

To flow, or to Fortify?

Water, Development, and Urbanism in Building a Deltaic Metropolis

Fahmid Ahmed

Thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy



School of Architecture and Built Environment

May 2017

Abstract

More than half of the world's population live in urban areas, many of which are located in vulnerable regions along the edge of water. Water is the life-blood of these settlements, but, at the same time, poses a huge potential threat as the pace of urbanisation and climate change intensify. Historically, Dhaka (in Bangladesh) had a symbiotic relationship with water, but today this rapidly urbanising metropolis is facing critical everyday stresses from water, which are being compounded by the onset of climate change. Dhaka is one of the most densely populated urban centres in the world, with more than fifteen million people concentrated at the centre of the low-lying delta of the world's largest river system. Thus far scholarship on Dhaka has tended to promote a somewhat impressionistic conceptualisation of 'water urbanism' to explain the physical and socio-cultural history of the city. However, the cultural and administrative (institutional) histories of water management in the context of urban development, along with the complex plan-making processes that have shaped them, have not as yet been sufficiently explored so as to explain how Dhaka is increasingly failing to live sustainably with water.

How water was managed in the past informs both present and future practices. The aim of this research is to shed light on the changes and continuities in the urban design practices in relation to water in Dhaka, with a particular focus on the development agencies and actors involved between the colonial and contemporary era. To explain the transformation from traditional to modern water cultures, the project has sought to identify and interpret changes in lifestyle, modern mobility and infrastructure, and the scale of modern urban development.

Adopting a mixed methodology, comprised of interpretive historical research and case studies, the primary research was conducted in Dhaka. The research employs a range of tactics, including a questionnaire survey of local residents; semi-structured interviews with various agents in the realms of design, planning, and policy; and a documentary survey and analysis of relevant historical maps and archives.

The final thesis begins by examining the hydrological history of Dhaka and its larger context within the Bengal Delta, in order to discern the historical pattern of human settlement in the region, which has been influenced by the consequences of constantly shifting water courses. The discussion then considers the typical architectural responses to water at the urban scale, which

became features of Dhaka's evolving water culture in the modern era (between initial colonial urban development and the accelerating growth and expansion of the city in the early post-independence period). Interpretation of relevant archival evidence and documentation identifies a paradigm shift from flow to fortification over the course of these early modern developments, where the natural forces of floods and river-flows were ultimately controlled through the introduction of increasingly hard and instrumental engineered features. These features include cordon system embankments and box-culvert drainage works, which have radically altered the pattern of urbanisation in Dhaka in recent years.

In the current development scenario two opposing tendencies are evident. One is to construct new parcels of land suitable for development by filling up low-lying wetlands. The other involves reconstructing, or even creating new wetlands, to ensure drainage and capture additional value from retained water for aesthetic and recreational use, and even as infrastructure for transportation and mobility. Taking two examples of these respective tendencies, Bashundhara Township and Hatirjheel-Begunbari Integrated Development Project, as comparative case-studies, the later chapters of the thesis investigate the embedded factors of planning that give direction and shape to these opposing tendencies. By unravelling the planning process the thesis seeks to explain the deep-rooted logic and influences upon such urban developments, which may not otherwise be self-evident. The interview findings explain how development agencies and actors who are part of the development system comprehend water in design. In contrast, the questionnaire survey reveals how differently people who live in the two developments relate to water today in comparison to the water culture of previous centuries.

The research underscores the need to rethink Dhaka's water urbanism and water culture, if it hopes to sustain further urban development. Questioning the sustainability of both passive traditional approaches and invasive modern engineering, the research indicates that a more flexible approach to urban water management, amenable to both flow and fortification, may be a more realistic and effective strategy.

The research addresses a gap in previous scholarship on the history of architecture and urban development in South Asia. With a particular focus on the planning process, it explains how the development agencies and actors operating in a changing political context, but deeply influenced by a technocratic mind-set that goes back to the colonial era, have sought to manage water in ways that have ultimately changed both the culture and the physical pattern of urban development.

This original research on Dhaka's urban history and culture, in relation to water, provides a platform for further research on related issues in the disciplines of Architecture and urban planning. It informs us about future policy and shows us how the future might be better framed, if water is kept in mind. Analysing the extreme case of Dhaka may provide lessons for the future development of cities in comparable situations.

Table of Contents

<i>List of Figures</i>	<i>vii</i>
<i>List of Tables</i>	<i>xv</i>
<i>List of Acronyms and Abbreviations</i>	<i>xvii</i>
<i>Declaration</i>	<i>xxi</i>
<i>Acknowledgement</i>	<i>xxiii</i>

Chapter 1	1
1.1 Research background and context	2
1.1.1 Overview	2
1.1.2 Geographical setting, urbanisation history and the context of the case study	5
1.2 Research questions	11
1.3 Research aim and objectives	12
1.3.1 Aim	12
1.3.2 Objectives	13
1.4 Rationale	13
1.5 Methodology	16
1.6 Thesis structure	16
1.7 Conclusion	18
Chapter 2	19
2.1 Introduction	20
2.2 Methodology and methods	22
2.2.1 Literature research	24
2.2.2 Historical research	25
2.2.2.1 Procedures for archival research in Dhaka, Bangladesh	26
2.2.2.2 List or category of collected historical documents used in this research	27
2.2.2.3 Analysis of maps, drawings and historical records	28
2.2.3 Physical observation	29
2.2.4 Questionnaire survey	30

2.2.4.1	Questionnaire design	30
2.2.4.2	Process of the questionnaire survey	31
2.2.4.3	Questionnaire survey analyses	32
2.2.5	Semi-structured interviews	33
2.2.5.1	The semi-structured interview Process	34
2.2.5.2	Interviews questions/topics of interviews	38
2.2.5.3	Interview analyses	39
2.3	Research ethics	39
2.4	Summary	40
Chapter 3		43
3.1	Introduction	44
3.2	Theory and practice of water urbanism	44
3.2.1	The concept of water urbanism as a new platform for discourse in the history of urban development	44
3.2.2	Multiple dimensions of water in the urbanism discourse	47
3.2.3	Cities in relation to their water and water culture	49
3.2.3.1	Traditional/indigenous cities in relation to water	49
3.2.3.1	Modern Cities in relation to water	50
3.2.4	Urban Development, Water and Sustainability	53
3.3	Discourses on urban development manifested by the colonial and post-colonial agencies.	56
3.3.1	Colonial modernity	57
3.3.2	Influences of institutional frameworks in urban development	59
3.3.3	Post-colonial realities of urban development	61
3.4	Current water urbanism discourses in Dhaka	62
3.5	Conclusion	65
Chapter 4		67
4.1	Introduction	68
4.2	Cultural practices in the Bengal delta relating to water	69
4.3	River migration	72
4.4	History of water courses and river shifting in the Bengal Delta	74
4.4.1	17th and 18th century river system	74
4.4.2	The 19th century river system	77
4.4.3	The 20th century water network and modern engineered interventions	79
4.4.4	The 21st century rivers and the impact of climate change	82
4.5	Micro-regional hydrology of Dhaka and the historical development of its internal water courses and wetlands	83
4.5.1	The historical water courses of pre-Mughal and Mughal Dhaka	83

4.5.2 Colonial Dhaka and its water network	88
4.5.2.1 Early colonial Dhaka	88
4.5.2.1 Colonial Dhaka during the second half of the 19th century	91
4.5.3 Early twentieth century colonial Dhaka in relation to its water system	94
4.5.4 Post-colonial and post-independence Infrastructure Interventions: managing water in the second half of the twentieth century	96
4.5.4.1 Post-colonial Pakistan period	96
4.5.4.1 Post-independence Bangladesh period	99
4.5.5 Constructed engineered landscape of contemporary Dhaka in relation to its wetlands in the twenty-first century	103
4.6 Conclusion	104
Chapter 5	105
5.1 Introduction	106
5.2 History of the Dholai Canal	107
5.2.1 The Dholai Canal during the Pre-Mughal and Mughal era	108
5.2.2 The Dholai Canal during the colonial era	109
5.2.3 The Dholai Canal during the post-colonial era	112
5.3 Historical embankments in Dhaka	114
5.4 The floods and the fortification of Dhaka during the twentieth century	117
5.4.1 The planning process of the Flood Actor Plan (FAP) in 1989 and its consequences	120
5.4.2 Post embankment Dhaka and the eastern bypass road cum embankment	125
5.5 Transforming canals into engineered drainage infrastructure during the 1990's	128
5.5.1 The case of the Sugunbagicha-Fakirerpool-Arambagh-Kamlapur Canal	132
5.5.2 The box-culvert as a drainage solution	136
5.6 Consequences of the modern engineered Intervention of Infrastructure and current development agency Initiatives	138
5.7 Conclusion	141
	143
Chapter 6	
6.1 Introduction	144
6.2 Land mass extension phenomena in Dhaka	145
6.3 History of the Bashundhara area	148
6.4 The planning process for the Bashundhara Township project	151

6.4.1	Initiation of the project:	151
6.4.2	Project details and the planning process	154
6.4.3	The Bashundhara Township project in relation to planning guidelines, bylaws, and other regulations	157
6.5	Performance of land constructed through landfilling	164
6.5.1	Physical and environmental implications of constructed Land after a landfill project	164
6.5.2	Socio-economic impact:	172
6.5.3	Stakeholders (residents) perspective of the Bashundhara area	172
6.6	Conclusion	179
Chapter 7		181
7.1	Introduction	182
7.2	History of the canal	183
7.3	The planning process	186
7.3.1	Background and Initiation of the project	186
7.3.2	Initiation of the planning and design process	191
7.3.3	Involvement of the VITTI-DPM-AIA consortium as Design Consultants in the Hatirjheel-Begunbari Integrated Development Project.	193
7.3.4	Project Details	196
7.3.5	Challenges during project implementation	200
7.4	Impact Of The Urban Regeneration: Post Construction Scenario And Findings From The Field Survey	202
7.4.1	Physical and environmental impact of the reconstructed Wetland Project	202
7.4.2	Socio-Economic aspects of the post construction scenario	206
7.4.3	Impressions of the residents around the Hatirjheel Project	211
7.5	Future scope for Hatirjheel	215
7.6	Conclusion	216
Chapter 8		219
8.1.	Introduction	220
8.2.	Constructed land versus reconstructed wetland: a comparative analysis of contemporary approaches towards urban development	221
8.2.1	Project details and findings from the comparative analysis of Hatirjheel and Bashundhara	230
8.3	Factors influencing water intervention in the urban development of Dhaka	233

8.4	Major investigation outcomes	237
8.4.1	Scale of the urban development	237
8.4.2	Influences of Modernity	239
8.4.3	Water culture transformation	241
8.4.4	Urban sprawl, or land mass extension, through landfilling	242
8.4.5	Reconstruction or redevelopment of wetlands	245
8.4.6	Governance and institutional framework	246
8.4.7	Bylaws and corruption	249
8.4.8	The impact of military dictatorship during the post- colonial era, and the influences of the military on contemporary urban development	250
8.4.9	Engineering intervention of water management in design: a solution or a problem?	250
8.4.10	Isolation and compartmentalisation of water	252
8.5	Conclusion	254
		257
Chapter 9		
9.1	Summary	258
9.2	Prospect/future of Dhaka's water urbanism	260
9.3	Future research recommendation	262
	Bibliography	265-300
	Appendices	A1-A52

List of Figures

Figure 1-1:	<i>Images showing different parts of Dhaka (sources: author, Tahwir Siraj, Yann Arthus-Bertrand and Anastasia Mikova).</i>	5
Figure 1-2:	<i>Bangladesh in the largest delta and its river system</i>	6
Figure 1-3:	<i>Dhaka on Google Earth, showing its four rivers</i>	6
Figure 1-4:	<i>Dhaka beside the Buriganga River. Source: Yann Arthus-Bertrand and Anastasia Mikova</i>	7
Figure 1-5:	<i>Growth of Dhaka city (source: Dhaka City Corporation, modified by author)</i>	7
Figure 1-6:	<i>Different types of urban areas with different patterns and density and its wetlands (river, canals, lakes, retention area and flood plains) in Dhaka in the same scale (source: Google Earth)</i>	11
Figure 4-1:	<i>Current water culture along river Budiganga (including the embankment built in 1989) and other waterbodies (the majority of the photos were taken during the field survey in 2014, and the rest were taken earlier by the author)</i>	72
Figure 4-2:	<i>Cartographical records of 1635 (source: Dr. Abu Syed Saeed M. Ahmed) and 1716 (source: https://www.raremaps.com/gallery/search?search_term=bengal)</i>	75
Figure 4-3:	<i>Map of Bengal in 1750 (source: https://www.raremaps.com/gallery/search?search_term=bengal)</i>	76
Figure 4-4:	<i>Survey map of 1780's republished in 1794 drawn by Major James Rennel (source: National Archive Bangladesh)</i>	77
Figure 4-5:	<i>Maps of the 19th century Bengal Delta (source: http://www.davidrumsey.com/search?utf8=%E2%9C%93&term=bangladesh)</i>	80
Figure 4-6:	<i>Bangladesh with its major watercourses (rivers and sea).</i>	82
Figure 4-7:	<i>Map showing the water channels of 1780 and 2015, including important structures of pre-Mughal, Mughal, and the early colonial period. The map indicates the forts (Killa) from the Pre-Mughal and Mughal period. In the background is a map of Rennell that was collected from the National Archive of Bangladesh. Wetlands present in 2015 have been traced from Google images</i>	87
Figure 4-8:	<i>A map showing the water channels and urban areas from the 1780's and 2015. The current area of metropolitan Dhaka is 303 km²; however, the DMDP area is much larger (1528 km²). This map also indicates the new lands form in some parts of Dhaka as 'Chars' such as Kamrangir Char due to shifting and fluctuation of watercourses</i>	88
Figure 4-9:	<i>Shows the Saat Gombuj Masjid (seven-dome mosque) from an earlier era, contrasted with Dhaka's urbanisation and hydrological transformation</i>	89
Figure 4-10:	<i>Dhaka's interior (the Dholai Canal and dilapidated structures, including ghats and bridge) published in 1814, and drawn by Charles Doyly collected from Dhaka City Museum DCC (Doyly, Charles 1991b, p. 96)</i>	90

Figure 4-11:	Map showing Dhaka during 1859 and 1912 including major structures built during the colonial period (map collected from the Dhaka City Museum, DCC)	92
Figure 4-12:	Map showing the urbanised area of Dhaka, including wetlands and flood plains (source: Library of Department of Architecture BUET.) The original map in the background prepared by the Government of Pakistan based on the survey in 1959-60.	98
Figure 4-13:	Master plan of 1959 (source: RAJUK, it is the only large copy, which is around 3mX2.5m)	99
Figure 4-14:	Photo showing a Flash flood caused by rainfall during the monsoon season in Dhaka, which is a regular occurrence, published in a daily newspaper on 2 September 2015 (source: http://www.thedailystar.net/frontpage/dhaka-deluged-136426)	101
Figure 4-15:	Map showing super imposed existing (2015) wetlands compared to the water channel and floodplains of 1960 (source: map prepared by the author based on the current Google Map images and map of 1960 collected from the Library of Department of Architecture BUET prepared by the Government of Pakistan based on the survey in 1959-60)	103
Figure 5-1:	Submitted plan of Ghats along Dholai Canal by Babu Revoti Mohon Das in 1901 (source: National Archive Bangladesh)	110
Figure 5-2:	Proposed plan for renovation of the Dholai Canal in 1921(source: National Archive Bangladesh)	110
Figure 5-3:	Correspondence letter on Dholai Canal canalisation May 1931(source: municipality record from the National Archive Bangladesh)	111
Figure 5-4:	Dholai Canal correspondence record of Dhaka Municipality dated May 15 1934 (source: National Archive Bangladesh)	112
Figure 5-5:	Municipality records of the Proposal for improvement of the Dholai Khal dated February 27, 1956.	113
Figure 5-6:	Correspondence letter of Dhaka Municipality of 1943 showing request for using the Bucklland Embankment area for loading-unloading (source: National Archive Bangladesh)	116
Figure 5-7:	Municipality record of the Buckland Bund (embankment) improvement project from 1959 prepared by DIT (Dhaka Improvement Trust) at present RAJUK	117
Figure 5-8:	Figure showing the cordon system embankment of Dhaka	120
Figure 5-9:	Part of the western fringe area beyond the flood protection area from 2003 to 2016, which was a part of the low lands and flood flow zones.	122
Figure 5-10:	Executive agencies of the western embankment and their scope of work (source: JICA 1991)	123
Figure 5-11:	Drawings western embankment proposal prepared by the JICA (source: DWASA)	123
Figure 5-12:	Proposed section of eastern bypass road cum embankment (Source: JICA 2006)	128

Figure 5-13:	Detailed drawings of the eastern bypass road cum embankment (source: JICA 2006)	128
Figure 5-14:	Box-culvert drawings of a part of Segunbagicha Canal prepared by the DWASA (source: archive of the DWASA)	131
Figure 5-15:	Open U-section and C-section canal/ large open drain converted from a natural canal between 2005 and 2011 (source: archive of the DWASA)	132
Figure 5-16:	Transformation of Segunbagicha Canal (Ahmed, F 2006) (sources: archival maps and google images)	133
Figure 5-17:	Conceptual section showing the Motijheel area and Segunbagicha canal in the 1980's and in 2014.	133
Figure 5-18:	1960 Map showing different water channels and wetlands including urbanised area.	135
Figure 5-19:	1912 Map showing the Segunbagicha canal (source: National Archive Bangladesh and Dhaka City Museum of the DCC)	135
Figure 5-20:	Map and google image showing existing top view of the box culvert road path instead of the Segunbagicha Canal	136
Figure 5-21:	1979 Map of the Motijheel commercial area showing the width of the Segunbagicha canal of (30 meters, 90 feet).	136
Figure 6-1:	Plan of Bashundhara area from Block A to P.	149
Figure 6-2:	Google Earth images showing the transformation of land through landfills by the Bashundhara group (in red shade) and other public and private developers between 2006 and 2015. In addition, these images shows the seasonal fluctuation of water due to seasonal and other variations, which makes the land-water boundary an unstable lines. Similar geo-hydrology is also visible in next two figures.	150
Figure 6-3:	Google images showing the land use transformation at the south-west of the Bashundhara Township area between 2001 and 2015.	151
Figure 6-4:	Google images showing the land use transformation (wetlands, agricultural lands, and villages) to urbanised land through land mass extension at the north-east of Bashundhara Township area from 2003 to 2015.	151
Figure 6-5:	Map of Dhaka in 1881, the Metropolitan Area Integrated Urban Development Project, showing land category. On the map Bashundhara and the eastern fringe area is categorised under potential for urban development.	153
Figure 6-6:	Map of the Metropolitan Area Integrated Urban Development Project, Dhaka in 1981 showing low-lying areas to fill and the retention basin in the Bashundhara area.	154
Figure 6-7:	Indicating the Bashundhara area in the Detailed Area Plan (DAP) Dhaka, showing retention ponds and water channels in the area, which are mostly filled (source: DAP, RAJUK)	161
Figure 6-8:	Map 01 showing geomorphology and map 02 showing drainage and filled boundary (source: Geological survey of Bangladesh)	165
Figure 6-9:	Map of potential ground subsidence zone from 1995 and satellite image from 1998 and 2000 of the Bashundhara area	166

Figure 6-10:	<i>Major problems according to respondents of the Bashundhara area</i>	168
Figure 6-11:	<i>Reason for choosing the Bashundhara area to live or work</i>	168
Figure 6-12:	<i>Negative aspects of Bashundhara area according to questionnaire respondents</i>	169
Figure 6-13:	<i>According to respondents if the new land development (landfill) projects are considering wetlands</i>	170
Figure 6-14:	<i>Reason for water clogging according to the respondents of the Bashundhara area</i>	171
Figure 6-15:	<i>Possible explanations of water clogging according to the respondents in the Bashundhara area</i>	171
Figure 6-16:	<i>According to respondents of the Bashundhara area actions to ensure protection and reclamation of water bodies</i>	172
Figure 6-17:	<i>Economic strata within the case study areas</i>	174
Figure 6-18:	<i>Overall rating of the neighbourhood according to questionnaire respondents in the Bashundhara area.</i>	175
Figure 6-19:	<i>Overall rating of the neighbourhood according to the respondents including the relationship to ownership.</i>	175
Figure 6-20:	<i>Overall rating of the neighbourhood in relation to building type</i>	175
Figure 6-21:	<i>Showing whether water body brings positive/negative effects for the urban areas for both Bashundhara Township and Hatirjheel area</i>	176
Figure 6-22:	<i>Relationship between ownership pattern and responses of the respondents to whether water bodies brings positive/negative effects (yes=positive, no=negative)</i>	176
Figure 6-23:	<i>Relationship between respondents' positive or negative views of aspects of wetlands with parameters, such as if they regularly visit wetland areas, or if they think that water bodies should be protected and reclaimed. Analysed in SPSS (yes=positive, no=negative)</i>	177
Figure 6-24:	<i>Positive aspects of reconstructed wetlands according to respondents from the Bashundhara area</i>	178
Figure 6-25:	<i>Negative aspects of reconstructed wetlands according to respondents from the Bashundhara area</i>	179
Figure 7-1:	<i>Google image of before and after the intervention, including photographs of the site in 2014</i>	183
Figure 7-2:	<i>A 1960's Tourist map published by the government during the Pakistan period (Source: Department of Architecture BUET)</i>	185
Figure 7-3:	<i>Project urban intercept by the student (Zahid Khan of Batch 95) from department of Architecture BUET exhibited in 2003 (source: Architecture department Library BUET).</i>	187

Figure 7-4:	<i>Dhanmondi Lake Development Project in 2014</i>	188
Figure 7-5:	<i>BGMEA building in 2016 (source: The Daily Star, http://www.thedailystar.net/city/sc-upholds-bgmea-building-demolition-order-1233319)</i>	189
Figure 7-6:	<i>Conceptual diagram of the planning process</i>	191
Figure 7-7:	<i>The plan proposed by VITTI-DPM-AIA consortium (this plan is partly constructed and not all the components of the design were built, such as wide pedestrian and floating walkways).</i>	195
Figure 7-8:	<i>Transformation of the area (sketches by the author from the field survey findings)</i>	195
Figure 7-9:	<i>Images of key architectural and landscape features of the initial concept design for the 'Hatirjheel Urban District', proposed in 2007 by the consultant architect, shows an original design that was more flexible and less infrastructure biased than the scheme that was ultimately built (Source: VITTI-DPM-AIA Consortium, Architect: Ehsan Khan)</i>	195
Figure 7-10:	<i>Hatirjheel and other water channel (source: Google Earth)</i>	197
Figure 7-11:	<i>Photos of the Hatirjheel area (source: author and Selim Azad)</i>	197
Figure 7-12:	<i>Hatirjheel-Begunbari Integrated Development Project initial master plan with details designed by BUET (source: LGED)</i>	198
Figure 7-13:	<i>Section of typical canal/lake edge section as originally proposed by landscape consultants (VITTI), and as built (source: field survey)</i>	202
Figure 7-14:	<i>Major problems (in %) according to respondents of the Hatirjheel-Begunbari surrounding area</i>	204
Figure 7-15:	<i>According to the respondents do Dhaka's water bodies should be protected</i>	205
Figure 7-16:	<i>Relationship between case study area and the response of the respondents on whether they think Dhaka's lost water bodies should be reclaimed.</i>	205
Figure 7-17:	<i>Reasons for water clogging, according to the residents of the Hatirjheel-Begunbari and surrounding areas</i>	205
Figure 7-18:	<i>Possible elucidate of water clogging according to the respondents in the Hatirjheel-Begunbari area</i>	206
Figure 7-19:	<i>Example of gentrification through transformation of land use and the boundary between neighbourhoods and the project.</i>	207
Figure 7-20:	<i>Hatirjheel area during the construction in 2011, eviction of informal housing (source: Prof. Dr. Shayer Ghafur)</i>	208
Figure 7-21:	<i>Relationship between the case study area and building type</i>	208
Figure 7-22:	<i>Ownership patterns in the case study areas</i>	209

Figure 7-23:	<i>Economic strata within the case study areas</i>	209
Figure 7-24:	<i>Percentage of people using or visiting wetlands in both Hatirjheel and Bashundhara area</i>	210
Figure 7-25:	<i>Informal economy and public activities in the Hatirjheel Begunbari area</i>	210
Figure 7-26:	<i>Residents' reasons for choosing the neighbourhoods, or positive aspects of the neighbourhoods for the Hatirjheel-Begunbari area</i>	212
Figure 7-27:	<i>Residents' negative perceptions of the neighbourhoods</i>	212
Figure 7-28:	<i>Relationship between case study area and whether water body brings positive/negative effects.</i>	214
Figure 7-29:	<i>Positive aspects of the reconstructed wetlands according to residents.</i>	214
Figure 7-30:	<i>Negative aspects of the reconstructed wetland according to residents.</i>	215
Figure 8-1:	<i>According to respondents if the new land development (landfill) projects are considering wetlands</i>	222
Figure 8-2:	<i>Relationship between case study area and the response of the respondents on whether they think Dhaka's existing water bodies should be protected (cross-tab analysis)</i>	223
Figure 8-3:	<i>Relationship between case study area and the response of the respondents on whether they think Dhaka's lost water bodies should be reclaimed (cross-tab analysis)</i>	223
Figure 8-4:	<i>Relationship between income group and respondents views on protection and reclamation of water bodies in the Bashundhara area as a result of its water bodies and prefer lower housing density.</i>	224
Figure 8-5:	<i>Images showing public activities (walking, playing football, temporary vendors, meeting people etc.) in the Hatirjheel area along the canal (photos taken in 2014 during the field survey)</i>	224
Figure 8-6:	<i>Percentage of people use or visit wetlands in both Hatirjheel and Bashundhara area</i>	225
Figure 8-7:	<i>Cross tab between does the water body bring positive or negative outcomes for the neighbourhood, and do the respondents regularly use/visit any type of water bodies in both Bashundhara and Hatirjheel</i>	227
Figure 8-8:	<i>Cross tab between questions: "does the water body contribute positively or negatively to the neighbourhood?" and "do the respondents think water bodies should be protected for both the Bashundhara and Hatirjheel areas?"</i>	228
Figure 8-9:	<i>Cross tab between questions: "does the water body contribute positively or negatively to the neighbourhood?" and "do the respondents think water bodies should be reclaimed"</i>	229
Figure 8-10:	<i>Rating of the urban area in both Bashundhara and Hatirjheel areas in relation to the ownership pattern and building type</i>	230

Figure 8-11:	<i>Timeline chart of regimes and major urban development events (after 1947 post-colonial period)</i>	236
Figure 8-12:	<i>Figure showing morphological transformation between 1960's and 2017 (source: Muntasir Mamum and Google Earth)</i>	238
Figure 8-13:	<i>Use pattern of wetland areas by the respondents of Hatirjheel and Bashundhara areas</i>	242
Figure 8-14:	<i>Map indicating late colonial city, north of historical city, with rail road, garden city, and grid iron pattern suburbs (source: Dhaka City Museum, DCC)</i>	244
Figure 8-15:	<i>The urban development intervention timeline in relation to the policy instruments introduced from the 19th century to the contemporary period</i>	248
Figure 8-16:	<i>Transformation of the part of Dhamalkot and Bhashantek area from 2006 to 2015 (clockwise) to introduce military housing with reconstructed wetland as water front project through displacement of informal sector housing.</i>	253
Figure 8-17:	<i>The Dhamalkot military residential development (source: Bangladesh Airforce)</i>	254

List of Tables

Table 1-1:	<i>Thesis structure</i>	16
Table 2-1:	<i>List of major case studies</i>	23
Table 2-2:	<i>List of collected documents during the field survey</i>	27
Table 2-3:	<i>List of interviewees and their details</i>	34
Table 2-4:	<i>Topic of interviews to different interviewees according to their disciplines</i>	38
Table 2-5:	<i>List of documents submitted for the ethics approvals</i>	39
Table 2-6:	<i>List of chapters in relation to the methods used for finding analysis</i>	40
Table 7-1:	<i>List of team members for the Master plan of the Hatirjheel Begunbari integrated project (source: BUET)</i>	192
Table 7-2:	<i>List of Ideas proposed by VITTI for the Hatirjheel-Begunbari Integrated Development Project as Hatirjheel Urban District (Source: VITTI Sthapati Brindo)</i>	194
Table 7-3:	<i>Project details of the initial master plan by BUET (source: LGED)</i>	198
Table 8-1:	<i>The Table showing the comparison of two current case histories in terms of various aspects, including project details, planning policies, and consequences</i>	231
Table 8-2:	<i>List of factors influencing the urban development in relation to its water</i>	234

List of Acronyms and Abbreviations

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi Taka (Bangladeshi currency)
BNBC	Bangladesh National Building Code
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Developmental Board
CEGIS	Centre for Environmental and Geographic Information Services
CIA	Central Intelligence Agency
CUS	Centre for Urban Studies
DAP	Detail Area Plan
DCC	Dhaka City Corporation
DIFPP	Dhaka Integrated Flood Protection Project
DIT	Dhaka Improvement Trust
DMA	Dhaka Metropolitan Area
DMDP	Dhaka Metropolitan Development Plan
DNCC	Dhaka North City Corporation
DND	Dhaka Narayangong Demra
DoA	Department of Architecture

List of Acronyms and Abbreviations

DoE	Department of Environment
DSCC	Dhaka South City Corporation
DU	Dhaka University
DWSA	Dhaka Water Supply and Sewerage Authority
ECNEC	Executive Committee of the National Economic Council
EWDP	East West Development Properties
FAP	Flood Action Plan
GoB	Government of Bangladesh
GDP	Gross domestic production
GSB	Geological Survey Bangladesh
HDI	Human Development Index
GHG	Greenhouse gas
IDCOL	Infrastructural Development Company Limited
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IWFM	Institute of Water and Flood Management
IWM	Institute of Water Modelling
JICA	Japan International Cooperation Agency
LGED	Local Government Engineering Department
PWD	Public Works Department

RAJUK	Rajdhani Unnayan Kartripakkha (Capital City Development Authority)
REHAB	Real Estate & Housing Association of Bangladesh
SWO	Special Works Organization
TI	Town Improvement
UN	United Nations
UNB	United News of Bangladesh
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
WB	The World Bank

Declaration

I, Fahmid Ahmed, certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Fahmid Ahmed

Acknowledgement

This research is indebted to many people. First and foremost, my sincere appreciation goes to my principal supervisor Associate Professor Peter Scriver and my co-supervisor Professor Jon Kellett, who constantly and patiently guided me through this ambitious PhD project. I sincerely acknowledge their enthusiasm, immense knowledge, selfless gift of time and genuine care. Without them, I could not have undertaken this research. Their critical comments immensely helped to enrich this research. I also acknowledge the contribution of my former co-supervisor Dr. David Ness, who supported me during the initial phase of my PhD research with his feedback.

I would like to acknowledge the University of Adelaide for granting me the ASI scholarship for three and half years without which, it would have been impossible to study and live in Australia. In addition, I am grateful to the University for providing me with the Research Abroad Scholarship that enabled me to conduct the field studies in Dhaka. My special thanks to the Building Science Organisation USA for granting me the Jeffry Cook Travel Grant to participate and present my paper at PLEA 2015 in Bologna Italy. I am also grateful to the School of Architecture and Built Environment at The University of Adelaide for providing the annual post-graduate allowance for thesis editing, conference participation fees and other research support. I express my deepest gratitude to the Kathleen Lumley College for offering subsidised rental as well as for granting Harold Rhoda Scholarship in 2013 and Cowan Bursaries in 2013, 2014, 2015 and 2016 without which, it would have been impossible to stay at that wonderful residential college. Apart from that, I thankfully acknowledge Bangladesh University of Engineering and Technology for granting me the study leave to pursue this PhD.

This research has involved a large number of people along the way, too many to mention here. However, I would like to especially thank Prof. Dr. Farida Nilufar, Professor Dr. Roxana Hafiz, Prof. Dr. Ishrat Islam, Prof. Dr. Mujibur Rahman, Prof. Dr. Abu Syed Saeed M. Ahmed, Dr. K. Z. Hossain Taufique, Prof. Dr. Shayer Ghafur, Ar. Kazi Nasir, Ar. Ehsan Khan, Ar. Iqbal Habib, Dr. Mohammad Shakil Akther, Ar. Atiqur Rahman, Kazi Habib Ullah, M. Ashraf Ali Akhand, Md. Emdadul Islam and Prof. Dr. Sharif Uddin Ahmed who gave their time for deeper discussion around their expertise and experiences on urban issues in the context of Dhaka.

I am very grateful to my research assistants Ar. Soniha Nuzrat and Ar. Tazrin Islam who sincerely conducted the questionnaire survey for this research with their team. I sincerely thank the interview participants who gave their time for long interviews. I appreciate the contribution of all the respondents of my questionnaire survey. I also acknowledge Dr. Sakrapee Paisitkriangkrai, Ar. Ashraful Azad, Ar. Reza Shahbazi, Dr. Tahmina Ahsan and Shamim Azad for helping me at various stages of this research such as field survey support, data entry and SPSS analysis. My special thanks to Prof. Felix Patrikeeff and Allyson Sandham for all kinds of support during my stay at the Kathleen Lumley College. I also thankfully acknowledge my thesis editor David Onley for his professional service.

Many thanks to Dr. Katharine Bartsch, postgraduate coordinator and the staff of the School of Architecture and Built Environment, who provided support to my research needs: Prof. George Zillante, Asso. Prof. Veronica Soeberto, Dr. Amit Srivastava, Stella Ho, Alison Bosnakis, Ian Florance, Melissa Wilson and Velice Wennan. My special thanks to my colleagues and friends at the university, particularly Kinda Tabbā, Dr. Jessica Huang, Dr. Lyrian Daniel, Dr. Tahmina Ahsan, Dr. Mizanur Rashid, Farjana Rahman, Carolyn Wigg, Pragathi Sridhar, Gillian Armstrong, Jade Ridell, Dr. Martin Freney, Dr Ruidong Chang, Isidoro Malaque, Armin Mehdipour, Martin Larbi, Zahra Ranjbari, Sareh Abooali, Mansoureh Rajabi, Athanasios Lazarou and Dr. Rehnuma Parveen for providing me amazing support.

My special thanks to my best and closest friends Syed Ahsan Sharif, Ar. Ashraful Azad, Dr. Sakrapee Paisitkriangkrai, Dr. Farhan Sirajul Karim and Syeda Nuzhat-E-Ibrat for their moral support throughout my PhD study.

Last but not the least, I would like to express my deepest appreciation and love for my family, to whom this thesis is dedicated: my parents Mohyuddin Ahmad and Jahan-Ara Ahmed, my brother Tanveer Ahmed and my dear wife Dr. Rehnuma Parveen for their sacrifices, tolerance, concern and moral support. Particularly, I would like to thank my wife for lovingly enduring my PhD anxiety. Thanks, I love you all a lot.

Chapter 1

Introduction and Background

1.1 Research background and context

1.1.1 Overview

Water has always been regarded as both a vital resource and a potential hazard in relation to urban development. It is necessary to support the basic functions of life, such as drinking, washing, agriculture, and industrial production, but it can also present dangers through flooding, disease transmission, and, in certain cases, landslides. At present, more than half of the world's population live in urban areas. Cities are located in many different physical environments around the world, including on mountains, plains, and coasts. A particular case is cities located on the flood plains of large river systems. Such cities were usually established for reasons of accessibility, navigation control, trade, and agriculture. Historically there tends to be a symbiotic relationship between these cities and their associated water system. The ancient Egyptian, Mesopotamian, and Harappan civilisations are all examples of well-developed and water dependent cultures that displayed a high degree of urbanisation. More recently, cities such as Amsterdam, Venice, and Can Tho (on the Mekong delta) have continued the tradition of urbanisation in association with water, in each case deriving benefits in terms of defence, transportation, and trade, whilst having to grapple with the threat of periodic and sometimes catastrophic flooding. As cities have dramatically increased in scale during the late twentieth and early twenty-first centuries, their relationship with the water landscape requires reappraisal. Modern urban lifestyles, and urban development processes, can sit uneasily with the historic legacy of hydraulic civilisations, which have taken centuries to develop.

Water has played a predominant role in urban development in these centres. Over time, these cities have grown and adapted to the natural characteristics of their water systems and fluid landscapes. These cities have used their physical environment in different ways to gain advantages in trade, communication, and production. Meanwhile, these cities have impacted on the physical environment of their regions, sometimes leading to catastrophic outcomes such as erosion, floods, and population

displacement. The nature of these cities and their relationship with water has inspired a literature that examines the concept and practice of water culture.

‘Water culture’ refers to the cultural practices associated with natural water systems (Shannon & Moulder 2008)¹. Water culture is particular to specific geo-climatic regions and contexts, both responding to and actively shaping the landscape/waterscape with which it is associated. Climate, life style, and geomorphology interact and produce different responses, cultural practices, and eventually distinctive architectures and urban forms that may be described as the defining patterns or cultural products of historically-developed water-based civilisations (Ashraf 1997). Urban development in regions defined by ‘wet’ or ‘water culture’ may also be viewed as a form of cultural practice strongly influenced by human interaction with surrounding water systems. To comprehend the logic of such urban development, there is perhaps a need, therefore, to reconceptualise the very notion of urbanism in the context of water civilisations; that is, to consider what has been called ‘water urbanism’.

‘Water urbanism’ refers to urban development intrinsically associated with water and hydrology. The term defines a conception of city-forming and making in which both natural and manmade water systems are integrated in the process of developing infrastructure, landscape, and built form (Feyen, Shannon & Neville 2009; Shannon 2009; Shannon & Moulder 2008; Shannon, Robles-duran & Theunis 2005; Shannon & Smets 2010; Shannon 2004). ‘Water urbanism’ has also been used to describe water sensitive urban design (Wong & Brown 2009; Wong & Eadie 2000). Water urbanism also includes water management, water ecology, water ethos, and water culture.

Dhaka, Bangladesh, is an emerging mega-city situated in the largest delta and one of the most extensive river systems in the World. This region lives by, on, and in the water. It could be argued, therefore, that Dhaka is the pre-eminent example in the world of a city that has to deal with its immediate riverine environment. For this reason it is also one of the most vulnerable mega-cities in the world, because its

¹ Harvard UofA referencing style has been used in this thesis as recommended by the University of Adelaide.

extraordinary rate of urbanisation is matched by an exceptionally high frequency of serious flooding, along with other disasters. This thesis seeks to analyse and elucidate Dhaka's failures and successes in the management of water in its urban development, past and present. At this moment in its development it is worthwhile to take stock of Dhaka's progress, as this research aims to contribute useful insights into the broader issues of urbanisation of mega-cities across the developing world, especially in respect to their relationship with water in an age of climate change and rising sea-levels.

For a low lying delta city such as Dhaka, developing a more open, objective, and critical discussion about water urbanism may be a vital step towards a more responsive and inclusive approach to the management of water in architecture, planning, and urban design, with the aim of improving Dhaka's resilience to future environmental stresses. How water was dealt with in relation to urban design in the past, is dealt with today, and may be dealt with in the future (when the level of threat is likely to increase as a consequence of climate change) makes for a fascinating and rewarding research topic.

The water culture of Bangladesh has, necessarily, made a fundamental contribution to the development of typical built forms and urban structures in the region. Over time, land and water have blended and interacted in harmonious and functional ways. The land and water are interdependent: one could not function, or thrive, without the other. Water culture has also been reflected in (and refracted throughout) Dhaka's history, society, and economic activity. Dhaka had many canals and water bodies, which were integrated into its socio-economic and cultural life up until the early post-colonial period (Ahmed 2003, 2009; Ashraf 2012; Chowdhury & Faruqui 2009; Dani 2009; Doyly 1991; Karim 1964). Water was the historical life-blood of Dhaka, providing a line of communication and a link to the ecology of the delta. More recently, however, it has come to be regarded as both a nuisance and an impediment to urban expansion and the wealth creation that such growth may engender. As a result, there has been a paradigm shift over recent decades in terms of society's relationship with water. Along with massive urban expansion has come a dramatic reduction in the amount of open water present in Dhaka, and a marked disregard for natural hydrological processes.

This research addresses how the city of Dhaka has been transformed from a water-dominated town to a metropolis that adheres to principles of development more suited to drier locations. In addition, it investigates how urban development, architecture, and planning have sought to handle water within the public realm. The research explores the factors embedded in administrative and bureaucratic systems and public attitudes, which have produced new physical manifestations of managed water in urban development. This study is an important step in extending the comprehension of lessons learned for future research regarding current urban development theories and practices in relation to water.

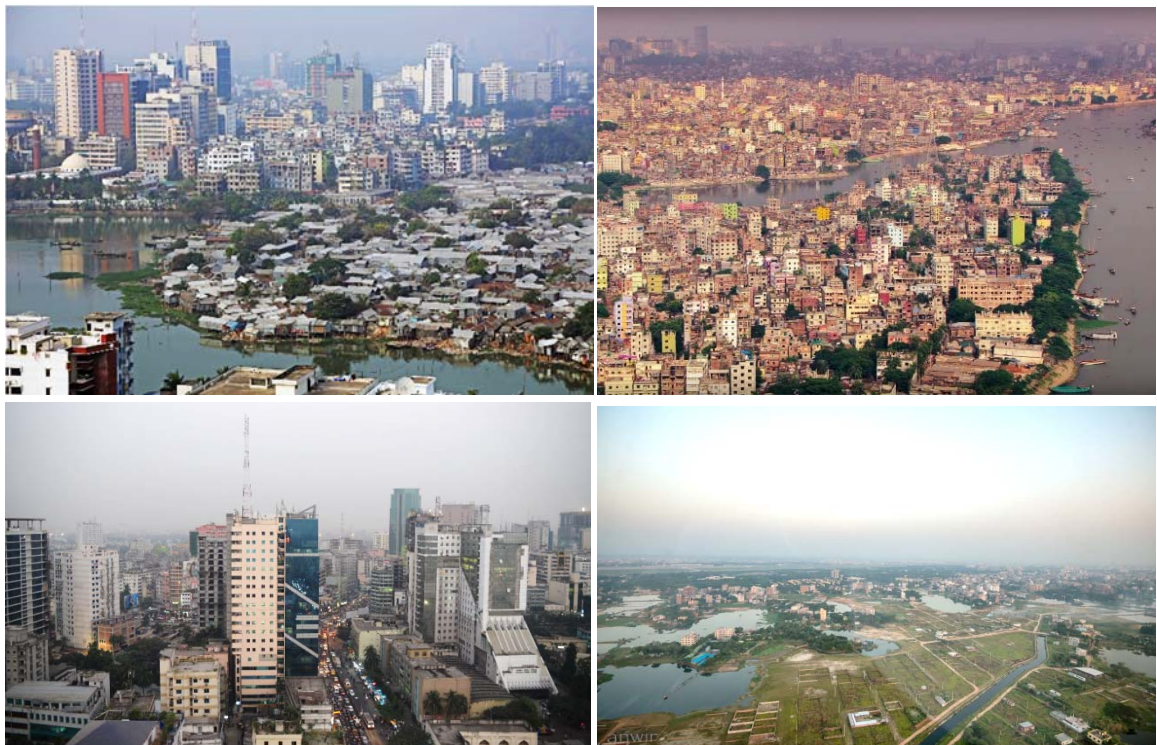


Figure 1-1: Images showing different parts of Dhaka (sources: author, Tahwir Siraj, Yann Arthus-Bertrand and Anastasia Mikova).

