, Institute of Wetland Management and Ecological Design (IWMED), State Remote Sensing Unit of Department of Science and Technology, etc., were extracted and meetings with officials of KMC, KMDA, and I&WD were conducted. The detailed assessment on "natural resources" also necessitated extensive field surveys and analysis of samples which was pursued by the project committee. The adoption of a robust methodology was followed by detailed projection and assessment relating to urban drainage-sewerage, solid waste management, canal functioning and restoration, etc., where CEMSAP could effectively bring out the cyclical and reciprocal interlinkages between land use change and urban sustainability.

The CEMSAP report clearly mentioned EIA as a pre-requisite for all development projects planned on the eastern periphery of the city, and it considered it essential "in view of the fragile nature of this ecosystem" which had been declared as a wetland of national importance by then (CEMSAP 1997, p. vii). The plan was a departure from the DPP and subsequent plans and reports as it sharply advocated that the future expansion of the city should be on the western side of the river Hooghly, specifically in the land available between Howrah and Bargachia and Dankuni to Saktigarh. Following the "regulated development" dictum in KMDA's Land Use Development Control Plan, CEMSAP identified core wetland area and declared it as "no development zone" and also pledged that thorough evaluation and endorsement of any development plan would be first made by the DoE, the nodal institution entrusted to implement the National Wetland Policy. The report also provided indications to optimize on the canal systems by not only clearing these for carrying the city's drainage load, but also at least partly as an inland transportation route. It recommended feasibility studies including technology identification for

[12]CEMSAP, http://wbenvironment.nic.in/html/CEMSEP/index.htm (accessed August 23, 2009).

developing a river and canal based transport network which could then be implemented on a private–public partnership basis. Technical recommendations were suggested to improve the capacities of the existing canals with suggestions for clearance of "encroachers" from canal banks followed by "acceptable" resettlement and rehabilitation packages for the "project affected people." The publication of the 1997 report was followed by the establishment of a special committee by the DoE to advise on the development and management of Kolkata's canals and wetlands (DoE 1999).

Vision 2025: Perspective Plan of CMA, prepared by KMDA in 2005, emphasized the need of land use maps and satellite remote sensing data for understanding urban settlement patterns, rather than merely relying upon demographic parameters as available in the decadal census reports. The plan provided information about the Monitoring Urban Sprawl (MUS) project for selected million-plus Indian cities undertaken by the Department of Space, Government of India. Attempts were made to examine urbanization in the metropolitan area of Kolkata combining information in terms of demographic distribution patterns in administrative jurisdictions based on census data and the nature of urban sprawl based on the land cover maps as obtained and analyzed in the reports of MUS for the Kolkata Metropolitan Area during 1989–90 (KMDA 2005). The KMDA continued similar studies in collaboration with IWMED and DoE, GoWB (KMDA 2005). *Vision 2025* was clear that in order "to avoid possible conflicts between development and environment, it is imperative to design plans and programmes in such a way that a proper reconciliation can be ensured" (KMDA 2005, p. 103). Environmental conservation remained "an important agenda in urban development programmes" with "eco-friendly" measures gaining top priority across different provisions laid out in *Vision 2025*, from protection of wetlands to conservation of open spaces, parks, greenery, etc., to social afforestation measures (KMDA 2005, pp. 103–104). It recommended consideration of the "Environment Sensitive Zone" while planning for development, application of control regulations, and also systematic study of the environmental impact, as recommended in earlier plans (KMDA 2005).

The environmental concerns get reflected in the action plan or project called KEIP, which was launched as a multi-agency endeavor to arrest environmental degradation and improve the quality of life in Kolkata. It was "aimed at a drastic overhaul of infrastructure with a focus on the wider environment of the city and its surrounding areas" (Bose 2015, p. 109). The first phase of this "institutional environmental action" was initiated and implemented between 2002 and 2007 at the level of national (Department of Urban Development and Economic Affairs), state, and local governments (KMC, KMDA, Bengal Chamber of Commerce, DoE, Department of Municipal Affairs) in partnership with international agencies (ABD), private consultants, and a range of NGOs (Concern for Calcutta, etc.) (Bose 2015, p. 110) at an estimated cost of US$220 million initially (KEIP 2006a). The costs increased during the subsequent period due to modifications in project design during various phases of its implementation (Table 7.1).

Major components of the project included pollution abatement, provisions for utilities in slums, sewerage and drainage network renovation in the metropolitan

Table 7.1 KEIP funding structure (US$ million)

Source	Original funds	Supplementary	Total	Percent
ADB	177.77	80.00	257.77	64.22
GoWB	54.60	19.50	74.10	18.46
KMC	55.40	14.10	69.50	17.32
Total	287.77	113.60	401.37	100.00

Source Bose (2015, p. 114)

Table 7.2 Proposed canal bank redevelopment and restoration

Canal	Desilted stretch (km)	Lining (km)
TP	24.41	1.470
Manikhali	9.255	2.039
Keorapukur	–	–
Churial	20.46	0.205
Total	54.13	3.174

Source Adapted from Karmakar (2019, p. 68)

area, solid waste management improvement in the city, rehabilitation of drainage canals (including inlet canals, connected to municipal canals carrying wastewater to EKW), improvement of recreational facilities for parks and water bodies (ponds and lakes), and affordable housing provisions for squatter settlements along canal banks (KEIP 2006b). Protecting the environment from advanced development impact was a major agenda of the project. Building sewerage infrastructures including trunk and secondary sewers, storm water drainage, pumping stations, and construction of treatment plants along with upgrading new ones formed the core component of the project design. Canal desiltation and dredging constituted a major part of the drainage restoration and improvement program. Canal improvement works (desiltation, renovation, and lining) were proposed in parts of the TP Basin, Keorapukur, Churial, and Manikhali basins (Table 7.2) and the construction of four pumping stations was planned to handle the additional SWF flow at Chowbhaga, Keorapukur, Manikhali, and Ghusighata.

The project laid down detailed provisions for rehabilitation, resettlement, compensation, and assistance to project-affected families. A resettlement plan was prepared in 2000 even before the commencement of the scheme and it was updated in 2006 relating to some changes in the project design. In the case of the Keorapukur Canal, canal improvement was reduced from 9 to 1.148 km, and so far as the Churial Canal restoration was concerned, to avoid a thickly populated settlement on the canal banks, a slight diversion through the Churial extension canal was made, leading to an increase in the canal length from 24 to 27.545 km as part of project implementation. The rehabilitation and resettlement policy frameworks

and entitlements followed guidelines laid down in national laws like the Land Acquisition Act, 1894 (amended in 1984), and the National Policy on Resettlement and Rehabilitation for Project Affected Persons (NRRP), 2004. Approximately 3000 canal bank households were rehabilitated in houses constructed under the Valmiki Ambedkar Awas Yojana (VAMBAY) and Basic Services for Urban Poor (BUSP) schemes.[13]

The EKW, comprising areas covered by KEIP (Borough VII, Borough XII, and parts of Borough XI), was studied and monitored by the project executive agency after consulting six local NGOs and organizations active in EKW protection: People United for Better Living in Calcutta (PUBLIC), Bharat Sevashram Sangha, Jayprakash Institute of Social Change, Jalabhumi Bachao Samity (Save the Wetlands), Purba Kolkata Fish Producing Association, and the Centre for Environmental Management and Participatory Development. The KEIP initiative emphasized the treatment of sewage discharged into the DWF to ensure increased production of fish. Supplementary finance was planned and arranged for this particular project component, which was initially not part of KEIP. The project authorities wanted to carve a transformation in the perception of wetlands among citizens from a landfill or sewage treatment site to a transition zone between different aquatic and terrestrial environments valued by residents while unanimously agreeing to the fact that development of the area should not change the current pattern of land use, nor should it result in upsetting the ecological balance. Additionally, KEIP recommended the setting up of a new EKW Park with a Nature and Wetland Interpretation Centre at its core spreading across 820 ha (approx.), which is yet to materialize.

Though the KEIP project can be regarded as a breakthrough in terms of addressing the urban sustainability of Kolkata across both ecological and social lines, yet there are major criticisms unleashing the gap between official promises and actual delivery of work packages, crafting a disconnect between aspirations and realities. Reflecting on how it was envisioned as the mega-project connected to the "aspiration of remaking Kolkata into a global city," Bose (2015) argues that it was "about more than sewage and drainage, cleaning canals, or creating sites to reinterpret nature. It is a program whose components and articulation bring together multiple themes and discourses, including those on global environmentalism, middle-class sensibilities, transnational spaces, international development, and local politics" (Bose 2015, p. 109). By conducting detailed interviews with consultants and government engineers and officials involved in the project, Bose highlights numerous problems during its implementation phase, such as the relative powers of various partners, poor conflict resolution skills, and the short-term political objectives of KMC over accomplishment of long-term development goals, etc.

[13]Launched in December 2001, VAMBAY was intended to facilitate the construction and upgradation of dwelling units for slum dwellers for providing them with a healthy and enabling urban environment. The BUSP is a component within JNNURM aimed at an integrated development of slums through projects for providing shelter, basic services, and other related civic amenities with a view to providing utilities to the urban poor.

Moreover, focusing on the ecotourism and edutainment initiatives ingrained in KEIP desires and designs (like the EKW Park and Nature Centre), Bose warns that since "the global city is not only a modernist fiction but depends on middle-class notions of environmentalism, sustainability, and cosmopolitanism, these aspirations pre-empt claims to social and environmental justice" (2015, p. 128). Karmakar (2019) brings out discrepancies in KEIP resettlement and rehabilitation packages by pointing out that though it was mentioned in the plan that all relocation sites would be within a distance of 2.5 km from the original areas to ensure better protection of sources of livelihoods for rehabilitated households, yet, in several cases, the distance increased to 3.8 km, and in one particular case (for people inhabiting the Krishnapur Canal) it was 12.5 km! Moreover, there were delays in rehabilitation due to non-availability of suitable land, challenges relating to the nature of entitlement, and failure on the part of project authorities to provide allowances to those non-entitled to rehabilitation (Karmakar 2019).[14]

7.5 Each City Has Its Own Narrative

This chapter argues that though Kolkata has encountered tremendous ecological conversions and "cleansing" drives affecting the social livelihoods of marginalized communities, yet urban environmental planning does not comprise the linear story of the city entirely succumbing to and being appropriated by global pathways and national trajectories. Here, I would like to echo Follmann (2016) by arguing that the incorporation of the environment or the "reintroduction of nature" into the urban realm does not follow a consistent narrative; it is fragmented across spatial and temporal scales, and can emerge as complementary or contradictory and highly politicized. A series of elaborately developed plans that emerged out of particular historical and political contexts addressed context-specific issues and provided clues and directions with regard to the urban sustainability puzzle in tune with Kolkata's very own aspirations, requirements, capacity, and limits.

The report titled *Development Perspective for CMD and Third Calcutta Metropolitan Development Programme of CMDA (1983–84 and 1987–88)* (KMDA 1981) considered the development of basic amenities and survival needs through employment generation more important than environmental considerations for the time being:

> The purpose of planning in the industrial cities of the developed countries, therefore, was mainly to restore a little bit of the blue sky, the green trees and the bright water which

[14]The major concern of the canal bank dwellers was regarding the nature of the entitlement. Most of the affected households demanded land as compensation rather than the small flats provided under the project. While each family was originally allotted 215 square feet per three family members in the resettlement sites, due to lack of available land, flats between 163 and 190 square feet with a balcony and a toilet were provided to the affected households irrespective of size of families.