1.1.2 Geographical setting, urbanisation history and the context of the case study

The city of Dhaka, which is in the world's largest delta system (Ganges-Brahmaputra- Meghna river system) was established primarily along the river Buriganga (old Ganges) (Figure 1-4). The country's largest city, Dhaka is strategically located at the centre of the country, where river systems converge. The city lies between eastern longitudes 90°20' to 90°30', and northern latitudes 23°40' to 23°55'.

This is one of the few cities on earth surrounded by four rivers (Ahmed 2012; Ahmed 2009; Ashraf 2012). The Buriganga is to the south and south-west, to the north is the Turag, and to the east is the Balu. The Lakha (Shitalakha) is further east, providing a boundary for the eastern part of the new eastern townships beyond the Balu River (Figure 1-3). During the seventeenth and eighteenth centuries many Europeans compared the city to Venice (Ahmed 2009; Ahmed 2003; Dani 2009; Rahman 2011). Up until the 1950's, the city still had a unique hydrological landscape with more than sixty canals and many water bodies (Ahmed 2003; Dani 2009; Haider 1966; Karim 1964, 2009; Rahman 2011). Today most of the low lands and canals have been filled in to enable the construction of buildings and infrastructure (to expand the city), or have been polluted with industrial and household waste.



Figure 1-2: Bangladesh in the largest delta and its river system



Figure 1-3: Dhaka on Google Earth, showing its four rivers



Figure 1-4: Dhaka beside the Buriganga River. Source: Yann Arthus-Bertrand and Anastasia Mikova

Dhaka today is the most densely populated city in the world, with 44,100 people per square kilometre (Cox 2016). The average density of other mega cities of the world is 7,918 people per square kilometre (UNEP 2005). In terms of population it is the ninth largest city in the world, with more than seventeen million people (population of DMDP area is 17.598 million¹) (Islam 2007; Lehmann 2010). A majority of scholars and development organisations predict that Dhaka's population will exceed 20 million by 2020.

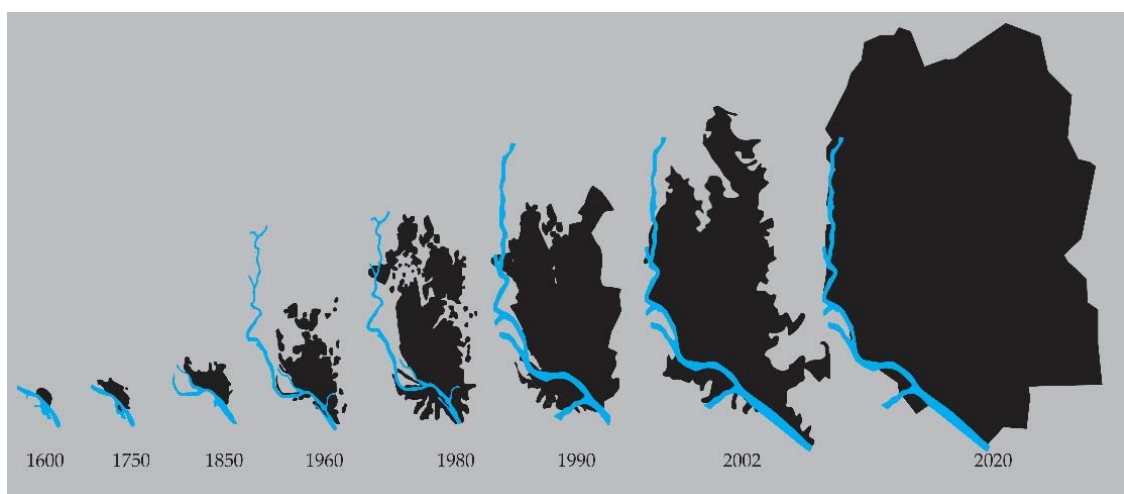


Figure 1-5: Growth of Dhaka city (source: Dhaka City Corporation, modified by author)

Dhaka has also grown enormously in physical size over the past seven decades since the end of British colonial rule in the Indian subcontinent (Figure 1-5). The current metropolitan area is 303 km², while the area of the colonial city was only 17 km², and Mughal Dhaka was only 4.5 km². 94.4% of Dhaka came into being during the post-colonial period. And 62% of the post-colonial city has come into being since the re-birth of the independent nation of Bangladesh from the former East-Pakistan, in 1971, with the majority of the area being urbanised since the 1990's. At present the total area of the mega city is 1,528 km² (total DMDP area), which includes the Dhaka City Corporation (north and south) and the other five municipalities (RAJUK 2015; United Nations 2014). The other municipalities are Savar, Narayanganj, Gazipur, Kadamrasul, and Tongi.

In 1604 Dhaka became the provincial capital of Bengal within the Indian Sub-continent. People started living in the area during the seventh century, because of ease of communication, trade, and to have access to higher ground (Ahmed 2009, 2012; Ahmed and Haider 1966; Ahmed 1986, 2003, 2009; Karim 1964, 2009; Mamun 2000). Dhaka grew from a river port into a town, which was a small Hindu trading port before the arrival of the Islamic Mughal Empire in the seventeenth century (Ahmed 2003b; Ashraf 2012; Dani 2009; Nilufar 2010). While Dhaka remained a small but important provincial capital for almost three centuries, its transformation into a megacity has been comparatively recent and rapid. The city is now one of the fastest growing mega-cities in the world (Khan & Nilufar 2009; Roy 2009).

The metropolis has four major spatial patterns, which co-exist in the present urban tissue, as indicated by the urban researcher Farida Nilufar (2010). These four spatial patterns consist of the indigenous city, the informal spontaneous city (or new indigenous city), the colonial and planned interventions, and, finally, the informal slum and squatter settlements. The historical core of the city is the indigenous city, which has a typically informal road system, shop houses, bazaars, landing stations for water interfaces, and row and courtyard houses. The colonial settlers developed the civil lines to the north, marked by park lands. Some prominent establishments that existed during the colonial period also existed in the core of the old city. The planned area is based on a grid pattern, or more formal interface, whereas the spontaneous

development is an indigenous city with a labyrinthine road layout, such as that of the old city, without organised row/shop houses. The informal settlements, or slums, are a consequence of urbanisation, where people mostly live on the edges (urban fringes and other vulnerable areas). Kabir (2012) describes informal settlers as "shadow citizens," who are essential to support the formal city. Such stark inequality is very visible in mega-cities in the developing world, and Dhaka is no different.

Mughal, colonial, and post-colonial administrations played important roles under diverse regimes, shaping the city over four centuries. The power exercised by the colonial and post-colonial governments has directed the city towards a style of development that fulfils a modernising vision with traditional texture. Post-colonial urbanism on the Indian sub-continent, and in similar cases, has received multiple inputs from western development models over time (Pieris 2010). Consequently, similar contemporary cities in the developing world are frequently a mixture of global and regional cities, which, in the case of Dhaka, has made the city more heterogeneous in character (Figure 1-1 and Figure 1-6).

Dhaka has experienced numerous types of intervention, based on diverse development philosophies, under different administrations from the pre-Mughal to the present day. The traditional water civilisation that existed during the pre-Mughal and Mughal period was overwhelmed by colonial and post-colonial modernity. Their preferences and aspirations were manifested through modern towns in the late nineteenth and early twentieth centuries. Colonial modernity introduced new sets of ideas concerning the handling of water in human settlements. Consequently, post-colonial modernity influenced late twentieth century Dhaka towards becoming a modern metropolis with modern infrastructure and new townships (built by both the public and private sectors), alongside spontaneous urbanisation by private individuals and groups, and the incremental growth of unplanned slums. The contemporary socio-political influences, which encourage free market economics, have supported rapid urbanisation through buildable landmass extension. However, current development phenomena increase social exclusion, urban sprawl, over densification of the city, and the disappearance of its wetlands.

More than 50% of the area of Greater Dhaka is currently built-up, whereas only 13% of the same land was built-up in 1975. Green areas (vegetation) within greater Dhaka totalled almost 50% in 1975, which was reduced to 24% by 2005 (Byomkesh, Nakagoshi & Dewan 2012). The introduction of the western embankment, after the 1987 and 1988 floods, dramatically transformed the urban landscape since the 1990's. The city has been fortified through embankments and box-culvert drainage to control the natural flow of water, which represents a paradigm shift for Dhaka. This change in paradigm, along with other factors that emerged during the late twentieth century, encourages landfilling. Low lands and the natural landscape have been in rapid decline for the last twenty to thirty years, because of land development along the fringe of the city (Ahmed 2009, 2012; Ashraf 2010, 2012; Dewan 2010; Islam 2009; Peeters and Shannon 2011). The low lands are being filled up and converted into urbanised land for new developments, such as new townships and suburbs. These developments, which ignore the indispensability of green spaces, open spaces, and natural waterways, are contributing to the current sense of ecological disarray and potential disaster in the city. Meanwhile, new urban design projects have been initiated and completed with the aim of restoring and redeveloping wetlands. However, all the processes of urban development are complex and have multiple facets. Both newly constructed land, and reconstructed wetlands, require a complex planning process.

To better comprehend the consequences of these transformative developments in the urban structure and fabric of Dhaka, it is essential to examine the contemporary megacity, and its development history, from the perspective of water urbanism.

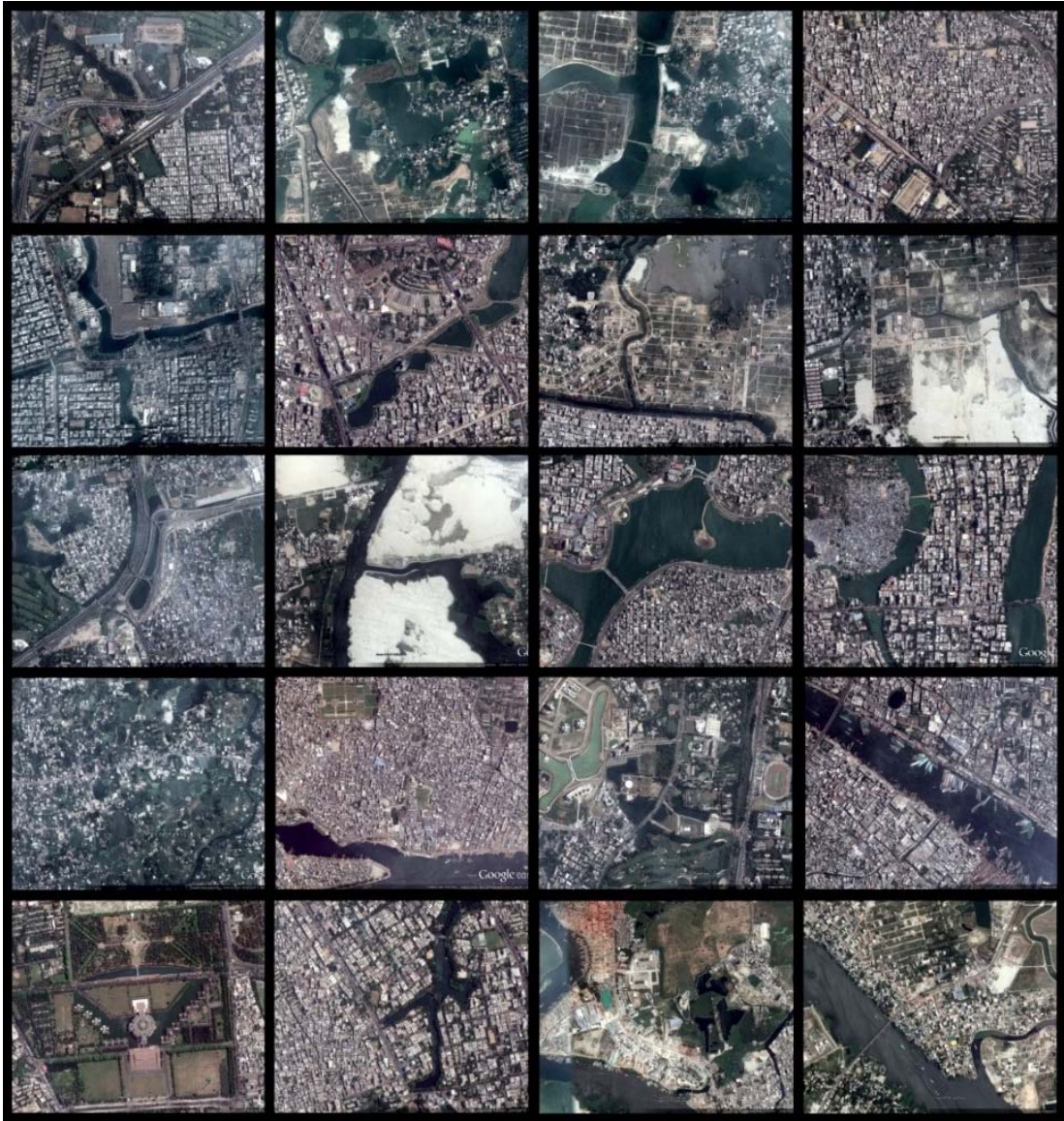


Figure 1-6: Different types of urban areas with different patterns and density and its wetlands (river, canals, lakes, retention area and flood plains) in Dhaka in the same scale (source: Google Earth). It illustrates different kinds of morphological variations as a result of interventions from various regimes.

1.2 Research questions

This thesis addresses a single overarching research question: Is ‘water-urbanism’ – a ‘wet’ approach to urban design and planning – a more sustainable paradigm for the future development of low-lying mega-cities like Dhaka relative to prevailing ‘dry’ approaches?

To answer this question, the study addresses a series of associated sub-questions:

- What are the factors – physical, technical, social, political and cultural – that have transformed the growing city of Dhaka from a ‘wet’ water-based town to a ‘dry’ relatively water-autonomous modern metropolis over time, and under different regimes?
- What role have instrumental and institutional factors – including government regulations, planning guidelines, the mind-set of development agencies and actors, and their routine practices and procedures – played in constraining planning and implementation processes, and how has urban development in Dhaka responded to changes in these broader technical and cultural frameworks?
- How can a comparative case-study of two examples of ostensibly opposing design strategies with regard to water management in urban development in contemporary Dhaka, enhance our understanding of the relationship between technical, social, and methodological factors in the urban design and development culture of Dhaka, with particular regard to the question of ‘water’?

1.3 Research aim and objectives

1.3.1 Aim

The broad aim of this research is to enhance understanding of the idea of ‘water-urbanism’, and its potential contribution to the theory and practical achievement of sustainable urbanism. To do so, it specifically aims to enhance understanding of the intimate relationship with water in Dhaka’s urban development history, and to examine in particular the cultural practices and plan-making processes and constraints under different governmental regimes that have mediated and changed that relationship in the colonial and contemporary era.

1.3.2 Objectives

To address this aim, the research has four strategic objectives:

1. To identify theories and practices concerning water management and water culture in the design of cities applicable to the development of a deltaic metropolis.
2. To compare and correlate the urban and hydrological histories of Dhaka in the context of the city's larger alluvial region – the Bengal delta – over the past several centuries, to illustrate the contest between human settlements and maneuvering water courses.
3. To determine the factors that have driven a progressively 'harder' engineered approach to the management of water, and eventual shift in urban development paradigm, over the course of Dhaka's historical growth from a provincial river-town to the industrial and commercial megacity that it is becoming today.
4. To identify representative actors, agencies, and embedded institutional factors engaged in building contemporary Dhaka, which have affected its changing relationship to water.

1.4 Rationale

The context of the research is that Dhaka has an untold history of urban development in respect to its cultural and administrative processes in managing water. This study portrays the current success and failures of urban development in relation to water. This research explores the concept of 'water urbanism' from a historical and contemporary perspective, examining development trends in theory, design, and practice, in order to lead to a better understanding of this concept. So far the scholarship on Dhaka, from the perspective of urban development, has explored the physical and socio-cultural history of the city from a somewhat impressionistic (if not idealistic) conception of 'water urbanism'. Yet, the cultural and administrative (institutional) histories of water management in the context of urban development, along with the complex planning processes that have shaped them, have not as yet

been sufficiently explored, so as to explain how Dhaka is increasingly failing to live sustainably with water. There is a large research gap with respect to the urban development history of Dhaka and its relationship to water. Despite the fact that, traditionally, water has been of crucial significance for this low-lying city, there has been little research to explain the planning process and its urban development outcomes during the colonial and post-colonial periods.

To explain and better understand the urban development history of modern Dhaka, the historical scope of the present study ranges as far back as the middle of the eighteenth century, investigating present day development through a comparative analysis of exemplary contemporary case histories. However case-specific this Dhaka-centred study appears to be, there are broader international implications for urban development that flow from this discussion.

‘Water urbanism’ is effectively an ideal and an emergent sub-discipline of contemporary design thinking and practice at the intersection of landscape architecture, urban design, and planning. Closely associated with the theoretical and applied design research of key advocates in contemporary European and American design discourse, such as Kelly Shannon, the concept has not yet been applied or engaged significantly in more historical approaches to research on the architecture and planning of cities associated with water. On the other hand, the relatively substantial body of scholarship on the colonial and modern cities of Asia – many of which represent the urban flowering of major water civilisations – has tended to privilege analysis from the perspectives of the political or the social production of urban settlements, rather than their water cultures. Moreover, scholarship on the urban development and history of the Bengal delta is relatively limited to begin with.

Scholars in the disciplines of architecture, urban history, planning, and urban geography have investigated the urban development of Dhaka from the perspectives of planning policies, along with its physical, geographical, and socio-cultural transformation. Considerable efforts have also been made to illustrate the urban history of Dhaka by historians such as Sharif Uddin Ahmed, Muntasir Mamun, Abdul Karim, Ahmed Hassan Dani, and others have examined urban history and planning

from the physical, socio-political, and cultural perspectives. However, researchers in the discipline of urban history have yet to examine the planning process rigorously, to explain the cultural and administrative history of water management in the region. Moreover, whilst scholars such as Kazi Khaleed Ashraf, Farida Nilufar, Israt Islam, Nazrul Islam, Mahbubur Rahman, among others have made significant contributions to the water urbanism discourse concerning Dhaka, based on contemporary transformations of the wetlands, the logic of urban interventions, from the perspective of water urbanism theory and culture, is currently under explored.

This research is expected to have a substantial impact on future urban design research. It addresses a gap in urban development history from a particular perspective: it provides an insight into the organisational processes and inferences of current urban development practices in managing water. Therefore, it is expected that the outcomes of this research will help urban historians, policy makers, urbanism researchers, and urban designers in making more informed design decisions for Dhaka, and enable them to create more resilient and flexible urban water interventions—taking into consideration diverse factors of environmental, economic, and social sustainability. In addition, the outcomes may be helpful for increasing awareness of the consequences of hard engineering interventions, along with the disappearance of wetlands.

This research seeks to contribute to a better understanding of urban civilisation in its crucial relationship to water. It attempts to explain why certain kinds of water-related urban development emerged in recent years in a particular urban context. It is acknowledged that water civilisations have much longer histories and larger regional contexts. However, the water-related development of traditional rural settlements was outside the scope of this research, as was a comprehensive historical examination of water-management in the colonial and early post-colonial urban development of the case outlined here. Similarly, a number of other significant urban developments in Dhaka and its region in the post-colonial era, including major US and other foreign aid funded projects, have not been examined in this study as they are not specifically exemplary of the water-management issues and questions that this research is exploring.

1.5 Methodology

The research employs a mixed methodology comprising different qualitative approaches and strategies. However, a limited quantitative analysis was also undertaken. The primary research was conducted in Dhaka. The project includes interpretive historical research and case studies. The research employs a range of tactics, including a questionnaire survey of local residents; semi-structured interviews of various actors from the realms of design, planning, and policy; and a documentary survey and analysis of relevant historical maps and archives. Detailed accounts of the methodology and methods are presented in the research design chapter (Chapter 2).

1.6 Thesis structure

The thesis is organised into nine chapters. The initial chapters consist of background, methodology, and literature research to establish the research project (chapters 1 to 3). The middle chapters (chapters 4 to 7) explain the hydrological and urban development histories of Dhaka and its region, and the findings of the two major case studies. The final two chapters (chapters 8 and 9) discuss the outcomes of the investigation, and the conclusions derived. Brief descriptions of all of the chapters are outlined in the table below.

Table 1-1: Thesis structure

Chapter	Contents/substance of the chapters
Chapter 1	Introduction
	Background and context. Research questions, aim, and objectives. Research rationale. Research structure.
Chapter 2	Research Design
	Methodology and methods.
Chapter 3	Literature Review
	Theories and practices of water urbanism.

	<p>Colonial and post-colonial discourses on urban development relating to water in the context of the Indian Sub-continent and Dhaka.</p> <p>Water urbanism discourses concerning Dhaka.</p>
Chapter 4	<p>Hydrological History and Urbanisation</p> <p>Illustrations of the hydrological transformation of the Brahmaputra-Ganges-Meghna delta (Bengal) with its relationship with human settlements.</p> <p>Urban history of Dhaka in relationship to wetlands transformation.</p>
Chapter 5	<p>From Flow to Fortification</p> <p>Analyses of the major case histories of water management in urban development.</p> <p>Changes in water management in Dhaka over the colonial and post-colonial eras, representing a paradigm shift in urban development.</p> <p>Illustrations of the logic of fortification against water (as infrastructure investment to control the flow of water) in urban design under the post-colonial regimes, through the analysis of the planning process and its consequences.</p>
Chapter 6	<p>Fortification: Urbanisation Through Landfill (Constructed Land)</p> <p>Illustrates the process of land filling as constructed land to build new urban areas through an exposition and preliminary analysis of findings from the field survey.</p> <p>Demonstrates the planning process for constructed land, taking the Bashundhara Township project as a primary case study.</p> <p>Illustrates the impacts (environmental and socio-cultural) and presents the impressions of different stakeholders of the project.</p>
Chapter 7	<p>Urban Regeneration Through Reconstructed Wetlands</p> <p>Illustrates the process for wetland reclamation, or re-development as reconstructed wetland through the exposition and preliminary analysis of further findings from the field survey.</p> <p>Demonstrates the planning process for reconstructed wetlands, taking the Hatirjheel-Begunbari Integrated Development project as a primary case study.</p> <p>Illustrates the impacts (environmental and socio-cultural) and presents impressions of different stakeholders of the project.</p>
Chapter 8	<p>Discussion and Comparative Analysis of the Case Studies</p> <p>Comparative analysis of the Bashundhara Township and Hatirjheel-Begunbari Integrated Development project, in terms of project details and impressions of the respondents (residents).</p> <p>Articulates the major findings of the research and influential factors of urban development in Dhaka.</p>

	Discussion of the research outcomes.
Chapter 9	Conclusion
	Summary of key overarching conclusions relative to the research questions. Reflections and recommendations for future research.

1.7 Conclusion

Water urbanism naturalises the city. The research aims to comprehend the water urbanism history through the dual concept of flow and fortification. Flow refers to a natural water system and its association with human settlement and its water culture. In contrast, the term fortification refers to a controlled system of water with engineered interventions to tame the natural flow. Dhaka has experienced both the concept of flow and fortification in its urban development history. The process and consequences of these two concepts are demonstrated in this research. In each case, the research relates these concepts to prevailing socio-technical and political regimes relevant to the period under discussion.

Chapter 2

Research Design

2.1 Introduction

This research has made use of a mixed methodology, including the following strategies: interpretive historical research, correlational research, and case studies. The system of inquiry for this project has mainly relied on qualitative approaches, but also includes some quantitative data collection and analyses. Multiple strategies were used for the investigations and analyses. For instance, information was gathered via a review of relevant literature, physical observation survey, archival research, semi-structured interviews, and a questionnaire survey. The research seeks to provide multi-factorial explanations (physical, social, environmental, political, and economic) for urban design development phenomena related to water. The major part of the research depends on secondary sources, case studies and practices. The research considers specific public scale case studies of architecture in Dhaka, which are identified as major urban development events concerned with the management of water.

To fulfil the research aim of unfolding Dhaka's urban development history in relation to its water, the study interrogates relevant data from three different perspectives. The research elucidates the planning process by examining embedded factors in both bureaucratic processes and organised urban development practices. Knowledge is captured with semi structured interviews, in order to explain the behaviour of actors who are part of the planning process, design, and decision making; this approach examines the influences and concepts behind urban developments under different regimes with different mind-sets. The second perspective involves interrogating archives and other documents relating to specific cases, planning processes, and policies, in order to present a cohesive perspective of hydrological history. Moreover, it explains the administrative processes, influences, and development culture of the actors and agencies involved in planning over time. The third perspective seeks to elucidate the perception of the citizen on the ground, who lives within the different types of urban developments that have been undertaken.

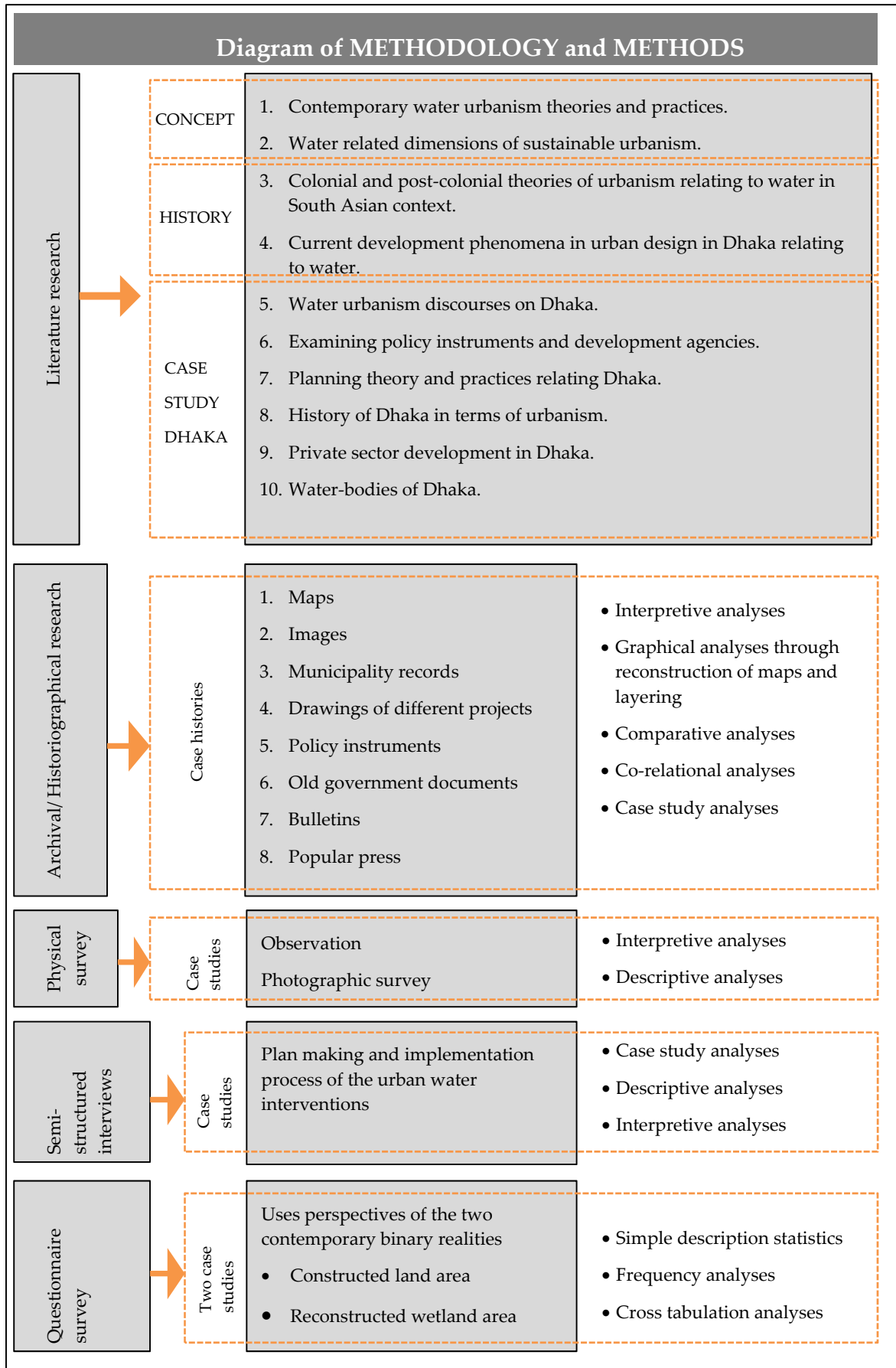


Figure 2-1: Visual representation of the research methodology.

2.2 Methodology and methods

The study has been conducted in three major stages. The initial section focuses on a literature survey of the theoretical analysis of urban development history in relation to water. This section includes the background and context of the research project. As the study is concerned with Bangladesh; initial scholarship focused on research into Dhaka's urbanism in relation to its wetlands. In conjunction with this, this section compares the contexts and theories of urban development in both South Asia and globally. The research sets out water urbanism scholarship (in theory and practice), focusing on both the notion and exercise of design philosophies in water civilisation, as well as attempting to explain the management of water in Dhaka and other similar contexts. The research traces the background of water related urban design concepts, which can provide a new perspective on contemporary urban landscapes. One of the particular focuses of the literature review is the administrative history of urban development. In addition, this section presents an interpretation of the complexities of urban development relating to water in colonial and post-colonial cities. By employing a literature review and historiographical research, this section of the thesis also explains the context of Dhaka in relation to colonial and post-colonial urban development theories and practice. This is significant, because Bengal and Dhaka are situated on a large river system that has exerted major influences on human settlement and urbanisation.

Prior to part two, major case histories are identified to explain the urban development in relationship to its water system. Major urban development projects that influenced the urbanisation and transformation of the urban landscape in Dhaka are identified. In order to analyse the transformation of the hydrological features and planning processes to determine the factors that have driven the progressively "harder" engineered approach to the management of water in the urban development history of Dhaka, historical cases from both the colonial and early post-colonial periods, as well as recent urban development projects are considered. Two major contemporary cases (sub-studies) are identified to explain the planning processes by relevant development actors and agencies engaged in building contemporary Dhaka, which explain its changing relationship to water.

The major case studies included are as follows.

Table 2-1: List of major case studies

sl	Major intervention of urban development in Dhaka in relation to its water system identified and explained as case histories in this research	year
1	Buckland Embankment project	Mid-19 th century
2	Dholai Canal project	Late 19 th and early 20 th century 1990's
3	Western embankment project for flood control	1989
4	Box culvert projects	1990's
5	Bashundhara Township as a landfill project (constructed land)	1989-till date (incremental expansion and some major phases are completed)
6	Hatirjheel-Begunbari Integrated Development Project as a reconstructed wetland project	2007- 2013 (first phase) and second phase is in process

Part two involves a historiographical examination of relevant case studies (case histories) (Groat & Wang 2002; Rousmaniere 2004). These case studies illustrate the breadth and depth of development factors involved in the planning and implementation processes during urbanisation. This is based on a re-examination of cultural transformation in relation to water and urban design during the colonial, post-colonial and post independent eras. The scope of the research includes analysing records such as municipality records, government reports, maps, drawings, and sketches. These resources provide a basis for a cultural critique and interpretation of different case-based urban design development events related to water.

Part three consists of a mixed-methodology account of two recent case studies of urban development in the city. One attempts to include water as a positive asset, the other ignores the existence of water. Qualitative and quantitative approaches are used in an analysis, which includes social inquiry such as a physical survey, questionnaires survey, and semi-structured interviews to investigate the case studies (Groat & Wang 2002; Hays 2004; Lucas 2016; Yin 1994). GIS data, maps and other information have been collected as necessary, and analysed along with secondary resources such as records, popular press, reports and government documents. This component is based on the recent history of urbanisation and developments associated with water. The research follows a "top-down"

process for data collection and analysis. This part seeks to illustrate the explicit and implicit practices in the bureaucratic process and regulatory framework of public and private enterprises involved in recent urban development.

The study was conducted in the following major stages.

2.2.1 Literature research

This part of the research was conducted to outline the disciplinary knowledge concerned with urbanisation and urbanism, water management in design and planning, as well as colonial and post-colonial urban development discourses. This initial review and discussion of the state of knowledge and debate in the broader field of water urbanism leads to the case study of Dhaka, and associated fieldwork which addresses the identified gap in the research on water related urbanism in South Asia. This literature survey fulfils objective one of the research project, which is to identify theories and practices concerning water management and water culture in the design of cities applicable to the development of a deltaic metropolis. The initial stage of the research includes the study of water urbanism and context, which includes the following topics.

- a. Background of water urbanism discourses.
- b. Contemporary water urbanism theories and practices.
- c. Water related dimensions of sustainable urbanism.
- d. Colonial and post-colonial theories of urbanism relating to water in the South Asian context.
- e. Current development phenomena in urban design in Dhaka relating to water.
- f. Water urbanism discourses on Dhaka.
- g. Policy instruments and development agencies.
- h. Planning theory and practices relating to Dhaka.
- i. History of Dhaka in terms of urbanism.
- j. Private sector development in Dhaka.
- k. Water-bodies of Dhaka.

A major part of the literature review is represented in chapters one and three. Case based (case history analyses of the historical and contemporary urban water interventions) literatures are referred to throughout the thesis in different chapters where cases are explained and analysed.

2.2.2 Historical research

To achieve objectives two and three historical research is used to illustrate the story of the planning processes concerning Dhaka, along with identifying the factors that have driven the progressively “harder” engineered approach to the management of water in its urban development. Historical research has been conducted to identify and interpret the key historical documents associated with unfolding water urbanism in Dhaka during the colonial, post-colonial and post-independence period. Through historiographical analyses the history of urban Dhaka is reconstructed and interpreted from the perspective of water urbanism using specific sub-studies (case histories) based on historical documents. The modern engineering driven approach to water management in Dhaka’s urban development in the recent past is explained by contrasting recent activities by government agencies and other relevant actors with previous practices. Through this method the hydrological transformation of Dhaka is investigated within the immediate context of the Bengal Delta.

This historiographical research analyses employs the following types of documents.

- a. Maps
- b. Images
- c. Municipality records
- d. Drawings of different projects
- e. Policy instruments
- f. Archived government documents
- g. Bulletins
- h. Popular press

2.2.2.1 Procedures for archival research in Dhaka, Bangladesh

Exploration and analysis of historical records is a time consuming process. Archival research was conducted at a number of locations, including government agencies, museums, institutes, and personal collections. In the majority of cases, photographs were taken of the records such as maps, municipality correspondences, planning documents, and historical research, whilst in other cases photocopies were made. In every case permission of the relevant authorities was sought and received. The most time and labour intensive archival research was undertaken at the National Archive of Bangladesh. It was necessary to work in conjunction with the registrar of archival documents, which have not been digitized. In each case a requisition form to request specific documents was required. Visitors are not allowed to request more than a certain number of documents at a time. It took almost two days to identify the list of possible records. In many cases the documents were fragile and difficult to handle. Nevertheless, persons from the National Archive assisted with appropriate handling of such archival records. The researcher worked for almost three weeks on searching and collecting information from the National Archive.

Some important data was collected from the Dhaka City Museum of the Dhaka City Corporation (DCC). It took two days to identify and collect the relevant documents and old publications. In addition, both the libraries of the Asiatic Society Bangladesh and Centre for Urban Studies (CUS) possessed useful material. The researcher spent three days in these libraries. Both institutes conduct research and have their own publishing houses. The libraries of the architecture and planning school of BUET are the two major sources of historical government records, planning documents, and other research outputs, such as research publications and theses.

Some of the major records were collected from different government development agencies, such as the RAJUK, DWASA and IWM. From the RAJUK and DWASA archives photographs were taken of old drawings and records; further, soft copies of the development drawings and documents were collected from these agencies. In all of these cases, government officials and persons who were interviewed (Table 2-3) co-operated to collect the data from relevant departments, such as RAJUK, LGED, CEGIS

and DWASA. Consulting firms, institutes, and individuals also provided information, reports, drawings and other documents. Some old maps and documents were recovered from the private collections of different persons. Apart from that, the famous book market at the New Market Dhaka is a further source for government publications and other books.

2.2.2.2 List or category of collected historical documents used in this research

Table 2-2: List of collected documents during the field survey

no	Name of the documents	Type of the documents	Collected from
1	Buckland Bund/embankment documents of the Dhaka Municipality from the 19th and 20th century	Reports and correspondent letters	National Archive Bangladesh
2	Municipality records of the Dholai Canal from the 19th and 20th century	Drawings, correspondent letters, planning documents etc.	National Archive Bangladesh
3	Old maps of the Dhaka city from the 17th, 18th and 19th century such as maps of 1780's by Major John Rennell	Maps	National Archive Bangladesh
4	Documents of Ghats and landing stations construction and permission along the Buriganga River and Dholai canal	Drawings and correspondent letters	National Archive Bangladesh
5	Map of Motojheel area and Segunbagicha Canal in 1912	Map	National Archive Bangladesh
6	Map of 1912 of Dhaka	Map	Dhaka City Museum of DCC
7	Old published books on Dhaka	Books	Dhaka City Museum of DCC
8	Photographs and sketches of Dhaka's water bodies and riverside from the 19th and 20th century	Photographs and sketches	Dhaka City Museum of DCC
9	Map of Dhaka during the Mughal and pre-Mughal period	Maps	Dhaka City Museum of DCC
10	Planning report of 1917 by Patrick Geddes	book	Dhaka City Museum of DCC
11	Dhaka Metropolitan Development Plan 1995	Planning documents, maps	RAJUK
12	Map of 1959 master plan	Map	RAJUK
13	Current maps of Dhaka	Maps	RAJUK
14	Detail Area Plan (DAP) 2009	Planning documents and Maps	RAJUK

15	Maps of new townships proposed and completed	Maps	RAJUK
16	Documents on the water bodies and plans for some water bodies	Maps and planning documents	RAJUK
17	Wetland protection Law and private sector development law	By-laws	RAJUK
18	Books published on Dhaka's urban and planning history.	Books	Asiatic Society
19	Reports, research and books published on Dhaka's planning and development.	books	CUS
20	Dhaka Master Plan 1959 by DIT	Government report	Department of Architecture, BUET
21	Maps and areal images (1997 and 2000) of Dhaka in the 20th century	Maps and images	Department of Architecture, BUET
22	Detail survey Map of 1960	Map	Department of Architecture, BUET
23	Geological maps prepared by the Geological Survey Bangladesh (GSB)	Maps and reports	Department of Architecture, BUET
24	Maps of low lands water bodies and filled area in 1995 prepared by the Geological Survey Bangladesh (GSB)	Maps	Department of Architecture, BUET
25	Dacca Metropolitan Area Integrated Urban Development Project 1981	Government report	Department of Urban and Regional Planning, BUET
26	Reports and theses on water bodies and landfill projects	Reports and theses	Department of Urban and Regional Planning, BUET
27	Theses of planning masters and undergraduates on Dhaka's water bodies.	theses	Department of Urban and Regional Planning, BUET
28	Box culvert drawings of different projects by the DWASA	Drawing documents	DWASA
29	Reconstruction and renovation of canal	Drawing documents	DWASA
30	Flood Action Plan (FAP)	Government report and drawing documents	DWASA
31	Dhaka Integrated Flood Protection Project	Government report and drawing documents	DWASA

2.2.2.3 Analysis of maps, drawings and historical records

Cartographical records tell the story of historical facts such as the road layout, natural features, major establishments, major infrastructures etc. in the history that help to

explain the history of urban development. Moreover, old drawing documents explain the planning initiatives and propositions of organised development agencies. On top of that, correspondence letters, government records and documents along with historical texts provide the story behind many interventions. These analyses provide evidence to represent the hydrological changes in urbanisation in Dhaka. Apart from that, these historical records add to our understanding of planning and design ideas. These historiographical analyses illustrate the role of specific instrumental and institutional factors, such as government regulations, planning guidelines, and routine departmental practices of public and private agencies.

This part of the research is based on interpretive and descriptive analysis through examining historical and contemporary maps, municipality records, government documents, and drawings. A majority of the maps in chapters three and four were reconstructed to show the relationship between current and historical water features in Dhaka. Software packages were used to reconstruct maps, including Adobe Photoshop and CorelDraw. Maps were created in different layers for different periods for comparative analyses of the water bodies, human settlements and urbanisation. These analyses enable an understanding of the transformation of wetlands in relation to natural and man-made interventions. For instance, water bodies that existed in 1787 were traced from the archival map, while the contemporary map of Dhaka was traced from more than 200 detailed google screenshot images in order to give a more precise outline of current wetlands. These maps were overlaid and analysed for different features. Some additional maps and drawings have been used directly, and interpreted to explain planning processes, policies, master plan propositions, as well as hydrological and physical (urban) changes over time.

2.2.3 Physical observation

Photography was employed as the major tool for documenting existing conditions on specific sites. This survey was conducted to observe the use patterns and cultural practices in relation to water in the identified sub-studies (Bashundhara and Hatirjheel projects) areas in Dhaka. The primary objective of the physical observations was to comprehend how the intervention is situated in the urban context of Dhaka. Apart

from this, physical observations enabled the researcher to recognise the relationship between people, the city, and its water features. Both a Nikon 610 camera and a cell phone camera were used to record the context, activities, urban water phenomena, and urban landscape.

2.2.4 Questionnaire survey

A questionnaire survey was conducted in two major case study areas, which together represent a contrast in design and planning approaches toward dealing with water. The respondents are inhabitants of the two case study areas. One case study was the Bashundhara Township, which is a new land development project based on filling up the wetlands and flood plains. The other case study was the neighbourhoods surrounding the Hatirjheel area, which is a reconstructed (restored) or redeveloped wetland project. The total number of respondents to the survey was 250, with 130 residing in the Hatirjheel area and 120 residing in the Bashundhara Township¹. All of the respondents were at least sixteen years of age. The response rate is 91.92%. Participants were asked for their experiences and views about the developments related to water in their neighbourhoods. No potential risk or direct benefit for the participants was identified in either location. Full ethics approval was given by the University of Adelaide Human Research Ethics Committee before the research was undertaken (appendix A-1).

This study identifies and explains the perspectives that a range of different users and stakeholders hold relating to water and urbanisation. This study investigates and explains the involvement, influences, and impressions of urban water interventions in order to elucidate the processes and consequences of urban development.

2.2.4.1 Questionnaire design

The design of the survey took a number of issues into consideration (Groat & Wang 2002; Raghunathan & Grizzle 1995; Sudman & Bradburn 1982). The survey broadly represents the inhabitants of the neighbourhoods, including both sexes and respondents

¹ Around 90,000 people live in the Badda Thana and Bashundhara is under Bada Thana (source: Bangladesh Bureau of Statistic). About 50,000 people lives in the Bashundhara area.

of different ages. The sample group is representative of the variations in income and social status characteristic of the neighbourhoods. Both leading and/or biased questions were avoided. The questions were short, clear, and easy to understand. Questions moved from the general to the particular, and both open and closed types of questions were employed. The survey maintained a sequence, going from factual to abstract questions. In addition, both negative questions and sensitive, personal inquiries were avoided.

The survey consists of three sections (appendix A-7), and the initial section is the generic information of the neighbourhoods and the respondents such as age group, sex, occupation, income, and the reasons given for choosing to live in the neighbourhood. The second section is concerned with identifying respondents' perspectives of both the urban and wetland areas in the neighbourhoods. The third section is more conceptual. This section concerns landfill and construction of new townships through filling up low-lying lands and wetlands. Respondents' views on alternative ways to reclaim and protect wetlands were interrogated in this section. The majority of the questions are open ended. There are options for multiple answers. The survey was administered by both the researcher himself and by research assistants. Questions were asked either in English or Bangla, depending on the respondents. On average it took about fifteen minutes to complete each survey.

2.2.4.2 Process of the questionnaire survey

Initially a pilot study for the survey form was undertaken by two recent architecture graduates from Bangladesh. Using the feedback from the pilot study the survey form was modified. For instance, the options of 'not aware of the problem' and other options in the possible answers were added for some questions after the pilot study. In addition, one new question was added (question B3 in appendix A-7 in page A22). Two groups of research assistants (three in each group) were formed to conduct the questionnaire surveys for the two areas. Around 20% of the survey was conducted by the researcher; whilst the rest were completed by the research assistants. The researcher briefed the team leaders on how to conduct the survey at the outset. Subsequently, a meeting was held every two weeks after the survey work. It took almost two months to

complete the 250 questionnaires. Participants were given the option to opt out at any time, as explained in the information sheet (appendix A-3).

For the questionnaire survey the following procedure was used to recruit the sample and conduct the survey.

- The selection of the samples was not completely random due to the scope of the selection process. Initial contacts were made through three different methods. First one was through communicating the local administrative authorities. Second one was to make contacts through known persons (friends, families, colleagues and acquaintances of researcher and research assistants) in those neighbourhoods. Through them the researcher, and the research assistants, contacted their neighbours to undertake the survey in those neighbourhoods. The third method involved undertaking a door to door survey, and through passive snowballing. Door knocking in Dhaka is culturally acceptable and appropriate. The first method did not work due to bureaucracy and lack of co-operation from the authorities or associations, the second and third method were applied to conduct the survey and worked well.

The process to conduct the survey is explained below:

- Visit or call the identified respondents for the survey.
- Explain to the participant about the research project and the participant information sheet.
- It is considered as consent for the questionnaire survey if the participants agree to answer.
- Conduct the survey.
- End the survey and acknowledge the participants' contribution.

2.2.4.3 Questionnaire survey analyses

Questionnaire survey forms were coded at the beginning, prior to the data entry stage. Data entry was completed using Microsoft Excel for the 250 questionnaire survey forms (30 questions on each form). Data from Microsoft excel was transferred to SPSS for

Cross tab analyses, with a chi-square test measured by the p -value (Pallant 2013).

However, the majority of the analyses for the frequency test was prepared through Microsoft Excel. All the questionnaire survey analyses findings are explained in chapters, six, seven and eight where contemporary case histories are explained. For the cross tab analysis, conducted through SPSS, the p -value is the probability of the assumption being correct; therefore the lower the p -value the sounder the analyses (De Vaus 2002).

However, as recommended by Bryman and Cramer (2002) for conventional social research, with relatively smaller sample size, the p -value is set at 0.05 ($p < 0.05$) for this research. The majority of the cross tab analysis is explained in chapter eight, where comparative analysis of two contemporary case studies are illustrated.

2.2.5 Semi-structured interviews

To fulfil objectives three and four, semi-structured interviews were used to explain instrumental and institutional factors, such as routine departmental practices in public and private agencies, played in determining Dhaka's urban development. Semi structured interviews were employed as one of the major approaches for investigating the history of water management, which transformed the growing city of Dhaka from a "wet" water-based town to a "dry", relatively water-autonomous modern metropolis. Through an in-depth consultation with a range of expert observers and agents of past and present water-related urban development in the city, this method of data collection was conducted to better understand the perceived problems and potential for water-urbanism in Dhaka. The research project was designed to better explain contemporary urban development trends in Dhaka, with regard to water management, relative to historical water urbanism in the city and its region. Developing an enhanced understanding and explanation for the institutional frameworks and associated 'mind-sets', from which the policies and practices affecting water-related urban development in Dhaka, is of critical importance.

All of the data concerns development issues relating to water, none of which involve classified documents or sensitive issues for the organizations or people involved in the study. The interviews collected data concerning participants' occupations, experiences, office and position, and the participant's name. Names have only been

included in the study where participants gave their explicit consent. The researcher is aware that the small number of case studies may lead to interviewees being identified through association with other data, so direct quotations have only been used after very careful consideration.

2.2.5.1 The semi-structured interview Process

Prior to the field survey, a list of possible interviewees was identified. Selection of the possible interviewees was based on their affiliation, experiences and expertise in diversified disciplines required for the research findings. To fulfil the objectives of the research, six different groups of professionals and experts were selected for the interview investigation. The first group consists of urban and architecture historians. The second group consists of actors from the public development agencies, which includes architects, planners, engineers, and bureaucrats. The third group consists of researchers and academics involved directly, or indirectly, in urban development who have experience of urban water phenomena. Group four consists of designers of relevant urban design projects, including architects, planners, and engineers with water management experience. The fifth group consists of private sector real-estate developers. The final group includes environmentalists and activists, who contributed to the water related dimensions of planning and urban design. In some cases interviewee respondents are representative of more than one group. In the majority of cases the respondents are very experienced in their field. The youngest interviewee has more than 10 years of experience. Conversations lasted between half an hour and two hours, depending on how much the respondent had to say.

Interviewees are selected based on their expertise, experiences and affiliation of different development agencies. On top of that, people who were interviewed, are the true representative samples (evident from the list below) to comprehend the urban development trends in Dhaka. The following is the list of interviewee respondents, including their expertise and affiliations.

Table 2-3: List of interviewees and their details

sl	Name	Profession/expertise	Position, affiliation and background
Historians			
1	Dr. Sharif Uddin Ahmed	Historian (Dhaka urban development)	Chairman of the Asiatic Society Bangladesh. Former director of the National Archive Bangladesh. Professor of Department of History in the Dhaka University.
2	Dr. Abu Syed Saeed M. Ahmed	Architect historian, researcher and academician.	Professor and head of Architecture School, The university of Asia Pacific. Former president of the Institute of Architects Bangladesh (IAB).
3	Dr. Shayer Ghafur	Architect, human settlement (housing) researcher, historian and academician.	Professor at the Department of Architecture, BUET (Bangladesh University of Engineering and Technology).
4	Shah Alam Zahiruddin	Architect, historian, engineer, academician and bureaucrat.	Former head of school at the Department of Architecture, BUET (Bangladesh University of Engineering and Technology). Former chief architect of the Department of Architecture at the Public Works Department (PWD) Bangladesh Government.
Actors from the public development agencies			
5	Dr. K. Z. Hossain Taufique	Architect and planner	Deputy director at the Urban Design Directorate (UDD) of Bangladesh Government. Former Senior town planner at RAJUK
6	Md. Sirajul Islam	Planner and bureaucrat	Chief town planner of RAJUK (Capital Development Authority).
7	Md. Emdadul Islam	Civil Engineer and bureaucrat	Chief engineer of RAJUK (Capital Development Authority).
8	M. Ashraf Ali Akhand	Planner	Deputy town planner of RAJUK (Capital Development Authority).
9	Mohammad Aminul Quaium	Planner	Assistant town planner of RAJUK (Capital Development Authority).
10	Md. Sirajuddin	Civil engineer and bureaucrat	Deputy Director of the Dhaka Water Supply and Sewage Authority (DWASA)
11	Shahidur Rahman Prodhan	Civil engineer and bureaucrat	Former managing director of the DWASA Senior consultant of urban water management at the Institute of Water Modelling (IWM)
12	Prof. Dr Firoz Ahmed	Civil and environmental engineer, academician	Vice Chancellor at the Stamford University Dhaka Former head of School at the department of Civil Engineering BUET Former deputy director of DWASA

13	Dr. Asif M. Zaman	Water resource and environmental engineer	Researcher of the Institute of Water Modelling (IWM)
14	Kazi Habib Ullah	Civil Engineer	Superintend engineer of the Health and Engineering department of Bangladesh Government. Member of the Flood Action Plan (FAP) Former Engineer of DWASA
15	Md. Masud Ahmed	Civil and water resource engineering	Chief monitoring Engineer at the Bangladesh Water Development Board (BWDB)
16	Tapas Choudhury	Civil engineer	Superintend engineer (design section) at the Local Government Engineering department (LGED) Project engineer of the Hatirjheel project
17	Shajiya Khanam	Architect	Architect in LGED (design section)
18	Md. Sirajul Islam	Architect and planner	Chief architect, Dhaka city Corporation (DCC)
Urban researchers, urban design and planning consultants, and academicians			
19	Dr. Farida Nilufar	Architect, academician and urban designer	Professor and former head of School of the Department of Architecture BUET. Advisor and consultant of Detail Area Plan (DAP) for Dhaka. Former treasurer of the Institute of Architects Bangladesh (IAB).
20	Dr. Israt Islam	Architect, planner, academician and water researcher	Associate professor at the Department of Planning BUET (Bangladesh University of Engineering and Technology). Reviewer of the Detail Area Plan (DAP) for Dhaka.
21	Dr. Roxana Hafiz	Architect, planner, private sector development researcher and academician	Professor, Department of Planning BUET (Bangladesh University of Engineering and Technology). Former dean of Architecture faculty (Bangladesh University of Engineering and Technology). Reviewer of the Detail Area Plan (DAP) for Dhaka.
22	Dr. Mohammad Shakil Akther	Planner, geographer, researcher and academician	Head of School, Department of Planning BUET (Bangladesh University of Engineering and Technology). Reviewer of the Detail Area Plan (DAP) for Dhaka.
Designers and consultants of the urban water projects			
23	Ehsan Khan	Architect and urban designer	Director of Ehsan Khan Architect Former principal architect of VITTI Sthapati bindo Limited.

			Consultant of the Dhanmondi lake re-development and Hatirjheel projects.
24	Iqbal Habib	Architect, environmental activist and urban designer	Principal architect of VITTI Sthapati bindo Limited. Consultant of the Dhanmondi lake re-development and Hatirjheel projects. Secretary of BAPA (Environmental activist group).
25	Prof. Dr. Mujibur Rahman	Civil and environmental engineer	Professor at the department of Civil Engineering BUET. Director, ITN-BUET, Centre for Water Supply and Waste Management, BUET. Team Leader of the Hatirjheel Project.
Private sector developer (real estate)			
26	Shaikat Mitra	Planner, (Real estate)	Planner of the Swadesh Properties Limited (Private sector land developer).
27	Mohammad Mazharul Islam	Planner (Real estate)	Planner of the Eastern Housing (private sector land developer).
28	Undisclosed interviewee	Admin (real state)	Former admin executive at the Bashundhara Group (private sector land developer)
Environmental activist			
29	Rezwana Hassan	Advocate, Environmental activist	Chief executive at Bangladesh Environmental Lawyers Association (BELA)
30	Shirin Akther	Politician and activist	Member of the parliament.

For the semi-structured interviews, the following procedure was used.

- Make contact with the possible interviewee via email, phone call, or direct, in person contact with the office.
- Send or handover the information sheet and request letters officially addressed to the participant's office as initial contact.
- Make follow-up phone calls to schedule the interviews.
- Fix a suitable time and location for interview. Most of the interviews were conducted in daylight at offices or public places.
- Explain to the participant about the research project and the participant information sheet.
- Facilitate signing of the consent form by the participant.
- Conduct the interview.
- End the interview and acknowledge the participants' contribution.

Note that:

- Participants may opt out at any time, as explained on both the information sheet and the consent form.
- Participants can choose not to answer any question, as explained in the information sheet and consent form.
- Semi-structured interviews could be conducted in native language if necessary, as both the researcher and participants speak the same language.

2.2.5.2 Interviews questions/topics of interviews

Interview questions are generated to address the research objectives three and four. The topics discussed in the interviews with different groups are listed below.

Table 2-4: Topic of interviews to different interviewees according to their disciplines

	Topics of interviews/discussions
Urban and architect Historians	
	History of different water bodies associated human settlements and water routes.
	History of urban development related to water management with specific regard to the planning and architectural histories of this morphological change from 'wet/soft' city to 'dry/hard' city.
	Pre-Mughal, Mughal, colonial, post-colonial influences in constructing the urban landscape relating its wetlands.
Actors from the public development agencies	
	History of different interventions associated with the wetlands and water system such as embankments, construction/reconstruction/ transformation of canals, new townships or urban expansion through filling up the wetlands etc.
	Project design concept, funding, initiation and process.
	The planning process and govern mentality and mind frames of the public agencies and actors.
	Post-construction scenario of different urban water intervention.
Urban researchers, urban design and planning consultants, and academicians	
	History of urban development related to water management with specific regard to the planning and architectural histories of this morphological change from 'wet/soft' city to 'dry/hard' city
	Policies and planning relating urban development and water management.
	History of different interventions associated with the wetlands and water system such as embankments, construction/reconstruction/ transformation of canals, new townships or urban expansion through filling up the wetlands etc.
	Post-construction scenario of different urban water intervention.
Designers and consultants of the urban water projects	
	History of the plan making and implementation process

	Project design concept, funding, initiation and procedure
	Involvement of different development actors and stakeholders
	Positive and negative aspect of the projects
	Post-construction scenario and consequences of the projects
Private sector developer (real estate)	
	Plan making and implementation process of the project
	Project design concept, funding, initiation and development approval procedure
	Involvement of different development actors and stakeholders
	Positive and negative aspect of the projects
	Post-construction scenario and consequences of the projects
Environmental activist	
	Policies, bylaws and planning in relation to the urban water interventions
	Legal issues of wetlands protection
	Public and private sector development project approval procedure

2.2.5.3 Interview analyses

The interviews were analysed in order to elucidate the planning process and development mentality. Also, historical information on planning and implementation was collected via the interviews. As the interviews were semi-structured and informal, only data from the interviews relevant to the research has been considered. The data derived from the interviews is mostly qualitative in nature.

2.3 Research ethics

Ethics approval was sought from, and granted by, the University of Adelaide Human Research Ethics Committee (HREC) (appendix A-1). The following documents were submitted for the ethics approval.

Table 2-5: List of documents submitted for the ethics approvals

1	Ethics form. (appendix A-2)
2	Information sheet for questionnaire survey participants. (appendix A-3)
3	Information sheet for interview participants. (appendix A-4)
4	Consent form. (appendix A-5)
5	Contacts for information on project and independent complaints procedure. (appendix A-1)
6	Questionnaire survey form. (appendix A-7)
7	Details of the interviewee respondents and topic of discussions for the semi-structured interviews. (Table 1.3 and 1.4)

All human ethics issues were considered, and the research that was undertaken subsequent to approval belongs in the low risk category. After submission and scrutiny of the ethics form (appendix A-1) along with the supporting documents (appendix A-2, A-3, A-4, A-5 and A-6) field the survey commenced in September 2014. The ethics approval documents were submitted in the first week of June 2014 and approved in August 2014.

2.4 Summary

The above chapter outlines the range of approaches used to explore urban development trends in managing water in the deltaic metropolis of Dhaka. It explains how the research was conducted, through different methods appropriate for historical research and case study analyses, to answer the key research question: *'Is 'water-urbanism' – a 'wet' approach to urban design and planning – a more sustainable paradigm for the future development of low-lying mega-cities like Dhaka relative to prevailing 'dry' approaches?'*. This chapter illustrates how data was collected from three different perspectives, in order to deepen and broaden the investigation. In order to explore the hydrological history in relation to urbanisation and planning processes, the study conducted historical investigations through exploring archived documents and literature research. In order to

examine the embedded factors of planning processes and the mind-set of development agencies, multiple individuals from development agencies and other relevant backgrounds were interviewed. Finally, a questionnaire survey was conducted to elucidate people’s perspective of current urban development trends in relation to water management.

The research is both exploratory and interpretive. A Constructivist notion of research was employed, analysed and illustrated in the following chapters to explain the role of water in relation to urbanity and urban development in Dhaka. The following lists the methods used to explain the arguments and findings in different chapters.

Table 2-6: List of chapters in relation to the methods used for finding analysis

Chapters	Name of the chapters	Findings explained in different chapters using different methods
Chapter 1	Introduction and Background	Literature research
Chapter 2	Research Design	
Chapter 3	Literature Review	Literature research
Chapter 4	Hydrological History and Urbanisation	Literature research, archival research and interviews
Chapter 5	From Flow to Fortification (historical case studies)	literature research, archival research, physical survey and interviews
Chapter 6	Fortification: Urbanisation through Landfill (Constructed land) (case study: Bashundhara Township)	Interviews, questionnaire survey, literature research and archival research
Chapter 7	Urban Regeneration Through Reconstructed Wetlands (case study: Hatirjheel-Begunbara Integrated Development Project)	Interviews, questionnaire survey, literature research and archival research
Chapter 8	Discussion and Comparative Analysis of the Case Studies	Questionnaire survey
Chapter 9	conclusion	

Chapter 3

Literature Review

3.1 Introduction

'Water appears to be one of the issues that is regaining salience in the contemporary debate and literature concerned with urbanism. (Shannon, K & Moulder 2008, p. 5)

This chapter consists of an exposition of literature concerned with urban development discourses related to water. In addition, it presents colonial and post-colonial theories of urban development to situate Dhaka within the broader context of South Asia. This chapter elucidates the state of current knowledge about the broader issues that this research addresses, in order to articulate and delimit the scope of the present study relative to previous research. This literature review interprets the complexities of theories of urban development, along with the designs and practices relating to water management that have left major impressions on the contemporary urban landscape of cities in different regions.

This chapter describes multiple dimensions of urban development discourse. It explains the term water urbanism by addressing colonial modernity and post-colonial urban development philosophy in a water civilisation. It reviews the discourses concerned with Dhaka's urban development from the perspective of water related issues.

3.2 Theory and practice of water urbanism

3.2.1 The concept of water urbanism as a new platform for discourse in the history of urban development

Current concepts of water urbanism are framed within landscape urbanism. Pioneer researcher Kelly Shannon¹ (2006) has widely discussed the term water urbanism

¹ Kelly Shannon is Professor of Architecture and Director of the Graduate Program of Landscape Architecture + Urbanism at the University of Southern California. She received her architecture degree at Carnegie-Mellon, a post-graduate degree at the Berlage Institute (Amsterdam, The Netherlands), and a PhD at the University of Leuven (Belgium), where she focused on landscape to guide urbanization in Vietnam. She has taught at the University of Colorado (Denver), University of Leuven, Harvard's Graduate School of Design, Peking University and The Oslo School of Architecture and Design amongst others. Before entering academia, Shannon worked with Hunt Thompson (London), Mitchell Giurgola Architects (New York), Renzo Piano Building Workshop (Genoa) and Gigantes Zenghelis (Athens). Her research is at the intersection of analysis, mapping and new cartographies and design. Most of her work focuses on the evolving relation of landscape, infrastructure and urbanisation. Of particular interest to the present study is her focus on development of landscape urbanism strategies that work with water and topography.

in recent times. Her scholarship on landscape urbanism incorporates explanations of water related phenomena. She describes its far-reaching conceptual scope through projects in urban sites, regional territories, ecosystems, networks, infrastructure, and large organisational fields. The term water urbanism was formally acknowledged when the Katholieke Universiteit Leuven, Belgium, published their series *Water Urbanism* in 2008 (Shannon, K & Moulder 2008). Shannon and her research partners, from across Europe and Asia, initiated the discourse when they officially arranged the first international seminar on water urbanism, titled '*water and urban development paradigm*', in 2008. The aim of the event was to portray the concept of '*water urbanism*' as a multidisciplinary approach, integrating design, ecology, engineering, and management. The scholars did not just make the platform interdisciplinary by including scholars from different backgrounds, contexts, and conceptual frameworks, but also included a range of territories from across the world. The idea was to address more than just euro-centric notions, design, and practices. In particular, the event addressed the issues concerned with regionalism from within different contexts. The theory of critical regionalism popularised by Kenneth Frampton in 1983 influenced scholars to articulate a new concept of urbanism in traditional cities (Shannon, K 2006). As a consequence, all of these ideas have influenced the discussion of landscape and water urbanism within contemporary urban landscapes.

In the twenty-first century a focus on water urbanism has begun to evolve, as a result of the disappearance of water in urban development and the expansion of urban centres in the late nineteenth and twentieth centuries. During these periods the interface between land and water had collapsed, resulting in the destruction of natural and ecological systems as a consequence of rapid urbanisation.

The concept of water urbanism that has been introduced during the twenty-first century is highly pertinent to landscape urbanism, because water is an indispensable component of urban landscapes. Landscape urbanism was officially introduced as a discipline in the second half of the previous century (Waldheim 2006; Weller 2008). New urban development was implemented in many European cities during the beginning of the landscape urbanism era, mostly on the post-industrial sites of the late twentieth century (Donadieu 2006; Graham 2009; Scitaroci & Matuhina 2012; Thoren 2007;

Waldheim 2006). Landscape urbanism, including components water, ecology, and infrastructure, became a model of urbanism in the late twentieth century: initiated and articulated as a disciplinary term by the landscape architect James Corner (Waldheim 2006; Weller 2008). According to Corner (1999, 2003), landscape urbanism provides stenographic screening for environments that have been engineered and instrumentalised by other disciplines.

According to Donadieu (2006), the introduction of landscape urbanism occurred as a consequence of urban sprawl, large infrastructure projects, and post-industrial realities during the late twentieth century in the Western world. The 'Parc de la Villette'² is considered to be the first endorsed, official landscape urbanism project. It was initiated in 1982 on a post-industrial site in Paris, France (Shannon, SK 2004; Waldheim 2006; Weller 2008). This project has had an enormous influence on urban design history during the late twentieth century, marking a paradigm shift. This shift influenced the development of the sub-discipline of '*water urbanism*' during the *twenty-first* century. The Parc de la Villette project made landscape into a framework for contemporary cities. Both the winning and runner up plans for the project – by Bernard Tschumi, and Rem Koolhaas, respectively – were layered, non-hierarchical, flexible, and strategic, and they articulated a post-modern philosophy. A horizontal urban landscape with infrastructure can accommodate all kinds of public activities: planned and unplanned, rigid and fluid (such as water). These ideas have been followed in recent years, illustrated in the growth of water urbanism projects.

Since the late twentieth century the discourse on urbanism has become more important, due to the scale of urban development and the introduction of modernity (Shannon, K 2009b; Steiner 2011; Stokman 2008; Weller 2008; Wong, T & Brown 2009; Wong, TH & Eadie 2000). Water urbanism has become an important conceptual and design instrument for the discipline of urban design. Contemporary urban landscape is often characterised through urban development and the management of water (water urbanism). In practice, water urbanism takes place in the widespread and comprehensive ground plains, integrating manmade and natural elements. Ecology has become an

² This was a competition project. The winner was architect Barnard Tschumi's proposal, which was ultimately built. The runner-up was Rem Koolhaas's proposition, which has also come into the limelight for its innovative ideas.

extremely useful lens for assessing urban schemes, because of the consequences of rapid urbanisation and the violent and threatening natural forces that are increasing as a result of climate change.

3.2.2 Multiple dimensions of water in the urbanism discourse

‘Water is both unpredictable and difficult to contain, making it a potentially threatening element. While at the same time it is a life bringing force, and a cleansing element, which plays an important role in various belief systems, mythologies, and cosmologies’ (Shannon, K & Moulder 2008, p. 49)

Water is one of the major substances required by human civilisations to survive and thrive. In the twenty-first century the water urbanism discourse reflects the trends and impacts of human civilisations living alongside water. The logic of water civilisations (to live with water) has been violated by present urbanisation practices. The traditional cultural practices relating to water within cities have been transformed by urbanisation and modernisation. Consequently, the water urbanism dialogue is essential to sustain human civilisation, particularly for urban centres that are growing rapidly.

Cities in Asia have not been sufficiently analysed from the perspective of the history of water related urban development. Most studies have a euro-centric perspective, as the majority of scholarship focuses on the developing regions of the western world. For instance, the scholarship of Antje Stokeman, Jacob Wagner, Richard Campanella, Janusz Niemczynowicz, Steffen Lehmann, Richard Weller, and Fredrick Steiner mostly describes city formation in relation to water in Europe and other Western territories. A majority of this research articulates issues of constructed landscapes related to water in post-industrial sites, or deals with urban decentralisation, urban sprawl, and ecology. (Lehmann 2010, 2011; Stokman 2008). Research also highlights the contemporary conflicts between water urbanism and urbanisation, which seek to explain the impact of modernity (Feyen, Shannon & Neville 2009a; Niemczynowicz 1996, 1999). In the late twentieth and

early twenty-first century historians of Architecture³ have explained water as an important substance of urbanism. They have also demonstrated how the South-East Asian region developed as a series of water civilisations, in terms of their agriculture, livelihood, and built environment. According to Jumsai, there are only two types of civilisations,⁴ and one of them is water civilisation (Hogan 2003, p. 118). This type of civilisation depends on flexible interventions and a capacity to adopt a water-based ecosystem.

Urban water intervention phenomenon represent a paradigm shift in modern urban history. Water urbanism may be viewed as having a bias toward infrastructure or ecology. The literature shows that socio-political and economic factors have had major impacts on the hydrological landscape of growing cities along major water channels (Chattopadhyay 2000, 2005, 2007, 2011; Chattopadhyay & Sarkar 2005; Chopra 2011; Dossal 2010; Feyen, Shannon & Neville 2009a; Glover 2007; Kusno 2010; Mathur, A & Da Cunha 2006; Niemczynowicz 1996, 1999; Prakash 1992; Tay 1989). Some of these studies show that in these regions where the landscape is fluid, land-water fluctuations are quite random and frequent, and settlements have tended to be adjusted over time for this fluid landscape. In contrast, engineered landscapes have been the main-stay for many European and American cities, such as Amsterdam and New Orleans (Luttik 2000; Manaugh & Twilley 2006; Mathur, A & Da Cunha 2001; Russell 2001; Shannon, K 2008a; Sowell & Wiedemann 2009; Steiner 2011). Infrastructure has become a major component of urban development in the twenty-first century. Urban water infrastructure has been used as a hybrid structure, both as a functional and an ecological space in modern cities, which allow for a human interface with the landscape (Shannon, K 2009b; Shannon, K & Smets 2010; Stokman 2008). Infrastructure has become a vehicle for designing and managing water for urban developments, as exemplified by aqueducts, fortifications (embankments and drainage), dams, transport corridors, and constructed wetlands.

As articulated by a number of scholars in recent years, the concept of Sponge urbanism is analogous to resilient, or flexible, urbanism, (Manaugh & Twilley 2006; Sowell & Wiedemann 2009; Van Rooijen, Turrall & Wade Biggs 2005). Extreme ecological

³ These include architecturally-trained theorists and critical practitioners such as Abidin Kusno, Sumet Jumsai, Tay Kheng Soon, Trevor Hogan and Qazi Khaled Ashraf, each of whom has considered the history of water based civilisation in their contemporary work.

⁴ Water and land urbanisation. (Hogan 2003, p.118)

events have disrupted the hard engineered landscape of cities such as New Orleans, destroying the physical, cultural, and social fabric of the city, which has promoted consideration of alternatives such as sponge urbanism. Sowell and Wiedemann (2009) have described how sponge urbanism can be applied to redevelop the city, with more resilience to natural forces through soft engineering approaches. It can create a balance between the man-made and natural elements of a city. It represents a kind of urban development that integrates the water system with infrastructure as a resilient medium. Similarly, Kelly Shannon (2008a, 2009a) and Kazi Khaleed Ashraf (2012)⁵ present cities in Asia where water has historically been the life-blood of the city. They demonstrate how to live with water by employing a flexible and resilient design. These authors illustrate how water works as an integral part of seasonal flooding. Furthermore, these studies undertaken by Shannon, Ashraf, Sowell, and other scholars, explain how the settlements of these water civilisations absorb water in their living systems and adapt to the hydrological cycle in their regions.

3.2.3 Cities in relation to their water and water culture

3.2.3.1 Traditional/indigenous cities in relation to water

Water civilisations represent a major type of human settlement in many parts of the world, especially cities along the major water courses in delta regions. Traditional cities, such as Can-Tho, Hoi-An, Singapore city, Bangkok, Dhaka, Hanoi, Phnom Penh, Angkor Wat and Suzhou have been dominated by water and possess their own specific water cultures. The culture of floating markets, water transport, stilt houses, mount houses, Ghats (steps into the water), and other activities related to water are examples of the major physical characteristics of these water civilisations. Traditional water civilisations are predominantly associated with natural components, such as Nigeria's water communities (Magdaleno 2013). In these incredible communities people literally live on the water, and water is the only medium of transport for these communities. Similar kinds of settlements are also visible in Bangladesh, Vietnam, Malaysia, Thailand,

5. Kazi Khaleed Ashraf is an architect, urbanist and architectural historian. Currently he is one of the director of the Bengal Institute for Architecture, Landscapes and Settlements. He is also a professor of Architecture at the University of Hawaii at Manoa. He has taught at the University of Pennsylvania, Temple University and at the Pratt Institute in the United States. He is the author of numerous publications including some major books on architecture and urban history in South-Asia and Bangladesh. He is also the Director of the Bengal Architecture and Design Institute.

and China, where communities live on the water in stilt structures, floating houses, boat houses, and earth mount settlements in flood flow zones, with traditional systems of built forms. Historically, the water culture of these settlements is related to trade, communication, daily household work, and public places other than natural drainage and contentious ecological space. For instance, Dhaka was established along the river Buriganga, which was a major trading route. Water courses in this region have historically been used for communication, military control, and for day-to-day household and industrial use. In addition, the water network was vital for natural, gravity drainage and for balancing the ecological biodiversity within the region.

Water urbanism is deeply-rooted within ancient civilisations. Traditional cities in water civilisations depended on water for access to major urban areas and important individual buildings (including residential structures) until the arrival of modernity (Ahmed 2009, 2012; Shannon, K 2008a, 2008b). These cities were considered to be traditional water front settlements where water took the place of front yards, such as in old Dhaka and old Lucknow. In contrast, some traditional cities have incorporated modern water systems. For instance, traditional city planning for Vietnamese cities was based on a combination of natural and manmade water systems. Riversides dominate the cities, with floating markets and trade in these areas. Kelly Shannon (2009a) has articulated an argument about the city of Cantho, proposing that it represents an alternative concept of indigenous modernity, based on cultural hybridisation and absorption of multiple foreign influences. She has described Cantho's landscape as a liquid geography and as an indigenous urban identity. As Shannon, K (2009a, p-58) explains: *'The expanding city and its periphery can be intentionally planned as a non-hierarchical territorial network that allows urbanization to occur where infrastructure (including high-land for structures) is organized. An intermingling of urban and rural activities across the territory's networks of water and roads can not only maintain the region's productivity and dispersal of public services, but also keep the ecological balance in-check'*. Similar traditional settlements have flourished in South-Asia, particularly where traditional and modern water urbanism have been juxtaposed, mostly during the nineteenth and twentieth centuries.

Historical settlements with major water interventions (engineering intervention) are epitomised in examples such as Angkor in present day Cambodia. Built during the

Khmer dynasty from the 9th to the 12th century, Angkor was the largest urban complex in the preindustrial world with an extensive hydrologically-engineered water system including human-made canals, irrigation channels and extensive reservoirs (Evans et al. 2013). Other Asian settlements such as Suzhou China, built in the 5th century BC, were built with similar concepts of human-made water channels and moat systems (Xu 2000). Urban history reminds us that large-scale urban development has always depended on successful water management, either through traditional water-conscious ways of living, or through engineered solutions.

3.2.3.1 Modern cities in relation to water

A number of cities have ignored these traditional water based urban landscapes during their more recent development. Using hard engineering infrastructure to control natural features has become a common practice in modern city planning. Evidently, infrastructure has become a major instrument for dealing with water in contemporary urban development practice. For instance, projects such as Borneo-sporenberg, the Cheonggyecheon canal, the Hatirjheel-Begunbari canal and the Singapore River reflect an infrastructure bias manifested through modern engineering interventions. However, these projects have multiple functions, ranging from recreational spaces to enhancing the areas ecology and drainage. Scholars have identified that reconstruction and development of urban landscapes, through landscape and water urbanism approaches, are fundamental techniques in contemporary urban development (Shannon, K & Smets 2010; Stokman 2008). As Shannon (2009a; 2008) has indicated, such engineering interventions radically alter the imagery of the landscape, along with the ecology and water dynamics across the territory. With an engineered approach to water, the urban structure of cities is increasingly dissociated from the organisation of the hydraulic system (Stokman 2008). Moreover, via this process the urban watershed has been erased from the visual and spatial logic of many deltaic cities.

There are numerous examples of both infrastructure and ecologically biased projects in the western and eastern worlds. For instance, Brooklyn Bridge Park is an urban promenade along the water, which emphasizes the edge between land and water. It can be viewed as an infrastructure project, as it integrates the natural landscape (vegetation)

and water (Urbanski 2009). Similarly, Allegheny Riverfront Park (in Pittsburgh, Pennsylvania) is a landscape project in which water is a major element (Moffat 2002). Constructed wetlands have been created through reclamation, in order to enable sustainable urban development, addressing issues related to natural drainage, ecology, public space, and infrastructure. By contrast, Unimetal Park (by Dominique Perrault in Caen, France, 1995) is a landscape recovery project. It employed flexible organisation and reprogramming of the ground plan of 700 hectares of land on the urban fringe along the River Orle, integrating water with the landscape and other functions (Shannon, K 2006).

Some hard engineering interventions have imposed a high price on cities, such as New Orleans. The City had to endure a massive natural disaster, due to the failure of its fortification against water. The engineered approach that had been employed made the city inflexible in terms of its ability to adapt to the rigours of climate change (Sowell & Wiedemann 2009; Wagner 2011). As a result, contemporary scholars and designers are now considering sustainable approaches to urbanism that are resilient to climate change and other natural disasters, and designed with ecology and other natural features such as water in mind.

'Many Landscape architects usually follow the landscape mitigation and camouflage approach, hiding and masking the urban water infrastructure rather than revealing its complex ecologies of intermingling' (Stokman 2008, p. 56). In reality, masking urban water infrastructure is a common approach in many cases of urban development. Engineered interventions, such as box culvert roads as part of engineered drainage systems, have contributed to catastrophic disasters in many cities, such as Jakarta, Kolkata, and Dhaka, where flash floods and water clogging are regular occurrences. In contrast, in a project such as the Cheonggyecheon canal in Korea, which is a reconstructed canal, the water channel had been converted previously to a box culvert road with a flyover above before the reconstruction in 2005. Using a reconstructed wetland the city has reclaimed the water-body, providing the city with public and green space (United Nations 2011). Similarly, the Hua Xin project in China is a constructed wetland, incorporating a green and meaningful residential open space (Stokman 2008). Reconstruction and/or redevelopment of wetlands has become a vital urban development process in recent

years, as the consequences of flash flooding, the destruction of natural drainage and retention ponds, and a lack of public open spaces has become evident in urban areas.

Major cities in Europe have also undertaken innovative urban development exercises. For example, new urbanism by OMA and West 8⁶ redefined the practice of urban scale architecture during the second half of the twentieth century (Corner 1999, 2003; Waldheim 2006). The function of these designs is adaptive, flexible, and capable of accommodating changing demands and unforeseen circumstances (Wall 1999). As a consequence of urbanisation during the late twentieth century, many housing projects were built in Amsterdam and similar cities after World War II, and in the later post-industrial era. IJ-plein by OMA is one of the earliest of such post-industrial housing projects built on reclaimed land in Amsterdam during the twentieth century. Borneo Sporenburg by West 8 is another fascinating new urban landscape project, which represents a new paradigm of urban development. Following these projects, many schemes have been built since the 1980's. Almost 70% of the land in Amsterdam on which new urban development projects are being built is reclaimed land, relying on hydrologically engineered infrastructure interventions (Shannon, K & Smets 2010). The city of Amsterdam has experienced urban development since the medieval period, incorporating water as a major component for transport, natural drainage, and other functional and ecological spaces, through its dike system.

In recent times the boundary between water and land has become the area for marginalised people in major developing cities, because of its ease of access and cheap accommodation. Between 20% and 40% of people live in such informal sectors in cities such as Mumbai, Dhaka, Kolkata, and Jakarta. They are mostly economic migrants from rural areas working in the informal sector (Islam, N 2006, 2011; Lehmann 2010; United Nations 2005, 2011). Consequently, the majority of these informal sector settlements are regularly affected by floods and other hazards. Living on the edge of land and water is a reflection of both cultural and socio-economic realities in developing countries where water culture has a long history in urban centres.

⁶ OMA (Office of Metropolitan Architects) was founded by architect Rem Koolhaas in 1975, and West 8 was founded by architect Adriaan Geuze and Paul van Beek in 1987. Both offices are located in Rotterdam Netherlands.

3.2.4 Urban development, water and sustainability

'A vision for protecting, restoring, and interconnecting urban ecological infrastructure; multifunctional green networks at every planning scale: the metropolitan area, the city, and the neighbourhood; a research community and citizenry that understand the city's ecosystem; landscape restoration that repairs fragmented ecological structure; and finally, natural processes visibly integrated in the design of urban landscapes'. (Girling & Kellett 2005, p. 146)

In the twenty-first century sustainability has become a major focus of urbanism discourse. Extraordinary levels of urbanisation, with its impact on the environment and on human life, have motivated a reconsideration of how we manifest urban development. Consequently, sustainability has become a topic for ongoing debate, which can be articulated in a myriad of ways. In this century water urbanism discourses have come to reflect the trends and impacts of human civilisation on the edge between land and water. Traditionally, major environmental movements have focused on ecological processes and open spaces, rather than on the process of urbanisation (Farr 2012; Jon, Robert & Carrie 2012; Lehmann 2010; Wheeler & Beatley 2009). Discourses concerned with sustainability have become key drivers of contemporary urban landscape theory, especially in regards to ecology and human habitation. This is even more critical in vulnerable regions alongside water.

Sustainable urbanism has been widely articulated as a fundamental requirement for urban centres in recent years. There are many definitions of sustainable urbanism from different scholars. In general, the term sustainability can be defined from the perspective of sustainability discourses, as *'development without compromising the needs of future generations, and living within the carrying capacity in order to support the eco-system by achieving equity and social justice with cultural diversity for a balanced and healthy living environment.'* (Beatley, Timothy 1999; Beatley, Timothy & Newman 2008; Bulkeley & Betsill 2005; Calthorpe 2010; Campbell 1996; Farr 2008, 2012; Jon, Robert & Carrie 2012; Lehmann 2011). As identified by a majority of scholars, the sustainability of cities refers to three major components: environmental, economic, and social sustainability (Beatley, Timothy 1999; Beatley, Timothy 2008; Bulkeley & Betsill 2005; Lehmann 2011; Satterthwaite 1997; Wheeler & Beatley 2009). Environmental sustainability means the

protection of the environment to serve the ecological balance between physical (mostly manmade) and natural components of the environment. Economic sustainability of urbanisation refers to the economic growth of the city, without impeding ethical and human factors. Social sustainability refers to the social developments that protect the cultural landscape and diversity, as well as social institutions that promote social equity and cultural balance.

In the present global context, the overriding issue of climate change has motivated a relocation of issues of sustainability to a position of primary importance. Scholars advocate that a balance between physical and natural features is essential in sustainable urbanism (Beatley, Timothy 1999; Bulkeley & Betsill 2005; Farr 2012; Lehmann 2010; Wheeler & Beatley 2009). Many scholars have articulated water issues in terms of access to water, water crises, flood management, and water quality (Akbar et al. 2007; Alam 2009; Azharul 2006; Donofrio et al. 2009; Eisen 1995; Hill 2009; Niemczynowicz 1996; Varis 2006; Wong, TH & Eadie 2000). A small number of researchers have identified the issue of sustainability as one of the primary elements in designing and managing cities in water civilisations (Feyen, Shannon & Neville 2009a; Shannon, K 2006, 2009a; Shannon, K & Moulder 2008; Shannon, K & Smets 2010; Shannon, SK 2004). For a majority of scholars writing on water urbanism, sustainability is related to flexible and resilient urban development in water civilisations.

A variety of researchers have identified and articulated sustainable urban development through the concepts of ecological urbanism, the eco-city, green urbanism, and renewable cities. Water is one of the components that is regularly discussed in relation to the design and management of cities (Beatley, Timothy 2008; Droege 2006a, 2006b; Wheeler & Beatley 2009). As cities are responsible for consuming the major part of natural resources, the aim of such discussions is to make cities liveable, self-sufficient, and efficient. However, it is clear that this aim tends to be addressed in a piecemeal manner by cities around the world (Lehmann 2010, 2011; United Nations 2011). Both the ideas of green and new urbanism encourage traditional, compact design, walkable and transit oriented cities, which reduce ecological impacts and promote a sustainable life style.

Urban interventions in the west have aimed to create hybrid functional spaces alongside water. Water networks have been integrated in many cities, such as in Antwerp, Stockholm, Singapore, Bruges, and Ghent, in order to achieve sustainable development (Shannon, K & Moulder 2008). Integration of structural and non-structural initiatives in urban development provides a further approach for sustainable cities, which aim to balance the natural and manmade built environment (Wong, TH 2006). The Cheonggyecheon Lake Project in South Korea, Hampton Park in Melbourne, and the Adelaide city constructed Torrens River are examples of this approach (United Nations 2011). These projects have integrated structural and non-structural elements by reconstructing wetlands and urban open spaces.

Many researchers and professionals are working on designing sustainable cities in different parts of the world. For instance, the future cities Laboratory in Singapore is a trans-disciplinary research centre motivated by urban sustainability in a global frame. The aim of the centre is to develop themes of comprehensive future cities with environmental sustainability. The centre's research focuses on energy and the city, renewable energy, recycling in design, and operating sustainable cities in the future. The Future cities laboratory prepares plans and designs for future cities, incorporating built form, mobility, urban sociology, and housing. Moreover, the centre focuses on micro level sustainability, such as built-form technology. Similar groups exist in Bangladesh, such as the Centre for Urban Studies (CUS), the Urban Study Group, and the Bengal Foundation, who have conducted and operated urban design research in conjunction with academic (i.e. BUET) and professional institutes (i.e. IAB). These organisations have been acting as activists in the area of urban development policy over the previous two decades. They have spoken out against landfills and encroachment in wetlands and flood flow zones. In addition, they promoted the reconstruction of wetlands, such as the Hatirjheel Project. They filed a case against the Ashiyan City⁷ township in 2012 (the project area is located on the north eastern fringe of Dhaka). It was eventually declared to be illegal by the High Court in 2014 and by the Supreme Court in 2016 (Prothom Alo 2016; The Daily Star 2016a, 2016b). The

⁷ On 22 December, 2012 a writ petition was filed by eight rights organisations which include Ain O Salish Kendra, Association for Land Reforms and Development, Bangladesh Environmental Lawyers Association, Bangladesh Legal Aid and Services Trust, Bangladesh Paribesh Andolon, Institute of Architects Bangladesh, Nijera Kori, and Paribesh Bachao Andolon.

developer will now have to provide compensation to affected people and return the area to the flood flow zone.