> would make life in the city more pleasant. The goal of metropolitan planning in developing countries, on the other hand, should be to promote the development of employment opportunities for the city as well as its hinterland. (KMDA 1981, p. 4)

Again, a major shift may be noted in the *Plan for Metropolitan Development, 1990–2015*, which considered investing heavily in recreational facilities (through the creation of open space, parks, etc.) and beautification programs which would be "environmentally pleasing" to the citizens (KMDA 1990). More recent robust projects targeted and dedicated to Kolkata's environmental improvement encompass elements of both elitist environmentalism (through ecotourism, edutainment, etc.) and compulsory and urgent urban environmental requirements (through repair and renovation of existing utilities and construction of new ones for enhanced performance, rehabilitation and resettlement arrangements for marginalized project-affected families inhabiting canal banks, etc.). Time and again the city plans have fluctuated between sincerely addressing "sustainability," crucial for its sustenance and the survival of its inhabitants, and implementing designs that are mere greenwashing in the name of sustainable urban environmental preservation. In spite of these perturbations, there is light at the end of the tunnel with new plans, programs, and projects being designed, developed, and implemented addressing crucial intersections among urban development, environmental restoration, and management on the one hand, and social amenities and requirements on the other. But the sojourn is long and rugged. The latest program to carry forward KEIP's legacy (which ended in June 2013), KEIIP, is dedicated to "build[ing] on results achieved and experience gained" and also to materializing incomplete (sewerage and drainage) work and visions laid out during the former years along with additional spatial coverage.[15] These ambitions and perspectives await detailed and systematic post-implementation evaluation frameworks and assessments. In spite of the warnings in the CEMSAP report and several plans since the 1990s about the crucial need for hindering east-centric development of the city at the cost of its wetlands, rampant conversions are going on till date. Some local promises and programs (at times connected to national plans and policies like the Ganga Action Plan) to rejuvenate canal stretches and revitalize the riverine system have not seen the light of day; those which have been accomplished have not undergone quality assessments and evaluations. Moreover, the argument for creating "environmentally pleasing areas" through beautification programs has gained ground at the cost of both long-term (urban) environmental sustainability and social livelihoods. The attempt to forge the "green city" ideal and vision in New Town Rajarhat can be considered as one of the greatest and most recent attempts in this direction, completely concealing the ruthless imposition of the built environment (and concrete structures) on the extensively evolved "living systems infrastructures": the

[15]KEIIP, https://www.keiip.in/bl3/aboutuskeiip.php (accessed June 16, 2019). The ADB has expressed its willingness to support this program by providing a multi-tranche financing facility through three tranches for US$400 million. https://www.keiip.in/bl3/aboutuskeiip.php (accessed June 16, 2019).

wetlands![16] Green frontiers are not necessarily the result of planning exercises and green functions may already be under way in urban frontiers, in which case the struggle is to retain the use of land for these functions (Sangameswaran 2018). The objective of planning history is also to be critical about things that have not gone the way they were intended, making way for environmental protests, activism, and maneuvering against statist development goals and planning agendas by non-state actors.

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[16]New Town Rajarhat was shortlisted by the center in the 100 "smart cities" list; but the state opted out of the scheme to develop this township as a "green city" in 2017. WBHIDCO plans to develop Rajarhat as the "Eco City in an Eco Park" through massive forestation, rainwater harvesting and recycling, and wastewater recycling, eco-friendly transport system, etc. But what remains concealed in the "green" claim and agenda is that while acquiring land for this township, WBHIDCO destroyed 1.5 million trees and engulfed agricultural lands, orchards, and wetlands.

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Chapter 8
Urban Environmentalisms

8.1 Urban "Varieties of Environmentalism"

In May 1979, a young American environmentalist, Mark Dubois, chained himself to a boulder in the Stanislaus river in California. The canyon where he lay formed part of the reservoir of the New Melones dam, whose construction Dubois and his organization, Friends of the River, had long but unsuccessfully opposed. In October 1978, the Army Corps of Engineers had completed the dam, and the following April it closed the floodgates. The level of the reservoir started to rise, and it appeared as if the campaign to "Save the Stanislaus" had failed. But then, in an act of rare heroism, Mark Dubois went into the waters and chained himself to a rock. He chose a hidden spot, and only one friend knew of the location.

Fourteen years later, an uncannily similar strategy of protest was threatened against another dam, on another river and on another continent. In August 1993, with the onset of the Indian monsoon, the vast reservoir of the Sardar Sarovar dam on the Narmada river began filling up to capacity. It now seemed that the decade-long Narmada Bachao Andolan had irrevocably lost its fight. But the leader of the movement, Medha Patkar, decided to drown herself in the waters. Patkar announced her decision to walk into the river on 6 August, with a group of colleagues, but at a place and time not to be disclosed. Fearing detention by the police, Patkar disappeared into the countryside weeks before the appointed date.

I dare say Medha Patkar had not heard of Mark Dubois, but the parallels in their chosen forms of protest are striking indeed. Both formed part of ongoing, popular movements against large dams. It was only when the movement seemed to have failed that Patkar and Dubois decided to throw the last card in their pack, offering their lives to stop the dam Notably, in both cases the political system was alert (or open) enough not to allow the environmentalists to make this supreme sacrifice. In Stanislaus, the Corps of Engineers stopped filling the reservoir, and sent search parties by air and on land to find and rescue Dubois. In the Narmada valley, Patkar and her band were found and prevailed upon to withdraw their samarpan dal (martyrs squad), in return for which the Government of India promised a fresh, independent review of the Sardar Sarovar project.

While the strategies of direct action might have been superficially similar, their underlying motivations were not. Mark Dubois and his colleagues were striving, above all, to save the Stanislaus canyon as one of the last remaining examples of the unspoilt Californian wilderness. As Dubois wrote to the Colonel of the Corps of Engineers prior to entering the

J. Mukherjee, *Blue Infrastructures*, Exploring Urban Change in South Asia,
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> river: "All the life of this canyon, its wealth of archaeological and historical roots to our past, and its unique geological grandeur are enough reasons to protect this canyon just for itself. But in addition, all the spiritual values with which this canyon has filled tens of thousands of folks should prohibit us from committing the unconscionable act of wiping this place off the face of the earth."
>
> In contrast, Patkar and her colleagues hoped not only to save the Narmada river itself, but also (and more crucially) the tens of thousands of peasants to be displaced by the dam being built on the river. When completed the Sardar Sarovar project will submerge a total of 245 villages, with an estimated total population of 66,675 people, most of whom are tribals and poor peasants. True, the dam will also inundate old-growth forests and historic sites, but it will most emphatically of all destroy the living culture of the human communities who live by the Narmada river. It is thus … a move "towards our ultimate goal of [a] socially just and ecologically sustainable model of development." (Guha and Martinez-Alier 1997, pp. 19–20)

With the Stanislaus/Narmada illustrations and Dubois/Patkar comparisons, Guha and Martinez-Alier (1997) succeeded in explaining "the fundamental difference" between two distinct "varieties of environmentalism" in the global North (the US) and the global South (South Asia), which they categorized as "ecology of affluence" and "environmentalism of the poor" respectively (Guha and Martinez-Alier 1997, p. 20). While the first variety epitomizes post-WWII post-material pursuits of the American affluent class striving for outdoor recreation, open space, and wilderness preservation (Nash 1982; Hays 1987; Rothman 1998), the second is intrinsically interconnected to larger questions of livelihood, distributive justice, and human rights originating as "a clash over productive resources … one with deep ecological implications… . Red on the outside, but green on the inside" (Guha and Martinez-Alier 1997, p. 18). Though a powerful epistemological tool, the edge of distinctness of these two varieties for both the US and South Asia (India) has become blunt with (urban) environmental historians capturing the prevalence of elements of both these varieties within each spatial scale. Rome's (2001) research on suburban environmentalism complicates Harvey's (1994) argument of reliance of the American environmental movement on the support of affluent suburbanites by demonstrating that suburban environmentalism encompasses much more than a function of affluence. "The desire to preserve wilderness was the tip of the iceberg, the most visible part of a much larger concern about the destructive sprawl of urban civilization" that robbed children of their places to play and the losses hit home (Rome 2001, p. 8). By focusing on local, grassroots environmentalism in the three American cities of Baltimore, St. Louis, and Chicago, Gioielli (2014) argues that classifying this activism as part of environmental justice activism and not considering it within the larger ambit of environmentalism is problematic. Gioielli's work serves as a corrective by bringing the history of activism by poor, disadvantaged, and minority urban groups against environmental inequalities under the broad conceptual umbrella of environmentalism. Gioielli asserts, "environmentalism is a big tent with lots of different types of activism going on," and this reconceptualization is important to "correct some of the teleology in the history of environmental activism" (2014, p. 7). With additional challenges, inequities, demographic explosion, housing crisis, and political maneuvering and bargains, urban

environmentalism in the global South entails deeper complexities that require detailed explorations and analyses.[1]

Urban environmental conflicts and activism have remained relatively unexamined within the South Asian context barring the emerging UPE literature. Overcoming the "rural bias" in environmental social science literature which has focused on loss of land and livelihoods due to dams, forestry, and other development projects in rural India, scholars have now paid attention to the urban context "where clashing claims to the environment are becoming sharper-edged" (Baviskar 2002). "Bourgeois environmentalism," a concept framed by Baviskar (2002, 2003, 2006, 2011), till date remains the most powerful paradigm to capture urban environmental projects (restoration, beautification, and housing schemes) facilitating middle-class desires, aspirations, and perceptions of urban environment at the cost of squatter clearance and eviction drives in Indian metropolises. Within the complex Indian urban scene, Baviskar traces elements of both "ecology of affluence" and "environmentalism of the poor," expediting "a complex interrelationship between two forms of environmentalism, with the green agenda of the rich leading to greater social and economic marginalization of the poor and their concerns over fair distribution of resources and safe working conditions" (Baviskar 2003, p. 89). "Bourgeois environmentalism" captures complex interactions on global environmental discourses among state actors, NGOs, transnational activists, and multinational corporations and how these have led to the "targeting and scapegoating of the urban poor in particular, for a range of environmental problems" (Bose 2013, p. 139). Focusing on Delhi as the point of reference, Baviskar (2002) argues that for the bourgeois environmentalist, the ugliness of production must be removed from the city. The alliance between the state, real-estate promoters, and politicians in channelizing the "bourgeois" dream of the city comes out sharply in the Baviskarian conceptualization of this particular variety of urban environmentalism.

> Commerce and leisure are fused together in the new shopping malls, amusement parks, cineplexes and other developments sprouting across the city, frequently on land vacated through slum demolitions. That this ordered landscape is underwritten by an ugly real estate mafia with links to politicians and city authorities is another inconvenient fact that is conveniently forgotten. (Baviskar 2002)

Critically interrogating the "environmentalism of the poor" formulated by Guha and Martinez-Alier (1997) as a label for the South Asian variety of environmentalism, Baviskar argues that within the Indian urban context, the prevalence of "bourgeois environmentalism" directly threatens the survival interests of the urban

[1]Rademacher (2011) draws attention to challenges associated with the common categorization of "cities of the global south" as it generalizes potentially catastrophic "urban explosion" and socio-ecological implications and also functions as "a shorthand for a certain kind of work that takes an understanding of the South as its point of departure en route to a theory of globalization" (Rao 2006, p. 226). Though these words of caution can be considered in terms of a neo-Malthusian element imbricated in the categorization, warning against the "same size fits all" prescription for Southern cities, yet additional vulnerabilities and complexities of these cities cannot be overlooked.

subaltern. And it is also within the complex urban scape that connections between ecology and equity become more complicated. Raising the crucial question, "How is the public sphere—the realm of collective practices that include the law, judiciary, capitalist media and NGOs—configured such that it excludes the most basic concerns of a majority of city dwellers?" Baviskar (2002) advocates for the urgently needed exercise of rethinking environmentalism.

In other recent case studies on Indian cities, the application of the "bourgeois environmentalism" perspective can be discerned. Reflecting on the contemporary history of the industrial and former industrial areas of Thane (Maharashtra), Sangameswaran (2015) postulates how efforts to "green" the city of Thane through the relocation of polluting industries to even more distant suburbs raise questions about the scale at which concerns about sustainability are conceptualized and the paradoxes involved in the idea of "sustainable urbanization." Bose (2013, 2015) applies the "bourgeois environmentalism" lens to explore conflicts between middle-class and poorer residents in various parts of Kolkata, especially in and around upscale housing developments. He captures the debate between middle-class aesthetics and the survival strategies of the poor in the context of the transforming landscape. Specifically focusing on the recent ADB-funded KEIP initiative, Bose asserts that this project can be considered as an important intervention in "coalescing and concretizing the dreams of the new urban middle class in Kolkata" (Bose 2013, p. 146).