3.3 Discourses on urban development manifested by the colonial and post-colonial agencies.

This section of the chapter presents critical historical scholarship related to South Asian cities that illustrate the interface between water and cities. This discussion outlines the literature on urban development issues from the colonial, post-colonial, and contemporary perspectives. These include institutional frameworks, governance, and the mind-set of development actors and agencies. This part of the literature review interprets the bureaucratic traditions and culture in South Asia, such as in Dhaka, which influenced urban development trends in the colonial, post-colonial and post-independence cities. In addition, the literature review critically interrogates contemporary academic and professional discourses on water related issues and possible crises in the process of urbanisation in Dhaka.

3.3.1 Colonial modernity

Modernity in the western world has its roots in the industrial revolution. In the nineteenth century industrialised societies in the west used their colonies to enhance their development and expand their economies (Chattopadhyay 2000, 2005, 2007, 2011; Chattopadhyay & Sarkar 2005; Glover 2007; Karim 2010; Sriver, PC & Prakash, V 2007). In the late nineteenth and early twentieth centuries modern development ideas were applied to a number of colonial cities and urban regions to expand colonial power. Several colonial cities, such as Mumbai, Delhi, Singapore, Jakarta, Kolkata, Lucknow, and Dhaka, were viewed as laboratories for the west.

To implement this modernising agenda, the British introduced new institutions and infrastructure for urban development. Between their imperial power and their modernising mission, they not only improved the infrastructure and settlements through technological advancement, but also expanded British dominance and control over the

region. For instance, to galvanize their political and military authority over their colonies, they constructed huge infrastructure networks in the form of roads, rail networks, bridges, dams, embankments, and sanitation and drainage systems during the late nineteenth and early twentieth centuries. British ideology was used to modernise society and settlements in the colonies by establishing a system of utilitarian knowledge and practice during the nineteenth century (Headrick 1979; Prakash 1999). The structure of the British colony helped them to rule over the Indian Sub-continent. As Prakash (1999) argues, the nineteenth century was the era of western global expansion via the introduction of new forms of discipline to the pre-existing traditional context, in order to control, occupy, and develop the colony to accommodate an extractive economy designed to serve Europe. Therefore, historians have consistently articulated that the Indian Sub-continent was an underfunded and over extended laboratory for modernism by the colonial administration.

'In most cases the British colonisers had little interest in learning from other long-established urban cultures, and sometimes sanctioned a violent physical assault on such cultures, justifying their action by a rhetoric concerned with issues of defence and public health. Later a strategy of preserving and sealing the old cities and cultures was endorsed by the dual mandate doctrine'. Home (1996, p. 219)

Colonial intervention may be viewed as a contradiction of local practices of architecture, planning, and urbanism. It was a period of imperial possession and domination over colonies that was instrumentalised by both indigenous and colonial modernity (Scriver, PC & Prakash, V 2007). New forms of development inevitably produced a new colonial urban landscape. With the idea of colonial modernity, new towns were established alongside old towns in British India, including New-Delhi, Kolkata, Lucknow, and Dhaka. New forms of urban landscape transformed the cultural practices of living with water in cities long associated with a hydrological system.

Bengal, like many other parts of the Indian Sub-continent, was underpinned by agriculture, which provided a steady source of revenue and a market for British industrial products. The British commercialised the agriculture in this region, which changed the dynamics of traditional agriculture (Chattopadhyay 2007, 2011). This commercialisation of

agriculture made natives more dependent on modern science in states like Bengal (Chattopadhyay 2007; Prakash 1994, 1999). The colonisers promoted science and technology through different exhibitions for natives. For instance, the Allahabad exhibition in 1910-11 and the Faridpur (now in Bangladesh) exhibition in 1873 had a great influence by introducing new science to agriculture (such as new motorised irrigation systems) which had an impact on the landscape of traditional villages (Prakash 1999). The British portrayed their western science in conjunction with Indian materials in order to gain the endorsement of the local people.

In the hydraulic civilisations, colonial urban development concerned with water involved control over and management of water. The colonisers built new infrastructure landscapes of magnificent grandeur, using engineering solutions in urban centres. The idea of fortification for cities in the Bengal Delta was associated with flood protection, health and safety, security, and sanitation. The British introduced railways and motorised transport in contrast to the traditional system of living in this region. These developments often represented a physical contradiction to traditional settlements in Bengal, which followed a historical concept of living with water. In the past, major access and mobility were associated with the water system.

3.3.2 Influences of institutional frameworks in urban development

To consolidate their civilising mission in the Indian Sub-Continent, the colonial institutional framework was used to disenfranchise local people. In many cases development schemes were a combined effort (joint venture) between the local elites and colonial agencies (Chattopadhyay 2000, 2005; Chopra 2011). Colonialism was not necessarily meant to be a venture of extended tenure, but *'the objective was certainly a profit venture and eventually to withdraw'* (Karim 2010, p. 182). The colonisers employed western-educated native elites, trained in western schools and colleges, to operate their institutional framework (Prakash 1992, 1994, 1999). Military and civil engineers and surveyors were employed to work in the field by the colonial rulers as part of the development process. Although there were decisions made by the supreme authority, field workers had their own priorities and mental frameworks for performing on site

(Chattopadhyay 2007; Prakash 1999). The intention to modernise the colony brought the British into cultural conflict with the local people, but the modernising mission also brought positive aspects to society, such as the education system, infrastructure, and health and safety improvements. Because of these conflicting facts, scholars have divergent views of British India's modernising mission (Headrick 1979; Prakash 1994). It is evident that British policy was designed to control, sustain, and extract wealth, but at the same time it also provided the impetus for philanthropic development ventures for the colonies and the natives.

After the 1857 mutiny the British revised the system of political-administration in the colony, and the exercise of administrative control became more extensive. Subsequently, the British crown took power from the East India Company and the British military engineers took control of most development. The colonisers established a bureaucratic system of development agencies, which were mostly dominated by the military engineers and public administrators (Chattopadhyay 2005, 2007; Scriver, P & Prakash, Ve 2007). An elite minority of military engineers had disproportionate authority in the institutional framework of the British colonial development agencies. The engineers saw themselves as Architects and Planners, and organised the development frameworks of the colonies. Rational and pragmatic engineering was implemented to fulfil the aim of modernising the territory.

Western modernism, characterised by a mono-cultural standpoint, appeared to dominate colonised traditional cities, which had previously displayed heterogeneous culture. Scholars argue that, the real project of colonisation was not the technical matters of bricks and mortar, or engineered grandeurs; rather, the colonisers envisioned a modern society that would undergo a rational reformation, changing its socio-cultural character (Scriver (ed.) 2007; Scriver 1994; Scriver, PC & Prakash, V 2007). Scholars believe that the colonisers expected their policies would bring about a secular, liberal enlightenment transformation at the same time as they were modernising the region.

During the late nineteenth and early twentieth centuries the British established new development planning, control, and implementation agencies, such as the PWD (Public Works Department) and the City Improvement Trust, which were dominated by

engineers and bureaucrats. The 1854 creation of the PWD was a landmark decision by the British, and it still operates in a number of post-colonial cities today (Chattopadhyay 2007, 2014; Scriver 1994; Scriver & Srivastava 2015). Through western enlightenment projects, using privileged technological advancement and industrialisation, PWD projects in the Sub-Continent functioned as a physical skeleton of the British Empire (Chattopadhyay 2005, 2007; McKay 2011; Scriver (ed.) 2007; Scriver 1994; Scriver, P & Prakash, Ve 2007). As a consequence of the PWD's interventions, the urban landscape was transformed by massive infrastructure projects, such as railways, bridges, embankments, roads, and utilitarian buildings. In Dhaka colonial interventions manifested in the forms of embankments, bridges, canalisation, factories, colonial gardens, and utilitarian buildings (cantonments, housing, and public and institutional buildings).

3.3.3 Post-colonial realities of urban development

Cities and towns along the major water channels implemented projects to control and integrate local water courses. Embankments, guide walls, dams, aqueducts, plazas, promenades, and other waterfront developments, mostly influenced by western development models, were built in many urban centers in the Indian Sub-Continent. For instance, Salt Lake City was developed on the fringe of Kolkata, which was a natural recycler of the urban watershed supporting large stocks of fish and an associated fish-farming industry (Chen, Wang & Kundu 2009; Rumbach 2014). In the majority of cases, these local Asian cities aspire to be global cities through western development models (Chen, Wang & Kundu 2009; Roy 2011a). As a result, major post-colonial developments contradict the logic of water, particularly in urban centres.

In the post-colonial era racial segregation has been replaced by social segregation, and the idea that low density equals high income and visa-versa remains. As Cities Alliance (2014); Home (1996) articulates, perhaps the most serious legacy of the post-colonial cities has been the failure to manage the tidal wave of urban growth and informal settlements. Urban scholars such as Roy (2011a, 2011b) have described these informal settlements as subaltern urbanism, which is most often developed on the edge, between land and water, such as the slums of Mumbai along the Dharavi, and the Korail slum in Dhaka. Researchers such as Kabir (2012) describe their occupants as shadow

citizens, who serve the huge informal economy of these large cities in developing regions. These people choose the fringes, or low lands, for easy and cheap accommodation, but at the same time these locations are very vulnerable. In most cases these marginalised people live along the water in informal settlements, or in traditional settlements, negotiated with real estate development ventures such as the Sabarmati river front development in Ahmedabad in the state of Gujrat, India, and Bashundhara in Dhaka.

The urbanisation process in these post-colonial cities demonstrates a lack of social justice. This is visible in almost every development project, such as Salt Lake in Kolkata, the Sabarmati riverfront in Ahmedabad, and the Hatirjheel-Begunbari in Dhaka. For instance, the Sabarmati Riverfront project in Ahmedabad displaced around 10,000 informal households between 1999 and 2002 (Desai 2012, 2014; Mathur, N 2012). Though there are lots of positive aspects of the project, such engineered manifestations of water urbanism have significant impacts on marginalised populations. The project has played a major role in environmental improvement, and it has created value for public and private sector developers, including generating major public spaces. In most cases wetland redevelopment and reconstruction projects improve the natural drainage, as well as introducing public spaces and green belts (i.e. the Hatirjheel and Dhanmondi projects in Dhaka, and the Cheonggyecheon river project in South Korea). However, some of these projects are neither flexible nor resilient due to their hard engineering approaches, which pay scant regard to environmental and social factors.

Post-colonial modernity flourished in the emerging cities of South Asia, such as in Chandigarh in India, Islamabad in Pakistan, and Sher-E-Bangla-Nagar in Bangladesh. The post-colonial world represents a vacuum that was filled with a euro-centric model of development, due to the legacy of colonial agencies. Modern professionals educated in the western system were frequently involved in the process of development. This Euro-centric view of modernity was opposed by the concept of critical regionalism at some point in the late twentieth century (Pieris 2010; Scriver 2010). Scholars believe that the binary opposition of traditionality and modernity shaped post-colonial cities in the late twentieth century through the process of the built urban environment (Kien 2010; Kusno 2010; Prakash 1990, 1995, 1999; Scriver 2010). The post-colonial world represents complexities and contradictions in urbanisation, driven by the realities of colonial legacies

in the institutional framework and in the urban development mentality of agencies and actors.

3.4 Current water urbanism discourses in Dhaka

In recent decades, research in the field of urban development in relation to water systems has focused on Dhaka as a major case study. For example, Kelly Shannon has made some significant research contributions on Dhaka, as well as on other similar cases (Feyen, Shannon & Neville 2009b; Shannon, K 2009b; Shannon, K & Moulder 2008; Shannon, K & Nilufar 2008; Shannon, SK 2004). In addition, researchers such as Kazi Khaleed Ashraf (Ashraf 2010, 2011, 2012), Ishrat Islam (Islam, I 2009; Islam, I, Katsuki & Hidehiko 2013; Islam, I et al. 2009), and Farida Nilufar (Khan & Nilufar 2009; Nilufar 1997; Shajahan & Nilufar 2013; Shannon, K & Nilufar 2008) have contributed to urban development discourses in relation to water. Shannon's scholarship focuses more on design and its interpretation for densely populated cities in developing regions. Her arguments are concerned with how to manage density in the contemporary urban landscape, addressing how water can act as an integral part of the city in urban design.

Shannon explains how the indigenous landscape was threatened by colonial modernity, and then later by capital driven modern living, in cities in the Mekong delta and elsewhere. Though her concepts do not conflict with the traditional landscape and culture, some of the physical forms of her ideas portray euro-centric notions (De Meulder, Loecx & Shannon 2004; Feyen, Shannon & Neville 2009b; Shannon, K 2009b; Shannon, K & Manawadu 2007; Shannon, K & Moulder 2008). Her impressions concerning how to blend thresholds between land and water in cities such as Cantho, Vinh, and Dhaka, are contextualised in terms of how people live on the margin of water. From her writing and images, it is evident that she was overwhelmed by the diversity of living environments of the people who live along water in water civilisations. However, her research does not highlight other facts, such as the social, political, and economic aspects in these regions. The majority of her exercises and concepts emphasise the physical and environmental aspects of urban development.

The current work on water urbanism in Dhaka by historian of architecture K. K. Ashraf (2010, 2011, 2012) illustrates the conceptual design of different segments of Dhaka in relation to water. As he states, we need to think of urbanism not as urbanisation, which is inappropriate in the context of Dhaka, where historically living with water is the cultural norm (Ashraf 2012). Further he portrays the dialogue between land and water in terms of history and possible designs for the future. Critics may consider the idea as a utopian exercise, however, his design research is conceptually strong and thoughtful in terms of an urban design manifesto. He presents his thoughts to a wider audience in a more provocative way as an activist who is published in newspapers and magazines. In contrast, his scholarly publications (journals and books) have a much smaller audience.

Most of Ashraf's ideas emphasise the concept of living with water. All of the design concepts displayed in his publications explain a hydrological landscape incorporating built form and infrastructure in a system of waterscape. He doubts how the Detail Area Plan (DAP) of Dhaka can resolve the pressure of development and give due weight to the environment, as there are no indications concerning the relationship between population and the system of urban land use in the city (Ashraf 2011). In addition, he explains how the embankment, which is a fortification against natural water flow, can be re-conceptualised through flexible design ideas.

Due to the fast growth that Dhaka has experienced, facts about wetland transformation and its impacts have been revealed and documented in recent years, including critical examination of the realities of land filling. Architect and planner Isirat Islam⁸ (2009; 2013; 2009) explains the urban water phenomena from a planning perspective. She describes how the wetlands have been rapidly transformed through the involvement of actors from different stakeholder groups (i.e. government and private development agencies). While urban design researcher Farida Nilufar⁹ describes the water phenomena from an urban morphological perspective (Khan & Nilufar 2009; Shajahan & Nilufar 2013; Shannon, K & Nilufar 2008). Her research demonstrates the

⁸ Dr. Israt Islam is an architect planner, academic and researcher. She is an associate professor in the Planning School BUET. Her expertise in planning from the perspective of water. She was one of the reviewers of the Detail Area Plan (DAP) for Dhaka. She is one of the interviewee of this research.

⁹ Prof. Dr. Farida Nilufar is an urban design researcher and academic. She was the former Head of the Department of Department of Architecture BUET. She was one of the consultants of the Detail Area Plan (DAP) for Dhaka. She is one of the interviewee of this research.

integration of local and global water bodies over time. She projects a possible water system for Dhaka that can perform as an integrated mobility network with hydrological features.

Recently a significant amount of research has been conducted on water issues from within the discipline of planning and geography. A majority of the research focuses on wetland transformation in relation to land use patterns and urbanisation, and its impact on urban populations, environment, and livelihoods (Byomkesh, Nakagoshi & Dewan 2012; Dewan 2013; Dewan & Yamaguchi 2009; Dewan Ashraf M. 2010; Islam, MS et al. 2010; Yamaguchi 2007). These studies suggest how to mitigate issues related to changing wetlands and uncontrolled urbanisation. Some of this research emphasises natural drainage patterns and how they have been impacted by the pressure of new land development for the growing urban population (Azharul 2006; Hossain & Rahman 2011; Sultana, Tarekul Islam & Islam 2009). However, all of the studies discussed in this section fail to explain the planning process in relation to transforming the landscape. Most of these studies describe issues related to flooding and seek to overcome water problems from an engineering perspective. Very few studies consider living with water in a way that satisfactorily explains the relationship between the built environment and the water system.

3.5 Conclusion

This chapter has identified and reviewed a number of relevant perspectives on theories and practices of water urbanism. In addition, it has identified and analysed contemporary notions and examples of urban design, which point the way toward a discussion of water urbanism using Dhaka as a case study. This chapter has explored the challenges and opportunities for cities in the process of urbanisation from the perspectives of modernity, colonial and post-colonial development, and contemporary urbanisation, in relation to water.

It is evident from this literature review that the history of urban development in Dhaka is underexplored in terms of how the city has transformed in relation to its water. Moreover, the Literature review identifies a gap in the administrative and bureaucratic

history of urban development in relation to water management in Dhaka. It also identifies a gap in colonial and post-colonial discourses on the urban development history of the city. Sufficient research has not yet been conducted on Dhaka's urban development history, particularly in terms of explaining the perspective and involvement of organised development agencies in water management over the last two centuries. Understanding water urbanism is crucial for water civilisations and can lead to more resilient and meaningful urban development.

Chapter 4

Hydrological History and Urbanisation

4.1 Introduction

This chapter presents the hydrological history of Bengal, using Dhaka as a case study. The chapter incorporates analyses of literature, old manuscripts, and cartographical records. The initial part of this chapter recognises the contestation between waterscape and human settlements in the context of the largest delta in the world: the Jamuna (Brahmaputra)-Padma (Ganges)-Meghna plain. The second part of this chapter explains the growth of Dhaka in relation to its water system over the previous four centuries.

Pre-Mughal and Mughal Dhaka were traditional riverine settlements where living with water and adapting cultural forms and practices to it was a daily reality. Later colonisers manifested their modernising agenda through developments that took a more engineered approach to water management and control, particularly during the final, most formal period of colonial administration under British Crown Rule, from the mid-19th to the early 20th centuries (Scriver 1994; Scriver and Srivastava 2015). The first major instance under colonial-modern agency of such an engineered intervention in the natural hydrology of Dhaka was the construction of the two kilometre long Buckland Embankment. Undertaken in the mid-19th century, soon after the establishment of the British Indian Public Works Department system, this was a joint venture between the British Governor and local elites that replaced and substantially extended an earlier Mughal-built embankment on the eastern bank of the River Buriganga.

The fundamental dilemma posed by this riverine landscape is how urbanisation might respond to and survive the enormous natural forces at work in the delta environment. While the organisational culture of urban development bodies tends toward hard engineering solutions which do not accommodate the natural force of water, there is a heightened risk of catastrophic outcomes.

There are four alternatives for constructing a settlement where major environmental risks from water exist. The first alternative is to ignore the risks, and to go ahead and establish settlements along volatile watercourses. The second alternative

is to avoid the environmental risks by placing human habitations far from watercourses, which frequently shift course. The third alternative is to adapt, as illustrated by the historical urban development of Bengal as well as other major deltaic civilisations where living with water was the normal practice for centuries. The fourth alternative – the approach undertaken in the majority of modern settlements along watercourses – is to defend against, or attempt to tame Nature through engineered interventions. For centuries, the Bengal delta region has demonstrated cultural practices shaped by adaptation, living with water in its rural areas. Colonial, post-colonial, modern, and post-modern interventions have superimposed engineering approaches onto these well-established local systems, especially in cities such as Dhaka.

4.2 Cultural practices in the Bengal delta relating to water

Bangladesh, or the Bengal delta, is a milieu of land and water. This region is characterised by researchers as a water civilisation, since the majority of settlements are established beside rivers, river junctions, and on the coastline (Ashraf 1997, 2011, 2012). Water culture is dominant in Bengal; therefore, settlements along watercourses are the logical consequence of communication, accessibility, trade, and political control. Moreover, water sources are important for household use, drainage, and military purposes. Controls over water sources are vital for agriculture and trade, and both of these activities are essential for the development and survival of civilisations.

The source of the massive river system that shaped the Bengal delta is the majestic Himalaya glaciers in the north-west, north, and other mountains in the north-east of Bangladesh and India. The majority of the outflow of water ends up in the Bay of Bengal, primarily through the Ganges, Brahmaputra, and Meghna Rivers. Bangladesh is a low-lying country, with the majority of its land area just a few meters above sea level. Hundreds of rivers criss-cross Bangladesh. Consequently, around two-thirds of Bangladesh's surface area is a combination of rivers, canals, wetlands, and flood plains, contributing to the Ganges-Brahmaputra-Meghna delta (Allison 1998).

Historically the characteristics of the river courses are diverse, which has contributed to the shape and cultural practices of its urban settlements. On the other hand, rural settlements in the Bengal Delta have been based on its water ethos. Cultural practices of rural Bengal were portrayed in a captivating way in literature and movies during the early post-colonial period such as in the 1973 film 'A River Called Titas' written by Adwaita Mallabarman and directed by an eminent Bengali director Ritwik Ghatak.

The cultural landscape of Bengal is profoundly associated with its water system. There are around seven hundred watercourses and rivers (Figure 4-6), which are immense when set against the area of the country (147,570 km²). Major settlements are located along the watercourses; hence, principle historical establishments face onto water bodies, such as in old Dhaka, along the River Buriganga, and the Dholai canal¹ (Figure 4-7 and Figure 4-11). Dhaka's physical, cultural, and economic history was based on its water system, as it had played a primary role in shaping the settlements in the region. Historian James Tailor described Dhaka as the '*Venice of the orient*' during the colonial period, in the mid nineteenth century (Ahmed, SU 2003, 2009; Chowdhury, MA & Shahidul 2011; Dani 2009). The older part of Dhaka is built on the higher ground, whereas the greater part of development in recent years was constructed by filling up low-lying land. A number of studies indicate that in the last fifty years the wetlands of Dhaka have been reduced by more than 30%, while urbanised land has increased by more than 350% (Ahmed, SJ, Bramley & Dewan 2012; Dewan & Yamaguchi 2009; Sultana, Tarekul Islam & Islam 2009; Yamaguchi 2007). Over time, urbanisation in Dhaka has altered watercourses as well as wetlands.

Bengal is a volatile region. Settlements in rural areas have been built to cope with naturally occurring flooding in the low-lying country. In general, settlements are on the higher land. In low-lying areas, houses are built on platforms, or on mounds formed from the soil excavated by digging a pond behind the dwelling. Stilt houses are more common as temporary structures in cities, towns, commercial centres, and ports along the water channels². During the dry season, the flood plains become the

¹ The Dholai Canal no longer exists, as it was partially filled-in. The remaining part was converted into a box culvert road during the 1990's.

² Stilt houses are not a common type of dwelling in settlements in low-lying parts of the region. However, stilt houses are a common type of structure in the hills.

agricultural fields. However, throughout the monsoon everything is under water, apart from higher ground, where houses and roads can be found. More than one third of the land in this low-lying country is irrigable, alluvial soil, which is suitable for rice production (Ashraf 1997). At present Bangladesh is the 4th largest rice producing country in the world, even though it is 94th in terms of its area. With modernisation and urbanisation, agricultural lands have been reduced.

Ghats are one of the major examples of the cultural landscape of the South Asian delta, which work as a hinge between land and water. Ghats are steps in the water, or a platform on the water (Figure 4-1). In a majority of cases, they are part of the building form and public realm. In south Asian traditional culture and religion, Ghats play an important role. For instance, in Dhaka Ghats are used for water transport, trade, bathing, washing, recreational space, offering worship, and for collecting water. During the 17th, 18th, and 19th centuries, forts, large mansions for the social elite, public buildings, caravanserais, and boulevards were built with Ghats beside water bodies. At present these waterbodies and Ghats are used for various formal and informal economic activities. Examples include commercial washing of clothes, cleaning recycled materials (such as plastics), and releasing toxic waste from the leather and dyeing industries (Figure 4-1). In addition, many cottage industries (such as the pottery industry) use these Ghats and riverside areas due to their easy access to water.

In many areas of rural Bangladesh water bodies are still critical for communication. In some areas boats are the only means of transportation, because of the morphology of the landform and water network within this distinctly hydrological landscape. River ports in many parts of Bangladesh are still vital functional spaces for trade, commerce, and mobility, as rail and road infrastructure are far more costly. Dhaka used to be a city incorporated with its natural water system, but it has lost many of its canals and water bodies. The city began to be defended against water by the British in the 19th century, and more comprehensive defence for the purpose of modernisation was undertaken during the 20th century. Various factors drove these changes, notably the desire to develop modern infrastructure, to improve the health of the city (to protect people from water borne diseases), and to develop modern

transportation. Consequently, the dialogue between water and settlement was transformed through urbanisation.

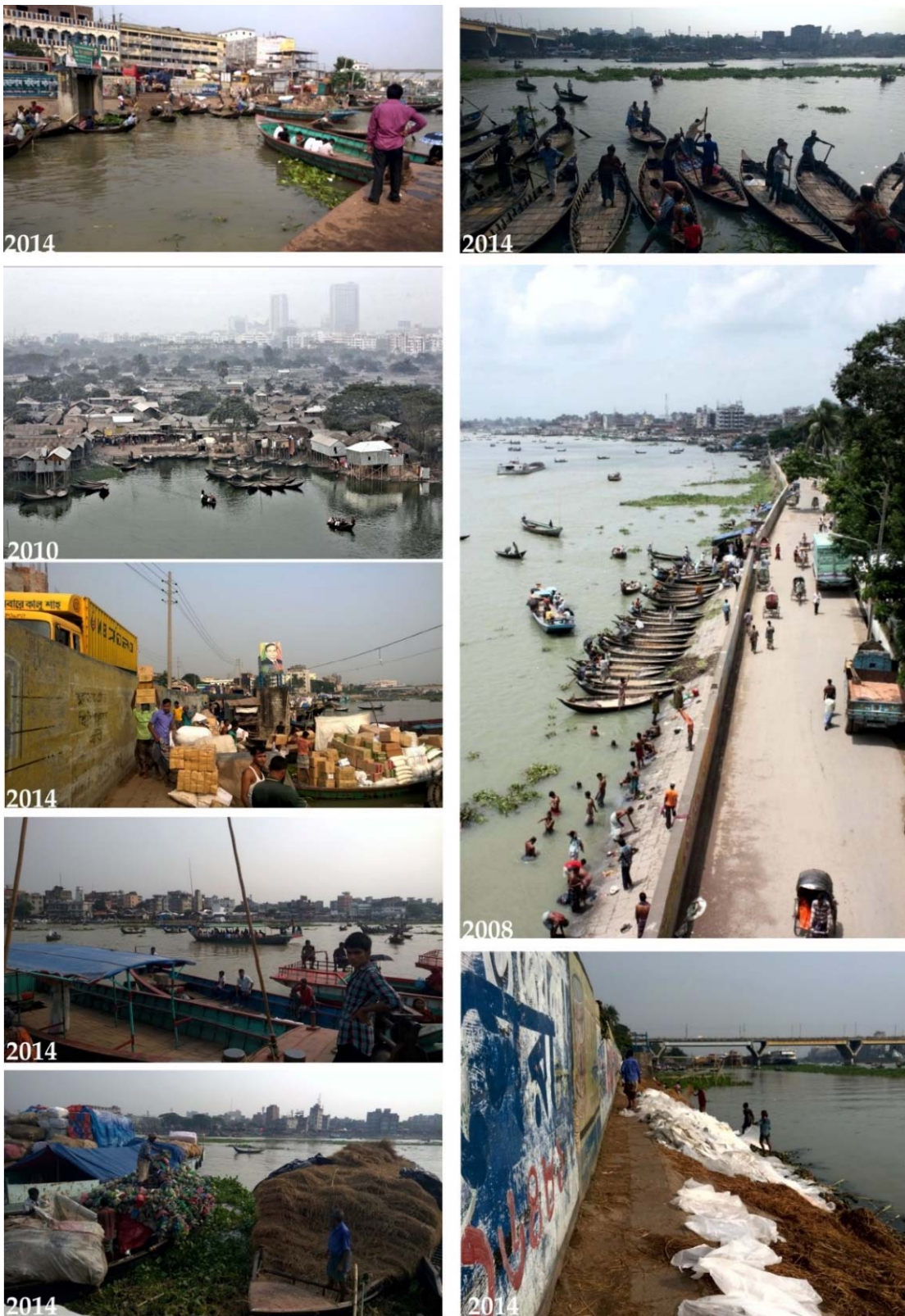


Figure 4-1: Current water culture along river Budiganga (including the embankment built in 1989) and other waterbodies (the majority of the photos were taken during the field survey in 2014, and the rest were taken earlier by the author)

4.3 River migration

Natural shifts in river courses have been one of the major reasons for the displacement and influx of migrants to urban centres in Bengal. The urban population in Bangladesh increased from 20% in 1990 to 34% in 2014 (United Nations 2014). Over the same period the population of Dhaka increased from 6.62 million to 16.98 million. About one third of the population live in informal settlements along the wetlands in temporary structures. This portion of the population is vulnerable and subject to frequent natural and manmade disasters.

This part of the chapter illustrates the shifting of river courses through analysis of historical documents, notably maps. Both landforms and river courses are constantly shifting, due to the fluid landscape (Figure 4-2, Figure 4-3, Figure 4-4 and Figure 4-5). It is evident from the cartographical records that watercourses have experienced large shifts. However, most of the studies suggest that lateral movement of river channels have been gradual rather than instantaneous in this region. Whilst gradual shifts have been the most common phenomena over the history of the Bengal delta, sudden shifts (known as avulsions) have also been documented. Avulsion can be described as sudden abandonment of the old course in favour of a new course (Bridge & Leeder 1979; Bristow 2009). Normally the river shifts to a new course on the lower flood plain.

Sometimes avulsion is noted as switching the main course, or river channel, into a braided river. A common term for river shifting used by the majority of these researchers is channel migration (Brammer, H 1993; Bristow 2012; Coleman 1969). There are six major reasons for channel migration that can be observed in the work of scholars from the disciplines of geology and hydrology (Brammer, H 1993; Bristow 2009; Coleman 1969). They include tectonic tilting, earthquake trigger, river capture, flooding, inverse discharge from upstream, and dramatic discharge from upstream. In the majority of cases river migration is caused by more than one reason. The massive and grandiose rivers of Bengal, such as the Jamuna (Brahmaputra), Padma (Ganges), and Meghna are mostly braided; therefore, they are characterised by unsteady bank lines and rapid rates of horizontal movement (Acciavatti 2010; Acciavatti, Bierig & Corrigan 2015; Khan & Islam 2003). The river Jamuna is the largest braided river in the

world, and is subject to constant shifts and frequent flooding (Ashworth et al. 2000; Best et al. 2003). The diversity of the river morphology characterises this delta. The following sub-sections present the river shifting chronologically from the 17th to the 21st century, by investigating historical evidence.

Another major characteristic of this delta is the seasonal fluctuation of water. Land-water fluctuations are quite random and frequent in this region due to its geohydrology. There are no permanent edges or boundaries between land and water. On the other hand, the nature and formation of "chars," the sand-silt islands formed by the annual dynamic flow of rivers, is a major geo-hydrological feature in this delta. The majority of these chars are short-lived or continuously shifting temporary landmasses.

4.4 History of water courses and river shifting in the Bengal Delta

4.4.1 17th and 18th century river system

During the 17th and 18th century the Bengal delta had a different geography than today. The transformation is evident when one considers the oldest published map of Bengal (printed by the French in 1635), and the earliest British map of India published in 1716 (Figure 4-2). All the historical maps from the 17th century tend to be conceptual and not to scale.³ Dhaka is almost at the mouth of the river system⁴ in the map of 1635 drawn by Jan Jansson, who was originally from Amsterdam (Barry Lawrence Rudeman antique maps 1991a). The oldest British map of India, produced by William Baffin and Samuel Purchas in 1716, primarily shows the Ganges and indicates Dhaka towards the east, near the old Brahmaputra channel. In contrast, the map of 1635 presents a wide channel and the connection of major rivers, along with the Bay of Bengal (Figure 4-2). The map indicates major cities, including Dhaka, in the region along the wide water channel. Both of the maps predominantly show the majestic Ganges, which was directly connected to the Bay of Bengal and the two other

³ As the maps from the 17th century are conceptual and not to scale, they are not fully reliable sources to confirm hydrological history.

⁴ The Buriganga, which means the 'Old Ganges', supports the existence of the Ganges close to Dhaka during the 16th and 17th century.

major flows in the vicinity: the Brahmaputra-Meghna and the Karnaphuli. However, none of these maps from the 17th century indicates the Jamuna (new Brahmaputra) River. The map of 1635 indicates the old Brahmaputra as the Caor River/Gaur and Karnaphuli as the Cosminus River. Conceptually, the two maps are similar in terms of the paths of the major water channels.

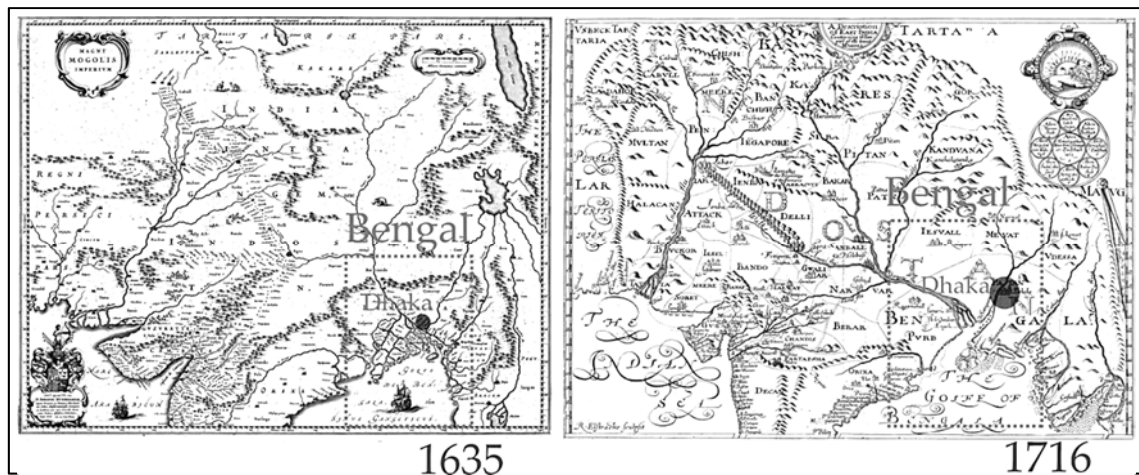


Figure 4-2: Cartographical records of 1635 (source: Dr. Abu Syed Saeed M. Ahmed) and 1716 (source: https://www.raremaps.com/gallery/search?search_term=bengal)

The British prepared the majority of the cartographical records during the major survey of British India during the mid-18th century. The prominent cartographer Major James Rennell (1742-1830), who was an engineer of the East India Company, drew some major maps during the 1770's and 1780's⁵ (Figure 4-4). Another major 18th century map of Bengal was produced by Robert Laurie & James Whittle in 1794, and was based on Rennell's map (David Rumsey Map Collection 2006). A further major historical map of the Bengal delta was drawn by Jacques Nicolas Bellin (Figure 4-3) (Barry Lawrence Rudeman antique maps 1991b) for the the Germans in 1750. All of these maps show two massive watercourses, namely the Ganges and the Brahmaputra. both of these rivers were on different paths than their current paths. Indeed, the Brahmaputra was around 100 km east of the present New-Brahmaputra (or Jamuna). Both the Ganges and the Brahmaputra separately ended up in the Bay of Bengal during the 18th century (Figure 4-4). In contrast, at present both the Ganges and Brahmaputra connect to the Meghna more than 100 kilometres before entering the Bay of Bengal (Figure 4-6). Rennell's map shows the Brahmaputra connected to the Meghna before it

⁵ Maps were collected from the National Archive of Bangladesh.

entered the sea. In addition, the Ganges ended in the sea separately towards the south-west.

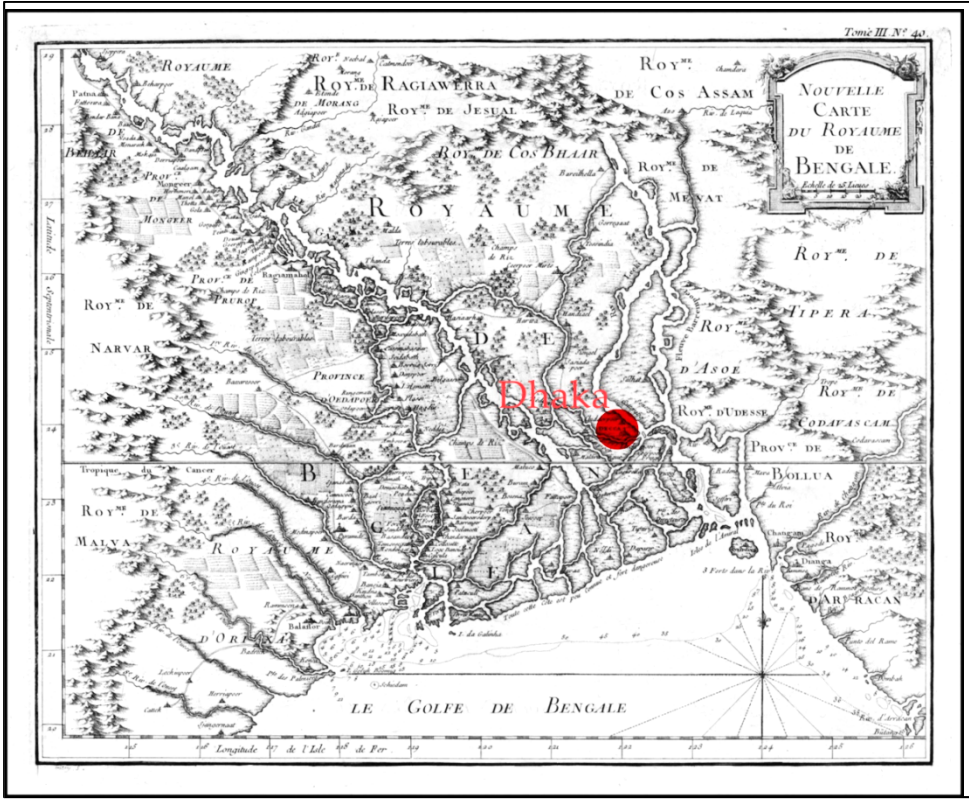


Figure 4-3: Map of Bengal in 1750 (source: https://www.raremaps.com/gallery/search?search_term=bengal)

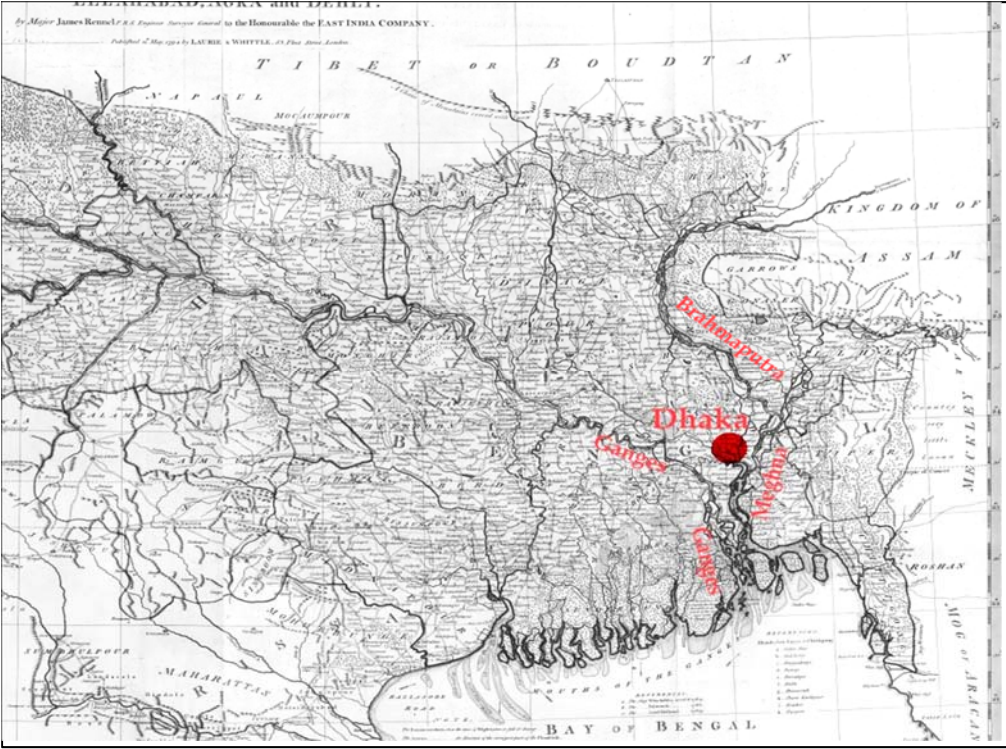


Figure 4-4: Survey map of 1780's republished in 1794 drawn by Major James Rennel (source: National Archive Bangladesh)

The massive Brahmaputra River of the 18th century is now a small stream compared to the other great rivers of Bangladesh and is called the old Brahmaputra⁶. The majority of researchers concur that the River Brahmaputra shifted westwards as an avulsion in the late 18th century (Brammer, H 1993; Bristow 2009, 2012; Coleman 1969; Khan & Islam 2003). The evidence from historical maps supports this shift. It is believed that tectonic movement followed by an abnormal flood in 1787 triggered this sudden shift (Khan & Islam 2003). In addition, it is suggested that uplifting of the Madhupur Tract (the Dhaka region and the north high land, which possess more stable soil) as well as a major increase of water flow down the Tista river from the Ganges activated the river migration (Rashid, Monsur & Suzuki 2006). A few commentators suggest that the whole incident happened in a very short time (Islam, MR et al. 1999; Khan & Islam 2003), but the majority of experts believe that the whole phenomena happened gradually over more than 50 years after the first major incident of tectonic tilt (Bristow 2009, 2012; Coleman 1969; Rashid, Monsur & Suzuki 2006). On 18th century maps there is no evidence of the massive Jamuna River. However, a very small water channel named the Jenni was located in the same position. The Teesta River followed the same path, but it was much narrower during the 18th century. It is now a large river with an average width of more than two kilometres. It is connected to the Jamuna, flowing from the Himalaya region.

4.4.2 The 19th century river system

British India underwent significant modernisation from the second half of the 19th century, with large numbers of bridges and railroads being built (Chattopadhyay 2011; Home 1996; King 1976). The British established the East Indian Railway in 1867 for faster communication. New railway bridges, culverts, aqueducts, and railroads disrupted the natural flows of water. Human agencies introduced a new system of infrastructure that posted new challenges for the natural landscape. In order to comprehend the landscape the British rulers manufactured maps that illustrate the river courses of this region in reasonable detail, and contained the river migrations.

⁶ The old Brahmaputra is the ancient stream inside Bangladesh. The new Brahmaputra is called Jamuna.

It is evident from the maps published by the British in 1831, 1842, 1875, and 1889, that the new Brahmaputra (or Jamuna) became wider over the course of time, because of an increased volume of water from upstream (Figure 4-5) (David Rumsey Map Collection 2006). In contrast, the old Brahmaputra became thinner and was transformed into a meandering (braided) river in this century, because of decreased discharge (Bristow 2009, 2012). Despite the river migration, the old channel of the Brahmaputra had reasonable flow during the 19th century. Over time the old channel became very narrow, less than 300 meters in width, compared to the New Brahmaputra, which is more than 10 km wide at present (Bristow 2012; Khan & Islam 2003). Although avulsion occurred in the late 18th century, the New Brahmaputra (or Jamuna) became the major course during the early and mid-19th century (Ahmad 2014; Bristow 2009, 2012; Coleman 1969). Notably, a map from the 1830's shows that the Old Brahmaputra was very active; however, a map from the 1840's shows both the new and old courses were of similar width (Figure 4-5). Nevertheless, because of high flow from the Teesta River, and the upstream Brahmaputra, the new channel became the main course by the 1820's, which is indicated in the historical documents.

The maps of the 19th century show that the Ganges was still a separate channel, though downstream it shifted more towards the east and linked with the Meghna river. With the shifting of the watercourses settlements were displaced and resettled. As the old Brahmaputra was not navigable for large ships, major towns and cities along it lost their importance. The town of Mymensingh was relocated to the old town at Begunbari after the region was devastated by floods during the late 18th century (Bristow 2009, 2012; Coleman 1969). Considering the river migration, it is assumed that the town of Mymensingh was established after the avulsion and flooding in 1787.

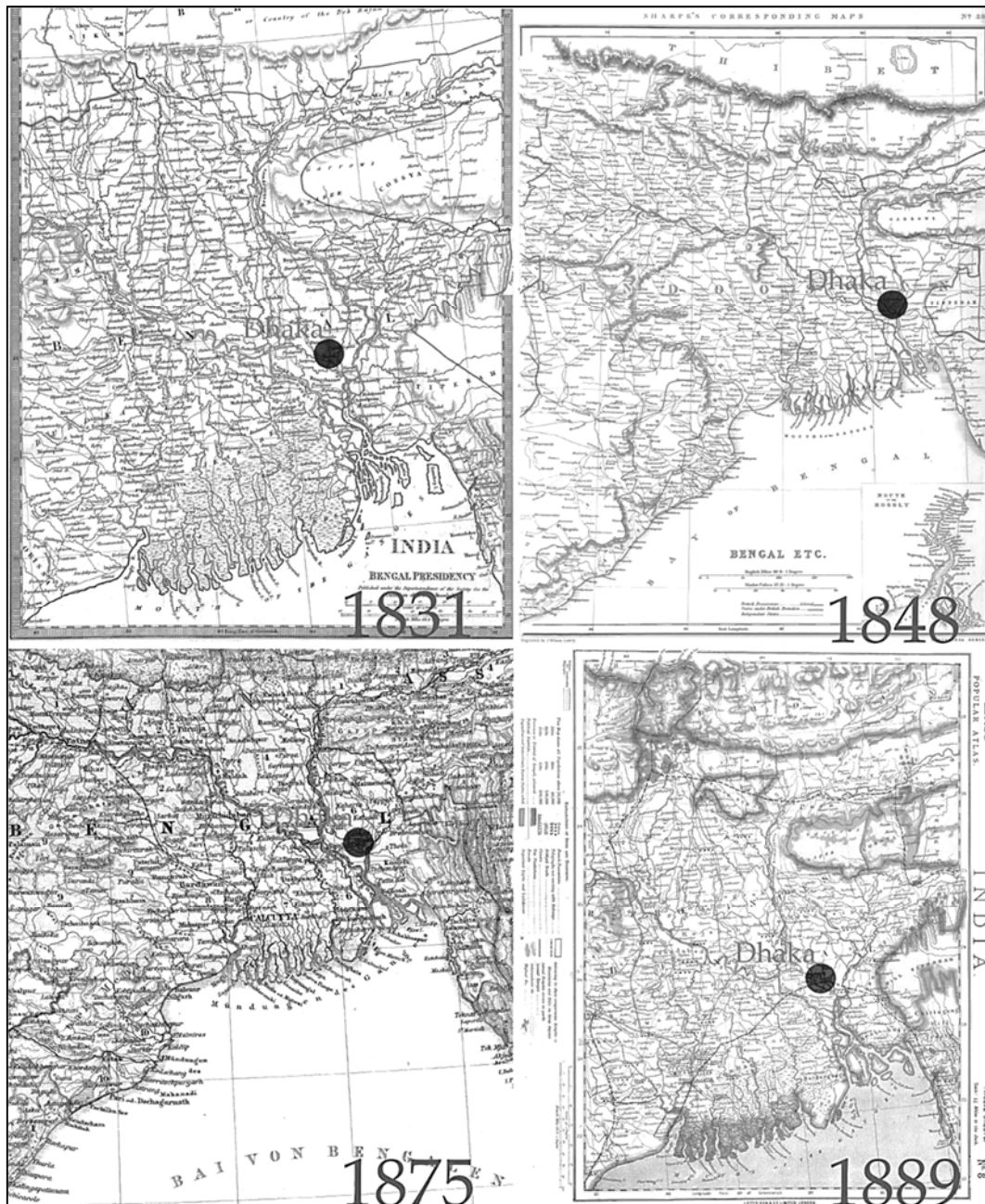


Figure 4-5: Maps of the 19th century Bengal Delta (source: <http://www.davidrumsey.com/search?utf8=%E2%9C%93&term=bangladesh>)

4.4.3 The 20th century water network and modern engineered interventions

The Jamuna is the most diverse among all of the rivers, with an average shifting of more than 1 km per year (Bristow 2012; Khan & Islam 2003). Research and maps illustrate that in the 20th century the average width of the Jamuna gradually increased from 6.2 kilometres to 10.5 kilometres, because of increased water discharge (Allison 1998; Bristow 2009, 2012; Khan & Islam 2003; Nicholas 2013). The vulnerability of

settlements along these large and diverse river courses forced people to migrate to the big cities and towns, leading to extraordinary rates of urbanisation from the late 20th century. Research demonstrates that during the late 20th century about 1200 km of rivers in Bangladesh were under active erosion (Islam, N 1992). Studies show that displacement in Bangladesh, due to river erosion, has been between 5% and 23% per year from 1988 until 2011. Therefore homelessness, inter-migration, and a large influx of people to the urban areas is ongoing (CEGIS 2014). As a result there is an increasing number of urban poor who settle in the most vulnerable areas beside water bodies.

In the twentieth century infrastructure became one of the vehicles of development, representing human domination over nature. Engineered interventions, such as barrages and dams, have become a major geo-political issue between up-stream and down-stream countries during the 20th and 21st centuries. Bangladesh sits in a basin for the region, which is several times larger than the country. The Brahmaputra (or Jamuna) catchment area alone is 380,000 km² which is 2.5 times larger than Bangladesh (Bristow 2012). Similarly, two other massive river systems, the Padma and Meghna have very large catchment areas. Consequently, the management of the upstream channel causes huge alterations in the downstream region, which can trigger catastrophic flooding and droughts, as well as transforming the river through erosion, sedimentation, channel migration, and salinity.

Bangladesh has suffered from upstream engineered interventions, such as the Farakka Barrage on the Ganges and the Teesta dam, which is one of the major points of inflow for the Jamuna (Bristow 2012; Islam, N 1992; Khan & Islam 2003; Mirjā & Mirza 2004; Mirza 1997, 1998). The mean monthly dry season water discharge of the pre and post Farakka period varies from 43% to 95% respectively (Mirza 1998). Therefore, manmade interventions have led to extreme hydrological changes, resulting in river shifting, erosion, and the displacement of huge numbers of people downstream in the Bengal Delta. Moreover, manmade interventions such as upstream barrages (along with other major factors) triggered devastating floods in 1987 and 1988. Almost two thirds of the Bangladesh basin was under water, because of extreme discharge, resulting in the displacement of millions of people.

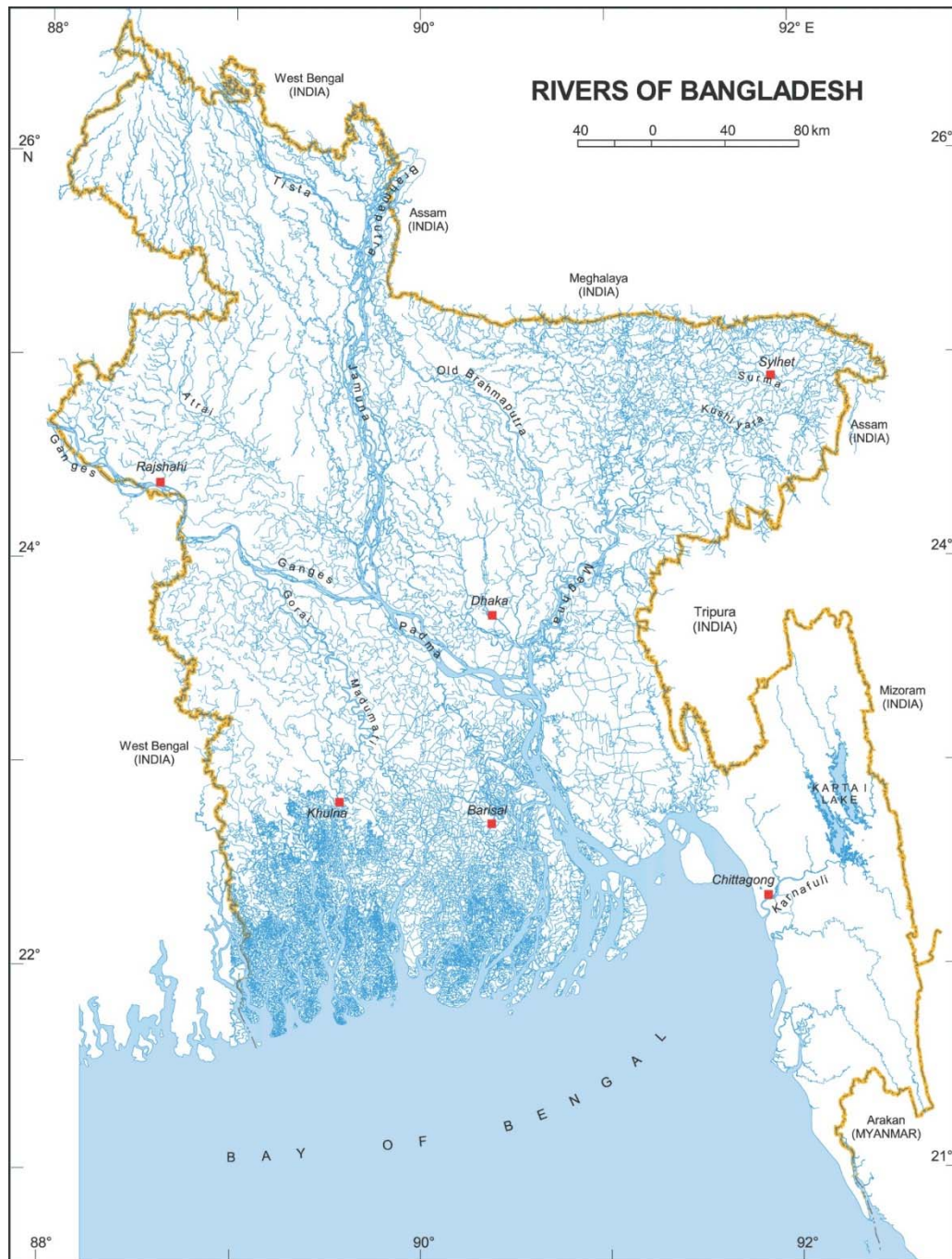


Figure 4-6: Bangladesh with its major watercourses (rivers and sea).

Massive engineering intervention such as river bridges challenge the immense river system. In addition, construction often involves building embankments to control the course of rivers. The 20th century also saw the construction of massive dams and cordon system embankments in order to provide protection from flooding (FAP) of 1989. Western models of development, such as the Dutch cordon system, were introduced in Bangladesh to protect settlements from flooding, altering the traditional approach of living with flooding (Islam, Ishrat 2009). As illustrated by modern

technological advancements and engineering interventions, the western development model has become the predominant ideology for urbanisation, development of infrastructure, and for fortification against natural water flow.

4.4.4 The 21st century rivers and the impact of climate change

According to the internal displacement monitoring centre, 1.11 million people were displaced in 2013, and the majority of these displaced people moved to both small and large cities (Ginnetti & Lavell 2015). According to *'World Urbanisation Prospects'* the urban population of Bangladesh increased from 21 million in 1990 to 53 million in 2014 (United Nation 2014). Climate change in the form of increased glacier melting, heatwaves, and sea level rise have had large impacts in Bangladesh, with frequent extreme weather effects and other catastrophic consequences. Displacement of people increased in recent decades, due to an increase in the number and severity of natural disasters, such as tropical cyclones, floods, and river erosion (Ahsan, Karuppanan & Kellett 2011).

The majority of the population of Bangladesh lives in vulnerable areas. For instance, 80% of Bangladesh consists of wetlands and flood plains, 12% hills, and 8% uplifted fault blocks/terraces (Brammer, Hugh 1990). In addition, two thirds of the population who live on the flood plain along water courses and coastal areas have been displaced at least once in their lifetime (Hutton & Haque 2004; Shaw 1989). Research illustrates that due to both natural and manmade reasons, natural disasters such as floods and cyclones are more frequent and higher in magnitude. For instance, the area affected by flood increased from 55,000 km² (38%) in 1974, to 69,000 km² (47%) in 1988, to 101,000 km² (69%) in 1998 (Ali 2007). Even though floods in 2004 and 2007 affected smaller areas, the flooding remained for a longer time (over six weeks), due to extreme weather effects such as heavy rainfall (Ali 2007; Brammer, Hugh 1990; Hofer & Messerli 1997). Manmade interventions such as the cordon system embankments and engineered drainage prevent natural drainage and cause longer durations of flooding (Ali 2007). As a result, the impacts of climate change and human interventions have a

direct impact on the natural environment, making human settlements more vulnerable than they once were.

4.5 Micro-regional hydrology of Dhaka and the historical development of its internal water courses and wetlands

Dhaka is located along the river Buriganga in the heart of the Bengal delta region. The name of the river, 'Buriganga,' means the 'old Ganges'. Some historians claim that this course was the main channel for the Ganges in ancient times (Dani 2009; Karim 1964, 2009; Mamun 2000). It is at least certain, and consistent with the hydrological history of the greater delta region, that the local river courses and other water channels within Dhaka's micro-region were very different historically from their present state. (Figure 4-8 and Figure 4-15). The hydrological transformation of the Dhaka metropolitan region has been influenced by the forms of urban development manifested by different regimes over the centuries. Contemporary urbanisation during the 20th and 21st centuries has had a radical impact on Dhaka's wetlands. For instance, 18.72 km² of rivers and canals in Dhaka, along with 76.67 km² of wetlands, were converted into urbanised land between 1978 and 2009 (Asad & Ahsan 2012; Mahmud et al. 2011). The dialogue between land and water has been transformed over the course of time. Consequently, the cultural landscape of the region has been consistently disrupted by the contest between the natural landscape and manmade interventions. The following sub sections illustrate the hydrological transformation of Dhaka in relation to its urban development history.

4.5.1 The historical water courses of pre-Mughal and Mughal Dhaka

Dhaka's location within the Bengal delta is exceptionally strategic as a consequence of a number of factors: accessibility, water communication, trading routes, along with political, marine, and military control. Forts in the Indian sub-continent were constructed to control land; however, in Bengal forts were built to control the

water routes. Nine forts were constructed in Dhaka and surrounding areas during the sixteenth and seventeenth centuries, which are evident in historical maps and documents (Figure 4-7). Pre-Mughal Dhaka was a kind of outpost, or small settlement, with a trading centre.

Historians have found evidence of settlements in Dhaka going back to the 7th century, when it was controlled by the Buddhist kingdom of Kamarupa (Dani 2009; Haider 1966b; Nilufar 2011). Scholars believe that some Hindu professionals, including artisans, were settled in this area from the 7th century. The sultans of Bengal established the historical old fort, the Pathan fort⁷, along the river in the 16th century before the Mughal Empire occupied Bengal in 1575. Previous rulers had constructed two small forts (as bastions) in the mouth of the Dholai canal, indicating the importance of navigation in and control over these water courses (Dani 2009; Karim 1964).

In the Pre-Mughal and Mughal periods, the River Buriganga was further inland in the western part of the city, and the inner water network was integrated with the surrounding rivers. There were also more topographical variations⁸ in the vicinity of the original historic city which have generally been levelled in the course of subsequent urbanisation (Ahmed, N & Haider 1966; Dani 2009; Karim 2009). Contemporary texts and maps suggest that the historical high lands of the natural levee were V, or U, shaped and surrounded by rivers (Roy 1913; Taylor 1840). The other side of the Buriganga was always low land, unsuitable for large settlements.

Dhaka became the capital of the Bengal Subah (province) of the Mughal Empire in 1608. It was named Jahangirnagar after the Mughal emperor Jahangir (Ahmed, SU 2009; Chowdhury, MA & Shahidul 2011; Haider 1966b; Karim 1964). A majority of historians⁹ suggest that Dhaka has been the principal town in the region since the late 14th/early 15th century (Ekattor TV 2014). The capital shifted from Rajmahal to Dhaka during the administration of the Mughal governor Islam Khan at the beginning of the 17th century. The capital was shifted primarily to protect Bengal from the Magh and

⁷ The old fort has been used as the central jail from 1810 (approximately) to 2016. Government plans to convert the area into a public place in the near future.

⁸ Topographical variation includes different elevation of highlands, small hills and different types of wetlands (canals, rivers, flood plains and retention areas).

⁹ According to Dr. Sharifuddin Ahmed, Muntasir Mamum and other major historians.

Portuguese pirates (as it is strategically located) and to suppress the rebellious Jamadars (Landlords) (Ahmed, SU 2009; Chowdhury, AM & Faruqui 2009; Dani 2009; Geddes 1990; Karim 2009, p. 35). The governor, Islam Khan Chisty, brought an additional 100,000 people to Dhaka, including soldiers, administrators, craftsmen, and their families (Geddes 1990, p. 10). A new area was constructed for the extra population in the early 17th century. A majority of the population used to live in the old city around the old fort. After the invasion of the Mughals, during the seventeenth century it became a major city, with a population of 1.25 million people.

The Dholai canal was the major inland canal for Dhaka, along with the river Buriganga, and together they encircled Pre-Mughal Dhaka (Figure 4-7). The Dholai canal was connected to the Balu River and the River Lakha in the east and northeast. Nine major bridges (aqueducts) were constructed over the Dholai Canal during the Mughal period (Dani 2009, p. 5; Karim 1964, 2009). The western part of the Dholai canal was excavated and connected to the Buriganga in the early 1600's for communication and drainage by Islam Khan (Ahmed, SU 2003, 2009; Karim 1964, 2009). During the Mughal period major developments in Dhaka were undertaken by Shaista Khan, Mir Jumla, and Islam Khan Chisty, including the construction of water-related public works such as bridges, embankments, aqueducts, and landing stations. During this era, other a number of other waterside structures including major forts, caravansary, mansions, and palaces were also built along the river Buriganga and Dholai canal (Figure 4-8 and Figure 4-11). The size of the city was 48 square miles in the early seventeenth century, when the Nawab (governor) of Bengal was Shaista Khan. According to historical documents and literature, it is evident that the water was a major element of urban development in Dhaka during the pre-Mughal and Mughal period. Until the late 19th century, two reasonably big water courses the Dholai River/Canal and the Pandu (Kawran/Caravan) River were connected from east to west (Figure 4-7). However, these no longer exist. According to historians¹⁰ and cartographical records, many historical waterways were converted to streets. For instance, the Satmasjid road in the west of the Dhanmondi residential area. Surviving older structures and settlement patterns suggest that they were originally sited beside

¹⁰ Interview of historian of architecture Dr. Syed Sayeed Ahmed and urban historian Dr. Sharifuddin Ahmed.

these now eradicated watercourses. Examples include the Eid-Gah at the Sat-Masjid road (dated 1640) and further west of the Sat-Masjid road the Saath-Gumbuj (seven domes) Mosque (from the mid seventeenth century). Old photographs of the Sat-Gombuj mosque confirm that one of the sub-channels of the Buriganga River was beside the mosque, even as late as the 1970's (Figure 4-9). Over time the urban landscape was transformed.

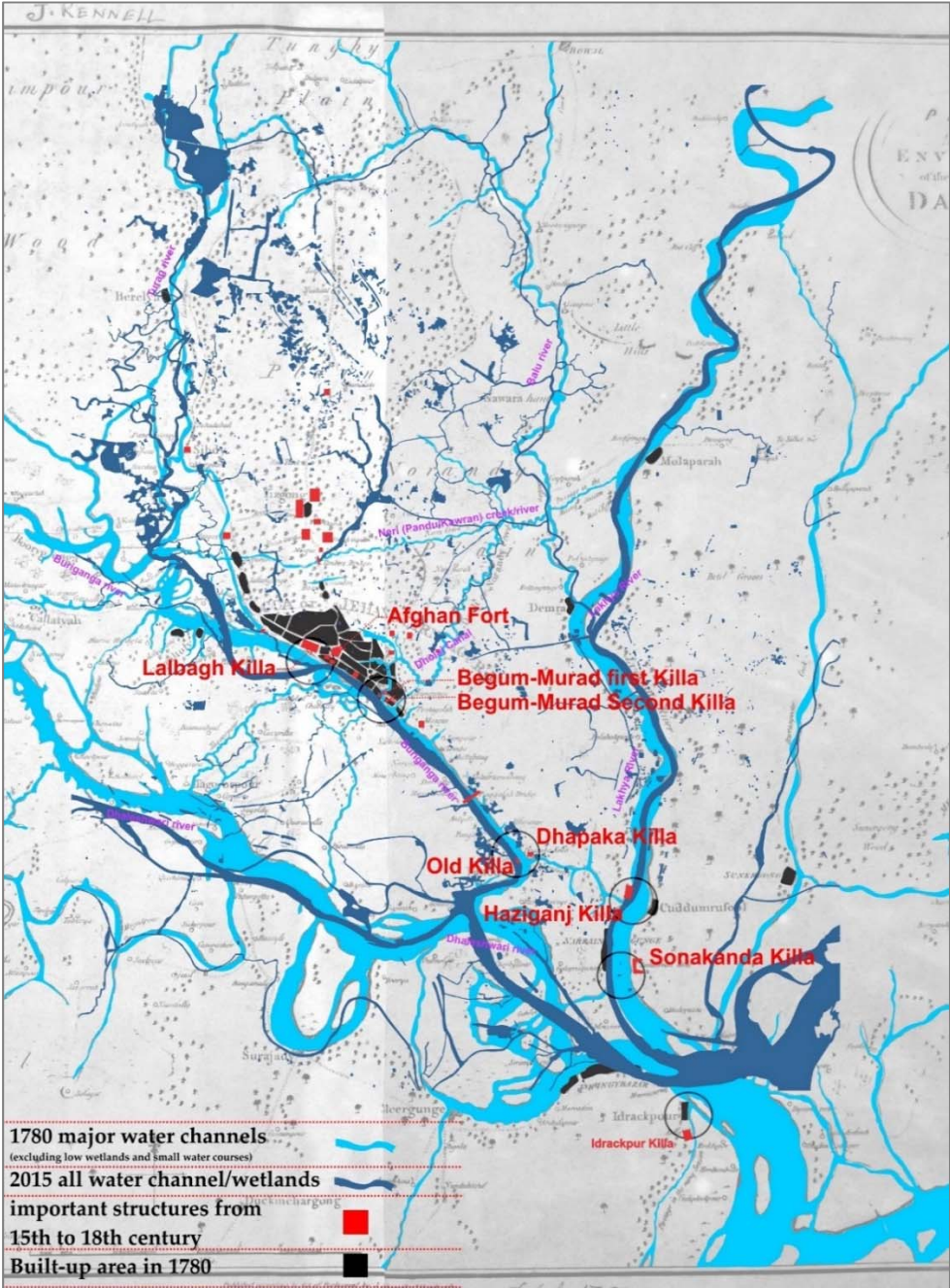


Figure 4-7: Map showing the water channels of 1780 and 2015, including important structures of pre-Mughal, Mughal, and the early colonial period. The map indicates the forts (Killa) from the Pre-Mughal and Mughal period. In the background is a map of Rennell that was collected from the National Archive of Bangladesh. Wetlands present in 2015 have been traced from Google images.

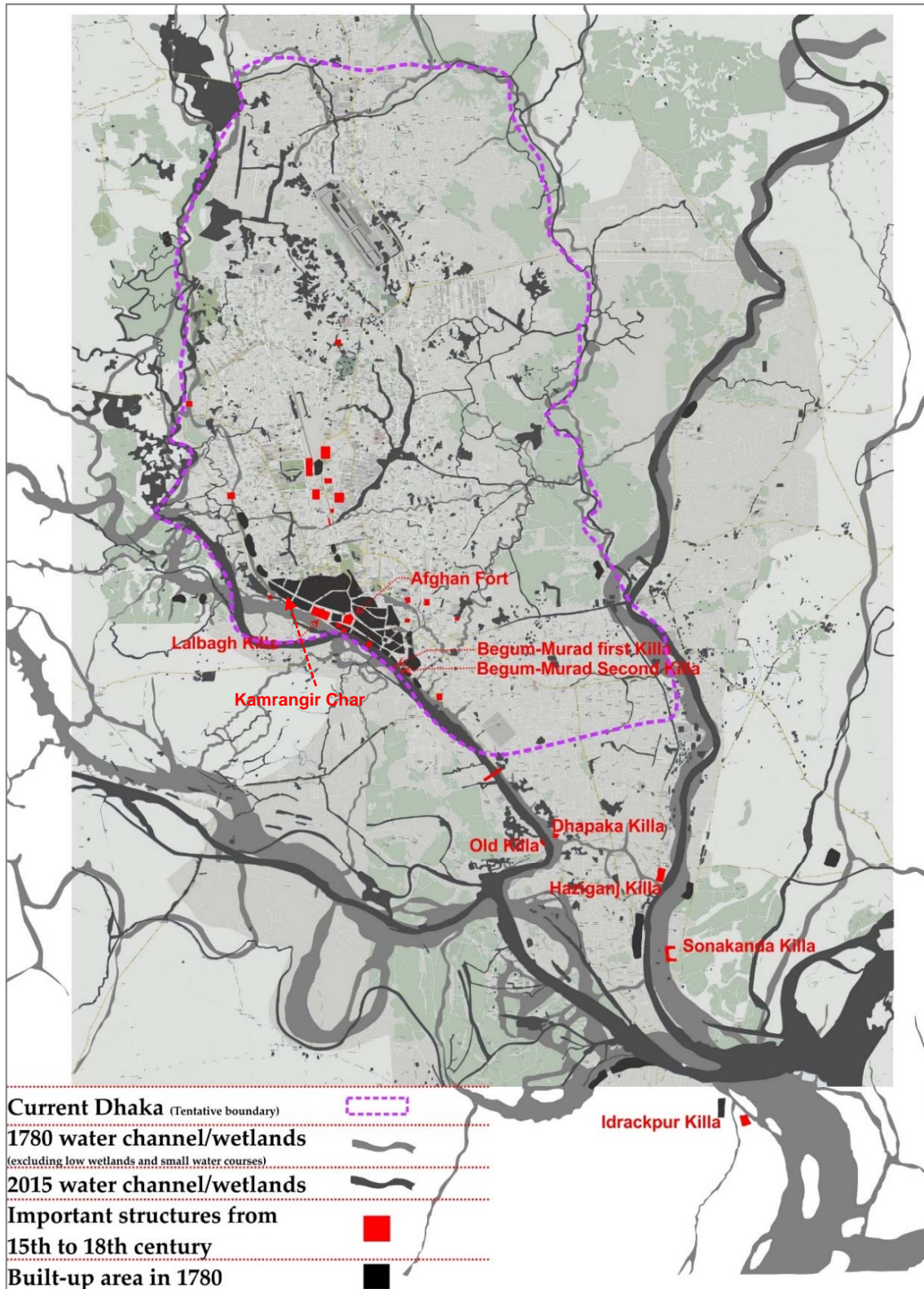


Figure 4-8: A map showing the water channels and urban areas from the 1780's and 2015. The current area of metropolitan Dhaka is 303 km²; however, the DMDP area is much larger (1528 km²). This map also indicates the new lands form in some parts of Dhaka as 'Chars' such as Kamrangir Char due to shifting and fluctuation of watercourses.



Figure 4-9: Shows the Saat Gombuj Masjid (seven-dome mosque) from an earlier era, contrasted with Dhaka's urbanisation and hydrological transformation

4.5.2 Colonial Dhaka and its water network

4.5.2.1 Early colonial Dhaka

The early colonial period, after the occupation of the British East India Company, was an era of decline for Dhaka. As discussed briefly in the previous chapter, the major activity undertaken by the British during this initial period of informal colonial rule was to extract wealth from the region. Under the Company, the colonial administration had no interest in encouraging trade and business that could help Dhaka to grow. Indeed, as a consequence of such neglect, among a number of other factors, the population had actually declined dramatically by the mid nineteenth century. From more than one million at the peak of the Mughal era two centuries earlier, it had already diminished to half that number when the East-India Company took over the Bengal region in 1757, and was just 60,000 a century later. In spatial terms, this resulted in the city shrinking to an area of less than five square kilometres (Dani 2009; Geddes 1990, p. 15; Haider 1966a, 1966b; Karim 1964, 2009; Nilufar 2011). . Over this long era of neglect and decline, Dhaka's Mughal infrastructure including buildings, water ways, bridges, and Ghats had fallen into a dilapidated condition, as evidenced by sketches and documentation from different scholars and European

officials, such as Charles Doyly¹¹ (Doyly, Charles 1991a). The illustrations from Doyly present the decline in Dhaka and its surrounding areas.

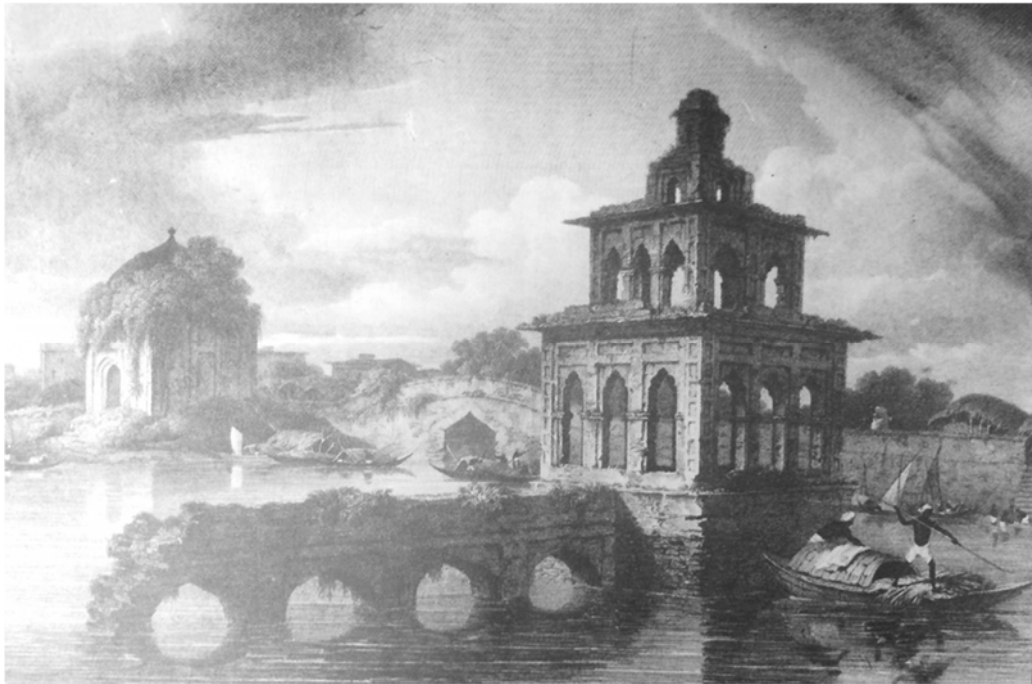


Figure 4-10: Dhaka's interior (the Dholai Canal and dilapidated structures, including ghats and bridge) published in 1814, and drawn by Charles Doyly collected from Dhaka City Museum DCC (Doyly, Charles 1991b, p. 96)

European colonial traders and officials used waterways in this region as their prime mode of mobility in and around Dhaka, building their trading and administrative establishments along these same water bodies in the historical city, and further north at Tejgaon. European gardens were built in Tejgaon during the eighteenth century¹² (Chowdhury, AM & Faruqui 2009, p. 57). In addition, factories were established by the Dutch, French, and the British along the Buriganga for easy access in the east of old Dhaka during the eighteenth century (Ahmed, SU 2003; Haider 1966b; Karim 1964; Mamun 2009). The majority of the establishments along the Buriganga and other waterways, such as the Dholai River and Kawran (Caravan) River, indicate the existence and importance of reasonably navigable major watercourses in and around Dhaka. Urban development during the colonial era was certainly associated with this water network.

¹¹ Charles Doyly was the collector of Dhaka from 1808 to 1811. During that time, he made dozens of sketches that illustrate Dhaka during that period.

¹² Rennels map in the 1780's indicates the major waterways, urbanised area, and the key structures in the Dhaka region in the late eighteenth century. The Kawran River connected the east west major water channel, which no longer exists.

According to historians, the decline of Dhaka was largely due to external policy, which aimed to control the political economy of Bengal during the first half of the British era. The British Government ruined the trade and business sectors of Dhaka in the late eighteenth and early nineteenth century by imposing a taxation rate of 75% on Bangladeshi cloth in England (Maslin fabric) (Geddes 1990, p. 15). They controlled the trade in Dhaka in order to compete in the European clothing market, as England started to produce clothing for trade outside of England in 1881 (Geddes 1990).

Dhaka had been one of the most productive regions for textiles during the mid-18th century, with maslin being a notable product. The city's revenue in 1765 was 20 million Bangladeshi taka, with maslin exports making up a predominant proportion (Iqbal 2013, p. 45). In 1817, exports from Dhaka to England ceased, as England started their own textile production to sell all over Europe. As a consequence, the city suffered a decline in economic activity and a displacement of population. Therefore, the population decreased and Dhaka was unable to maintain its prosperity.

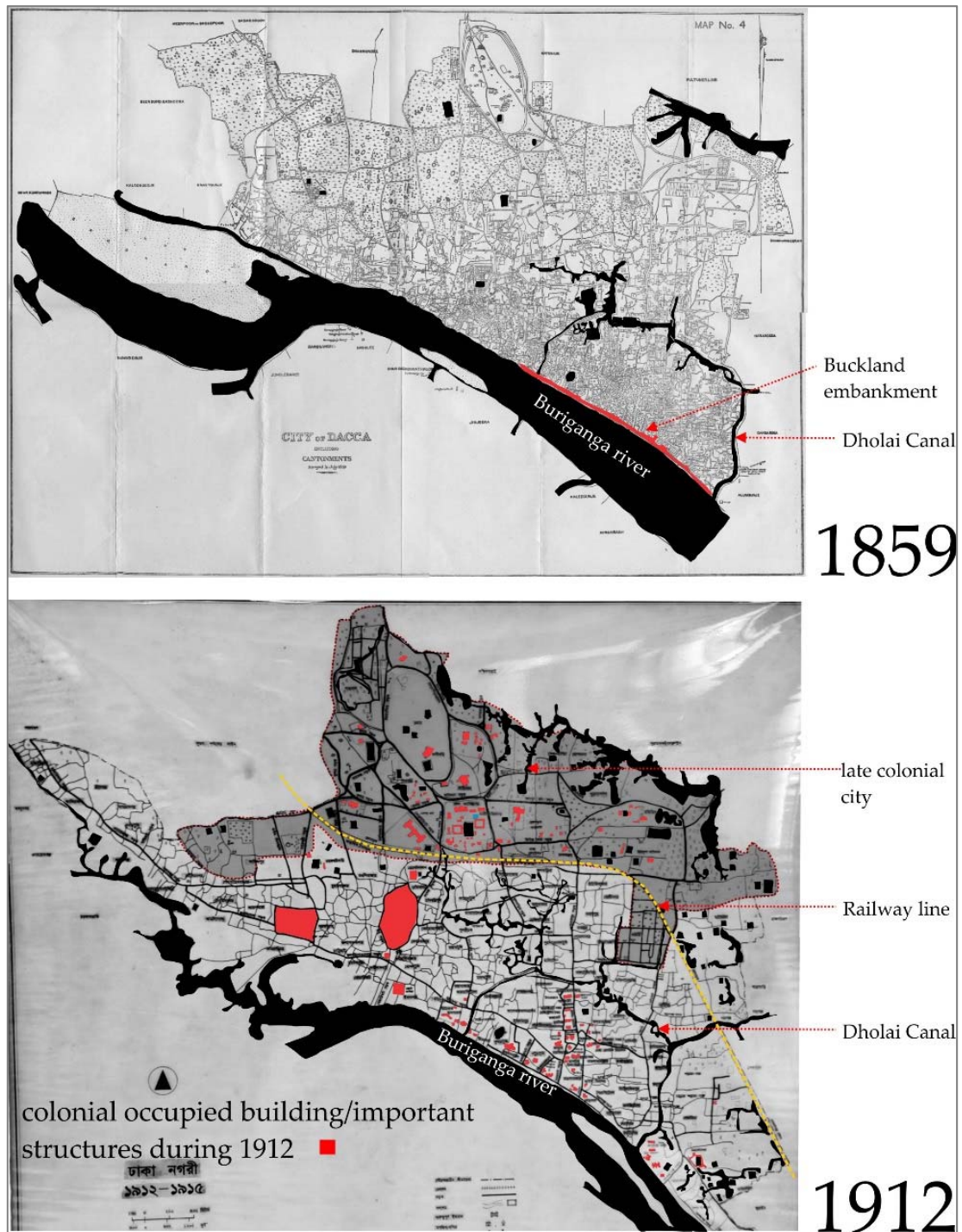


Figure 4-11: Map showing Dhaka during 1859 and 1912 including major structures built during the colonial period (map collected from the Dhaka City Museum, DCC)

4.5.2.1 Colonial Dhaka during the second half of the 19th century

Major changes were undertaken in Dhaka from the 1850s onwards, precipitated in particular by the abolishment of the East India Company regime and reorganisation of the British Indian colonial administration under direct Crown Rule, after the mutiny and associated popular rebellion across much of northern India of 1857-58. Scholars

suggest that the colonisers believed in the transformative power of a modernising vision, aiming to transform the colonial society into a secular culture. During this period comprehensive civil works were realised, which illustrates the shift in the colony from a feudal to a capitalist economy. In order to fulfil their mission the British administration prepared a comprehensive cadastral survey for land control, as part of their land legislation and revenue management (Chopra 2011; Dossal 2010). Through this modernising mission, along with the introduction of English language education and the development of infrastructure for sanitation and other new technologies, the revamped colonial regime introduced a degree of economic liberalisation and a new model of political economy to the Indian sub-continent.

With regard to the push for modern sanitation, statistics gathered by the colonial government had determined that more people died in India due to water borne disease than died in conflicts between natives and colonisers (Oldenburg 2014, p. 96). Propelled, however, by the contemporary Sanitary Reform movement back in Britain, where water borne disease was also a major issue, colonial officials and their engineers began to aspire to the idea of a drier and harder city made more secure from water borne diseases, among other threats, by modern infrastructure.

The first metaled road was constructed in 1865, and in 1885 the colonial administration introduced a railway system in Dhaka (Ahmed, SU 2003; Gallagher 2011; Geddes 1990). Here, as in other typical colonial urban developments in British India in the post-mutiny era, the railway line provides a conceptual boundary and line of control between the native and colonial cities (eg. Lucknow and Dhaka) (Oldenburg 1979, 2014; Scriver 1994; Scriver & Srivastava 2015, pp. 35-38) (Figure 4-11).

With a modernised transport system, including steam engines and motor vehicles, waterways became less important for short distance travel, with Dhaka eventually turning its face towards the land (Ahmed, F 2009; Iqbal 2013). Though rivers and canals began to lose their economic prominence and social status, the water network was still the major mode of transport until the middle of the twentieth century. In 1947 there were only 4400 motorised vehicles on the road in the whole of East Pakistan, currently Bangladesh (Gallagher 2011, p. 4). Meanwhile, water

continued to be one of the major modes of transport for long routes until the 1970's. Importantly, numerous initiatives were taken to manage water, such as embankments, dredging for navigation, protecting natural wetlands, and drainage, during the colonial era (as will be discussed in the next chapter)¹³.

Late colonial urban developments in cities such as Bombay, Lucknow, Kolkata, and Dhaka are the creations of joint enterprises between the colonial administration and local elites (Chattopadhyay 2011; Chopra 2011; Dossal 2010; Kidambi 2013; Oldenburg 2014). In addition the edge of the water was a major area for urban development. The landlords were the major partners for urban developments in Dhaka, Calcutta, and Lucknow, while the major partners in Mumbai were the industrial elite (Chopra 2011; Dossal 2010; Glover 2007; Kidambi 2013; McGowan 2013; Oldenburg 2014; Scriver (ed.) 2007; Scriver 2010; Scriver & Srivastava 2015). The landlord elite of Dhaka played an important role in initiating and funding the construction of its embankments (Ahmed, SU 2003; Dani 2009; Mamun 2000), including the previously discussed Buckland Embankment in 1864. These structures not only protected the city from floods and erosion, but simultaneously provided Ghats and a promenade for the inhabitants to engage in traditional as well as newer modes of modern urban cultural practices (Scriver & Srivastava 2015, pp. 60-62).

In nineteenth century Dhaka palaces and mansions (such as the Ahsan Manjil and Ruplal House) were built on the river front of the Buriganga, along the embankment and promenade. The colonial rulers also initiated maintenance and improvement of the old canals, such as the Dholai and Wari¹⁴. Municipality records from the 1880's to the 1940's, as well as the design drawings from the 1920's of the Dholai Canal, show the planning and design of the water channel to provide protection from encroachments, ensure navigation, natural drainage, and walkways for pedestrians. Although planning began in the 1880's, implementation did not begin until the 1920's due to funding issues¹⁵. Moreover, two bridges were constructed over

¹³ Archival documents collected from the National archive including municipality records in Bangladesh illustrate some major projects in managing water during the colonial era. The Buckland embankment and Dholai Khal canalisation were two of the major examples that are discussed in the next chapter.