This chapter argues that in spite of retaining powerful theoretical traction, "bourgeois environmentalism" fails to capture multiple trends and trajectories of environmental activism in different Indian cities with their divergent historical and political cultures. Heterogeneous components within class affiliations are overlooked and complex mediations across various actors are often missed in this pigeonholing of urban environmentalism which overshadows the fact that "there is a great deal of diversity and dynamism within the middle classes in relation to the environment" (Mawdsley 2004, p. 94). We need to avoid the tendency to reduce actors to caricatures of "ecosystem people and omnivores" and instead "develop situated understandings of what constitutes 'the environment' among different middle class groups; and underline the ways in which environmental issues reflect and are often emblematic of wider social and political debates" (Mawdsley 2004, pp. 88–89). The emerging framework of situated urban political ecology, paying close attention to everyday practices and situated dynamics, and unfurling the heterogeneity of India's urban environments, provides greater options for exploring not only multiple forms of urban environmentalism but also multilayered processes, equations, and realities within each of these varieties.[2]

[2]For situated urban political ecology, see Zimmer (2015) and Zimmer and Cornea (2016). Rademacher's (2011) ethnographic work on new ecologies of Kathmandu (Bagmati and Bishnumati Rivers) and Jain's (2018) qualitative study on the Kudasiya Ghat, New Delhi, should be mentioned in this context. While Rademacher contributes to the situated urban perspective by examining competing understandings of river restoration among multiple actors, including bureaucrats, conservation development agencies, and cultural heritage activists, and advocates for

This chapter empirically investigates, chronologically covers, and qualitatively analyzes varieties of environmental activism across conflicting, negotiating, and mediating actors surrounding the preservation and restoration of the Adi Ganga and the EKW. It complicates "bourgeois environmentalism" and the power-laden political ecology perspective by capturing multiple motives and intentions among various stakeholders, ranging from heritage conservation priorities, to conservation of ecosystem resources for the sake of ecosystem services for both the city and its marginalized ecosystem-dependent communities responsible for generating these services and also surviving on them, to social justice concerns asserting entitlement of basic human rights over placid ecological concerns. It is neither the linear story of middle-class alliance with statist goals facilitated by transnational networks of funding nor the entire vanquishment of ecological and social agendas flagged by divergent groups of activists. By focusing on two case studies, this chapter demonstrates that urban environmentalisms comprise vibrant stories of both violations and victories with long-lasting implications for the future urban environmental trajectory of Kolkata.

8.2 The Adi Ganga Bachao Andolan

The initiative to pressurize state agencies for reviving and restoring Tolly's Nullah as part of the heritage river, the Adi Ganga, surfaced during the 1990s when city NGOs led by Rebati Ranjan Bhattacharya launched campaigns for almost a decade to clean up the canal and its banks.[3] The conservationist urge in the activist Bhattacharya was an outcome of his attachment to the river and his first-hand exposure to its rapid transformation from a navigable canal to a *nullah*, from a heritage river to a polluted sewer! In 1996, Bhattacharya filed a writ petition following which the case for Tolly's Nullah's revival started to be heard by the Green

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the security of tens of thousands of rural-to-urban migrants settled along the exposed riverbeds, Jain explores the ways in which the discourse of "bourgeois environmentalism" effectuated through the Delhi Master Plan 2021 is circumvented by an ensemble of actors—traditional elites, the bureaucratic class, and political agents—within their respective micro-settings. Jain emphasizes that representing the poor as hapless victims misses out the ways in which power is often negotiated in everyday life.

[3]The 17-mile-long Tolly's Nullah was excavated by William Tolly following part of the moribund route of the Adi Ganga (Chap. 3).

A rare document entitled *A Plan for Adi Ganga–Tolly's Nullah* developed by the Tollygunge Development Council (TDC), a city-based environmental NGO, and accessed from the primary source collection of Mohit Ray's personal library, shows that TDC had called the attention of I&WD and KMDA officials to the issue of "cleaning and clearing" of the river as early as March 1981. In April 1982, TDC submitted a comprehensive action plan on *Resuscitation of Adi Ganga and Its Merger with Re-excavated Nischintapur-Hotor Khal for Navigation, Pollution Control and Small Irrigation Facility* to the government. In 1983, the state authorities set up a task force to suggest strategies and plans for improving the flows and drainage capacity of Tolly's Nullah. However, though "plans after plans" were formulated, yet they did not materialize.

Bench of the Kolkata High Court (C.O. 9502[W]/96).[4] On February 2, 1997, the high court ordered the government to clean the channel and evacuate squatter settlements along both its banks, which was imperative for river rejuvenation and beautification. A committee for improvement of Tolly's Nullah, comprising the chief engineer, KMDA, the commissioner, KMC, the secretary, I&WD, and headed by the chief secretary of the state was formed on the instructions of the high court for execution of the work. In May 1997, the committee recommended that INR 40 crore needed to be sanctioned for the canal restoration scheme. R. P. Sharma, financial advisor of the National River Conservation Directorate (NRCD), visited Kolkata to meet representatives of KMDA, KMC, and I&WD.[5] He demanded a detailed report from the committee on the contemporary status of the river against which the grant could be approved.[6] No report or proposal was submitted and no further planning was implemented by KMDA, the authority which was supposed to intervene in the matter. In 1998, on the basis of a revised plan submitted to the NRCD, the budget sanction was reduced to INR 29 crore and 50 lakh. The project was supposed to be immediately executed and completed within the next 18 months. But the project did not materialize due to protests from shanty dwellers inhabiting the canal banks who were mobilized by grassroots organizations and wanted an immediate rehabilitation plan during the pre-implementation project phase. Neither the rehabilitation plan nor the project saw the light of the day.[7]

In 1997, the pilot project targeting generation of data and options for feasible and sustainable management of EKW and the canal system was launched under CEMSAP. The report entitled *Management of East Calcutta Wetland and Canal System* (March 1997) can be considered seminal in establishing the interdependence between EKW and Kolkata's canal system. This report also provided serious

[4]The Green Bench of the Kolkata High Court was formed after a public interest litigation (PIL) submitted by city-based NGOs against conversions in EKW.

[5]The NRCD, Ministry of Environment, Forests and Climate Change, is responsible for providing financial assistance under the National River Conservation Plan (NRCP) to the state governments and local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from them. The NRCP (1995) is the further expansion of the Ganga Action Plan initiated in 1985 to include other rivers. The projects submitted by the state governments are taken up under NRCP depending upon the degree of pollution in the river, the designated best use of the river stretch as well as the priorities of the state government, formulation of the project as per NRCP guidelines, commitment of the state government to bearing its share of capital cost, as well as availability of funds under the plan. https://nrcd.nic.in/ (accessed May 24, 2019).

[6]There was no detailed report on pollution and siltation in Tolly's Nullah, except the data generated by the All India Institute of Hygiene and Public Health which projected that the river was choked with 85 mg/l of grease that soared to 135 mg/l during summers, while the permissible limit was only 35 mg/l.

[7]When the rejuvenation scheme had just begun, a PIL was filed in the Kolkata High Court by the Bekar Bazar Samiti on the basis of which a stay order halting the project work was issued. In view of providing rehabilitation to 40,000 people (approx.) inhabiting both sides of the entire stretch of the river, the circumstance became complicated and the project was called off (interview with Mohit Ray on October 23, 2019).

recommendations for the revival of Tolly's Nullah, strongly justifying the requirement and relevance of the project (CEMSAP 1997).[8] It suggested that Tolly's Nullah should be connected with the decaying Piali River and the moribund southern part of the Bidyadhari River to permit controlled release of flushing doses of water from the Hooghly. It also discussed the provision for integrating eco-tourism and economic needs through the restoration of the canal, which would then facilitate trans-shipment of commodities and commuters. The experts proposed a plan for connecting the eastern extension of Tolly's Nullah with Circular Canal, Bhangarkata Canal, and Krishnapur Canal by excavating another 11 km of a new water stretch. The final aim was to create a girdle canal 42 km (approx.) in length for accomplishing both transportation and tourism targets (CEMSAP 1997). The plan targeted a rejuvenated Tolly's Nullah that would give a fresh lease of life to the decaying river systems of southern Bengal.

In 1999, events took a different turn when the metro rail extension project, connecting Tollygunge with Garia through Tolly's Nullah, was floated. With brewing apprehensions about technical details of the project and its relation to eflows of the canal, leading environmental activists of the city including Bhattacharya, Subhas Dutta, Mohit Ray, Sankha Ghosh, Gautam Bhadra, and others became vocal and active in gathering more information about the same. With this purpose, a letter was submitted to the metro rail authorities who responded by clarifying that metro project components would be finalized only after consulting I&WD. It was also ensured that the concern for the Adi Ganga would definitely be taken care of.[9] The assurance appeared to be false when it gradually surfaced that the project would proceed by constructing 300 pillars over Tolly's Nullah, dissecting the water body with 2-meter diameter reinforced concrete columns at 20-m intervals with 5 headroom over the decks of the existing bridges in the reach (Mukherjee 2010, 2016). The river was already polluted, choked, and degraded; the metro project ensured its "ignominious death" (Ray 2000).

The first public meeting to protest against the metro extension scheme was organized by the environmental NGO Vasundhara Foundation at the auditorium of the CSSS, Kolkata, on April 25, 2001, where the Vasundhara secretary and environmental scientist Mohit Ray explained that the project was not only unscientific but also illegal as the work had commenced violating the EIA Act guidelines. The protest meeting was joined by several NGOs like Calcutta 36, TDC, and Disha, with participation by leading intellectuals, environmental activists, and academics

[8]The report evolved following detailed consultation of archival documents, maps, extensive field surveys, and insights from NGOs. The project coordinator Dr. Asish Ghosh explained that this was the first report on Kolkata's canal system and wetlands that was comprehensive, inclusive, and participatory at the same time (personal communication, May 23, 2011).

[9]Mr. K. Gangopadhyay, chief engineer, metro rail, wrote, "We share your concern for 'Adi Ganga.' As such we have decided, in consultation with the Irrigation and Waterways Deptt. of the State Government to carry out all technical redressals necessary so as to ensure that the flow does not get obstructed." Letter no. METS/ TG–15/03 (PR) dated July 30, 1999.

of Kolkata where the rich past of Tolly's Nullah was discussed along with contemporary problems of degradation and encroachment.

The project meetings and campaigns were followed by judicial activism when Subhas Datta, the renowned ecological crusader of Kolkata, filed a writ petition against the metro extension scheme in the Kolkata High Court (W.P. No. 2094 [W] of 2001) in January 2001. Datta lost the case when the court gave its verdict in favor of the metro rail project based on the archaic Section 11 of the Railways Act 1989, a leftover of the colonial revised edition of the Act of 1890 that provides for the railways to construct "upon, across, under or over any land, any rivers, canals, brooks, streams or other waters" (Mukherjee 2010, 2016).[10] Even after the passage of the verdict, activism remained undaunted; activists argued that the Environmental Protection Act, 1986, enacted as a commitment to the United Nations Stockholm Conference of 1972, should be given preference over the Railway Act, 1989. In April 2001, another major meeting assembling the pro-conservationist network, including representatives from Utsa Manush, Nagarik Mancha, Disha, Swastha-O-Paribesh, Purba Kolkata Paribesh Sameekshan, Bigyan O Bigyankarmi, Sahay, Calcutta 36, TDC, and Kaladhawani, expressed its collective opinion of remaining united for a sustained struggle against the metro project. But the movement lost its meaning as the project work started based on the verdict of the high court.

The issue of canal restoration during the early 1990s and the formulation of the metro extension project in the late 1990s led to another wave of protests, not involving the environmentally aware middle class who wanted to protect the heritage river, but the grassroots whose survival needs and livelihood options in terms of access to shelter and employment opportunities were directly affected by both rejuvenation and assassination of the river.

The banks of Tolly's Nullah remained dense with squatter settlements. Apart from the infiltration of migrants in the immediate post-partition years, marginalized communities from different districts of rural West Bengal (especially the Sundarbans) migrated to Kolkata in search of employment opportunities and inhabited pavements, railway tracks, dark bellies of bridges, and canal banks. For almost half a decade, stretches of Tolly's Nullah provided shelter (but not security) to poor people who were already "victims of development" from the countryside where landlessness, natural disasters, and repeated poverty cycles compelled them to abandon their homelands in search of better urban livelihoods (Seabrook 2002). During the 1990s, the canal was populated by 41,500 people (approx.) (Table 8.1). The dwellers were employed in the informal, unorganized sector; while males worked as rickshaw pullers, small-time vendors, and construction workers, females served as maids, nursing attendants, and also construction workers, assisting their partners. And "the supreme irony" was that as construction workers, they remained

[10]Datta laments this defeat till today, mentioning that out of 101 cases on Kolkata's environment that he had fought, he had only lost this case (interview, October 14, 2018).

Table 8.1 Squatter population on the banks of Tolly's Nullah

Stretch	Families	Number of people
Hastings to Tolly Golf Club	2,500	12,500
Tollygunge to Garia	1,300	6,500
Garia to Samukpota	450	2,250
Boat Canal to Tolly's Nullah	4,350	20,250

Source CEMSAP (1997, p. 140)

"busy making high-rise apartments for privilege even when their own fragile shelters" were "about to be bulldozed" (Seabrook 2002).

The official claim that the shanty dwellers (or "encroachers") peacefully vacated their houses when officially notified is not true as they were "determined to fight back and stall all efforts of the State Government to evict them in the name of modernization" (*Hindustan Times* 2001). The squatters under the aegis of the Ucched Bachao Jukta Mancha (UBJM), a radical grassroots organization, were determined to demonstrate and throw themselves in front of the bulldozers to protest against the squatter eviction and demolition drive (*Hindustan Times* 2001). The UBJM acted as the primary platform and a forum uniting several radical action groups like Manthan, Association for Protection of Democratic Rights, etc. The UBJM spearheaded the movement in September 2001 demanding rehabilitation before eviction during the pre-project implementation phase. It released a statement pleading for social justice for the squatter population which was signed by city intellectuals like Nabanita Deb Sen, Badal Sarkar, Debesh Ray, Gautam Chattopadhyay, and others (*Statesman* 2001). The then opposition party Trinamul Congress (TMC) and left front partners (like the Revolutionary Socialist Party and Forward Bloc) also joined hands in the protest.

On September 22, 2001, i.e., the day of eviction near the Garia bridge, thousands of "shocked men and women, many without food or shelter and weeping, trailed the demolition team" (*Times of India* 2001b). The UBJM and the TMC brought out processions in the streets "promising to lie in front of the bulldozers if they ventured into the area" (*Times of India* 2001b). The Rapid Action Force blocked the protesters and the protest rally was *lathi* charged, leaving many injured, bruised, and scarred; even the elderly, women, and children were not spared.[11] The additional vulnerability of women was addressed by feminist organizations like Nari Nirjatan Pratirodh Mancha, Sanlap, All India Progressive Women's Association, and Maitree, dedicated to the cause of poor and insecure women inhabiting inhospitable urban patches like canal banks. These efforts could mobilize women's participation in the anti-eviction movement as they seemed to be the worst sufferers. "Displacements

[11]A *lathi* charge is a protest management tactic which involves attack by the police force on a protesting mob with batons and riot shields.

like evictions not only affect families but entire communities. The worst affected are as expected women because the simultaneous loss of shelter and livelihood pose problems of security and privacy" (Chatterjee 2001). Hundreds of children also submitted a mass petition before the Juvenile Justice Board to protect the cause of project-affected children. On United Nations Human Rights Day (December 10, 2001), children participated in a sit-in demonstration organized by the UBJM outside the Taj Bengal to draw the "attention of the development planners from various parts of the world who assembled at Cities Alliance to the fact that the authorities had done nothing to ensure their welfare while pushing through development projects" (*Times of India* 2001c).

The eviction occurred in phases, and within months squatter settlements across the canal banks disappeared, only to reappear soon thereafter. The UBJM continued its mobilization strategies and activities even during the post-eviction phase with the hope that the people's voice would be heard and rights asserted, but in vain. A community kitchen was set up where evicted shanty dwellers cooked and ate together after their houses were demolished. When it became apparent that the "community kitchen is a symbol of their continued protest and a centre around which they can rally," the police force brutally turned it to dust (Marik 2001).

Two varieties of environmental activism clashed with each other over the issue of saving the Adi Ganga River, and none of these movements turned out to be successful as reflected in the death of the river and the displacement of squatters from its banks. The differences in these varieties are prominently reflected in the divergent types and patterns of protest strategies and mechanisms. While environmental activism, concerned only about the conservation of the river, was channelized through media activism, seminars, peaceful (and non-violent) rallies, and judicial activism, grassroots activism often took a violent turn as evident in clashes between police, activists, and victims participating in the protest movement. "Walking gently for a river must be a new event for a city known for its turbulent rallies and marches" (Ray 2001a). On December 26, 2000, a group of "eminent Kolkatans" gathered on the bank of the Ganges and walked a few kilometers to highlight their concern for the river. The rally was meant to support the new initiative by government agencies, business groups, international bodies, and NGOs "to develop the waterfront for this city and also to raise awareness about a clean river" (Ray 2001a). The Walk for River "naturally" ended at the Millennium Park on the Hooghly Riverfront which was developed and inaugurated by the KMDA in 1999 as part of the river beautification scheme (Ray 2001a). On the other hand, to the radical protest groups joined by (metro) project-affected marginalized shanty dwellers, "This was Kolkata's very own Narmada. The ingredients were there all right, albeit on a much smaller scale" (*Times of India* 2001a).[12]

[12]Kolkata's story bears a marked resemblance with Kathmandu's. Rademacher (2011, p. 1) observes, "The combination of musicians, dignitaries, and activists gave the ('Help save Bagmati,' December 2002) procession the simultaneous air of cultural celebration and political protest. But the setting, river channels choked with garbage and sewage and riverbanks host to seemingly countless shacks of the city's poor, framed the festival as a portrait of despair."

Environmental activists like Mohit Ray raised their voice against displacement of "encroachers" during the execution of the metro project, bringing to the fore the initial argument of the metro and state authorities that one of the reasons for constructing the pillars on the river was not to upset its squatters, only to expose statist legitimization of hugely funded "development" interventions and indifference to the ecological agenda, like cleaning up the "heritage" river, the Adi Ganga. The "heritage" argument was strongly infused in middle-class environmental activism to save the river, where the educated and historically and culturally conscious activists boldly upheld that "Kolkata is about to lose its heritage river" (Ray 2001b), and "no city can restore its pride neglecting its oldest river with a heritage of several centuries" (Ray 2001a). There was strong media activism on the issue when, using pre-colonial (vernacular) literature and the colonial archive, environmentalists like Bhattacharya and Ray highlighted that the Adi Ganga met all the criteria for being declared a heritage river as it had a rich historical past linked with local culture and tradition. The sacred name had been sanctifying to the people of the city for ages. Kalighat, one of the most significant spiritual centers of the country, stood on the Adi Ganga. "It is a river on which Shri Chaitanya had sailed on his way to Orissa. It is also a river that Chand Saudagar of *Mangal Kavya* had sailed during his wanderings" (Ray 2001b).[13] "As Ganga represents a spiritual, cultural and historical link with the country, Adi Ganga evokes similar feelings for southern Bengal" (Ray 2000). Activists drew examples from the West to mobilize the citizens and policy makers of the city. "When the world is supporting community based efforts to restore and protect the environmental, economic, cultural and historic value of old rivers, why are Calcuttans allowing the Metro Rail to exterminate their own heritage river?" (Ray 2000). The American Heritage River Initiative was cited time and again to mobilize citizen awareness and state accountability towards conservation efforts (Ray 2000; Hossein and Ray 2000).[14] Criticizing the narrow vision of the NRCD which focused only on municipal and industrial pollution encountered by rivers, the activists claimed that British Waterways had specific environmental and heritage policies and was credited for maintaining 25 canal museums and interpretation centers visited by around 7.5 lakh people every year. Though the activists realized that "it may not be proper (right now) to compare with the present achievements in Britain or in America," but at least there can be clear policies with identified priorities for having clean waterways

[13]Shri Chaitanya is the Vaishnavite saint who propounded Vaishnavism in Bengal during the early 16th century. Chand Saudagar is the protagonist of the *Manasa Mangal Kavya*, the Bengali medieval text that depicts how the snake goddess Manasa, using destructive strategies, could establish her worship in Bengal by converting Chand, an ardent devotee of Shiva, to her own worship.

[14]On September 11, 1997, the American president issued an executive order for federal support of community efforts along American Heritage Rivers followed by the designation of 14 US rivers as "Heritage Rivers." It was initiated to "help communities revitalize their rivers and the banks along them—the streets, the historic buildings, the natural habitats, the parks—to help celebrate their history and their heritage" (US Bureau of Land Management 1999, p. 106).

(Ray 2001a). The "heritage" argument was exemplified and animated by activists' plea to adhere to the nomenclature "Adi Ganga" and not "Tolly's Nullah," as the latter only captured the constricted history of re-excavation of part of the river by the colonial official William Tolly, erasing its rich history, culture, and connections with the riverine terrain of Lower Bengal.[15]

Apart from the "heritage" edge, the element of nostalgia was strongly prevalent in middle-class activism. During an interview in a fortnightly Indian English-language news magazine, Bhattacharya lamented, "As a boy I swam here. But now it's just a 15 km toilet dispenser."[16] His childhood and adulthood identities were deeply attached to the river:

> This Adi Ganga was never like this before. I have seen during my childhood that large boats plied through it laden with bricks, sand and other commodities.… The bhatiali songs of the boatmen could be heard during the full moon night. Markets thrived on the banks of the River which has a dated history of 225 years. (Quoted in Hossein and Ray 2000; translation by author)

Popular vernacular and English dailies and brochures circulated by activists to draw mass awareness published perceptions of citizens inhabiting the riverbank:

> We inhabit the last house of the Hume Road on the bank of the Adi Ganga. I had been born here. During my childhood after 8 pm, our family members used to sit on the River's bank and recited poems, sang songs and told stories. We used to spot boats laden with commodities. It was such an excitement to see bride and groom's boat plying through the River. … It's such a pain to see this River getting converted into a polluted drain. (Krishna Dasgupta, housewife, quoted in Hossein and Ray 2000; translation by author)

The grassroots environmentalism against the metro project had more to do with the basic requirements and rights of squatter settlers than the health of the river. While environmentalists fighting for river cleaning and conservation were vocal against encroachments on the canal banks, moaning how these had transformed the once navigable channel into a dirty pool of stagnant water and hence a potent source of health and environmental hazards, grassroots activists fighting for the squatter settlers reflected on the latter's concern about the condition of the river and their strong will to clear and dredge the canal using their own labor against only the assurance of shelter on the canal banks.[17]

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[15]While environmentalists validated their argument in favor of the Adi Ganga by accessing information on the rich history of the river as reflected in various historical (pre-colonial vernacular and colonial) sources, the Green Circle of India, another environmental NGO mainly consisting of geologists from Calcutta University, conducted a detailed field survey between February and April 2001 on the downstream section of the river (from Kudghat to Shamukpota and further down) to record and document topographic and geomorphological attributes (Green Circle of India 2001). The survey report concluded that dredging a particular stretch of the river would be unscientific and unsound and the entire stretch should be revived to retain riverine eflows (Green Circle of India 2001; interview with Asit K. Biswas, Secretary, Green Circle of India, on October 11, 2018).

[16]Document accessed from Mohit Ray's personal library.

[17]Interview with Sushovan Dhar, activist and member of Manthan, August 10, 2009.