¹⁴ Evidence from the Municipality records from the national archive of Bangladesh. Dholai Khal canal history is explained in the next chapter in detail.

¹⁵ *ibid*

the Dholai Canal in the late colonial era. These were built to expand the transport network and urbanisation beyond the Dholai canal in the north. This area was mostly gardens, wetlands, and agricultural lands before the British interventions of the new administration hub, civil lines, and the cantonment. During the late colonial period new areas were developed by filling up low lands, such as the Wari canal, which was shown, in municipal records, to be under threat from littering and illegal encroachments. Historical records provide evidence for the decreasing size of wetlands during the colonial period, due to the expansion of settlements.

4.5.3 Early twentieth century colonial Dhaka in relation to its water system

The re-structuring of the Indian-Subcontinent in the later nineteenth and early twentieth century resulted in major urban development in India's emerging metropolises – Bombay, Kolkata, and Madras – as well as a number of increasingly important regional cities such as Lucknow, Hyderabad, Poona and Dhaka. These regional centres became important administrative and commercial urban hubs for their own hinterlands (Chopra 2011; Dossal 2010; Oldenburg 2014). It was also during this period that Western-educated outsiders began to transform Dhaka, making it the intellectual and, at least briefly, the political centre of eastern Bengal (Ahmed, SU 2003). Major urban development began to be realised when, in 1905, Dhaka became the capital of the short-lived new province of East Bengal.¹⁶ In 1917 the famous town planner and urban theorist, Patrick Geddes¹⁷, defined Dhaka as one of the very few cities where planning and urban design could intervene. He suggested a city with integrated ecological spaces along the wetlands, which could have provided a fantastic open space for people and for natural habitat, with proper drainage and mobility (Geddes 1990; Jahan 2011). Geddes's idea was more of a counter plan when compared to the colonial planning policies. Geddes suggested that the natural water network of the urbanised area of Dhaka should be preserved, including water channels that were

¹⁶ This was the eastern, predominantly Muslim, half of the former British Indian Presidency of Bengal which was partitioned in 1906 in a deeply unpopular colonial experiment in religious segregation that was ultimately aborted in 1911 with the repeal of the Bengal Partition.

¹⁷ Sir Patrick Geddes (1854-1932) FRSE was a Scottish biologist, sociologist, geographer, philanthropist and pioneering town planner. He is known for his innovative thinking in the fields of urban planning and sociology.

about 25 miles (40 km) in length in 1917 (Geddes 1990, p. 124; Iqbal 2013). He also recommended that vegetation be planted along the edge of watercourses, and that advice should be sought from a water resource engineer. In 1909 the Public works department of the British government put forward the proposition that 12 miles (19.31 km) of canals in Dhaka should be filled-up for health and safety reasons, which was estimated would cost the equivalent of 750,000 Bangladeshi taka (Ahmed, SU 1986; Geddes 1990, p. 124; Haider 1966b; Iqbal 2014). Geddes opposed the plan and suggested instead that the government should protect the canals with good navigability and natural drainage at one fifth of the cost of the fill-up. He also recommended cleaning and dredging these canals, so that they could be made more useful for trade and communication with larger boats. Geddes advised that destruction of the wetlands would cause a collapse in bio-diversity, as well as having negative impacts on the environment and people. Moreover, Geddes (1990) advocated for open space and vegetation, including urban agriculture parks along the 25 miles (40 km) of wetlands. This certainly would have provided a continuous ecological space for Dhaka. He proposed to only build on the land that is above the flood plain, which is free from regular flooding.

The cartographical records of 1859 and 1912 (Figure 4-11) demonstrate that major establishments of imperial Dhaka, such as the civil lines, cantonment, and racecourse are constructed at the north of the old city, distant from the major river. A Majority of the establishments from the early 20th century were not directly associated with watercourses. However, early European establishments built by the Dutch, French, Armenians, and Portuguese were along the river. In similar inland cities along watercourses, such as Lucknow, the British constructed their establishments far from the old city and the Gomti River (Oldenburg 2014). In such urban settlements modern interventions were not associated with the water system, but were dependent instead on modern infrastructure.

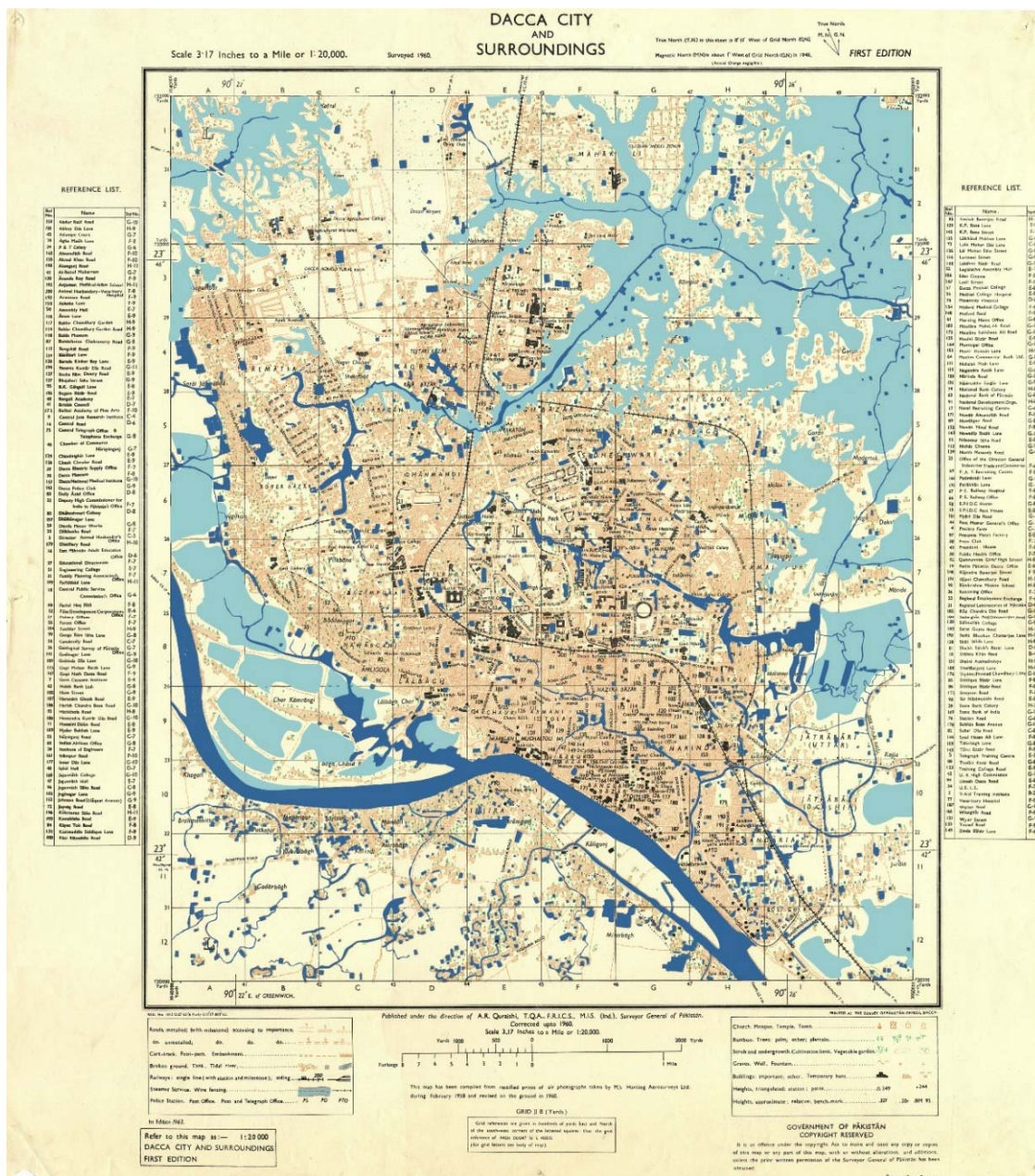
4.5.4 Post-colonial and post-independence Infrastructure Interventions: managing water in the second half of the twentieth century

4.5.4.1 Post-colonial Pakistan period

Dhaka became the capital of the Eastern province of the new Islamic state of Pakistan, in 1947, after the departing British colonial regime decided, once again, to partition the Indian Sub-continent along religious lines. After this date Dhaka developed and grew as a modern metropolis. Post-colonial Dhaka urbanised rapidly with many new developments towards the north. The first modern CBD was established at Motijheel in the 1950's, and the government built large housing projects in the north for government officials. A majority of this land was a combination of natural highlands, gardens, agricultural lands, and wetlands that were transformed into urbanised areas.

The Dhaka Improvement Trust (DIT)¹⁸ was established in 1956 as a legacy of the British colonial institutional framework (the Dhaka municipality was established in 1864). The DIT developed large urban areas, such as Gulshan in 1961, Banani in 1964, Uttara in 1965, and Baridhara in 1972 to expand the city and accommodate a larger population (Chowdhury, AM & Faruqui 2009). Thereafter, urban development transformed and/or re-organised many large water channels. By 1960 Dhaka resembled an island surrounded and crisscrossed by wetlands and water channels, as illustrated in historical maps (Figure 4-12). The 1960 map of Dhaka suggests that the early post-colonial city was built mostly on higher ground, to keep the urban area free from flooding.

¹⁸ DIT was later converted into RAJUK, which is the Dhaka city development authority.



1960 WETLANDS AND FLOOD PLAINS

Figure 4-12: Map showing the urbanised area of Dhaka, including wetlands and flood plains (source: Library of Department of Architecture BUET.) The original map in the background prepared by the Government of Pakistan based on the survey in 1959-60

In 1959 the government introduced a master plan under DIT's supervision. The development authority never comprehensively implemented the plan. However, the Pakistani regime implemented a few aspects of the plan. The master plan included planning policies for wetlands and watercourses, and integrating urbanisation. Scholars and government officials still argue over whether the 1959 master plan was reasonable¹⁹. The Master plan (Figure 4-13) proposed a water network with existing

¹⁹ Interviews of scholars and government official suggest the claim including different literature.

and new manmade canals (Iqbal 2014; Macfarlane 1959). The plan also suggested that there should be urban renewal along the River Buriganga and other water front areas, including access to public spaces and vegetation along the water. In contrast, the master plan also recommended filling-up a part of the Dholai canal to construct a road, which would create access between old and new Dhaka (Macfarlane 1959, p. 28). Jahan (2011) argues that major suggestions from the 1959 master plan relating to wetlands and open spaces were not implemented. Instead, projects related to the construction of roads, bridges, and housing for urbanisation proposed in 1959 were deemed to be important.



Figure 4-13: Master plan of 1959 (source: RAJUK, it is the only large copy, which is around 3mX2.5m)

4.5.4.1 Post-independence Bangladesh period

The largest project undertaken in the early post-colonial period was the Second-Capital, or Sher-E-Bangla Nagar. Designed by the prominent American architect, Louis I. Kahn, the project incorporated constructed wetlands, as a representation of the Bengal Delta. In addition, the lake works as a retention basin and attractive landscape feature. The project was started in the 1960's, under the Pakistani military regime, but was only completed in the early 1980's under the government of what was now the newly independent nation of Bangladesh, following a brief but violent war of independence from Pakistan in 1971.

For practical reasons, the master plan of 1959 had become invalid after Independence. Meanwhile, however, huge numbers of new people had begun to move to the new capital for a variety of reasons. As the pace of urbanisation accelerated, the wetlands began to be transformed. In the 1980's the growth rate of Dhaka was more than 10%, due to the displacement of people from rural areas as a result of natural disasters, such as floods, river erosion, and cyclones (Hossain 2008). Thereafter Dhaka became a monocentric urban centre of extraordinary growth, materialised by filling-up low areas (including water bodies) to create new land developments.

The construction of the embankment²⁰ (cordon system) after the 1987-1988 flood had a major influence on Dhaka's urban development. This incident can be considered as the start of a real departure from gravity to fortification in terms of natural drainage. Fortification against water, instead of living with water, altered the land formation pattern in Dhaka. After this point, land developers filled the lowlands and wetlands without any obligation to maintain natural drainage, or the eco-system (Figure 4-14). The government had no policy in place to regulate private land developers until 2000. The Low Land Act came into force in 2004. Some Engineers in the Bangladesh Water Development Board (BWDB) believe that a cordon system is the best solution to protect the city from water²¹. In the late 1980's and 1990's the mind-set of the development agencies and actors was to control nature through engineering

²⁰ Details of the Flood action plan project on Dhaka is explained in the next chapter.

²¹ Interviews of the engineers in BWDB, DWASA and IWM.

interventions. This was the starting point for a major environmental shift. Subsequently dryness became the driving concept of the modern city, independent of the natural landscape and water bodies.



Figure 4-14: Photo showing a Flash flood caused by rainfall during the monsoon season in Dhaka, which is a regular occurrence, published in a daily newspaper on 2 September 2015 (source: <http://www.thedailystar.net/frontpage/dhaka-deluged-136426>)

In 1995, the development control authority RAJUK introduced the Dhaka Metropolitan Development Plan (DMDP) with a structure plan and an urban area plan from 1995 to 2015. Due to bureaucratic and administrative failures the Detail Area Plan was not realised until 2012. Private land developers expanded the city through land filling from the 1990's onwards, without considering wetlands, natural drainage, and other major elements. Meanwhile, RAJUK published the revised structure plan for the current DMDP area in 2015 (1,528 km²), which is currently in the process of being implemented. A review report was published in 2014 for the DAP²². Controversially, RAJUK is also the largest public land development agency, which is viewed as a conflict of interest by a majority of critics.

According to old literature and cartographic records, there were more than sixty canals in Dhaka until the 1960's, but this number was reduced by half in the late twentieth century (Afrin & Dalia 2011; Das & Islam 2010; Islam, Israt 2009). From the late 20th century new engineering interventions were employed in Dhaka to manage

²² Details of the planning policies in relation to land development is illustrated in chapter 6.

water in urban development. As a result, many human induced disasters have happened in recent years (Momen 2015; Rahman et al. 2015; Sufi 2015). In the mid 1990's the BWDB and DWASA initiated a project to convert ten canals into box culvert roads (Mirror 2009). This project was part of the Flood Action Plan proposed in 1989. The next chapter investigates the planning process and the consequences of this box-culvert drainage project.

The development actors from these agencies who were involved in the box culvert project did not consider water as a natural corridor for drainage and for the eco-system²³. This project has had an immense impact on the natural drainage system and has been a major cause of flash flooding and long term water stagnancy (Sultana, Tarekul Islam & Islam 2009; Tawhid 2004). In contrast, in the mid 1990's the government initiated and implemented the Dhanmondi Lake re-development project. This was the first wetland re-development project undertaken during the Bangladesh period. This was part of the watercourse connecting the east and west rivers during the Mughal and Pre-Mughal period. The Dhanmondi canal was connected to the Kalabagan canal²⁴ to the east before the Panthopoth road was constructed via a box culvert road (Figure 4-12 and Figure 4-15).

The western part of the Dhanmondi canal was connected to one branch of the Buriganga River, which is now the Sat-masjid road. The river Buriganga shifted gradually towards the south west during the twentieth century, 1.5 kilometres from its original path during the Mughal period due to sedimentation, river migration, illegal occupation, and landfills (Ahmed, F 2009; Ahmed, SU 2009; Karim 2009). During the late twentieth and early twenty-first century, land developers have built new areas with constructed land (landfills) along the western embankment. These lands were part of the river Buriganga, foreshores, rice fields, and natural retentions until the middle of the twentieth century²⁵.

²³ Archival documents of DWASA and interviews of engineers of DWASA and IWM IN 2014.

²⁴ Kalabagan canal was connected to the Hatirjheel in the east until the 1990's.

²⁵ Cartographic evidence and google maps images show the transformation of land and water.

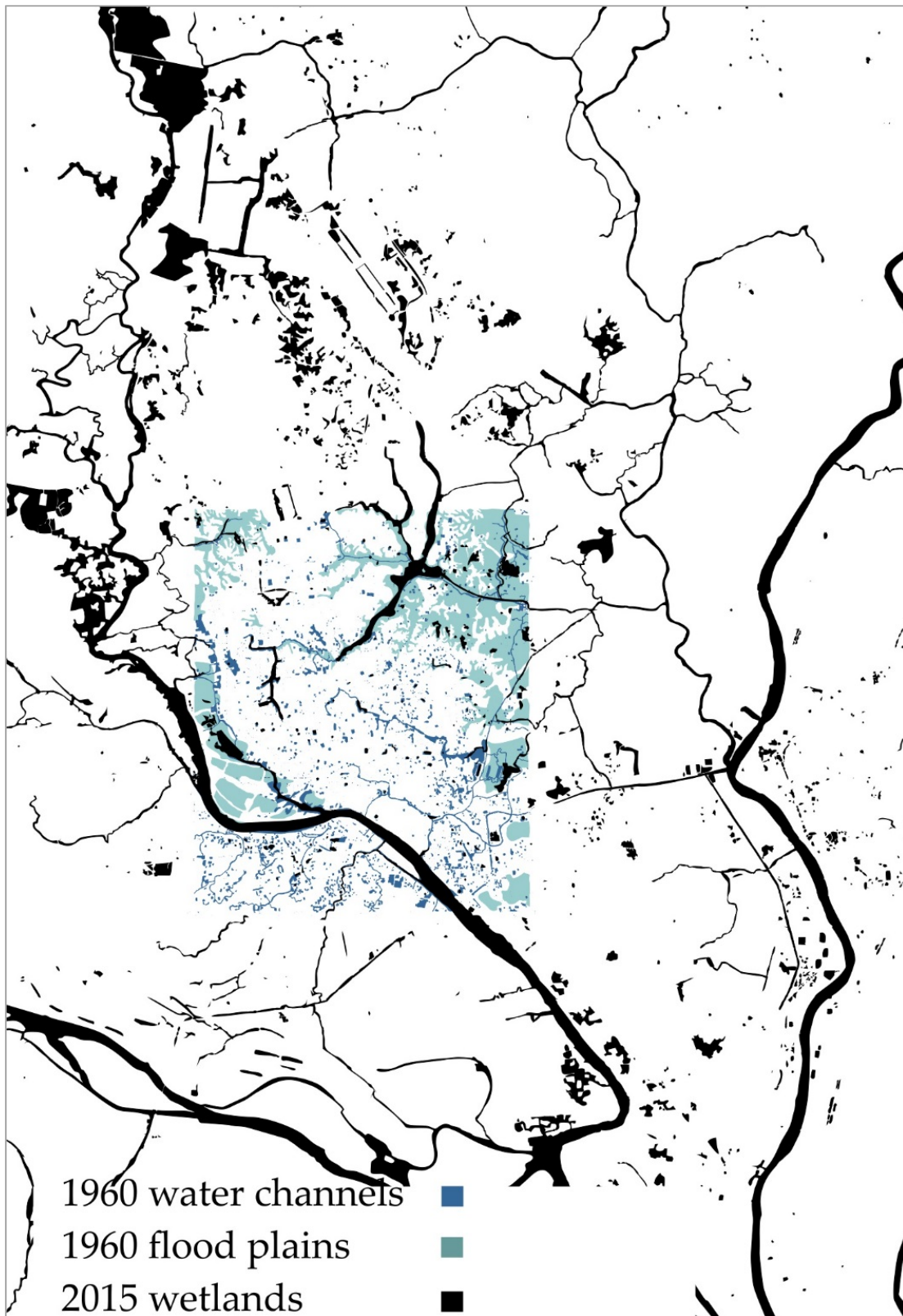


Figure 4-15: Map showing super imposed existing (2015) wetlands compared to the water channel and floodplains of 1960 (source: map prepared by the author based on the current Google Map images and map of 1960 collected from the Library of Department of Architecture BUET prepared by the Government of Pakistan based on the survey in 1959-60)

4.5.5 Constructed engineered landscape of contemporary Dhaka in relation to its wetlands in the twenty-first century

In recent times both public and private sector development agencies have developed new urban areas and satellite towns through landfills. Population growth is now 6%, which has driven densification and expansion at an enormous rate (United Nation 2014). In the north-eastern fringe the public sector developer (RAJUK) is operating the biggest land development project, which is around 2500 hectares. In contrast, the government has built projects using reconstructed wetlands in recent decades. An example is the Hatirjheel-Begunbari integrated development project, which is the most significant urban water intervention in Dhaka in recent history. In chapter seven and eight the planning process, project details, and influences of this development will be discussed. Following the Hatirjheel project, new constructed (reconstruction or re-development) wetland projects were initiated. However, a majority of these are not integrated with the natural drainage network, and these projects also do little for the marginalised population²⁶.

According to RAJUK and the Department of Planning (BUET) about 250 registered developers²⁷ are working in the city. In 1970 there were only 5 developers, and in 1988 the number was 42. Out of 16 big land-development housing projects 6 are located on restricted flood flow zones and areas demarcated for retention ponds, water sheds, and on agricultural land²⁸. Because of this landfill process, gravity drainage is under threat in eastern Dhaka.

Nevertheless, major land development projects for high and middle income earners in the city continue, neglecting a major portion of the population (between 20% and 30%) who live in the informal sector. With increasing levels of environmental awareness in the twenty-first century development control agencies have demolished numerous illegal encroachments to save rivers, foreshores, retention water sheds, flood plains,

²⁶ Projects following the Hatirjheel projects are briefly explained in chapter eight.

²⁷ According to the interviewees, there are more than 1000 unregistered small-scale private developer agencies.

²⁸ According to architect-planner Israt Islam who is a wetland researcher and reviewer of the Detail Area Plan (DAP) Dhaka.

and canals. While at the same time land developers have been operating to construct new lands without considering the wetlands and regulations in a majority of cases. Therefore, wetlands are being reduced as urbanisation progresses. As a result, human interventions have created threats in the form of water clogging, flash flooding, water scarcity, and the destruction of eco-systems, because of the destruction of natural drainage.

4.6 Conclusion

Bengal has a broad history of settlement, which has contributed to the creation of a rich, centuries old water civilisation. The Ganges-Brahmaputra-Meghna delta has a fluid landscape, which is constantly transforming due to the characteristics of its geomorphology and waterscape. Watercourses manoeuvre and human settlements are displaced by the constantly shifting delineation and re-definition of the boundary between land and water. This chapter has demonstrated the diverse transformation of water channels in the Bengal delta, which have influenced human settlements in this water civilisation. It restates the history of Dhaka's urbanisation, with its transformative hydrological features. Through revisiting history this chapter illustrates the changing dialogue between the major urban centre of Dhaka and its water system from the perspective of urban development history.

Chapter 5

From Flow to Fortification

5.1 Introduction

This chapter presents and analyzes some major case studies of urban development that involved the use of modern engineering interventions to manage water, which have had significant impacts on the urban development history of Dhaka during the nineteenth and twentieth centuries. It explains the planning processes and the consequences of the engineered approach to managing water in urban developments. Planning processes include the embedded factors of project commencement, design processes, and implementation by organised development agencies. The operations of organised development agencies have been influenced by factors including the mind-sets of development actors and the nature of political regimes.

Historically, Dhaka has had an interdependent relationship with its water system: a gravity drainage system with rivers, canals, flood plains, and retention areas. Until the construction of the western embankment in 1989, the city had grown in conjunction with this vital water system. We can observe a paradigm shift after the construction of the embankment, in terms of urbanisation and the framework for managing water in Dhaka. The rapid rate of landfilling has been one of the characteristics of the post-embankment era, including the major intervention of drainage through the introduction of box-culvert roads, which have been created by converting canals.

The first half of the chapter presents the history of urban development during the colonial period through canalisation and embankment projects. While the second half of the chapter explains Dhaka's urban development strategies for managing water during the late twentieth century, which was characterised by a significant departure from flow to fortification, through a form of cordon system with a new drainage intervention. The FAP (flood Action Plan) from 1989 is also analysed in the second half of this chapter, which played a major role in the transformation of the city from gravity drainage to engineered drainage managed by modern means.

Over the course of time, the modern city with a new water culture and lifestyle has succumb to disregarding the importance of water. As a consequence, more than half of the canals in the city have disappeared and the relationship between the city and water has been transformed. Until the middle of the twentieth century, 24 canals played a major role in the gravity drainage system, which was naturally integrated with rivers, retention areas, and flood plains (Haq 2006). However, at present Dhaka has 10 km of box-culvert drains, 205 km of buried storm drains (ranging from 450 mm to 3000 mm in diameter), and 57 km of open canals (DWASA 2014; Haq 2006; IWM 2014). Even though a domestic sewerage service began in 1923, in 2014 only 30% of the service area in Dhaka was serviced by piped sewage controlled by DWASA (Haq 2006). In the 1969 master plan more than 30% of the land area was supposed to be wetlands. In reality, only 22% of the land area was wetlands in 1989, and this was reduced to only 12% by 2007, illustrating the dangerous imbalance between increasing urbanisation and a decrease in natural retention and drainage capacity (Das & Islam 2010). According to a study in 2014 undertaken by the Department of Planning (BUET) only 5% of Dhaka's land area is covered by wetlands, excluding rivers which are measured separately. The combination of urbanisation and fortification against natural flow has played a significant role in the disappearance of water channels and low lands in Dhaka.

5.2 History of the Dholai Canal

Historically canals were an integral part of Dhaka, facilitating communication, trade, industrial activity, natural drainage, fishing, washing, cleaning, and other day-to-day household activities. As stated in the previous chapter, the Dholai canal was the major water body in Dhaka during the pre-Mughal, Mughal, Colonial, and early post-colonial period. Over time many historically significant canals, such as the Dholai, were converted into box-culvert roads as part of the introduction of modern mobility and drainage system infrastructure to meet the needs of rapid urbanisation.

5.2.1 The Dholai Canal during the Pre-Mughal and Mughal era

In the Pre-Mughal era two forts (or bastions) were constructed to maintain control over the navigation channel, illustrating the importance of the canal as a water route (Figure 4-7). During the Mughal Period (the seventeenth and eighteenth centuries) the historical Dholai Canal was made up of a combination of natural and manmade canals. The eastern part was naturally connected to the Buriganga, while the western part was connected to the Buriganga via excavations completed by the Mughal Governor, Islam Khan, between 1608 and 1610 to maintain territorial control, navigation, local communication, and water drainage (Dani 2009; Karim 1964).

The Dholai Canal formerly represented the lower course of the Balu River. The canal started at the Balu River (near the Demra) and ran southwest through Dhaka, eventually ending near the Mill Barrack on the River Buriganga. The canal subsequently branched off into two channels, one towards the north, and the other westward through the city. This second branch went through the Dhaka-Tejgaon Road close to the present Shahbagh urban area (Figure 4-7). According to Dani (2009), the Dholai canal was connected to the Bagh-e-Badshahi/ Shahbagh (Emperors garden) by canals. He has concluded that the canal was also connected to the Dilkusha and Motijheel areas (one of the existing central business districts, which was built during the 50's as a post-colonial modern urban development), as illustrated in historical maps from 1859 and 1912¹ (Figure 5-18 and Figure 5-19). Shahbagh and Kawran-bazar areas (historically situated beside the Kawran River and at present a commercial district beside the Hatirjheel Canal) area was connected at this point via the Amber Bridge (figure 4-7 in chapter 4). During the Mughal and colonial period the Dholai canal was used for boat races and other sports including swimming. It was also a location for Annual fairs during festive occasions. Many Ghats were established to connect the land with the water for purposes including communication, day-to-day household work, trade, industrial use, and various religious purposes. These cultural practices associated with water played a major part in living with water throughout history.

¹ Maps collected from the National Archive Bangladesh and city Museum of Dhaka City Corporation.

5.2.2 The Dholai Canal during the colonial era

The canal earned revenue for the city from the Mughal period. The average tax collected per year from the passage was estimated to be more than 3,500 Rupees between 1869 and 1871² (Mamun 2000, p. 137). In 1864-65 the British re-excavated the canal at a cost of 2500 rupees to enhance navigation, trade, communication, and drainage. There were between nine and twelve bridges over the canal, which indicates the importance of communication and transit between the Pre-Mughal, Mughal, and new colonial city (Dani 2009; Karim 1964; Mamun 2000). In 1909 the colonial engineers advised that the canal and its connection, which was 12 miles (around 20 kilometres) in length, should be filled. While in 1917 Planner Patrick Geddes proposed that the canal should be protected (Geddes 1990; Mamun 2000). The iron suspension bridge was built connecting Farashganj (French-Ganj) and Gandaria in 1932 by the collector of Dhaka to connect a major river port at the Narayanganj town. There is evidence of a proposal to renovate the Dholai Canal project in the late nineteenth and early twentieth centuries. Individual owners such as Reboti Mohon Das (in 1901) asked permission to construct Ghats along the Dholai canal, which indicates a strong association with water during the colonial period. A plan was submitted for approval to the Municipality and was eventually built (Figure 5-1). This is one of the several examples that indicates the relationship between water and human settlements at the time.

Archival research during the field survey found a very important piece of evidence: the 1921 plan of the Dholai canal. The plan shows proposed renovations to the canal, including a metalled road along the waterway and three new bridges (Figure 5-2). The proposed western portion was meant to maintain the water flow without major intervention. The proposed plan straightens the natural curves of the canal. In addition, a plantation was proposed on the slope between the metalled road and water channel. However, the map from 1960 shows that the canal was not straightened (Figure 5-18). Neither the peripheral roads nor the vegetation belt were implemented, indicating that the whole scheme was never realised.

² Correspondent letters of municipality collected from the National Archive Bangladesh.

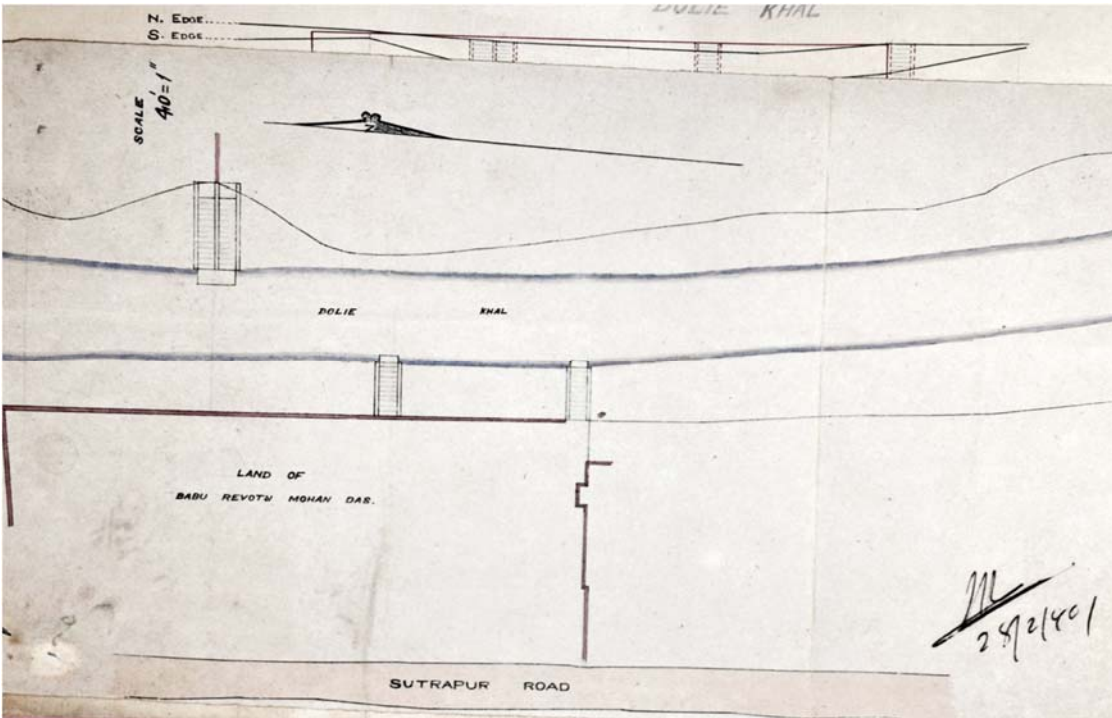


Figure 5-1: Submitted plan of Ghats along Dholai Canal by Babu Revoti Mohon Das in 1901 (source: National Archive Bangladesh)

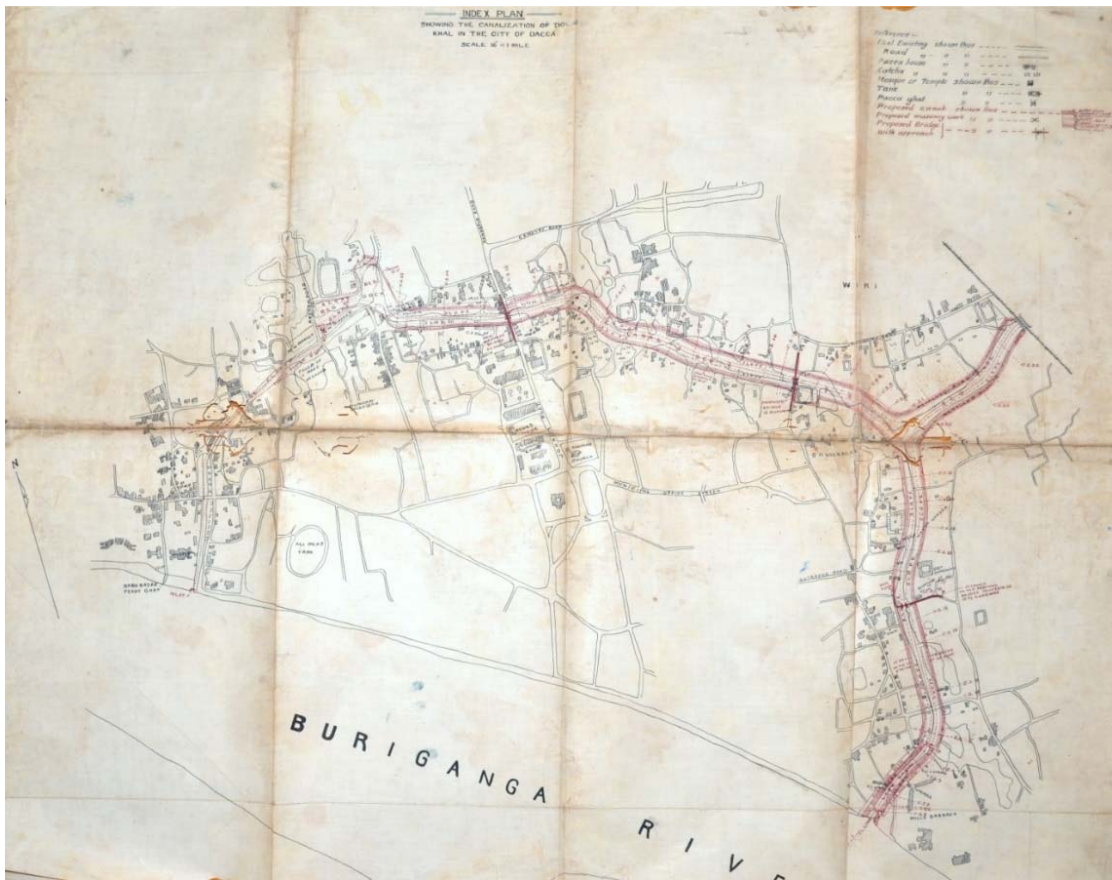


Figure 5-2: Proposed plan for renovation of the Dholai Canal in 1921 (source: National Archive Bangladesh)

In the late colonial period initiatives were undertaken to improve the canal. In the 1930's many letters were forwarded to the collector of Dhaka and to the Chief engineer at the irrigation department of Bengal concerning the improvement of the Dholai Canal. The local authority was concerned about the canal's navigability and pollution. As is evident from municipality records, they repeatedly sent requests to higher authorities asking for the improvement and canalisation of the Dholai (Figure 5-3). One of the letters, dated 2 May, 1931, from the chairman of the Dhaka municipality to the collector of Dhaka mentioned the long overdue canalisation of the Dholai. The chairman of the Dhaka municipality also asked for the Buckland embankment to be extended, to expand the promenade and to provide extra flood protection. The estimated cost of this Dholai Canal scheme was 1.3 million rupee. The letter also mentions the toll revenue from the Dholai Canal, which was 5,000 rupee per annum. It is evident from the correspondence that there was a shortage of funds for the project. Another letter, dated 15 May, 1936, from the chairman of the Dhaka municipality to the superintendent of engineers assures him that the project will go ahead (Figure 5-4). After the project was accomplished, the chairman indicates the increase of traffic volume after the canalisation scheme. He also mentions the increase in toll revenue after the canalisation, and asks for further improvement of the canal to enable proper navigation during the dry season (Figure 5-4).

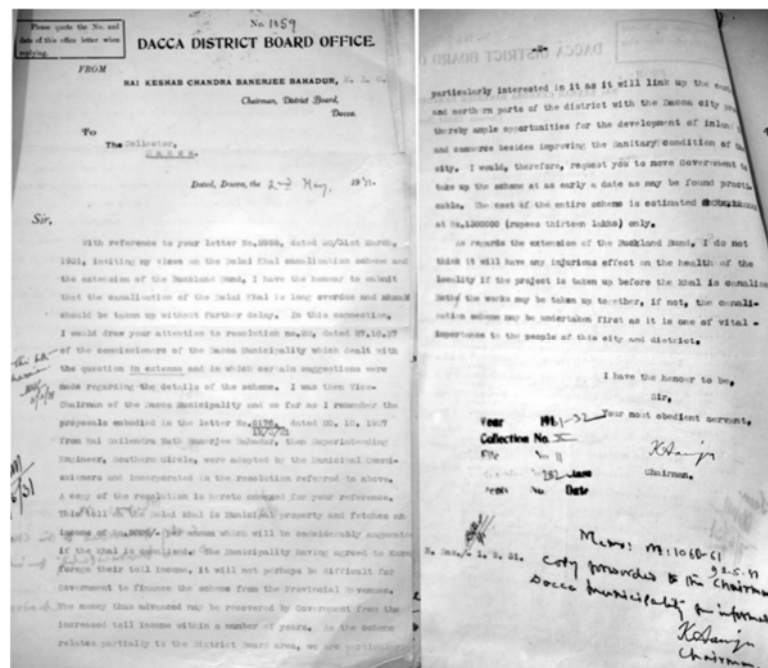


Figure 5-3: Correspondence letter on Dholai Canal canalisation May 1931(source: municipality record from the National Archive Bangladesh)

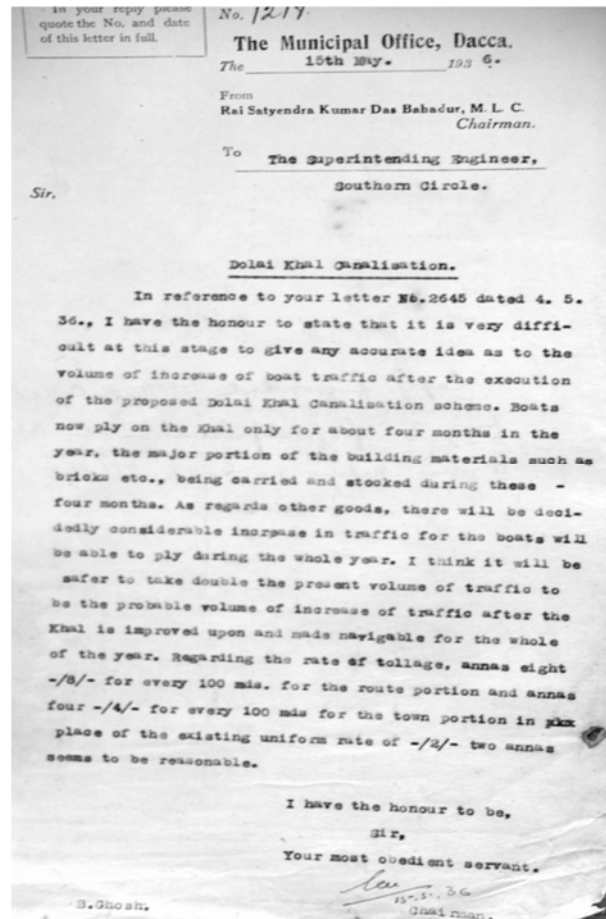


Figure 5-4: Dholai Canal correspondence record of Dhaka Municipality dated May 15 1934 (source: National Archive Bangladesh)

5.2.3 The Dholai Canal during the post-colonial era

According to the study undertaken by the Municipality and the planning commission in the 1950's, the Dholai canal was degraded during the post-colonial era. Consequently, in the middle of the 1950's the Dholai Khal canalisation project was initiated by the municipality of Dhaka. The study estimated an approximate cost of seven million rupees for the renovations, which included dredging, walls, Ghats, and land acquisition (Figure 5-5). In addition, the study estimated the cost of filling (6.5 million rupee) and maintenance work (1 million rupee). The western portion of the canal was deteriorating rapidly as a result of illegal encroachment and pollution (Macfarlane 1959). The navigability of the western portion was very poor and was not at all navigable during the dry season. However, the eastern portion was operational and fairly connected to the Derma, Narinda, and other canals, and with the Buriganga, Balu, and Lakha Rivers. During the 1950's the western portion was used for moving logs as well as serving as a drainage and sewerage outlet.

According to the 1959 master plan, three possible propositions were articulated for the Dholai Canal (Macfarlane 1959, p. 7): to dredge and widen the canal throughout to make the canal into a properly navigable water channel; to fill the entire canal and reclaim the land for roads and open spaces; and to fill the western portion of the Dholai Canal and make the rest navigable all year round for larger boats, maintaining a shorter and effective route through the Buriganga and other water channels in the north.

The master plan recommended implementing the final option. The plan advocated for an engineered underground drainage system for sewage and waste water in the western portion. It was suggested that the filled portion could be used as a ring road for the historical city. The documents mention that dredging, widening, and maintaining the entire canal throughout its length would be disproportionately expensive compared to its usefulness and amenity value. Significantly, the planning documents do not mention any of the environmental issues related to the canal.