8.3 Protests to Protect the EKW

Dembowski's *Taking the State to the Court* (2001) sheds light on how PILs filed by environmental NGOs exerted pressure on the state, which was then compelled to withdraw some of its urban development projects encroaching on the EKW against the 1992 verdict declared by the Kolkata High Court. Dembowski (2001, p. 83) demonstrates how, motivated and briefed by "environmentally minded bureaucrats, city-based NGOs took up the cause of wetland protection and conservation" in 1991. However, urban environmentalism surrounding the EKW during the 1990s has precedence. A detailed interview with Naba Datta, General Secretary, Nagarik Mancha (and its environmental wing Sabuj Mancha), a civil society organization fighting environmental and social injustice, unraveled that before the environmental aspect of wetlands came into the limelight, there had been in existence a strong grassroots movement during the 1970s when fishers (more specifically, laborers working in *bheri*s) had demanded tenurial rights and better employment protection from the private *bheri* owners and zamindars.[18] Seasonally employed laborers working in farms and fisheries and with no access to additional employment incentives and allowances protested against employers often backed by political cadres of the then leftist government which had the "pro-poor" agenda on its priority list. Kundu (1994) describes how *bheri* owners complained against constant labor unrests and serious disputes with agricultural workers affecting productivity in the wetlands and unleashing insecurities among them. Moreover, "illegal" land-holdings that resulted from land grabbing operations during the 1960s and 1970s created uncertainties among *bheri* owners who wanted legal ownership but had no valid documents of land (*bheri*) transfer and sale.[19]

When the EKW was brewing with these complexities, uncertainties, and unrests, it drew the attention of the sanitation engineer Dr. Dhrubajyoti Ghosh, who was enthralled by the resource recovery mechanisms pursued by local fishers and farmers in the area. He can be credited with the mission, vision, and agenda of incorporating this "low-cost folk technology" within the ambit of mainstream science.[20] "What he discovered would change his life forever and open a new chapter in urban ecology" (Acharya 2016). Emphasizing the immense significance of this multifunctional ecosystem resource, Ghosh claimed, "What I had discovered within the sewage and muck of Kolkata was a living laboratory of science" (quoted in

[18]Interview conducted on June 27, 2018.

[19]Interview conducted with Nitai Kundu on January 2, 2019.

[20]Knowing him closely, I had the opportunity to listen to the personal stories of his life in his south Kolkata apartment. He explained how after getting his degree in ecological engineering from the West, the sewage-fed wetlands in Kolkata's backyard fascinated him and he became motivated to advocate for the cause of protecting this ecosystem resource and the local people whose knowledge and labor kept it vibrant. Though he was involved in other projects, the EKW was his lifeline, and he was the ecological crusader who devoted his entire life not only to understanding its ecological and social complexities but also actively rallying and protesting for its conservation at local, regional, and international levels.

Acharya 2016). Recognizing Ghosh's research, agenda, and conviction, the IWMED was established for dedicated wetland research in 1986. Through its scientific publications, IWMED validated the claim that resource recovery practices in the wetlands were economically attractive and reasonably safe in terms of health and environmental sustainability parameters (IWMED 1988, 1995; Ghosh and Sen 1987; Ghosh 1993, 1996). The institute is also credited with preparing the first map of the WRR which was designed and developed through an intensive two-year participatory wetland mapping process following the flow of the wastewater through successive resource recovery cycles purifying wastewater at the end (IWMED 1988; Lokgariwar and Dewani 2016). The research conducted by IWMED drew national and international recognition, as evident from the inclusion of the "Calcutta model" (of functioning of sewage-fed fisheries) in the Ganga Action Plan by the central government and the 1988 conference in Kolkata where the World Bank, the Food and Agriculture Organization, and the Gesellschaft für Technische Zusammenarbeit emphasized the need to preserve the area.

The importance of wetland ecology gained ground, making citizens aware about the significance of the EKW and hence activating them towards protecting it against conversions and encroachments. The nature of protests to protect the wetlands complicates the "bourgeois environmentalism" discourse, as a wing of the state bureaucracy (also referred to as "environment-minded bureaucrats") in close "contacts with people living in the wetlands and with urban, environmental, middle class pressure groups" actively mobilized grassroots and civil society to assert resistant voices against statist policies and projects leading to wetland conversion (Dembowski 2001, p. 96). That the state is a heterogeneous entity with its different departments and officials having divergent takes on conservation, conversion, and larger questions of urban planning and development came out sharply in the case fought for Kolkata's wetlands protection. The "rift between conservationists and developers" was apparent "even within the State Cabinet" (Dembowski 2001, p. 98). While some government officials (most prominently Dhrubajyoti Ghosh and Asish Ghosh) actively supported and backed environmental NGOs like People United for Better Living in Calcutta (PUBLIC), others proposed and promoted urban expansion and development goals at the cost of the wetlands.[21] Again, within the pro-conservationist bureaucracy wing, there were debates about exactly how much of the vast expanse of eastern wetlands should be preserved. While some officials claimed that the IWMED map of the WRR covered the minimum area urgently needing conservation, some opined that preservation of an even smaller area would solve the purpose for the time being. The "hard-line conservationists"

[21]Dhrubajyoti Ghosh was the chief environment officer, GoWB, and Asish Ghosh served as the director, Zoological Survey of India, during the 1990s. Both were convinced about the need to protect the wetlands from state-led development projects. Asish Ghosh was very enthusiastic in repeating stories of the good old days when he was young and emotional and harbored a radical urge to save wetlands in spite of holding his prestigious bureaucratic position. He felt proud all his life that his responsibility as a citizen towards the collective good of the city and the wetlands superseded his bureaucratic obligations.

opposed any encroachment on Kolkata's east, roping in larger questions of geo-hydrology and biodiversity. Some bureaucrats also adhered to the idea that environmental needs required to be reconciled with insurmountable pressures of urbanization through strictly controlled and implemented planning, monitoring, and enforcement.

A report published in the *Telegraph* on August 31, 1988, mentioning a plan to expand Salt Lake City that would have affected the northern rim of the WRR, alarmed and alerted the conservationist bureaucratic network which contacted environmental NGOs to take up the matter at the Kolkata High Court. The *bheri* owners did not immediately join hands in the movement as they were already scared by the land grabbing activities that were going on under the aegis of the political cadres of the then leftist (CPI[M]) government as part of the larger land reforms movement in Bengal. A letter was drafted, signed, and submitted by representatives of different NGOs like Concern for Calcutta, PUBLIC, Indian National Trust for Art and Cultural Heritage (INTACH), Prakriti Samsad, and the World Wide Fund for Nature-India (WWF) to the state environment minister asking him to get actively involved in the cause of wetland protection. In the early 1990s, these NGOs published advertisements in the media along similar lines drawing public attention. They appealed to members of the state assembly against sporadic and forceful *bheri* annexation by party mafias facilitating sale of property to promoters. An open letter with 8,000 signatures was prepared and submitted to the chief minister.

Though the mobilization drive progressed, it was not strong enough to stop and craft an impact on the state-led east-centric development drive. There were repeated advertisements in prominent newspapers like the *Statesman*, the *Economic Times*, etc., about the opening of the World Trade Centre, residential complexes, and sale of land by promoters on the east of the EM Bypass. With the development spree remaining unhindered, the next level of the battle was fought at the Kolkata High Court when civil society dragged the state to the court for ensuring Kolkata's environmental sustainability coupled with livelihood security of communities drawing sustenance from the wetlands.

The PIL *People United for Better Living in Calcutta (PUBLIC) and Another versus the State of West Bengal and Others* (Matter No. 2851 of 1992) was framed in a strong way to interrogate government unaccountability inflicting environmental and social injustices. The writ petition was filed in January 1992 by PUBLIC where the state of West Bengal, through the secretaries of the Departments of Local Government and Urban Development, Development and Planning, Land and Land Revenue, and Metropolitan Development, the chief executive of the KMDA, along with the Union of India through the secretary of the Ministry of Environment and Forests, Government of India, were listed as respondents. The state government was accused of violating the West Bengal T&CP Act, 1979 (Section 46[1]) that included provisions for wetland protection. The petition was comprehensive and all-pervasive in terms of its appeal for wetland conservation. It demanded that the "state authorities should be directed to maintain the wetlands' character in its present form, to stop all development plans and to prevent any further

encroachments. They should also be ordered to prohibit any further reclamation as well as any change of land use from agricultural to residential and/or commercial" (Dembowski 2001, p. 103). By pointing to massive encroachments that had already led to shrinkage of EKW, the petition demanded that an expert body should be constituted by the central government which would then be responsible for identifying, documenting, and reporting on preservation options for the EKW.

The detailed court proceedings have been captured by Dembowski (2001). The case took an interesting turn when, not being satisfied with the maps provided by the state government agencies, the judge visited the wetlands personally. This was followed by another visit to explore the physical state and study the technical mechanisms prevalent in *bheri*s. The first verdict was delivered in September 1992 and it was a victory for PUBLIC.[22] The verdict stated, "There can't be any matter of doubt that the Calcutta Wetlands present a unique ecosystem apart from the materialistic benefit to the society at large" and that no government or non-governmental body could reclaim any more wetlands (Kundu et al. 2008, p. 879). However, the state government was also provided with (limited) scope to plan a World Trade Centre and a permanent fair ground. One of the revolutionary accomplishments of the case was that the ruling made it clear that wetlands did not consist only of permanent water bodies and swamps; marshes and seasonally flooded areas were included in the court's definition. The importance of the EKW as the spill basin was also recognized apart from its function in providing numerous ecosystem services.

The collective voice of members of the administration and civil society including think tanks and NGOs led to "the most important case of environmental litigation in Calcutta" (Dembowski 2001, p. 83). This was also "the first incidence of a movement building up with an explicitly environmental goal" in the city (Dembowski 2001, p. 83). However, though the judgment seemed to be historical, neither did it recognize incidents of land occupation by force nor did it take into account the socio-economic woes and worries of wetland dwellers in great detail. Dembowski explains, "failure to deal with the social strife in the wetlands was another serious flaw of the rulings—all the more so, as these conflicts were again linked to the lack of good maps and proper landholding records" (2001, p. 139). The issue of relocation of tanneries and the construction of the Kolkata Leather Complex in Bantala through the heart of the EKW added fuel to the fire. Interestingly, the clash between the Supreme Court order following *MC Mehta versus the Union of India* (W.P. [C] No. 3727 of 1985) and the high court judgment concerning EKW protection signifies how context-specific environmental realities and priorities are key variables determining larger questions of environment and development.[23]

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[22] *Calcutta Law Journal*, 1993, vol. 1 (January to June), cited in Demboswki (2001).

[23] During the 1990s, the Kolkata tanneries polluting the river became a major issue within the context of the *MC Mehta* case focusing on industrial pollution in the Ganges. The Supreme Court finally ordered relocation of the tanneries to an area that fell within the boundary of the EKW, which in contrast was an already protected space as per the 1992 high court ruling (Mehta 1996).

In August 1995, PUBLIC filed another affidavit against cases of conversions and encroachments where state officials were accused of violating the 1992 high court verdict. The Supreme Court judgment on construction of the Kolkata Leather Complex, however, seemed to be irreversible and binding. Other subsequent cases included *Surojit Srimani versus the State of West Bengal* where petitioners including leading environmentalists of the city like Mohit Ray and Debaprasad Bhattacharya demanded adequate urban planning and stringent implementation along the EM Bypass. Reports with robust details of environmental challenges associated with rampant construction on the wetlands and in Dhapa were prepared, but in vain. By the late 1990s, several major projects had come up along the Bypass, such as Science City, the East Calcutta Township, the Satyajit Ray Film and Television Institute, and the Ruby General Hospital. But in spite of continued conversions and threat of real-estate speculation, the 1992 verdict had important implications in terms of abandonment of some of the proposed private projects (like the World Trade Centre), and also gearing forward national and international conservationist initiatives that finally culminated in the designation of EKW as a Ramsar site in 2002.

Following the 1992 judgment, the Land Reforms Department and the DoE, GoWB, identified around 32 *mouza*s to be preserved as part of the WRR.[24] The land schedule and reports were sent to the Ramsar Convention on the basis of which, on August 19, 2002, the EKW was declared as Ramsar site No. 1208. The broad Ramsar definition of wetlands as inclusive of lakes and rivers, swamps and marshes, wet grasslands, oases, estuaries, deltas, tidal flats, near-shore marine areas, mangroves and coral reefs, and also human-made sites such as fish ponds, paddy lands, reservoirs, etc., facilitated the incorporation of the EKW within its list of "wise use wetlands." The EKW became the Ramsar-designated "Wetland of International Importance," a major milestone and outcome of the long saga of struggle to craft a protectionist regime for the wetlands by recognizing their integrated ecological services and social value at large.

In 2006, a statutory authority called the East Kolkata Wetlands Management Authority (EKWMA) was set up under the East Kolkata Wetlands (Conservation and Management) Act for the implementation of wise use principles for the management of the EKW. The EKWMA is a 19-member body consisting of secretaries of different departments of the state government, other government officials, and three representatives from NGOs under the chairmanship of the chief secretary, GoWB. The EKWMA is guided by the East Kolkata Wetlands (Conservation and Management) Act, 2006, the East Kolkata Wetlands (Conservation and Management) Rules, 2006, and the Wetlands (Conservation and Management) Rules, 2010.[25]

[24]Later five more *mouza*s were added. Thirty-seven *mouza*s and a total area of 12,500 ha of WRR came under Ramsar designation and protection (Chap. 4).

[25]See http://ekwma.in/ek/ (accessed May 12, 2019).

However, construction even within the Ramsar-designated WRR has not ceased, which in turn has triggered fresh sets of petitions and protests from conservationists and activists, the process operating in a cyclical pattern. Though some projects lining the EM Bypass have been immediately stopped and the high court has even ordered demolition of housing complexes which were almost 80% complete, yet other government projects have received a nod at the cost of wetlands.[26] In 2006, PUBLIC filed a petition against KMC for its plan of constructing an INR 100 crore investment-laden water treatment plant in Dhapa. In 2008, the high court granted conditional approval to KMC, instructing that following inclusion of compensatory greening, creation of water bodies, minimization of ecological damage, and detailed dissemination of information about the quality and nature of materials to be used, KMC could go ahead with the project. The WWF and other environmental NGOs, with the support of the Ministry of Environment and Forests, Government of India, also protested against the failure of the Kolkata Leather Complex to construct the common effluent treatment plant in Bantala. In 2008, EKWMA issued an order that barred local authorities (municipal corporations and panchayats) from issuing licenses or sanctioning building plans for commercial activities without clearance from this statutory authority. By 2009, some of the projects which were opposed by the state government earlier (like Sanjeeva Towers) got EKWMA approval (Basu 2009).[27] In 2011, the fact that 33 water bodies located within WRR were filled up illegally for the construction of the New Town Rajarhat Township drew large-scale protests. In the same year, the government had to prepare a draft management plan to conserve the EKW.

Several illegal constructions have been going on in recent times, and at least 300 first information reports (FIRs) on violations within the EKW are pending, the most glaring one being Sri Sri Ravi Shankar's The Art of Living Foundation (Basu 2016). Despite a stop-work notice in September 2015 to halt the 8000 square foot building project, construction continued clandestinely. The National Green Tribunal ordered the demolition of the building in October 2017 in response to a petition filed by PUBLIC. In addition, the verdict clarified that the trust had to restore the wetland area to its original position after demolition was completed, as it had lacked any sanction order from EKWMA to build the property (Basu 2017a).

The plan to set up an eco-park with a bird sanctuary in EKW also drew the attention and concern of civil society. The proposed site was near the abandoned Dhapa garbage dump where a World Bank–funded project was also under way (Basu 2017b). Though the mayor of Kolkata confirmed, "Whatever we plan, it

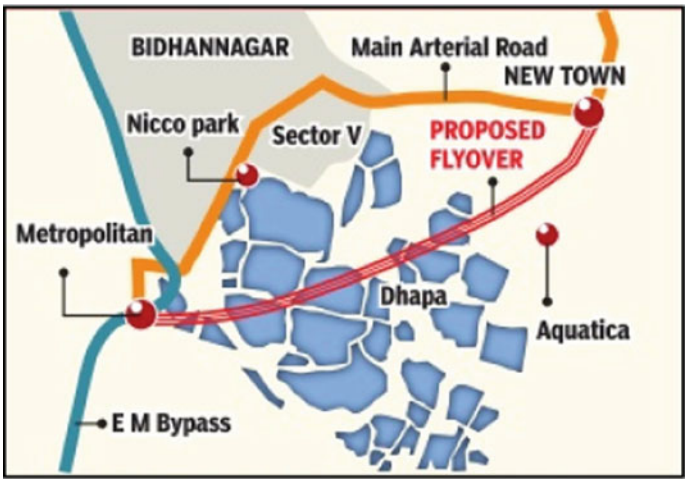
[26]The housing complexes include Sanjeeva Towers, a bungalow estate in Rajarhat, and Green Valley Towers (Basu 2005).

[27]The particular case of Sanjeeva Towers remained very controversial, drawing huge public and media attention. The promoter (Raj Modi, who also constructed the Vedic Village within the EKW) was imprisoned but managed to get both bail and project approvals. Basu (2009) considers this project approval as "green murder" and apprehends that "[t]he deal has emboldened all land sharks to think that the Wetlands are up for grabs and the authority will regularise all violations with 'post facto approvals' if the right strings can be pulled."

should be in tune with the local environment" (Chatterjee, quoted in Basu 2017b), yet there are doubts that this "will entail a lot of change in land use" (Kakkar, quoted in Basu 2017b). Satellite imagery reveals that *bheri*s close to the Bypass have shrunk by 77% in the last one and a half decades despite the protective legislation that EKW enjoys and environmental activism surrounding the issue (Basu 2017c). The Society for Creative Opportunities and Participatory Ecosystems (SCOPE) report (2017) on the Bhagabanpur *mouza*, one of the largest *mouza*s within the wetland belt that constitutes 5% (approx.) of the total area, exhibits how land sharks have rampantly filled up water bodies to create a 464-acre cluster of habitation, reflected in census figures (Basu 2017c). Of 47 large *bheri*s, 37 were converted between 1996 and 2016. While in 2006, water constituted 57% of the area, now it has come down to only 20%. A comparison of census data between 2001 and 2011 shows a fourfold increase in the number of houses in the area and population density, and since "the last census, the scale of violations has been even greater" (Dhrubajyoti Ghosh, quoted in Basu 2017c). In one of its Indian Council of Social Science Research (ICSSR) sponsored studies, SCOPE projected that the number of *bheri*s within the EKW has reduced from 264 to 202 (Ghosh and Dasgupta 2015). Complaints about unauthorized construction and illegal filling up of *bheri*s within the EKW peaked between June 2016 and June 2017. In the 12 months from June 2016, 57 complaints were lodged; the highest number of complaints lodged in a 12-month period since the formation and functioning of the EKWMA (Basu 2017c). These rampant illegal constructions within the EKW, validated and verified information of land use change through scientific surveys and research, the passage of the Draft Wetland Bill, 2016,[28] the amendment in the EKWMA Act in 2017 and its administrative implications for the EKW,[29] and the

[28]The Draft Wetland Rules, 2016, Section 4, lays out a proviso that maintains changes to the wetland areas may be allowed in "exceptional cases" with the prior approval of the central government. http://www.indiaenvironmentportal.org.in/files/file/Wetlands%20(Conservation%20and%20Management)%20Rules,2016.PDF (accessed May 12, 2019).

[29]According to the EKWMA Act, 2006, the chief secretary, GoWB, would also act as the chairperson of the wetlands authority. There has been a recent amendment (February 20, 2017) to the act, allowing the present environment minister to replace the chief secretary as the head. The minister also holds three other portfolios in addition to the most recent: those of the city's mayor, the state housing minister, and the minister responsible for fire safety. He has been known in the past to demand a say in the management and conduct of the wetlands tribunal (this was before he was appointed the chairman of EKWMA), going so far as to state his displeasure with the center for allowing the EKW to be included in the list of "Wetlands of Importance" and alleging that the KMC had been kept in the dark when the Ramsar status was acquired (Basu 2017d). The amendment to the EKWMA Act has vested power in one man—the environment minister—and this begs the question as to how he will delineate and discharge his manifold duties. Moreover, as he is also the mayor and housing minister at the same time, his ascription of precedence to "development" goals has reasons.



Map 8.1 The proposed flyover. *Source* Ray and Niyogi (2017)

most recent controversy surrounding the construction of a flyover connecting the EM Bypass with New Town Rajarhat have instigated renewed civic activism on the issue of wetland preservation and protection (Map 8.1).[30]

The proposal to build the flyover met with stiff resistance from environmentalists. The revival of civic activism has run analogous to a spate of articles in leading dailies (Basu and Ray 2017; Basu 2017d; Das 2017). Citizens took to social media to effectively and expediently spread the news of a charter undertaken by an environmentally minded populace to contain and overturn the imminent threat to the wetlands. Taking the assistance of hashtag campaigns (#SaveAndSustain and #HandsOffEKW), news was shared on Facebook about the environment minister's decision of pursuing the flyover project which raised alarm among citizens, given his past public statements attributing greater significance to "civic service" (development projects) than to conserving a wetland for the sake of "environmental nicety" (Acharya 2016). The post highlighted the demands of the concerned public; the swift dissemination strategy was effective in exposing the woes of the wetlands to a mass audience, quite a percentage of whom might not have heard or read about the EKW or its specificities previously. A charter entitled "Kolkata's Citizens Issue Statement Demanding Protection of East Kolkata Wetlands" was discussed at the Press Club, Kolkata, on March 1, 2017, which demanded that:

[30]WBHIDCO has proposed the construction of a 5-km-long flyover (to be completed by 2019) between the Bypass and the New Town passing through the EKW and involving construction of 146 piers across eight water bodies (Basu 2017e). Bonani Kakkar, PUBLIC, rebukes this as a "monstrous project" (Ray and Niyogi 2017).

- Actions must be taken with respect to more than 200 FIRs lodged by the EKWMA at various police stations against violations in the wetland area and the offenders should be identified. Further, appropriate action must be taken against police officers who have been negligent in their duty in this regard.
- In cases of reluctance and indifference in performing their duties in implementing the law, necessary actions must be taken against concerned officials of the EKWMA.
- Appropriate and precipitate actions must be taken with respect to other FIRs/complaints lodged by individuals/communities against wetland violations in the area. To enable prompt action, an Emergency Help Line must be set up to enable citizens to lodge complaints (Deb 2017).

Furthermore, the minutes of the Press Club meeting were posted and shared as it was occurring in real time, in separate sets, accompanied by same sets of hashtags. A total of eight Citizens' Reports were thus shared (#1, #2, and so on). In addition to this charter of rights, a petition campaign to garner signature support was activated on the Change.org platform.[31] The aim was to forward these demands to the secretary general of Ramsar and the Ministry of Environment and Forests, Government of India. On March 2, 2017, activists demanded a judicial commission headed by the Supreme Court or a high court judge to probe the destruction of water bodies within the EKW. The resolution "Save and Sustain East Calcutta Wetlands" was initiated by Sabuj Mancha and supported by environmental crusaders like Dhrubajyoti Ghosh and Subhas Datta during the same time. Several protest meetings involving environmental and grassroots NGOs, academicians, and scientists were organized in 2017 and 2018. Ruling on a PIL filed by PUBLIC, an order was passed by the high court restraining the state from pursuing the flyover project. The order clarifies that even if the Central Wetland Authority sanctioned the proposal, the approval first had to go through the green bench of the Kolkata High Court which would then decide the project's fate.

Dembowski's (2001) analysis of the first phase of environmental activism surrounding the EKW echoes the "bourgeois environmentalism" argument. He postulates that "attempts to gain the general public's attention had a strong bias towards the upper income, educated elites of the city" and the "NGOs were obviously able to mobilize people of their own social stratum" (Dembowski 2001, p. 101). He clarifies,

> The NGOs enjoyed considerable support, particularly in the first phase of the PUBLIC case, from the media and from bureaucrats frustrated with the inadequate performance of their own administrations. All these actors shared the same social background. They were

[31] https://www.change.org/p/save-the-east-kolkata-wetlands-ramsar-site-1208-total-125-sq-km-from-illegal-encroachment-over-the-years-wet-land-filling-and-stealing-of-ekw-water-bodies-are-going-on-hampering-ecological-balance-ekw-is-the-2nd-largest-wetland-in-the-whole-world?recruiter=117741415&utm_source=share_petition&utm_medium=facebook&utm_campaign=autopublish&utm_term=mob-xs-56997-reason_msg (accessed May 12, 2019).