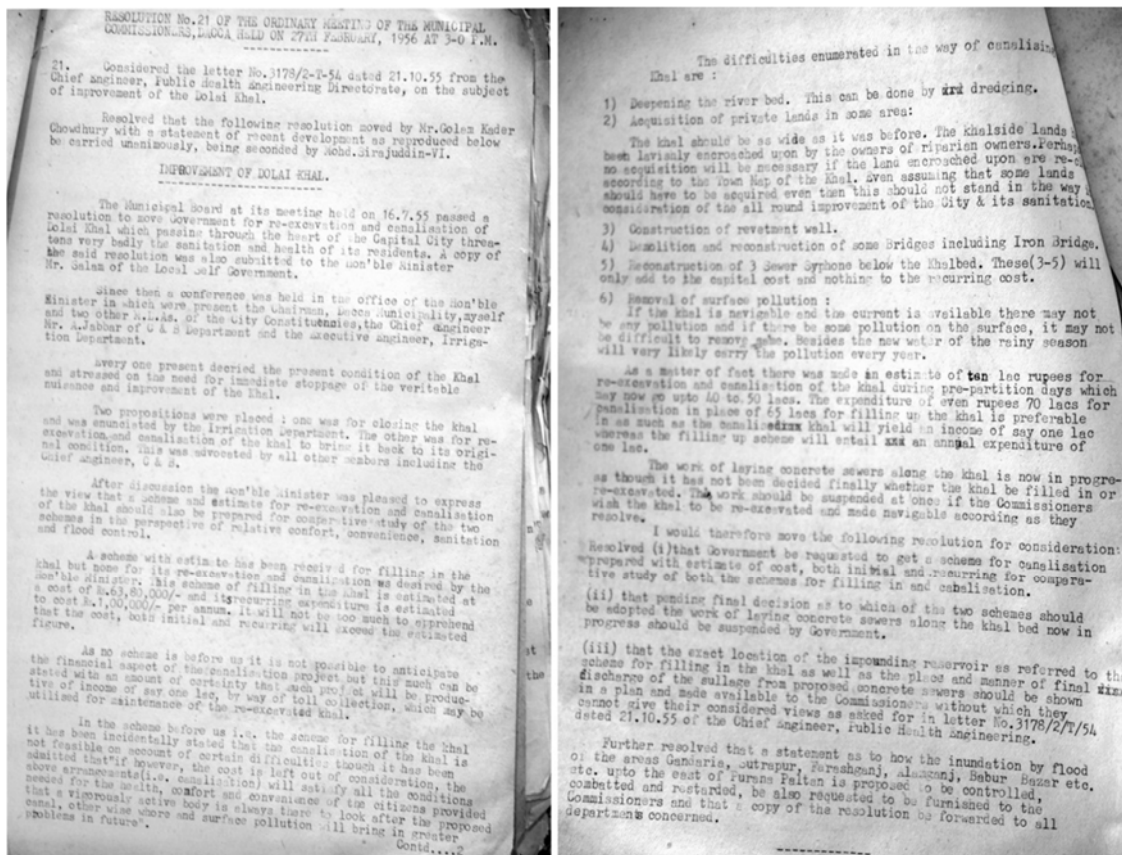


Figure 5-5: Municipality records of the Proposal for improvement of the Dholai Khal dated February 27, 1956.

If the Dholai Canal still existed boats could avoid 26 miles (40 km) of detours between Dhaka and the Lakha River. In 1990 the Dholai Khal rehabilitation project was initiated by the DCC, and, once again, environmental issues were not considered. As in the 1959 master plan, three options were considered during the planning and design phase, and in the end major portions of the canal were converted into a box-culvert road in the mid 1990's (Ullah 2002). The connection between the Dholai canal and the Balu river, the Debi Dholai canal, existed until the construction of a box-culvert by the DCC in 2004 (Mirror 2009). The connection was navigable and used for a number of purposes before it was converted into an engineered drain. The Debi Dholai Canal was 100 feet wide in the middle of the 1990's and used for communication and drainage. At present, only 350 meters of the canal exists as a drainage outlet at the south-eastern end, connecting a box-culvert drain to the river Buriganga.

5.3 Historical embankments in Dhaka

As explained in the previous chapter, the first large, modern engineering intervention for managing water undertaken by the organised development agencies was the Buckland Embankment project, along the eastern bank of the river Buriganga, beside the historical city of Dhaka. It was built by the British governor C. T. Buckland in 1864 (Mamun 2000). According to a majority of historians, such as Muntasir Mamun (2000), there was an embankment during the Mughal period. Later, the Buckland embankment was built over it, with a one mile metalled road/promenade from the Babu-Bazar to Farashganj (French-Ganj).

The embankment was a joint venture project, initiated and financed by the elite landlords and the local government. The embankment and the boulevard were constructed along the river's edge, which was old Dhaka's front yard during this period. Major built forms such as the palaces of the Jamindars and public buildings were along the embankment. The historian Muntasir Mamun states in his book that 65000 taka was provided by the Jamindars, 10000 taka came from local funds from the city council, and another 8000 taka was on loan from Khaza Abdul Gani (Nawab of Dhaka). According to historical records, the funds from the Jamindars were requested by the British governor of Bengal.

The Buckland embankment and promenade was well protected during the British period; hence, loading and unloading, or any other commercial use, was subject to the permission of the municipality (Figure 5-6). Approvals were required to operate any commercial or trading activities on the embankment, including construction of jetties, staking of materials for loading and unloading, and temporary shops. For almost one hundred years the Buckland embankment area was the major public recreational open space of the city, until the early post-colonial period. The embankment was used as a major point of access to the city, and ghats were built to provide citizens with a direct connection to the water. The embankment accentuated the traditional water culture, with the promenade and Ghats functioning as a hinge between the city and the water.

The Buckland embankment road was under the authority of the Dhaka municipality, and they maintained it in a reasonable manner. The Pakistani military regime took control of the management of the embankment and the promenade away from the Dhaka municipality in 1963 (Mamun 2000). After this point it was placed under the control and management of the central government. As a result, because of a lack of maintenance, the area became dilapidated and encroached upon, including some of the historical buildings along the river Buriganga. Major historical buildings, such as Ahsan Manjil, Ruplal house, and Northbrook Hall, still exist along the River. The renovations of the Ahsan Manjil palace (formerly the residence of Dhaka's Nawab) and the landscape in front of the building, which won the Aga Khan award, returned the area to being a public open space (Imamuddin & Longeteig 1990). However, the area (including the traditional city) is very inaccessible due to the obliteration of water routes (Nilufar 1997, 2004). A majority of the old buildings, such as Ruplal house, Choto Katara, and Bara Katara,³ which are historical imprints of the old Dhaka, are occupied by illegal inhabitants and are in the process of degeneration.

³ Evident from the field survey.

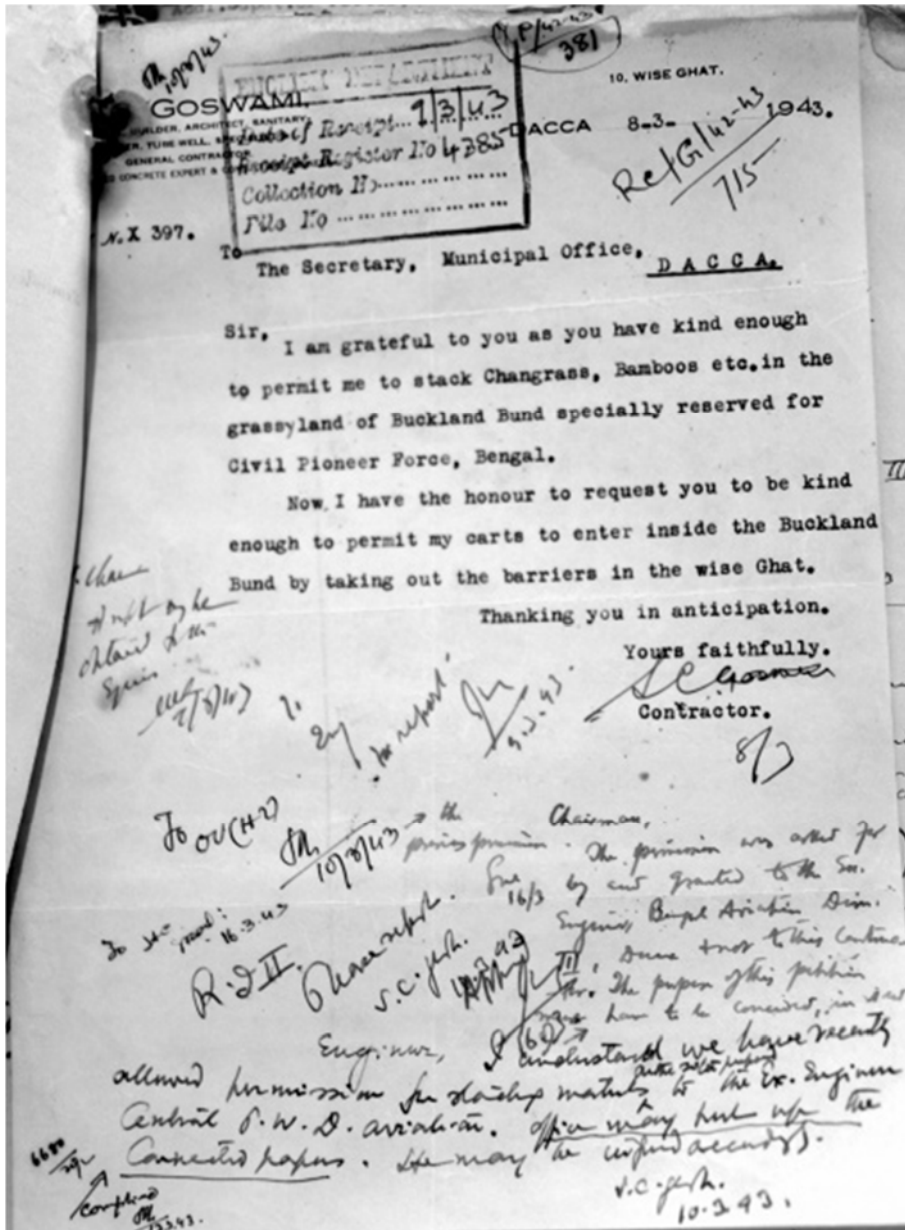


Figure 5-6: Correspondence letter of Dhaka Municipality of 1943 showing request for using the Buckland Embankment area for loading-unloading (source: National Archive Bangladesh)

According to the 1959 Dhaka Master plan, the Buckland Bund (embankment) area should be reclaimed as open space, and as a loading and unloading area (Macfarlane 1959). The 1959 proposal suggested conserving the Buckland embankment, including cleaning up the area and demolishing the illegal settlements, to make it a more accessible and attractive public open space. Moreover, the government planning report from 1969 suggested reconstructing the embankment (Figure 5-7).

PART - "A". Project Serial No.....
 Sector & Sub-Sector.....
 (to be filled in by the
 Planning Commission).

Name of the Project : BUCKLAND BUND IMPROVEMENT, Phase-I.

2. Is the Project in Five year Plan? Yes ₹.98.85 lacs will be required
 If so, what allocation is provided. as grant & ₹.18.58 lacs as loan
 will be required during the years 1969-71 to 71-72

3. Administrative Authority:

a) Sponsoring authority: : Dacca Improvement Trust.

b) General Ministry concerned : Ministry of works, Govt. of Pakistan.

4. Location of project : Along the Bank of River Buriganga
 (attach map, where necessary) starting from Badamtoly upto Sham-Bazar (map attached)

5. Cost of Project (in thousand of rupees) with interest. : ₹.17084 (i/e. interest on loan ₹.452)

<u>Rupee expenditure</u>	<u>Total cost.</u>	<u>Already incurred.</u>	<u>To be incurred.</u>	<u>Total.</u>
	17084	Nil.	17084	17084
Foreign exchange component.	600	"	600	600

6. Annual recurring expenditure after completion : ₹.1,00,000.00

7. Proposed Dates of commencement and completion : 1969-70 to 1973-74

8. Agencies other than sponsoring authority involved in the project

a) General or Special consultants: Nil.

b) Construction agencies, whether local or foreign on turnkey basis or otherwise. : Local.

c) Agency for operation and maintenance : Will be handed over to local body after completion.

9. List of preparatory survey's feasibility reports and project reports (indicate where attached) : Report is as in item No.11. Index map of the scheme, layout plan of the side lands, layout plan of the road detail drawings of the Hawker's Market are attached.

10. Name and designation of officer responsible for preparation of this form. : M.A. KARIM
 EXECUTIVE ENGINEER (PROJ)
 DACCA IMPROVEMENT TRUST.

SIGNATURE & DESIGNATION
 OF OFFICER OF SPONSORING AUTHORITY

Figure 5-7: Municipality record of the Buckland Bund (embankment) improvement project from 1959 prepared by DIT (Dhaka Improvement Trust) at present RAJUK

5.4 The floods and the fortification of Dhaka during the twentieth century

In recent times the Bengal delta has suffered an increase in natural disasters, in terms of floods and tropical cyclones, relative to historical norms. For instance, six major floods were recorded during the nineteenth century (1842, 1858, 1871, 1875, 1885, and 1892). In contrast, eighteen major floods occurred in the twentieth century. The consequences in terms of loss of human lives and physical damage from floods in 1951,

1987, 1988, and 1998 were catastrophic. More recent floods (in 2004, 2007, and 2010) were also devastating. Annual average inundation of Bangladesh is 21% of its land (Ali 2007). The Ganges-Brahmaputra-Meghna basin drains 115 million hectares of surface runoff and 1.6 billion tons of sediments annually from an area 1.75 million km² of which 93% is outside of Bangladesh (Ali 2007). After the fortification against water through the construction of embankments and a pumping drainage system, river floods now have only minor impacts on Dhaka. However, according to experts and newspaper reports, the city is now confronted with a new and more frequent cause of floods, from heavy rainfall, which has nowhere to go due to water clogging. This is occurring more than twice per year.

The DND (Dhaka Narayanganj Demra) embankment was the first major embankment project undertaken in Dhaka by organised development agencies during the twentieth century. The project, which includes embankments, a network of canals, and sluice gates, was initiated to assist agricultural production and provide food for Dhaka. Construction began under the Pakistani military regime in 1962 and was completed in 1968 at a cost of BDT 22.9 million (Rahman, KA & Debnath 2015; Saha 2012). Since 1990 the area has been converted into a residential zone without any approval (Ahmed, SJ, Bramley & Dewan 2012). The DND area is spread across the south east of Dhaka, and major parts of Narayanganj city, and Demra, and is about 56.79km² (Figure 5-8). The current population of the area is around 1.2 million people. In 1990 there were 3173 hectares of agricultural land and by 2010 it had been reduced to 532 hectares (Saha 2012). The area was developed spontaneously through land-filling without appropriate infrastructure, and all of the development lacked formal approval. As a consequence of the destruction of wetlands and poor drainage, due to unregulated urbanisation, excessive water clogging occurs frequently and every year some areas inside the DND are under dirty water for months (The Daily Ittefaq 2013). Clearly, the project is not serving the purpose that it was designed and built for during the 1960's, and it has been declared a flood hazard zone (Islam, MA 2007). To solve the water clogging issue in the area the government introduced a drainage improvement programme in 2013 at a cost of BDT 2,380 million (The Daily Ittefaq 2013).

The 1988 flood was remarkable for its high water level and impact. It was a one in seventy-five year event (Halcrow Group Limited 2006). The flood water in Dhaka achieved a highest level of 8.35 meters above sea level (Huq & Alam 2003; Nishat et al. 2000). Between 80% and 85% of the city was under water for at least two, and up to four, weeks (Faisal, Kabir & Nishat 1999). In 1989 a cordon system was introduced as a defence mechanism against flooding.

The 1998 flood occurred during the post embankment period in Dhaka and was devastating. It was a one in fifty years flood event (Halcrow Group Limited 2006). The flooding lasted for around nine weeks, due to heavy upstream and local rainfall while the water level was at its peak (Nishat et al. 2000). The 1998 flood inundated almost 100% of eastern Dhaka and 20% of western Dhaka (Faisal, Kabir & Nishat 1999). Flood protection did not work during the 1998 flood, because of internal drainage congestion induced by heavy rainfall, leakage through underground pipes, unprotected culverts, broken floodwalls, incorrect gate operation at flood protection embankments, inadequate pumping, and a lack of coordination between agencies (Das & Islam 2010; Dewan, Nishigaki & Komatsu 2004; Faisal, Kabir & Nishat 1999). In 1998 flood water did not flow over the top of the western embankment; however, in many cases flood walls were broken to give access to the jetties and Ghats in the river Buriganga. In 1998 many buried pipes in the sewerage system, which are connected to peripheral rivers and canals, experienced back flow that enabled flood water to penetrate central and eastern Dhaka during the high water period (Faisal, Kabir & Nishat 2003). Water breached the DND embankment inundating major areas within the DND project area (Islam, MA 2007). It should be noted that the DND area was not created to protect the urban area, but was intended to be a cultivation project in the suburban zone.

Following the rectification of flood walls and flood management after the 1998 flood, the river floods of 2004 and 2007 did not affect fortified Dhaka. Today, localised flooding happens every year in Dhaka, which inundates around 12% of the city for almost one week (Halcrow Group Limited 2006). Despite the fortification through modern engineered interventions, major parts of Dhaka are inundated every year during the monsoon, due to heavy rainfall and water clogging.

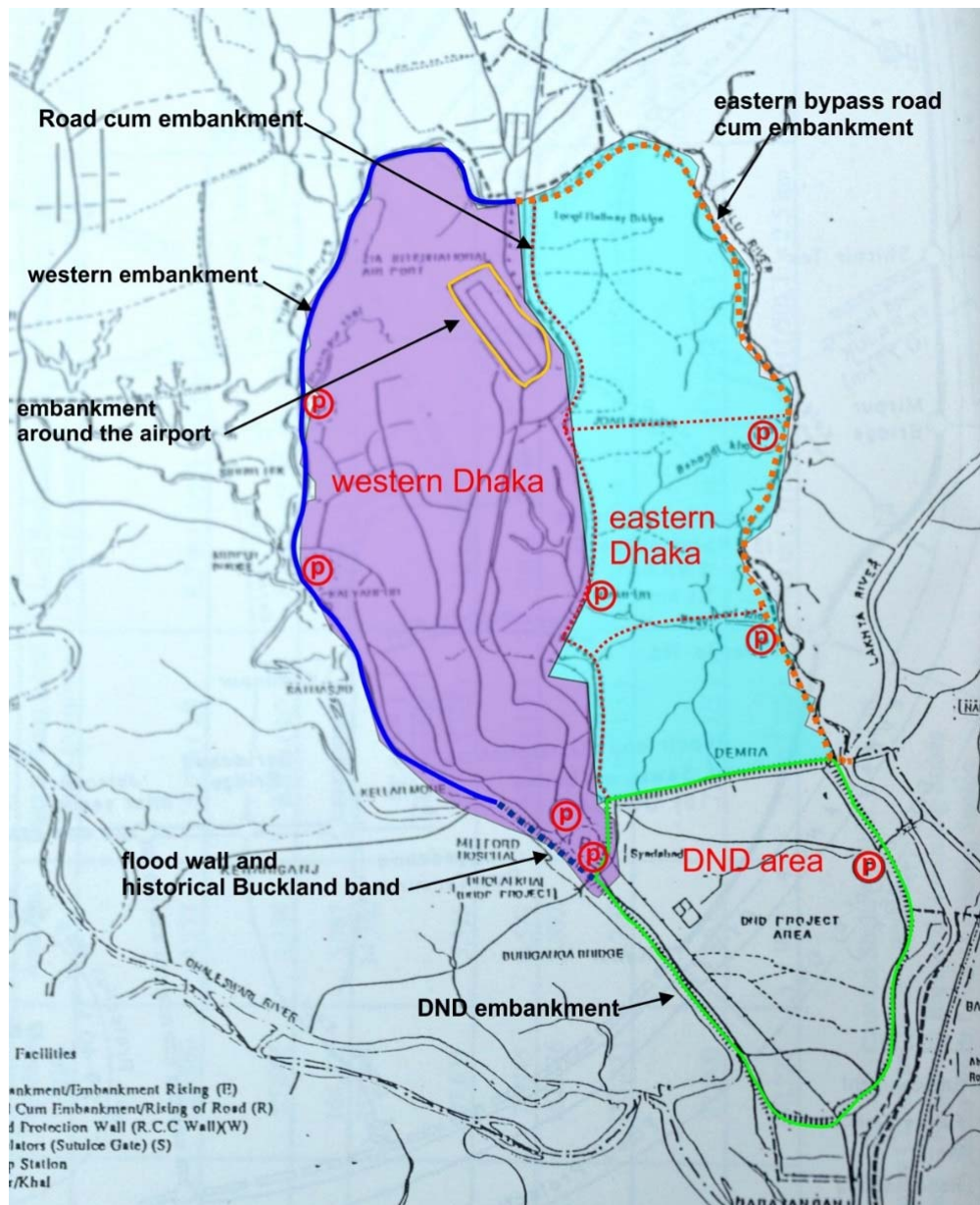


Figure 5-8: Figure showing the cordon system embankment of Dhaka

5.4.1 The planning process of the Flood Actor Plan (FAP) in 1989 and its consequences

The Dhaka Integrated Flood Protection Project (DIFPP) was initiated by the military regime after major flooding in 1987 and 1988. Twenty-six projects were planned all over the country as part of the Flood Action Plan (FAP) and 22 of them involved structural plans, such as engineering drainage with a cordon system embankment. According to interview respondents, three different groups prepared proposals for flood protection⁴. The first proposal was prepared by an international

⁴ Information collected through interviews of planners and engineers.

group, and was based on the concept of the Tennessee flood action plan. The second proposal was presented by the French and Japanese. The third proposal was created by NGO's supported by local intellectuals and technocrats. The third proposal made an argument for living with flooding rather than creating fortifications against it. However, this adaptive and resilient approach never gained broad support or momentum. Eventually a large team lead by the Japanese, French, and Dutch designed the project with the collaboration of local development agencies and actors.

The FAP was primarily funded by the World Bank along with 14 additional donor organisations, including ADB, JICA, UNDP, USAID, France, the Netherlands, and Germany. The FAP is one of the largest development projects in Bangladesh's history and it cost more than USD\$ 155 billion to build dams and other types of infrastructure across the country (JICA 1991). The study and plans were prepared by the JICA, BWDB, and consultants from the Netherlands.

The DIFPP includes embankments, flood walls, box-culvert drains, canal upgrades, retention reservoirs, pumping stations, underground drainage, sluice gates, and other interventions for managing water. The project was conducted by multiple development agencies (Figure 5-10). The western embankment includes 31.67 km of embankments; 4.3 km of flood walls (Figure 5-8), making a total of 37 km of fortification. Three pumping stations and twelve sluice gates were installed to improve the drainage network of the western part of the city (Bala et al. 2009; Faisal, Kabir & Nishat 1999). A total of 11 regulators were installed along the embankments at the outfall of the canals to the surrounding rivers (Nishat et al. 2000). In addition, 10.53 kilometres of embankment was built to encompass and protect Dhaka's international airport (Huq & Alam 2003).

The FAP included proposals to upgrade the capacity and flow of 21 major canals with a combined length of 78.6 km, and to conserve 22 canals in the west (JICA 1991). In addition, the FAP proposed 185 km of underground pipes (from 450 to 3,000 mm in diameter) and box-culverts for drainage (Huq & Alam 2003). However, both development authorities and law-enforcement agencies were unsuccessful in upholding the comprehensive guidelines of the plan. As a consequence, since the 37

km embankment was constructed in 1989 low lands inside the embankment have been filled with unregulated urbanisation (Ahmed, SJ, Bramley & Dewan 2012; Dewan, Nishigaki & Komatsu 2004). According to interview respondents, some of the proposals were not constructed due to shortages of funds. Over the next 20 years all the low areas in the western fringe were filled. The majority of the filling was done by the co-operative housing societies who were operating in the western fringe areas, such as Mirpur, Mohammadpur, Mohmodia, and Adabor. The extent of the landfilling is evident from the maps, google images, and other records. After 2003 low lands outside of the embankment began to be filled with new housing projects (Figure 5-9). This has led to the destruction of natural drainage, which has contributed to flooding and water clogging inside the city.

In 1989 the DIFPP divided Dhaka city into eastern (128.5 km²) and western (136.5 km²) drainage zones (Figure 5-8). The western part of western Dhaka is protected by flood walls and an embankment, while the eastern side of western Dhaka is protected by the Pragoti Shoroni Embankment road. The Eastern part remained unprotected until construction began on the new eastern bypass road in 2014, which is being built on a flood protection embankment.

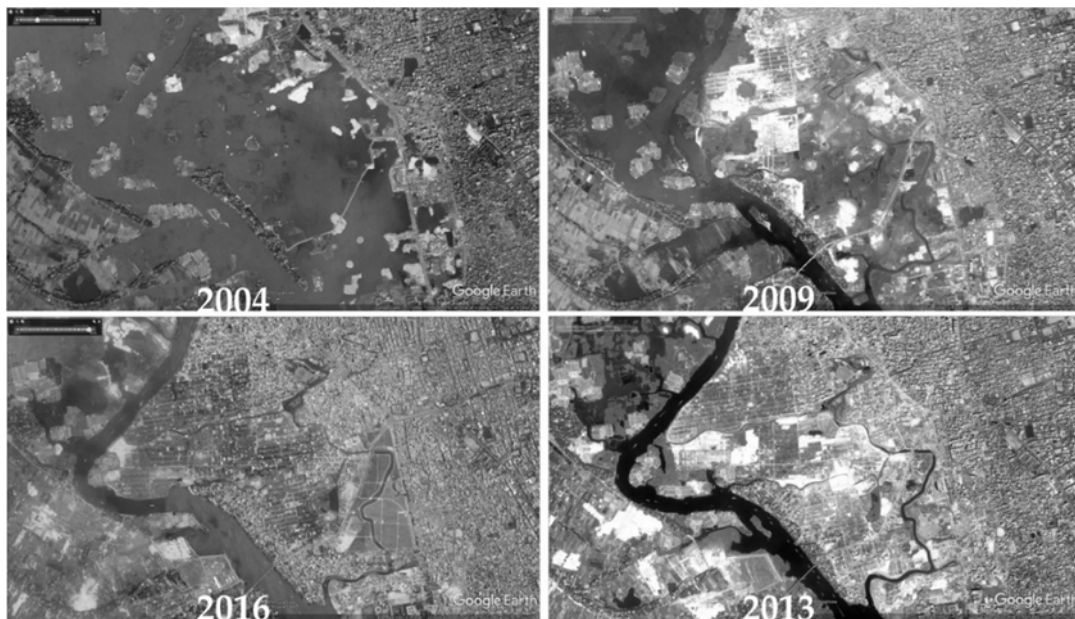


Figure 5-9: Part of the western fringe area beyond the flood protection area from 2003 to 2016, which was a part of the low lands and flood flow zones.

Embankments, Flood walls (T or I section), and road cum embankments are three types of flood protection infrastructure used by the development authorities

(JICA 1991) (Figure 5-11). The whole drainage system proposed in the DIFPP is dependent on the pumping system, drains, canal network, sluice gates, and embankments. Through the introduction of a cordon system, the natural drainage system became obsolete in western Dhaka.

The development actors from BWDB, along with other engineers involved in the planning process, viewed a cordon system with pumped drainage as the best solution for Dhaka. However, critics and experts have different perspectives on flood protection. A majority of planners, architects, and environmentalists (including engineers) believe that the hard engineering defence mechanism approach that was employed for the FAP to solve the flooding problem was an inappropriate strategy. According to them, the city can reconceptualise the embankment and cordon system with a softer engineering approach, which would be adaptive and resilient.

Table G.2(1) Flood Control Facilities

A. Existing and On-going Facilities

Executing Agency	Component of Work	Location	Quantity	Elevation/Capacity
Army	Embankment	E1 : Tongi to Diabati	8.00 km	10.0 m +PWD
		E5 : Satmasjid to Kellar More	5.80 km	10.0 m +PWD
BWDB	Embankment	E2 : Diebati to Sirmir Tek	9.69 km	10.0 m+PWD
	Sluice	S1-S6	6 nos.	
	Pump sta.	DND Project	1 No.	14.5 cubic meter/sec.
DMC	Embankment	E3 : Sirmir Tek to Mirpur bridge	1.50 km	10.0 m+PWD
	R.C.C Wall	W1 : - Ditto -	0.75 km	2' above flood mark
	Rising of BWDB Dam			
	Embankment	E4 : Mirpur bridge to Kallyanpur	1.42 km	10.0 m+PWD
	R.C.C Wall	W2 : - Ditto -	0.16 km	10.0 m+PWD
	Embankment	E4 : Kallyanpur to Satmasjid	2.75 km	10.0 m+PWD
	R.C.C Wall	W3 : Mitford Hospital to Buriganga bridge	4.31 km	2' above flood mark
	Rising of road	R1 : Rampura main road	0.98 km	7.9 m+RWD(Approx.)
	* Dholai Khal Project (UNDP/World Bank Project)			
	Improvement of Khal		2.35 km	
	Pump Station	Pmd1: Confluence of Buriganga river	1	80,000 m3/hr
Reservoir	Narinda, Dayaganji areas	1Nos	205,000 m3	
Removal of Pump Sta.	Existing Narinda Pump Sta.			
CAAB	Embankment	E6 : Surroundings of Zia Airport	10.53 km	9.8 m-10.5 m+PWD
RAJUK	Rising of road	R2 : Joar Sahara to Rampura	6.00 km	7.9 m+PWD(Approx.)
		R3 : Rampura to Syedabad	5.90 km	8.4 m+PWD(Approx.)
		R4 : Sirmir Tek	0.77 km	10.0 m+PWD
RHD	R.C.C Wall	W4 : Surroundings of DND Project area	26.61 km	2' ~ 3' above flood mark
DWASA	Reexcavation of 12 khals			
	* Japan's Grant Aid Project			
	Pump station	Pmw 1: Kallyanpur		20(Tentative 10)m3/sec
	Sluice	Smw 1: Kallyanpur		
Railway	Raising of Railway	R5 : Southern part of DND Area	2 km (Approx.)	6.8 m

Note: *Contd.*

Figure 5-10: Executive agencies of the western embankment and their scope of work (source: JICA 1991)

Research demonstrates that a majority of the engineers who were involved in the FAP project completed their qualifications in the Netherlands, having studied

water resource management and civil engineering.⁵ In addition, the Netherlands government was one of the major funding organisations (JICA 1991), and consultants from the Netherlands took part in the project. Consequently, the project demonstrates a bias towards western engineering approaches, such as the Dutch cordon system. Therefore, critics suggest that the Dutch treated Bangladesh as a laboratory to trial the cordon system⁶ (Das & Islam 2010; Islam, I 2009). Experts criticise the project for being a very visible intervention, which broadcasts Western influence over the design and funding of the project. The development actors commented that the former military regime, along with the development agencies, wanted to undertake a project that involved large infrastructure and lots of money⁷. Moreover, donor agencies from western governments were looking for a large investment project. According to the interviewees, during the late 1980's the living with water approach was not popular. As a consequence, the development agencies, foreign consultants, and financial experts shaped the project with the aim of keeping the city free from flood through fortification against water.

⁵ Discovered from the interviews of the development actors and agencies.

⁶ According to interviewees and other research publications.

⁷ Interview findings from the engineers of DWASA, BWDB; and Health and Engineering who were directly involved in the project including architects and planners who work with water issue.

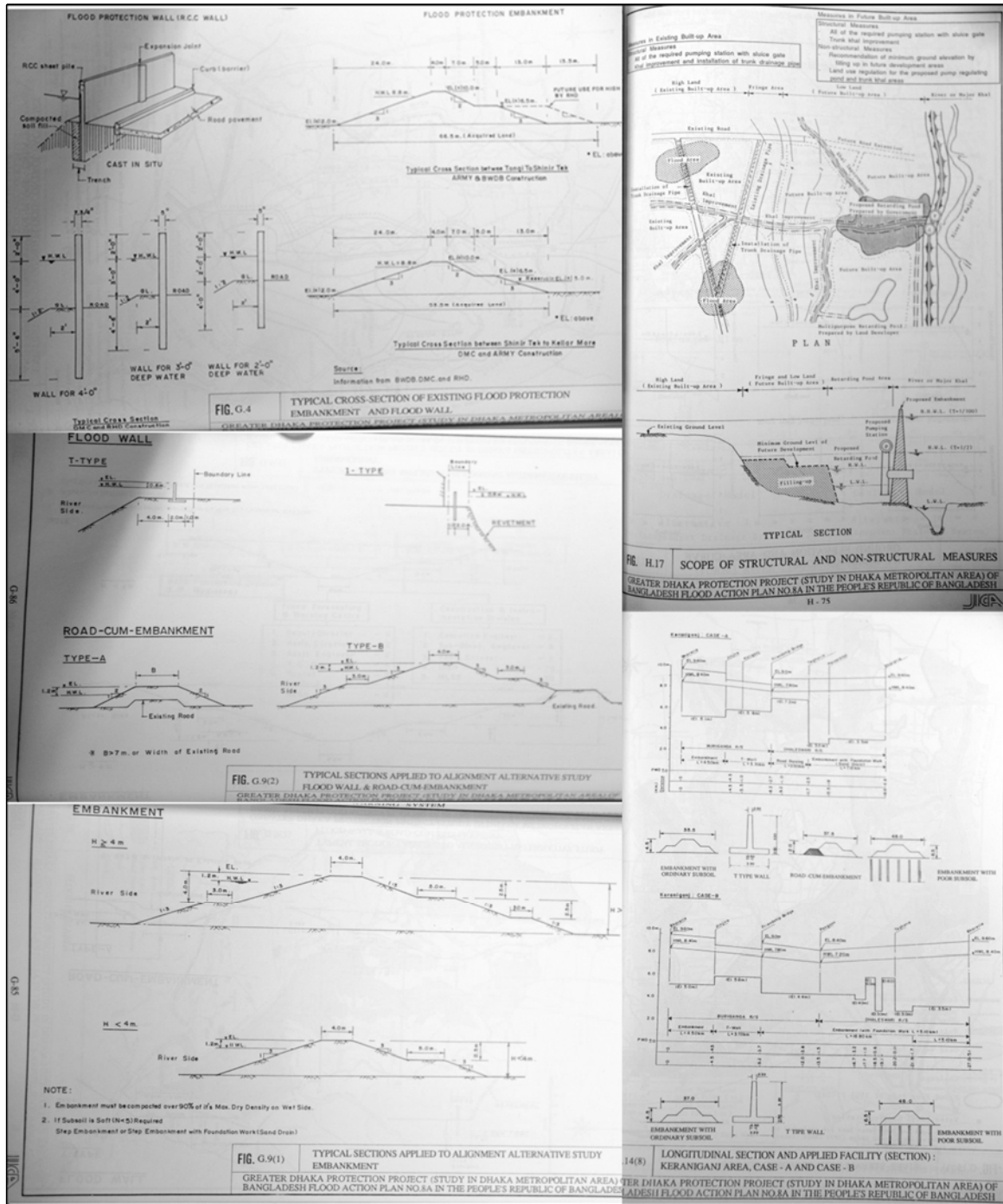


Figure 5-11: Drawings of the western embankment proposal prepared by the JICA (source: DWASA)

5.4.2 Post embankment Dhaka and the eastern bypass road cum embankment

Post-embankment Dhaka, particularly the western part, is dry and fortified, which has led to a different development pattern, because wet areas can be landfilled to create suitable land for new urban development. Gravity drainage has been replaced by an artificial pumped drainage scheme supported by drainage infrastructure. With

the embankment-cum bypass road as an intervention for defence against water, which will be completed by 2017, the eastern part is undergoing the same process. The majority of the historical canals have been transformed into vehicular roads, or disappeared due to encroachments. Therefore, the integrated network of canals, which had performed as a communication and trading network, has been lost and gravity drainage and bio-diversity have been destroyed. Hence, with the transformation of the cultural landscape, the water culture of this hydrological civilisation has largely disappeared.

The eastern part of Dhaka is subject to flooding every year, as a majority of eastern Dhaka still consists of low lands, flood flow, and sub-flood flow zones. However, some major landfill projects have been under construction in eastern Dhaka since the 1990's. For instance, the Bashundhara group have filled almost seven square kilometres of their ten square kilometres area for different phases of their township over the last twenty-five years. About 50% of eastern Dhaka faces flooding almost every year, due to river flooding and heavy rainfall.

At present a 28 km long embankment is under construction, along with the bypass road (Figure 5-12). The project includes a 13 km river erosion protection slope and two sub embankments (Halcrow Group Limited 2006). It also includes six pumping stations and sluice gates (or Regulators). The project divides eastern Dhaka into three hydrological sub-areas, based on the type of cordon system solution employed and major east-west road connections. The plan proposed 1,895 hectares of retention areas at six locations, and excavation (or re-excavation) of 80 kilometres of canals for drainage. The plan was prepared in 2006 by the Halcrow Group Limited from the United Kingdom in conjunction with the association of the House of Consultants Bangladesh, Halcrow Bangladesh Limited, and CEGIS of Bangladesh. The height of the main embankment is 9.5 meters above sea level and it is designed to provide protection against a one in one-hundred year river flood. The scheme has

room for foreshores⁸ at a minimum of 50 meters from the river bank protection to the embankment cum by-pass road (Figure 5-13).

The compartmentalisation of eastern Dhaka, because of the cordon system embankment and pumping drainage system, has been severely criticised by experts. They believe that compartmentalisation might create more water retention and floods due to rainfall. However, if the drainage capacity and retention area is maintained free from encroachments, flash flooding due to rain fall may not happen. Unfortunately, it is evident from the landfills and destruction of canals, caused by the construction of townships such as Bashundhara, Aftbnagar, and Banasree, that integrated drainage and natural retention have been destroyed in major parts of eastern Dhaka. If the development authorities can re-excavate 80 km of drainage canals, which was suggested in the proposal, a major part of eastern Dhaka may well survive flooding from rain and blockages. Importantly, the Eastern bypass embankment violates the Wetland Conservation Act (2000), as it is obstructing natural flow and compartmentalising retention areas. Consequently, the runoff capacity of the eastern canals is much lower. Research found that with the maximum capacity (54.6 m³/sec) of the pumping system which will be installed in eastern Dhaka, that it will take 11 days to pump out the volume of water retained during the monsoon (Khalequzzaman 2011). Clearly, if eastern Dhaka is going to avoid extreme flooding, the project needs more canals, extreme run off capacity, and retention capacity. Though the cordon system altered the natural drainage system in Dhaka, unregulated landfill urbanisation and incomplete implementation of drainage infrastructure projects have reduced its effectiveness. Therefore, whether engineered drainage is a solution or a problem for Dhaka is a significant question.

⁸ Some rivers in the delta have foreshores which is under water during the monsoon. And in the dry season the area sometime used for agriculture such as rice production.

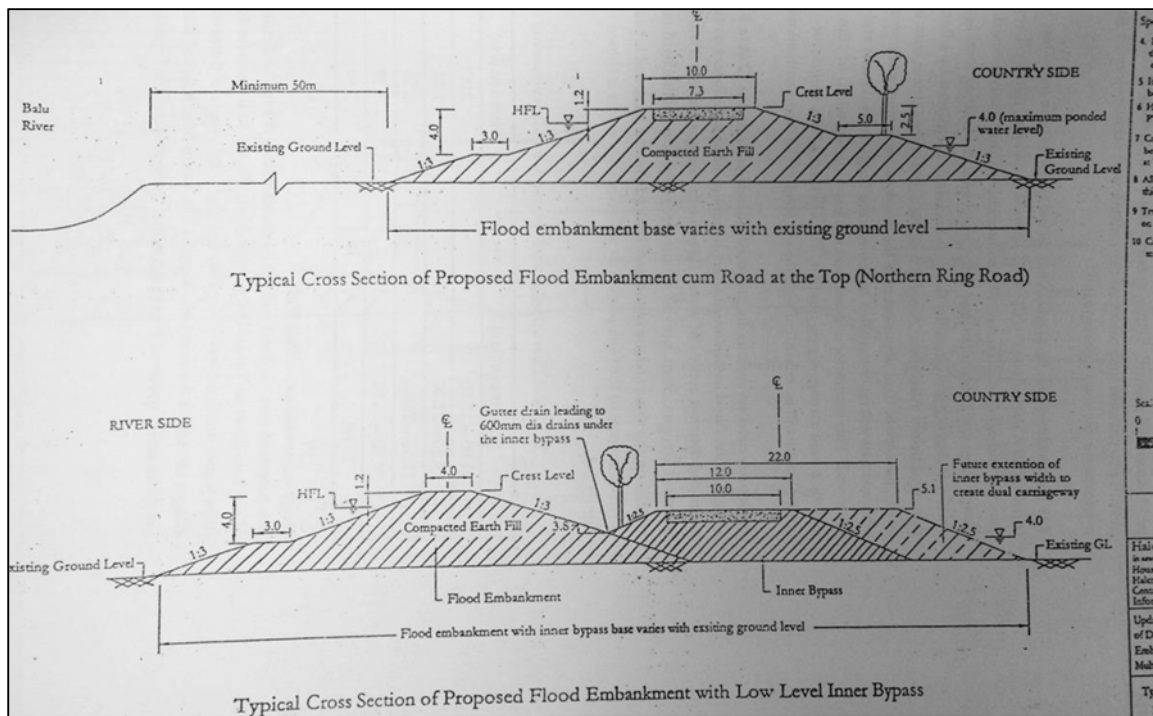


Figure 5-12: Proposed section of eastern bypass road cum embankment (Source: JICA 2006)

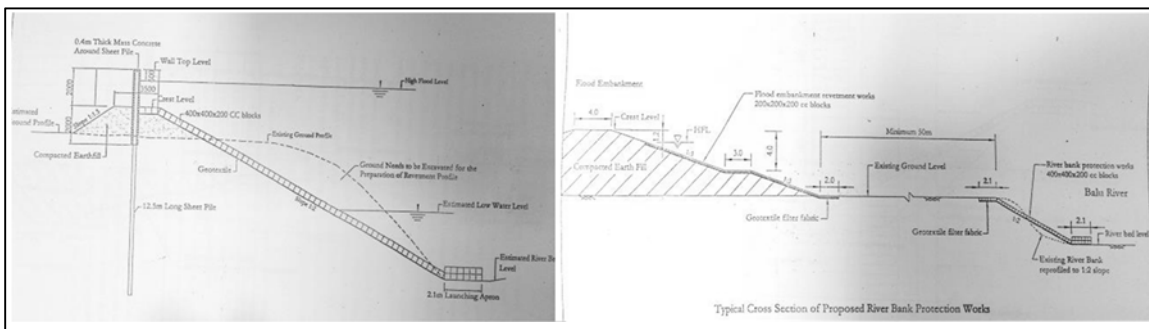


Figure 5-13: Detailed drawings of the eastern bypass road cum embankment (source: JICA 2006)

5.5 Transforming canals into engineered drainage infrastructure during the 1990's

A rapid transformation of canals occurred after 1989, during the post-embankment era. After the construction of the western embankment, between 1990 and 2000, 270 km² of wetlands were filled (Mahmud, MA 2013). In addition, 18.72 km² of canals and rivers were destroyed during the post embankment period (Mahmud, MS et al. 2011). According to the popular press and environmental experts, a majority of Dhaka's canals only exist on paper (Kamol 2009; Rahman, M 2008; Roy 2007). The introduction of the cordon system embankment not only fortified the city against water, but also played a role as a catalyst for landfilling for urban development. Recent research in Dhaka suggests that about 125 kilometres of canals disappeared between

1960 and 2004 (Hossain, AM & Rahman 2011). Research shows that inland water bodies, such as canals and lakes, were reduced to around 65% of their earlier levels in the second half of the twentieth century (Hossain, AM & Rahman 2011; Sultana, Tarekul Islam & Islam 2009). Studies indicate that in 1960 there were fifty major canals, of which twenty-six had disappeared by 2004. As a result of the transformation of canals through box-culverts, encroachments, and land filling, floods and water clogging have become regular occurrences (Rahman, S 2004). At present a majority of canals have completely disappeared from the map of Dhaka, and many others are in great danger of shrinking due to rapid urbanisation.