> educated, upper caste, English-speaking Bengalis. The poorer sections of West Bengal's population did not play a role in the judicial proceedings or in the public discourse accompanying the litigation. (Dembowski 2001, pp. 140–141)

This accusation negates the significance of urban environmentalism surrounding the EKW, maybe also because of the fact that it only considers PILs and judicial activism which occupy the core of the movement, but are not the complete story. The other significant components of activism relating to EKW protection include rallies, protest meetings, on-site field meetings, discussions and exchanges, media mobilization, etc., that have played crucial roles in achieving milestones from getting the Ramsar designation to the formation of EKWMA to demolition of buildings within wetland boundary. That "the court proved to be a better forum for agitation than the streets had been for the educated middle class NGOs, with the particular advantage that this forum had the power to pass legally binding judgments and to make government officials answer during the proceedings" (Dembowski 2001, p. 101), was a major move that marked the beginning of the long-drawn struggle to protect the EKW assembling bureaucrats, environmental NGOs, grassroots activists, and, more recently, citizens including college and university students. That the Ramsar designation has proved to be a "big advantage" for EKW is evident from not only the petitioners referring to the fact time and again to make their argument strong and fight different conversion cases, but also the recent intervention by Ramsar authorities pressurizing the government to come up with a management plan which was one of the conditions for the Ramsar recognition (Bhattacharya 2018; Basu 2017d).[32] Lew Young, an adviser to the Ramsar secretariat who visited Kolkata in 2017, made it clear that Ramsar authorities would not consider any request for modification of the rules in the absence of the management plan. And hence, none of the environment minister's plans "will see the light of the day unless the rules barring construction in the wetlands are relaxed" (Basu 2017d). The recent online eco-activism is the outcome of battles being fought since the 1990s. With the demise of Dhrubajyoti Ghosh and Asish Ghosh in early 2018, and numerous challenges relating to quantity, quality, and access to wastewater among different *bheri*s, the fight to save the wetlands along collective lines has become ever more difficult and challenging. But generating awareness about this rich history of sustained collective action, whose topicality is never in question due to the constant and imminent threats to the EKW, is a commendable approach that highlights the needs and merits of treading the trajectory of environmental activism to secure the rights of this ecosystem and the multitude whose livelihoods are entangled with and ensured by sustainable flows between the city and its wider ecological surroundings.

[32]Interview with Nitai Kundu, January 2, 2019.

8.4 Beyond the Bourgeois–Subaltern, Nature–Culture Divide

In this chapter I have interrogated the "bourgeois environmentalism" lens as the sole frame of analysis that can be applied to explore environmental activism within India's urban contexts. Through two case studies, the chapter has validated why and how it is significant to transcend the "bourgeois environmentalism" approach to include varieties of urban environmentalism, shaped by specific political conjunctures in particular regional contexts. Through this chapter, I have attempted to postulate the need to capture multiple trends and trajectories of environmental activism across complex mediations among various stakeholders in situated contexts.

In the Adi Ganga movement, two contradictory wings of protest are discernible. While radical grassroots protests remained restricted to the direct correlation between the state of the river and basic survival provisions for the urban subaltern, the "heritage" argument in middle-class environmentalism unfurls the intellectual universe of Kolkata's educated, cultured, and affluent activists, to whom the rich riverine history of the Adi Ganga and riverine flows connecting the city of Kolkata with its larger deltaic-estuarine scape seemed to be extremely significant. These two varieties of environmental activism clashed with each other and none of these turned out to be successful, as evident in the death of the river and displacement of squatters from its banks.

In the EKW case, however, protests for the preservation of wetlands directly overlapped with the protection of livelihoods of marginalized fishers and farmers. Again, in the efforts to save the wetlands across different waves of environmentalism since the early 1990s, bureaucrats, NGOs, and grassroots organizations came together with the consolidated cause of sustaining Kolkata through the survival of her peripheral wetlands and wetlanders. Public interest litigations have been accompanied by protestations tapping the potential of online protest forums including social networking sites to draw large-scale participation of people including students and youth. Time and again, rallies, protest meetings, on-site field meetings, discussions and exchanges, media mobilization, etc., have comprised the thick story of activism surrounding EKW. The inconsistent series of verdicts given by judges relating to construction activities within the Ramsar-designated EKW can be explained better by development trajectories treaded by the state than by the whims of individual judges making decisions in cases of interventions.

Finally, through the analysis of these movements, I have tried to argue that these protests and the complex contestations surrounding them should not be understood only as pointers to power hierarchies geared towards the politico-economic imperatives of statecraft, but should be perceived as pathways to the future of urban sustainability.

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Chapter 9
Conclusion: Beyond Declensionism, Towards the Useful Narrative

Within the present context of the "Anthropo-obscene," the major urban challenge is how to create a city along ecologically saner trajectories with a resilient future.[1] In this book, through the application of HUPE, I have argued that political ecology is not only political but also plural, i.e., it has the capacity to capture and activate dominant, counter, and suppressed story lines that make and unmake the urban environmental palimpsest. Moreover, the stories of mediations among multiple stakeholders including engineers, planners, municipal officials, farmers, fishers, and the citizens of Kolkata including middle-class environmental enthusiasts, grassroots activists, and squatter settlers that I have narrated across historical scales enable us to map not only clashing priorities but converging interests to optimize on Kolkata's ecological assets.

I have demonstrated how the functioning of various components of the "blue infrastructures" of Kolkata indicates strong municipal–local, bureaucracy–technocracy, and state–civil society interactions over a long period of time. Detailed archival research, multiple rounds of field exposure, and interviews, exchanges, and conversations with municipal officials and engineers, scientists, activists, leaseholders, and fishers working in the EKW over a decade provided me with rich insights and perspectives to understand different sets of drivers and dynamics that can be considered as key variables in the functioning and sustenance of the wetlands. These drivers and dynamics keep changing with shifting development perspectives; yet the basic municipal–local interactions continue, which is the lifeline of the EKW. Through historical analyses of empirical records, I have critically interrogated binaries or compartmentalizations between "nature" and "city," "state" and "local," "tamed" and "untamed" that prevent us from comprehensively

[1]Using and combining critical geography, urban studies, and political theory, Ernstson and Swyngedouw (2019, p. 5) mobilize "Anthropo-obscene" to explicitly bring out the contemporary cyborgian web of human/non-human entanglements and also to undermine "the utterly depoliticized concept of 'the Anthropocene.'".

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capturing city–nature dynamics on which the survival and sustenance of both the urban and the environment rest.

With the global environmental change scenario in general and additional vulnerabilities of the cities of the global South in particular, experts are more concerned about the ability of developing cities to cope with the contemporary climate crisis. India's urban transition and its implications for climate change mitigation and adaptation has brought to the fore an emerging urban climate debate (Khosla and Bhardwaj 2018). In Chap. 5, I discussed reports shedding light on the vulnerability of the delta city of Kolkata to the climate change crisis. I discussed in Chap. 1 the diverging sets of arguments between historians and scientists about risks and resilience in reclaiming Kolkata from the marshy, deltaic scape comprising the Indian Sundarbans. The explorations of the evolution and functioning of Kolkata's "blue infrastructures" since colonial times address this debate by arguing that Kolkata's vulnerability and viability are not mutually exclusive. Chapters 2 and 3 described why and how the selection of the site as the British capital was determined by ecological (estuarine and deltaic) incentives that the place offered followed by a series of tamed colonial hydraulic interventions to harness utility costs for the city. That the urban environmental template of Kolkata not only provided affordable utilities but became a space offering an array of ecological services including provisioning, regulating, and supporting services finds vivid reflection in Chap. 4, which discussed in detail the evolution and emergence of sewage-fed wetlands on the periphery of the city across municipal–local interactions and initiatives. In Chap. 4, by combining archival methodology and ethnography, I clarified that the portrayal of the EKW as an entirely "locally driven," "locally owned," and "locally managed" system is a eulogizing narrative. The Calcutta Corporation and the DoF, GoWB, were enthusiastic about sewage-fed fisheries development and also laid out technical plans to harness the best possible solutions for simultaneously managing municipal waste and wastewater, generating local livelihoods and establishing a sustainable revenue regime (Calcutta Corporation 1946; I&WD 1947).

In Chap. 5, I discussed recent research focusing on the significance of Kolkata's canal system and wetlands as a flood relief line with major implications for the flood-resilience efficacy of the city. In this chapter, I also countered the mainstream narrative that projects the colonial period as the golden era for Kolkata's canal infrastructure and the contemporary period as marked by sheer apathy and indifference on the part of the municipal agencies and the state towards maintaining and revitalizing the system. I argued why and how this should be understood as a succession of technologies across different modes of production, determining and being determined by politico-economic imperatives of statecraft.

Dhrubajyoti Ghosh used to painfully hint at EKW being "real estate in the making." Huge expanses of wetlands have made way for estate with urban planning and development promoting an east-centric urban sprawl (Chap. 7). I have discussed its economic, ecological, and social costs in Chap. 6, clearly showing how Kolkata's environmental vulnerability and reduced sustainable livelihood opportunities are being intensified with insane and unending real-estate speculation.

There has been ongoing urban environmental activism surrounding the coupled conversion-displacement issue which is loaded with both "green" and "brown" agendas, as evident in the campaign for saving the Adi Ganga River, and the convergence of the two in protests to protect the wetlands, which I covered in Chap. 8. Here, I have pushed the contours of the "bourgeois environmentalism" paradigm to focus on various shades of urban environmentalism involving multiple stakeholders and complex mediations among them along a wide spectrum from conflicts to collaboration with negotiations and bargains in between.

Like its other Indian counterparts, Kolkata has also plunged into beautification drives and green initiatives, including the development of New Town Rajarhat as a "green city." Experts like Dhrubajyoti Ghosh and Asish Ghosh who had fought for the protection of EKW and wetlanders for several decades were skeptical about state-sponsored ecotourism in the wetlands as it excluded local inhabitants and replaced local ecological practices, displacing wetland-dependent communities.[2] These sanitized ecological initiatives can at best serve the needs of ecology "in" cities without paying heed to the ecology "of" cities that studies and emphasizes the "sustainable flows" between the city and its wider ecosystems for long-term sustenance and survival of both (McDonnell 2011; Mukherjee 2015). And it is in these ecological subsidies offered by the wider urban ecological infrastructures that the resilience of a city is rooted.

I argue that the resilience of Kolkata has to be nurtured, harnessed, and garnered by optimizing on her ecological incentives by understanding compulsions and exploring converging equations among multiple stakeholders beyond conflictual affiliations and positioning. An illustration can be effective within this context not only to validate this argument but also to provide a lens through which these overlapping interests can be mapped and optimized. In recent times, the major bone of contention in the EKW has been wastewater supply and distribution from municipal canals. It has been mediatized that KMC and I&WD are deliberately discharging the city's sewage directly into the outfall system, depriving the fishers and discouraging fisheries in the EKW which is compelling them to sell their *bheri*s to the real-estate market.[3] So the direct correlation between urban development, wetland conversion, and wastewater supply is manifested in this discourse. However, I have complicated the projected hierarchical positioning between the state (with municipal and irrigation officials having the entire control of the effluent discharge and disposal mechanism through operation of pumping stations, lock gates, sluices, etc.) and the fishers (at the receiving end, with no decision-making power and influence) through detailed mapping of technical apparatuses and social arrangements facilitating the canal-(sewage-)wetland integrated system since its evolution in the 1940s. This case study clearly shows that though there is power

[2]One example of such an initiative is the newly constructed "Eco Park" in New Town Rajarhat, which I have briefly discussed in Chap. 2.

[3]A report published in the *Times of India* commented, "The flow of sewage into the fish farms or bheris has been deliberately reduced in an attempt to snuff out fishery and farming and make way for conversion of the land into real estate" (Niyogi 2015).

asymmetry and conflict in terms of wastewater control, supply, and distribution mechanisms, yet there are also compulsions and convergences among multiple stakeholders which should be accounted for and worked upon towards effective delivery of ecosystem services in the EKW.

Traditionally, the lock-gate regulation at Bantala which controls the distribution of sewage should be maintained at a maximum GTS (Grand Trigonometric Survey) of 9 points, which is lowered to 4.5 during the monsoons. This arrangement ensures that there is an appropriate amount of sewage water flowing into the *bheri*s during peak fish cultivation season. At the Bantala point, however, the I&WD has been diverting water into the Kulti River after an accumulation of just 7.5 GTS rather than the regulated 9 GTS. This has generated two significant problems. First, it has impeded the flow of nutrients to the fish in the sewage-fed ponds, impacting the livelihoods of the fishermen working in the *bheri*s. Second, the water flowing into the Kulti River is untreated, affecting the ecology of the river as well as the health and well-being of more than 20,000 people residing in the Sundarbans (Mukherjee and Ghosh 2015). In an interview with Sasidulal Ghosh (leaseholder, Jhagrashisha Bheri), he explained that maintaining the recommended GTS level through the DWF is time consuming for pump operators employed at the pumping stations, due to which they often channelize the city's sewage directly and quickly to the Kulti Outfall Scheme through the SWF which has a better capacity than the former.[4] Visits to pumping stations to validate the argument revealed that the pump operators were not aware of the nitty-gritty of this entire mechanism and only operated as per instructions from irrigation higher authorities on a time-to-time basis. Pump operators, however, emphasized the greater use of SWF in recent times even to flush (dry weather) sewage.[5]

With this changing scene, the *bheri* owners are interested in using wastewater from SWF with a positive response and infrastructural support from KMC and I&WD. But the government departments have still not confirmed the possibility of this arrangement. Sewage mainly flows into the *bheri*s by gravity during 270–300 days of the year as the regulator gate at Bantala on the main sewage canal is kept closed during the dry seasons to raise the level of wastewater in the canals so that it flows into feeder canals and then into the fishponds. The regulator gate is kept open during the monsoon season to lower the water level in the main canal to prevent flooding in the city, which makes fishers complain about inadequate flow in feeder canals. In another interview, an irrigation official explained how the I&WD remains sandwiched between the pressing needs of the KMC on the one hand and the fishers on the other. With pressure of waterlogging in Kolkata which not only affects daily amenities but also draws huge media and activist attention especially within the context of climate change, strict instructions from KMC to I&WD are provided to keep DWF dry and SWF with water at a much lower elevation, which is ensured through quick discharge into the main outfall in order to protect the city

[4]Interview conducted in December 2018.

[5]Site visits were conducted in December 2018.

Table 9.1 Major stakeholders associated with wastewater supply, distribution, and management in the EKW

Stakeholder	Roles and responsibilities
KMC	Discharge of sewage through pumping stations
I&WD	Responsible for disposal of sewage, regulation of lock gates, and maintenance of storm and sewage channels
Water user committees	Wastewater allocation, monitoring, and enforcement in respective *bheri*s
Fishers	Wastewater management in *bheri*s in respect of the "wise use" principles

Source Compiled from secondary literature and field findings

from the backlash of monsoon (storm) waters.[6] Time and again stakeholders' meetings and discussions are held to ensure that varied needs and interests of the agencies involved in Kolkata's drainage-sewerage-aquaculture business and enterprise are met. Within KEIP, funds were allocated to reclaim the existing distribution channels of the EKW and therefore improve the supply and distribution of sewage. The KEIP report observes that this reclamation or desiltation of canals "would have not only benefitted the fish ponds but also got rid of the 'technology option' for the treatment of municipal sewage and wastewater which is very expensive (both capital and recurring), operationally unreliable and require a lot of electricity" (KEIP 2012, p. 24). Major portions of the distribution channels were reclaimed by KEIP, which also built six sluice gates and nine culverts in close consultation with the stakeholders (KEIP 2012) (Tables 9.1 and 9.2).

Locals have been enthusiastic and appreciative of the measure, arguing that government funding and support have boosted their confidence to pursue fishing to a great extent. Moreover, though locational advantages and disadvantages (in relation to the proximity of the main municipal canal) determine wastewater supply, the internal mechanism of wastewater distribution and allocation within *bheri*s is commendable. Oral interviews conducted with leaseholders and fishers affirmed that there are wastewater users committees (WUCs) that control and keep track of wastewater distribution in *bheri*s which share wastewater from the same secondary or tertiary canal. The intake of wastewater by each shared *bheri* is managed by the locally constructed lock-gate system (*kapat* in the local dialect). When one particular *bheri* receives wastewater, the *kapat* of other *bheri*s in the shared system is closed. Wastewater allocation and time of intake from a few hours to three days a week is determined as per the size of *bheri*s, roughly ranging between 5 and 50 hectares. Locals report that violations of these internal arrangements are extremely rare as this leads to social ostracism. The WUCs meet at least once a month to discuss water allocation and other issues relating to better and effective management of fish production.

[6]Key informant interview with the sub-divisional officer, Calcutta Drainage and Outfall Committee, I&WD, January 2018.

Table 9.2 Desiltation of canals under the KEIP scheme

Name of basin	Name of the canal	Length desilted (km)	Total length (km)
EKW (North)	Paran Chaprasi Khal	3.210	*34.953*
	Nalban Khal	3.600	
	Karunamoyee Khal	4.146	
	Defunct DWF (Dhapa Lock Gate)	0.760	
	Ghosher Khal	6.177	
	District Board Khal	3.640	
	Charcharia Khal	2.680	
	Fishery Feed Canal	3.840	
	Main DWF Channel	4.500	
	Defunct DWF Khal	2.400	
EKW (South)	T.P. Bajbarantala Khal	3.800	*36.197*
	Nodar Khal	5.210	
	Lalkuthi Khal	3.480	
	Deara Khal	6.787	
	Kharkibere Khal (Bajbarantala)	3.970	
	Fishery Feed Canal	4.220	
	Kanchagheri Jhowkhali Khal	4.200	
	Bidyadhari Extn. Canal	4.530	

Source KEIP (2012, p. 61)

Again, I have projected that each *bheri* has its own narrative, focusing on context specificities within the larger story of "blue infrastructures" to avoid impressionistic generalizations and to be effectively aware of sets of challenges and potentials that have to be worked upon. *Bheri* owners, leaseholders (private *bheri*s), secretaries (cooperatives), and project managers (government *bheri*s) have different levels of enthusiasm, skill sets, and approaches towards the water bodies, influenced by, and in turn influencing, a range of economic and political variables. While there are some private leaseholders who are keen to sell their *bheri*s to promoters due to reduced profits during recent times, there are others, like Sasidulal Ghosh, who are not only attached to their own *bheri*s against economic returns but also have the technical knowledge and intense enthusiasm for the well-being of this integrated scape. They keep mobilizing WUCs through series of meetings among wetlanders and represent the EKW at government platforms and multi-body committees like the EKWMA for optimizing on effective management practices in the wetlands. While some cooperatives had given way to private *bheri*s, there are successful cases like the Baro Chaynavi Matsyabay Samiti where enthusiastic secretaries like Gobinda Sardar are able to draw government attention and funds to increase productivity and profits. Very recently, Baro Chaynavi has also started ecotourism

supported by government funds amounting to INR 5 crore, which the secretary thinks will provide a better edge to its performance and sustenance.[7]

With the contemporary mega-urbanization drive at the cost of Kolkata's ecological infrastructures, the micro realities discussed above might seem unsubstantial. Yet, the nitty-gritty needs to be learnt and told, and the efforts appreciated. Renewed civic activism might seem small against the overarching reality of the real-estate drive, yet it is putting tremendous pressure on the unabated sprawl on Kolkata's eastern periphery. Some innovative projects, protest meetings, and academic workshops involving actors from divergent domains and disciplines to collectively address the complex system of Kolkata's "blue infrastructures," making Kolkatans aware of challenges, complexities, potentials, and opportunities, and activating agency among Kolkatans for Kolkata, are also a contemporary reality.[8]

Finally, I conclude by arguing that it is important to craft a common language of conversation between academicians and policy makers. Loftus (2015, p. 180) envisions that political ecology has the capacity to evolve from a theoretical and academic tool to an effective framework of application by simultaneously giving and taking as an endless "engaged praxis." I believe that the analytical lens of HUPE can provide a perspective to policy makers through which they will be able to visualize the larger picture. Again, this methodological tool will also gain much from a closer engagement with bureaucrats and engineers through a better grasp of their ideas, perceptions, policies, and actions. While detailed understanding of "sustainable flows" between the city and its wider ecological infrastructures falls within the academic and methodological purview of HUPE, by enabling "exchange flows" among multiple actors across divergent domains, disciplines, and departments, it will render the much-needed political commitment geared to the ultimate agenda of formulation of a robust, resilient matrix, comprehensively capturing every dynamic variable making way for Kolkata's resilience (Fig. 9.1).

The positive moments in the long evolution of the "blue infrastructures" of Kolkata, including fascinating technical designs carved out by municipal engineers optimizing upon the urban ecological subsidies, entrepreneurial enthusiasms among *bheri* owners, leaseholders, and cooperative secretaries, and the best intentions, efforts, and initiatives of bureaucrats, civil society, and grassroots environmentalists to protect the wetlands, have to be lived with and cherished together with the collective realization that these attempts cannot go in vain. Within today's context of over-dominance of dividing discourses channelizing declensionism, the utopian

[7]Key informant interview (conducted by research scholar Shreyashi Bhattacharya) with Gobinda Sardar in June 2019.

[8]These include the recent KMC plan to revamp the Kalighat Temple along with the restoration of Tolly's Nullah (involving innovative architects like Anjan Mitra), and the workshops conducted by SEARCH–IIT Kharagpur on Kolkata's canal systems in 2016 and 2018 ensuring participation from municipal officials, architects, social scientists, NGOs, and students to design rejuvenation plans addressing the intersections between physical and social components within the urban fabric.

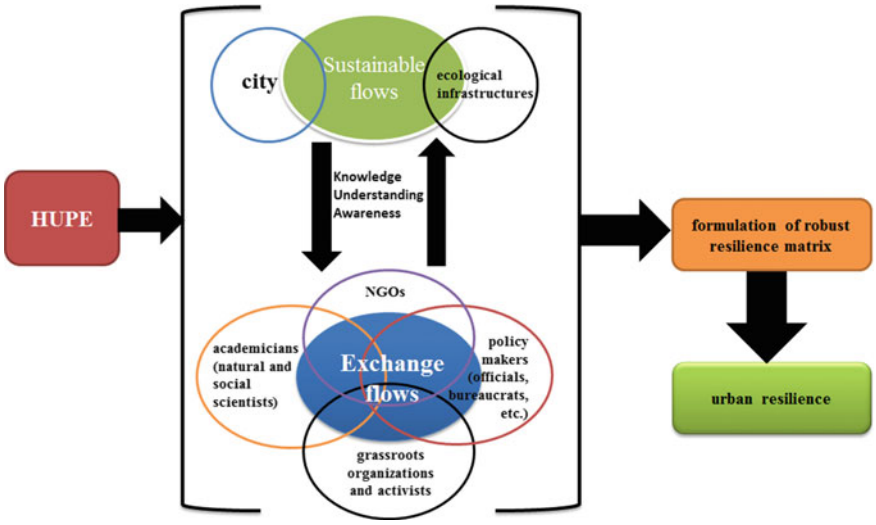

Fig. 9.1 Facilitating flows towards urban resilience, through HUPE. *Source* Author

urge to bring change by optimizing on existing opportunities and upscaling these can be considered as a radical option.[9] The "blue infrastructures" book project has been pursued with this political commitment to conveying the "useful narrative," unleashing multiple moments across both challenges and opportunities in the long and complex urban environmental sojourn, enabling Kolkata re(gain) her resilience against adversities within the "Anthropocene."

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[9]Braun (2015, p. 103) argues for "a 'post-critical' political ecology" through "utopian thinking," which to him is not impossible to imagine or at least to experiment with.

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