After the great flood of 1988 an engineered drainage system called the 'box-culvert road' was introduced as part of the DIFPP, along with the cordon system. The common cross section of box-culverts proposed by the JICA and DWASA were 2.5 x 3.4 meters and 6.0 x 4.1 meters (Figure 5-14). By 2013 ten kilometres of box-culverts had been built in Dhaka city (Khan 2013, p. 25) to go along with the sixty-five kilometres of open canals (DWASA 2014; Tawhid 2004). DWASA states that they operate about 315 kilometres of waste water line. There are 4 water treatment plants, 4 pumping stations, and 66 small pumps in different locations across western Dhaka (Bala et al. 2009; Tawhid 2004). The canals are no longer directly connected to the rivers, but are instead connected through sluice gates. In different locations, including four pumping stations, water can drain out from inside fortified Dhaka.

To ensure accessibility and controlled drainage, box-culvert roads were constructed⁹. However, development actors from the DWASA, IWM, and other public development agencies suggest that the box-culvert road is the brain child of international consultants who did not have any idea about the context and drainage system of Dhaka¹⁰. According to former and current directors (and deputy director) of the DWASA, and the advisor to the IWM, the box-culvert is a major design problem for drainage infrastructure in the context of Dhaka. Dr. Firoz Ahmed claims that local engineers advised that a box-culvert should be designed with a U or V cross section,

⁹ According to the development actors of the public development agencies.

¹⁰ According to the development actors of the DWASA, IWM and other public development agencies who were interviewed.

with frequent and easy access from the ground. Some other experts advised that larger cross section culverts should be built. Nevertheless, due to technical difficulties and a shortage of funds, the DWASA, BWDB, JICA, and government employed the design proposed by the foreign consultants. Eventually, ten box-culvert roads were constructed with a typical rectangular cross section using the funding from the JICA and ADB (Figure 5-14).

The proposal to build box-culvert roads did not take the quality of storm water drainage and cleaning issues into consideration, notably the amount of sludge and sedimentation. This sludge occurs because Dhaka's sewage is mixed with storm water, due to the lack of a comprehensive sewerage network: only 25% of Dhaka is serviced by the sewerage system (DWASA 2011, 2014; IWM 2014). Moreover, owing to the populations lack of awareness and negligence on behalf of development and law enforcement agencies, the sewerage network is connected to the storm water network in a majority of cases where the sewerage network is not available.

According to the DWASA, 43 canals exist at present (in 2014), including major and minor canals and branches. However, BAPA claims Dhaka has 34 canals. Referring to the urban water researchers from the BUET, 44 major canals existed in 1977. In 2005 this number had been diminished to 26, and at present the number is 18. According to a study in 2008-09, in western Dhaka 58.16 hectares of canals have already been encroached out of 172.94 hectares, which is about 33.63% of the total surface area of canals (Islam, I 2009). Another source claims that at present there are 35 canals in Dhaka (Afrin & Dalia 2011). Five of them have fully disappeared due to landfilling and construction of roads, while seven of them are partially filled and disappearing. Six of them have been converted into box-culvert roads by public sector development agencies. However, in reality, a majority of them are in a dilapidated condition as a result of encroachments (DWASA 2011, 2014; IWM 2014). According to Khalequzzaman (2011), 21 historical canals have disappeared that used to flow during the Pre-Mughal, Mughal, and Colonial period. A majority of the 13 canals in western Dhaka are under threat. Similarly, eastern Dhaka's canals are disappearing as a consequence of landfilling urbanisation.

Four major and six small canals have recently been converted into box-culvert roads in the western part of the city. The Dholai, Segunbagicha, Dhanmondi (Kalabagan), and Paribagh canals are the four major canals that have been transformed into box-culvert roads. During the first decade of the twenty-first century some of the canals were converted into open concrete drains with walkways (Figure 5-15). Development actors supported these interventions to protect them from encroachment and for easy maintenance; though, converting natural canals to concrete drains destroys the natural system of flow. The Segunbagicha canal is presented in the next section as a case of transformation from flow to fortification.

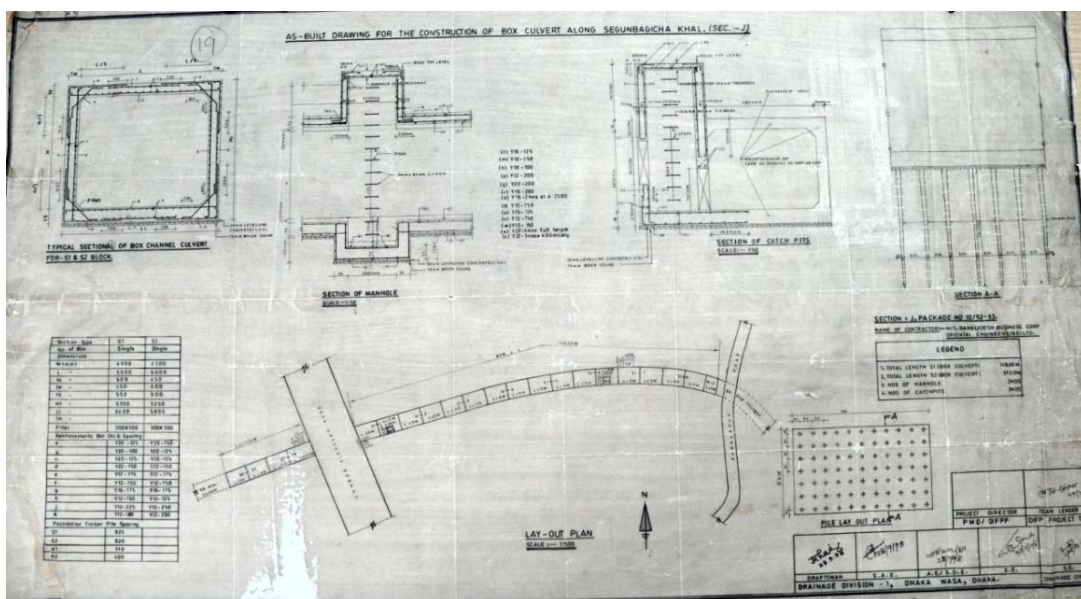


Figure 5-14: Box-culvert drawings of a part of Segunbagicha Canal prepared by the DWASA (source: archive of the DWASA)

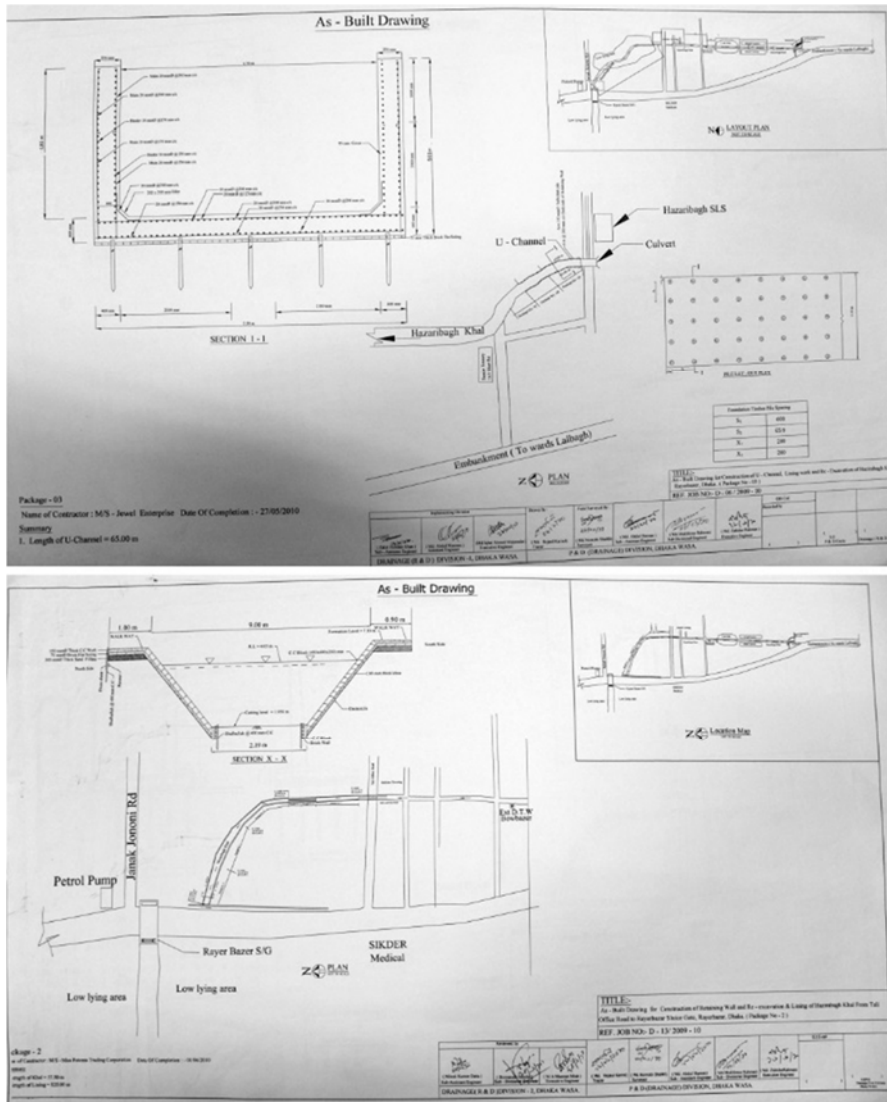


Figure 5-15: Open U-section and C-section canal/ large open drain converted from a natural canal between 2005 and 2011 (source: archive of the DWASA)

5.5.1 The case of the Sugunbagicha-Fakirerpool-Arambagh–Kamlapur Canal

The Segunbagicha Canal is one of the major canals that has recently been encroached, filled, and converted into a box-culvert road (Figure 5-16 and Figure 5-17). The water channel went through the areas of Segunbagicha, Paltan, Fakirapool, Arambagh, Motijhel, and Kamlapur, and it was connected to the Manda Canal in the east and another major canal in the west (which was filled), and had previously been connected to the Dhanmondi Lake and Kalabagan (Dhanmondi) Canal. The word ‘Motijheel’ means the ‘Lake of Moti,’ ‘Fakirapool’ means the ‘Bridge of Fakir,’ and the word ‘Shegunbagicha’ means ‘Teak Garden.’ The name ‘Arambagh’ means ‘Comfort Garden’ and ‘Kamlapur’ means ‘Garden of Orange’. The names are associated with the

natural environment that existed in the past. The Motijheel Lake was also part of the original canal. According to a majority of historians, semi-urban establishments were present during the early colonial period. However, some colonial establishments were built near the lake during the late nineteenth and early twentieth centuries.

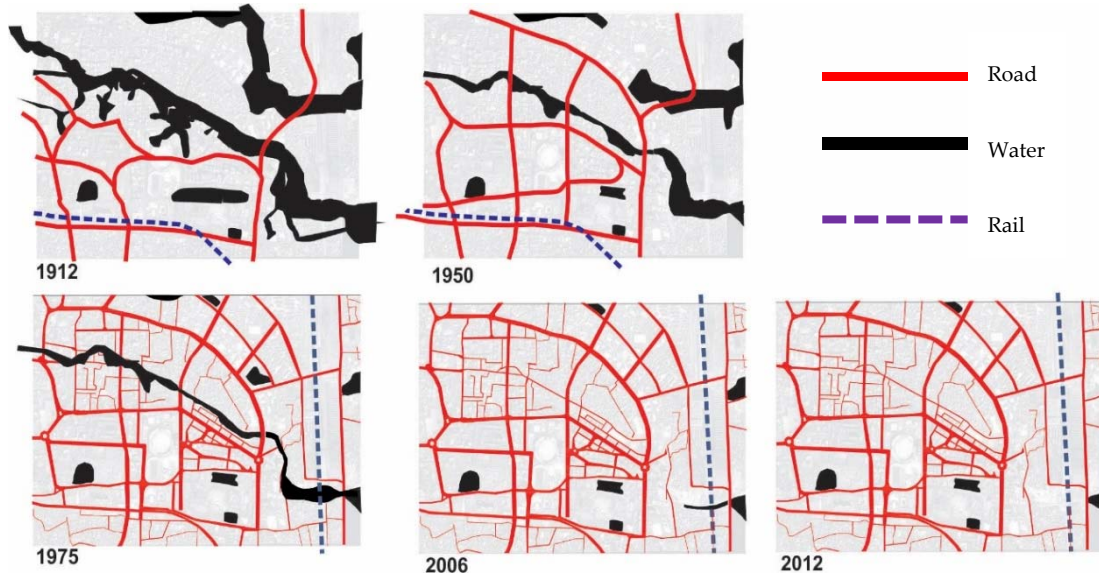


Figure 5-16: Transformation of Segunbagicha Canal (Ahmed, F 2006) (sources: archival maps and google images)

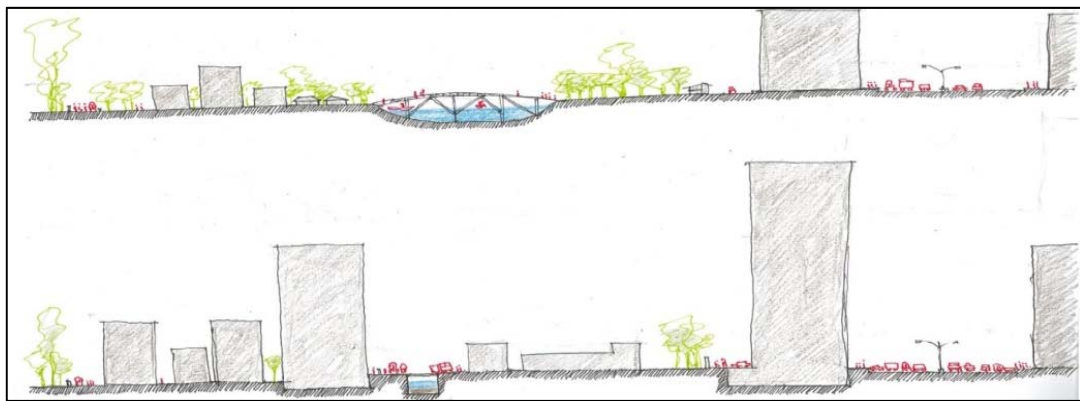


Figure 5-17: Conceptual section showing the Motijheel area and Segunbagicha canal in the 1980's and in 2014 (Source: drawn by the author from the site analysis during the field survey in 2014).

The canal and the large lake were integrated parts of the landscape and ecosystem. These water bodies were also part of the integrated natural drainage system, which was used to transport people and goods during the Mughal, Colonial, and early post-Colonial era. Before the fifties, the area was part of the Dilkusha Palace and gardens, built during the Mughal period by the Nawabs of Dhaka. Government House was built in the Dilkusha garden in 1905 by the British Raj, and presently serves

as the president's residence. Until the post-colonial and early independence period the canal was a major route for transporting construction materials (Ahmed, F 2006; Haider 1966; Karim 1964, 2009). It was connected to the Dholai Canal, Buriganga River, and other major water channels such as the historical Kawran River (Figure 5-18 and figure 4-7 in chapter 4). Local traders used the canal for local business during the British period. The canal was also used by local residents for day-to-day activities including household work (cleaning, washing, and drinking), transport, and fishing.

The 1915 map indicates that the canal was more than 60 meters in width (Figure 5-19). However, the 1960 map illustrates that the area had become urbanised as a part of the early post-colonial city (Figure 5-18), resulting in the canal becoming narrower and having some bridges constructed over it. The bridge on the Circular Road was very high and had enough room under it to allow medium sized boats to pass underneath it¹¹. According to the 1979 and 1980 map the canal was 30 meters wide (Figure 5-21). The canal was used for communication, fishing, and household purposes until the 1980's. According to JICA (2006) report the original canal was between 50 and 80 meters wide and 5.7 kilometres long. At present it is a box-culvert (5.5MX6.3M) with a 10 to 15 meters wide road over it (Figure 5-14 and Figure 5-17). During the late 1960s and 1970s the Motijheel Lake was filled by the Public Works Department (PWD) to build government housing areas to cater for the growing population (Ahmed, F 2006; Ahmed, SU 2003). A box-culvert road was constructed by the DCC during the mid-1990's and was connected to the major roads of the city and other neighbourhoods.

¹¹ According to architect and planner Dr. Roxana Hafiz who used to travel regularly using that bridge during the 60's, 70's and 80's.



Figure 5-18: 1960 Map showing different water channels and wetlands including urbanised area. (source: Drawn by the author from the collected map from the Department of Architecture BUET, the original map was prepared by the Pakistan Government in 1960 based on the survey of 1959-60)



Figure 5-19: 1912 Map showing the Segunbagicha canal (source: National Archive Bangladesh and Dhaka City Museum of the DCC)

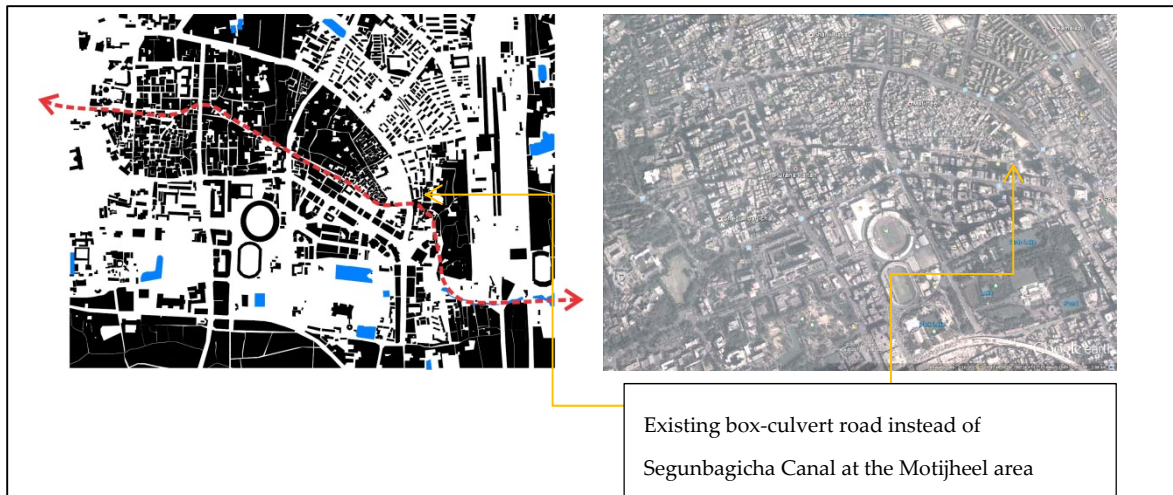


Figure 5-20: Map and google image showing existing top view of the box-culvert road path instead of the Segunbagicha Canal (source: drawn by the author from the Google Earth image)



Figure 5-21: 1979 Map of the Motijheel Commercial Area showing the width of the Segunbagicha canal of (30 meters, 90 feet) (source: RAJUK)

5.5.2 The box-culvert as a drainage solution

According to experts box-culverts are hydraulically inefficient in terms of flow.¹² In addition, the structure of box-culverts typically results in a gradual reduction in flow, as sedimentation builds up due to a lack of regular maintenance. The design of

¹² Interviews of Dr. Majibur Rahman, Architect Iqbal Habib, Dr. Firoz Ahmed and Dr. Israt Islam.

Box-culverts noticeably reduces the carrying capacity for drainage. The development actors, researchers, and experts made their opposition to the rectangular cross section box-culvert design known, preferring a V-cross section to maintain the velocity of water flow. Unfortunately, due to construction difficulties the V-cross section was not used. Subsequently, development agencies realised that they have to demolish the top slab to have sufficient access to properly clean the culverts, which is both an expensive and time consuming process.¹³ According to the JICA and IWM, it was calculated that there was 18,200 m³ of sludge and sediment in the box-culverts in 2006, which would take 2.2 years to clean properly if they worked for 140 days per year (60 M³ per day) (JICA 2006). As a result, box-culverts not only reduced the carrying capacity of water drainage, but also created major problems for maintenance.

Water resource engineering experts from the public agencies, along with planners, architects, and environmentalists, believe that the box-culvert solution is inappropriate for the drainage system in Dhaka.¹⁴ Current (and former) engineers from the government agencies who were involved in the box-culvert drainage project acknowledge that this intervention has destroyed the natural drainage and ecosystem. However, responsible agencies claim that they did not comprehend the likely consequences of the intervention, and during the 1990's they thought box-culvert roads would be a better solution to stop encroachment of canals and would improve vehicular accessibility. In time, major water clogging, rainfall induced floods, and other drainage issues have become apparent. The majority of newspapers reported the box-culvert intervention as a suicidal decision by the public sector development agencies (Kamol 2009; Khan, MA 2014; Mirror 2009).

¹³ According to the interviewees from the DWASA and IWM.

¹⁴ Interviews of development actors and experts from DWASA, IWM, BUET, DCC, and RAJUK.

5.6 Consequences of the modern engineered Intervention of Infrastructure and current development agency Initiatives

Due to the engineered intervention to manage water, through the construction of embankments and box-culvert drains, there have been major environmental consequences. In 1998 average August rainfall was more than 500 mm compared to 180 to 190mm in 1988, which has caused catastrophic floods during the post embankment period (Faisal, Kabir & Nishat 1999). A good deal of research on climate and water resource management has identified that there has been an increase in frequent heavy rainfall incidents and an increase in annual rainfall in recent decades (Hossain, F et al. 2013; Murshed, Islam & Khan 2011). These increases have caused regular floods and water clogging in the city, such as on 28 July, 2009, when 448mm of rain fell in just six hours (Hossain, F et al. 2013). According to researchers and experts, water retention occurs in some parts of Dhaka if more than 40-60mm of rain falls per day¹⁵ (Mark et al. 2001). With the existing drainage capacity, the city is not prepared to deal with more than 60mm of run-off per day. According to weather data, rainfall of between 200 and 400mm per day occurs during at least one out of every two years (Pervin et al. 2010). In August 2004 600mm of rain fell over five days, leading to a large flood in Dhaka.

Dhaka has had negative experiences as a consequence of mechanical pumping drainage and the cordon system. The engineered drainage and flood control system is very dependent on the performance of the regulators, flood walls, pumps, the run-off capacity of the canals, retention areas, and sluice gates. On many occasions, including the 1998 floods, the engineered drainage has failed for a number of reasons (Bala et al. 2009). These include a lack of coordination among regulatory agencies, pump malfunctions, shortages of energy to run the pumps, and encroachment/landfill in the canals and retention areas. Mechanical systems are critically dependent on reliable energy and regular maintenance. As a result, flooding is inevitable inside the cordon

¹⁵ According to interviewed environmental activists, planners, and other public development actors.

system due to rainfall, clogging, and possible penetration of river floods, combined with the failure of the engineered, mechanical flood control scheme.

In 2015 two major floods caused by rainfall occurred in Dhaka: one in June and another in September. On the first of September 80mm of rain fell in the city in less than two hours causing flooding for one day, putting major roads under more than 50cm of water (Momen 2015; Nowshin 2015; Sufi 2015; The Daily Star 2015a, 2015b). Similar flooding occurred on the eleventh of June 2015, when 59mm of rain fell in three hours affecting a major part of the city. Reporting claimed that the government and its agencies were not fully implementing their plans, or abiding by their own policies, including taking action against land grabbers. A majority of newspapers blamed the authorities for allowing the obliteration of canals and landfilling for urbanisation.

DWDB installed a pumping station with a capacity of 60m³ per second, which is far beyond the capacity of the drainage infrastructure, and is considered to be over design by experts. A huge section of water channel was required to serve this pumping station, but many water channels have been reduced by encroachments, or conversion into open C-section or U-section drains, or conversion into box-culvert roads. Experts¹⁶ suggest that a better solution would be to create larger retention areas with a lower pumping capacity and a proper integrated drainage network. The same experts also recommended strongly regulated urbanisation to sustain the drainage intervention.

Development agencies and actors were not familiar with the consequences of the box-culvert, as the idea was new to them when it was introduced by the foreign consultants. The FAP destroyed Dhaka's interconnected water network and compartmentalised the city. As a result, the water network inside the city collapsed, with significant environmental consequences for the ecosystem. Fisheries, vegetation, and agricultural land have all been diminished due to this process of engineered drainage and flood control.

The destruction of the natural water system, along with pollution, has made the population more dependent on ground water, which is neither economically nor

¹⁶ According to Architects and environmental and water resource engineers who were interviewed for this research.

environmentally sustainable. The government is implementing a project to increase the use of upstream surface water, with the aim of raising the proportion of surface water used from 22% to 70%, while reducing the proportion of ground water used from 78% to 30% by 2035 (DWASA 2011, 2014; Khan, TA 2014). The government is also implementing a USD \$1.6 billion project for 11 water treatment plants in the Dhaka region, which is necessary to meet the growing needs of the population and to counter the loss and pollution of surface water.¹⁷

DWASA initiated a number of actions against land grabbers to save canals, and has prepared strategies to reclaim and conserve wetlands.¹⁸ However, as a consequence of a lack of political will, an absence of co-ordination among public agencies, the influence of powerful private developers, and a lack of awareness among the population, in a majority of cases the agencies involved in these projects have failed to protect water bodies¹⁹. In 2009 Parliament ordered the land ministry to demarcate all 43 canals in Dhaka (The Daily Star 2009). A committee was eventually formed to achieve the task through a combined effort by DWASA, DCC, and RAJUK. The parliamentary body identified 1,000 land grabbers in 39 canal areas over the subsequent year (Hasan 2010). The government initiated 26 canal recovery projects between 2007 and 2009, and successfully managed to implement some of the schemes, such as the Harirjheel-Begunbari project, with 40 hectares of wetland completed in 2014 (Kamol 2009). Some other canals were converted into wide drains with C or U cross sections to avoid encroachment, to demarcate boundaries with pathways and to facilitate maintenance. Nonetheless, the government could not comprehensively recover all of these canals until 2016, because of the reasons stated above.

In the DMDP the total area of the retention zone was 41 km². In contrast, DAP proposed only 7 km² of retention areas in Dhaka. According to experts, a city such as Dhaka needs between 12% and 15% of its area to be retention areas to have a proper drainage system. Clearly, the post-embankment era transformed the urban landscape through fortification against the natural flow of water. This fortification has been a

¹⁷ According to the former director of DWASA and government report.

¹⁸ Reports and minutes collected from DWASA archive, Department of Urban and Regional Planning BUET and RAJUK.

¹⁹ According to the interview respondents.

catalyst for the destruction of natural drainage, because of the transformation of the natural canals and shrinking of retention areas.

5.7 Conclusion

This chapter has explained the recent transformation in the management of water in Dhaka from flow to fortification. It explains the modern urban development interventions of the twentieth century that have influenced, and been influenced by, the rapid urbanisation of the city. It has illustrated the influential factors of design and development of the projects that have had a large impact on the city's attitudes toward urban development. It examines the administrative processes of urban development of Dhaka in controlling the natural flow of water through engineered interventions in one of the most vulnerable locations.

Flooding is a natural phenomenon and historically people have been living with flooding for centuries. However, due to frequent natural disasters, as a consequence of rapid urbanisation, fortification against flooding was introduced.

According to Khalequzzaman (2011), a *'cordon system approach advocates flood control by keeping water away from the river from reaching the flood plain through engineering means.'* From a modern perspective on living, flooding is a nuisance and needs to be eliminated. The natural relationship between water and human settlements, which has been one of interdependence has collapsed due to the policy of fortification against water to safeguard the modern city. As a result, the embankment along the river destroyed the dialogue between river and city with its dynamic water culture. The proposition of the box-culvert road is a common solution for Dhaka's drainage. Equally, the intervention is controversial as it has reduced the drainage capacity, destroyed the natural drainage and bio-diversity. As a result, the dialogue between the land and water has been terminated.

In terms of land use and drainage, the city has been transformed by the scale of urban development over the last few decades. The Introduction of box-culverts along with the cordon system marks a paradigm shift for Dhaka. The introduction of

the cordon system embankment has not only fortified the city against water, but has also played a role as a catalyst for transforming the urban landscape through land fill and the destruction of canals. Following this the destruction of the natural drainage system is inevitable.

Chapter 6

Fortification: Urbanisation Through Landfill (Constructed Land)

6.1 Introduction

Two contrasting tendencies are apparent in the contemporary development context in Dhaka. One of these tendencies, to construct new parcels of land suitable for development by filling up low-lying wetlands, will be analysed in this chapter. The other one is reconstructed wetland which is illustrated in the next chapter. Landfill will be presented as a tool for urbanisation, and its impact on the natural landscape and livability for humans in Dhaka will be analysed using the Bashundhara Township as a case study. It elucidates the urban development history of landfill urbanisation in Dhaka. The chapter sets out the planning process for the Bashundhara Township, and explains the project through the relationship between development and planning guidelines and bylaws. It then explains the project from the perspectives of different stakeholders, including private sector developers, actors from different agencies, and residents from the area. At present in Dhaka a few hundred private sector land developers and some public agencies, such as the RAJUK, are undertaking different projects to create new suburbs. For instance, in 2006 143 developers were actively involved in land and housing projects (Islam, Israt 2009). The Bashundhara Township is the largest land development project by any private sector developer in Dhaka to date, and is around ten square kilometres (1012 hectares) in size (Islam, Israt 2009).

Urbanisation through landfill is a common phenomenon in many cities across the world. Constructing land through filling low-lying areas is one of the major tools for urbanisation in a city such as Dhaka, which is surrounded by flood plains and water bodies, as it creates value for land developers: 43% of the urban population of Bangladesh live in Dhaka, with a density of 4,795 persons per acre (Islam, Israt 2009). With a population of more than fifteen million, Dhaka is one of the fastest growing cities in the world, so the expansion of the city through filling up the wetlands and low areas to cater for population growth is widely used. The consequences of which include the loss of wetlands and agricultural fields, along with the destruction of natural drainage and biodiversity.

6.2 Land mass extension phenomena in Dhaka

Landfilling has been on-going in Dhaka for close to a century, but rapid broad-scale reclamation of wetlands has only been a technically and economically feasible urban development strategy in the post-embankment period, after the major flood of 1987-1988 (as explained in chapter five). During the late British period, early in the twentieth century, the first recorded landfill project was undertaken at Wari (south east of current Dhaka) in the form of a grid iron plan as an upper class residential area. A number of projects were realised predominantly on the northern side of historical Dhaka during the Pakistani and early Bangladeshi periods, mostly by public sector development agencies during the 1960's, 1970's, and 1980's. Up until the 1980's a majority of this development involved transforming natural landscapes into urbanised land, without comprehensively filling up wetlands and flood plains. Compared to current landfill projects, the majority of these projects were on higher ground and were low density areas, until the 1980's when a major shift toward high density and high land coverage built areas occurred. Eventually, land use in many areas was transformed from low density residential to high density mixed-use. For instance, the Dhanmondi Residential area, Banani area, and many other suburbs in Dhaka have been transformed in this way.

Many more agencies and actors have been involved in this transformation process in recent decades. According to Islam, N (1990), these include land owners (subdividing their own land), land developers, building developers, land speculators, contractors, professional advisors, land brokers, builders, owners or possessor occupiers, tenant occupiers, intervening agencies on behalf of the government (public development agencies), politicians, and financiers.

Sand is the most common medium used for landfill extension to facilitate urbanisation. The filling process is evident through google maps (Figure 6-2) and research conducted by multiple researchers (Ahmed, S & Ahmed 2013; Islam, Israt 2009; Islam, MS et al. 2010; Kamal & Midorikawa 2004; Mahmud et al. 2011; Mowla 2013; Roy & Islam 2007; Seraj & Islam 2013; Sultana & Islam 2009; Sultana, Tarekul Islam & Islam 2009; Yamaguchi 2007). It is a large task that involves small dragging units, vessels carrying

sand, and hundreds of kilometres of pipeline with pumps to transfer sand from underneath large water channels to landfill areas, such as Bashundhara. The rate of urbanisation is enormous: since the 1960's the built area within the present boundaries of Dhaka city increased from 11% to almost 65% (Islam, Israt 2009). In 1970 only five private sector developers were operating, but by 2005 this number had increased to 250, reaching 450 in 2007 (Ahmed, F & Akhter 2013). As a consequence, the urbanised area doubled from 23% in 1993 to 47% in 2007.

Government approved 35 land projects, including the Bashundhara township, between 1984 and 1998 (Islam, Israt 2009, p. 72; Roy & Islam 2007). By 2002 an area of 80 km², including phase one of the Bashundhara project, had already been filled (Islam, I, Katsuki & Hidehiko 2013; Kamal & Midorikawa 2004; Sultana, Tarekul Islam & Islam 2009), and by the end of that decade it was estimated that more than 8000 hectares of once permanent wetlands had disappeared forever (Mahmud et al. 2011), (Islam, MS et al. 2014).¹

According to Roy and Islam (2007), 36 land development projects undertaken within Dhaka's city limits since 2000 to create sites for new townships are in the flood flow zone, and a further 17 are only slightly better placed, in the sub-flood flow zone. The Bashundhara township development alone played a considerable part in the loss of 18.72 km² of rivers and khals (canals) (Mahmud et al. 2011).

Government agencies such as the Public Works Department (PWD), RAJUK, National Housing Authority (NHS), and Dhaka City Corporation (DCC) have designed and developed many satellite towns, housing estates, and land development projects to accommodate the ever increasing population. The city has sprawled out mostly toward the north of the urban core during the post-colonial and post-independence eras. After having filled up the north, the city has expanded towards the west and east. From the 1990s onwards, private sector developers began to rapidly fill up low lying areas along the fringe. As a consequence, urban sprawl has been one of the major problems on the fringes of Dhaka for more than twenty years (Islam, Israt 2009; Islam, I, Katsuki &

¹ Estimates vary considerably. In a later publication Mahmud has stated that between 1990 and 2000, as many as 270 square kilometres of wetlands in and around the city were filled (Mahmud 2013).

Hidehiko 2013; Islam, S 2007; Parveen 2012). Here on the periphery growth is not just exceptionally rapid, but a technologically extraordinary phenomenon as the city advances into the low lands through an array of hundreds of long-distance metal pipes transporting sand to quick-fill the wetlands. The result is a completely engineered and constructed landscape, accomplished technically with batteries of pumps, pipelines, and boats, but driven and orchestrated by powerful real-estate developers and vested interests.

According to different studies, a majority of the land projects undertaken by private developers are unregistered and lack any proper legal approval (Hassan 2014; Islam, Israt 2009). Land speculation has become widespread as demand for land has increased, with the price of land increasing by more than 500% over the last 30 years (Hafiz 2001, p. 58). In 2014 the High Court of Dhaka and BELA identified 78 illegal housing projects, including major sections of Bashundhara, on the flood flow and sub-flood flow zones—including water channels and retention areas.

The escalation in the value of land, and associated issues of graft and speculation, are among the more bitter fruits that have come with modernisation and Dhaka's belated economic take-off. No longer recognised as the primary resource and economic medium of the hydraulic civilisation in which Dhaka was once the very heart, water bodies have now come to be regarded as wasteland from which there is no direct financial return until they are filled and readied for building development. According to Advocate Sayeda Rezwana Hassan, landfill projects represent the outcome of a *"free market economy complemented by a total lack of governance."*² A majority of interviewees identified a lack of political commitment to protect wetlands, with pressure from bureaucrats and developers to destroy the natural landscape as urbanisation proceeds. The institutional framework can be indicted for faulty planning and implementation, as development agencies are both collaborating with land grabbers and not properly implementing the law.

In addition, there are multiple authorities who are responsible for wetland protection, which makes the situation more confusing still for development agencies in Dhaka. The ministry of urban design and housing was converted into the ministry of

² Interview of Rezwana Hasan, Advocate Supreme Court and Chief Executive BELA (Bangladesh Environmental Lawyers Association).

housing and works in 1992, while the UDD (Urban Design Directorate) was created to support the government's urban design projects. According to experts, such as the director of the UDD, urban design has been ignored by development agencies, policy makers, and political regimes. Meanwhile, the UDD does not have sufficient power to comprehensively operate urban design when compared to other government agencies, such as RAJUK and LGED, who are more powerful in terms of capacity and authority in design and urban development.³ RAJUK has been designing and developing new townships for a long time. On the other hand, LGED only started its design section after 2010.

6.3 History of the Bashundhara area

East-West Property Development (private) Limited (EWPD) is the flagship company of the Bashundhara group of companies, and is one of the largest private sector institutions in Bangladesh. The Bashundhara group started with land development projects and has become one of the most powerful and influential corporate groups within the country, with the capacity to manipulate public development agencies' decisions. Among its assets, it also owns the largest number of small dragging units⁴ among other competing land developers in Bangladesh, with which it has played a major role in transforming the natural 'wetscape' into artificially constructed land.

Until the middle of the 1980's the Bashundhara⁵ area was still considered to be the urban fringe. The government had acquired these low lands in the post-independence era to maintain the natural landscape, which included water channels, flood plains, and some small households and agricultural fields in sub-flood flow zones. During the 1980's under the subsequent military regime, however, the government had reversed its earlier strategy and returned all of the wetlands in the fringe areas to their original owners.⁶ Over time many owners then sold their land to private land developers. Before the area was filled,

³ According to the interviewees from the development agencies (UDD, RAJUK, and DCC) and other experts on urban policy and development. RAJUK is the development control authority and LGED is the Local Government Engineering Department.

⁴ Dredgers that collect sand below the water locally, and transfer it through pipelines for land filling in other locations.

⁵ Bashundhara is the name of the group of companies as well as the Township.

⁶ Interview with planner Roxana Hafiz, Professor of Department of Planning, BUET and reviewer of DAP.

during the monsoon it became wetlands and there was no boundary between the river and the land. While during the dry season a majority of the area was used for agriculture, excluding rural homesteads, water channels, and lakes.

The Bashundhara area is a part of a geological fault and a natural depression (Figure 6-8 in page 168), as is evident in the study report from the Geographical Survey of Bangladesh (GSB) (Asaduzzaman, Nasreen & Olsen 1999). According to the GSB, the first phase of the Bashundhara area was filled with more than 6 meters of sand in most places. By 2004 the first phase of the Bashundhara residential area land development had been completed. According to the report from the Department of Urban and Regional planning BUET, between 7 and 8 meters of landfilling was undertaken during the second phase of the project (Rahman, Islam & Zaman 2014). In the first phase (until 2004) the Bashundhara group constructed the land from Block A to Block D, and after that the company started rapid land filling. Over recent years more landfills have been completed in the direction of the (still under construction) eastern bypass of Dhaka. The Google map and master plan for Bashundhara both illustrate the loss of a significant area of wetlands (Figure 6-2, Figure 6-3 and Figure 6-4). According to the master plan and other records, the first phase of Bashundhara is in the sub-flood zone, while later phases are in the flood flow zone, including retention areas, canals, and on river fore-shores. In addition, according to the DAP (detailed Area Plan) and the Dhaka Structure Plan 2015-2030, Block N to P is in a designated retention area (Figure 6-2 and Figure 6-7).



Figure 6-1: Plan of Bashundhara area from Block A to P (source: RAJUK)

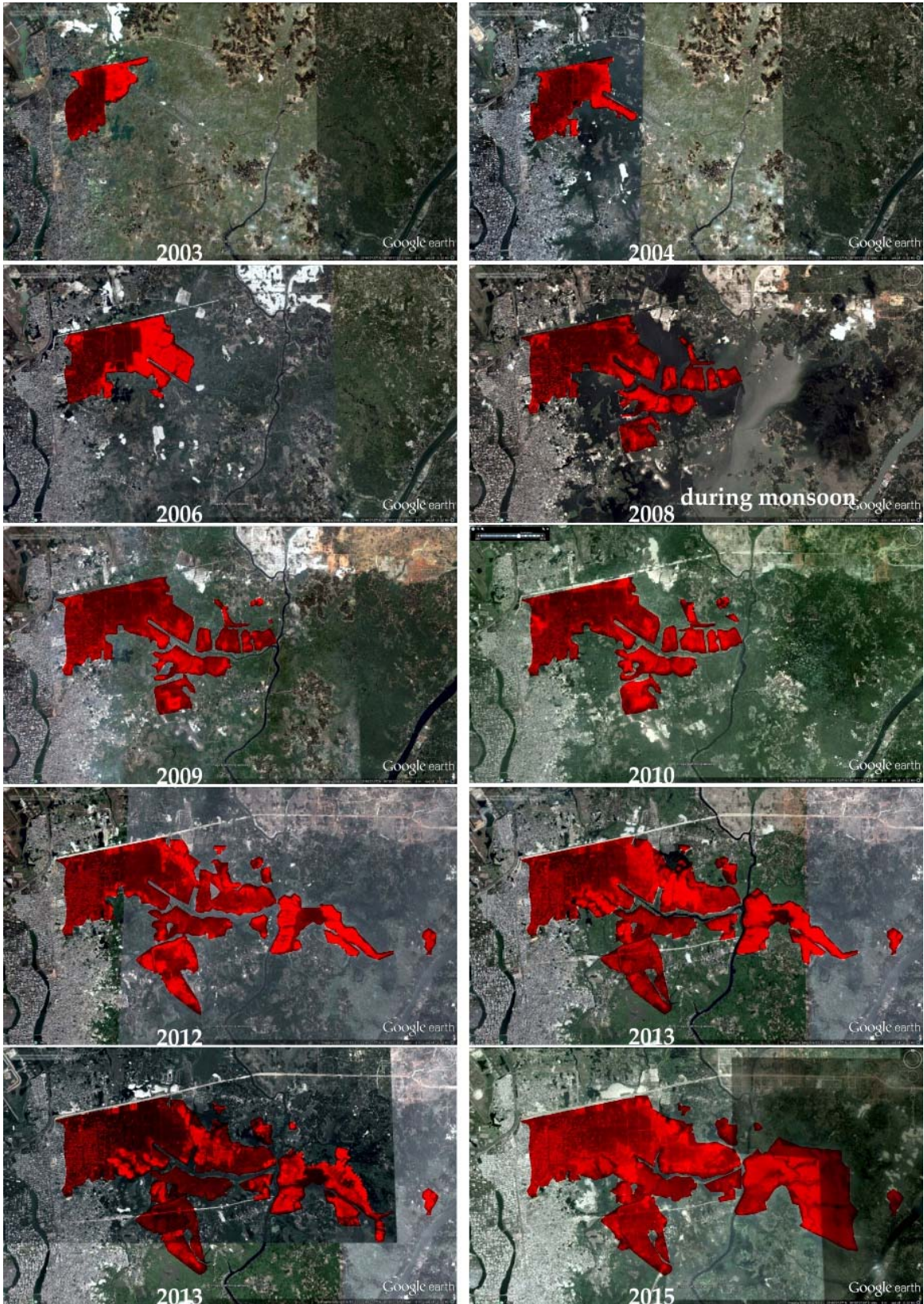


Figure 6-2: Google Earth images showing the transformation of land through landfills by the Bashundhara group (in red shade) and other public and private developers between 2006 and 2015.

In addition, these images shows the seasonal fluctuation of water due to seasonal and other variations, which makes the land-water boundary an unstable lines. Similar geo-hydrology is also visible in next two figures.

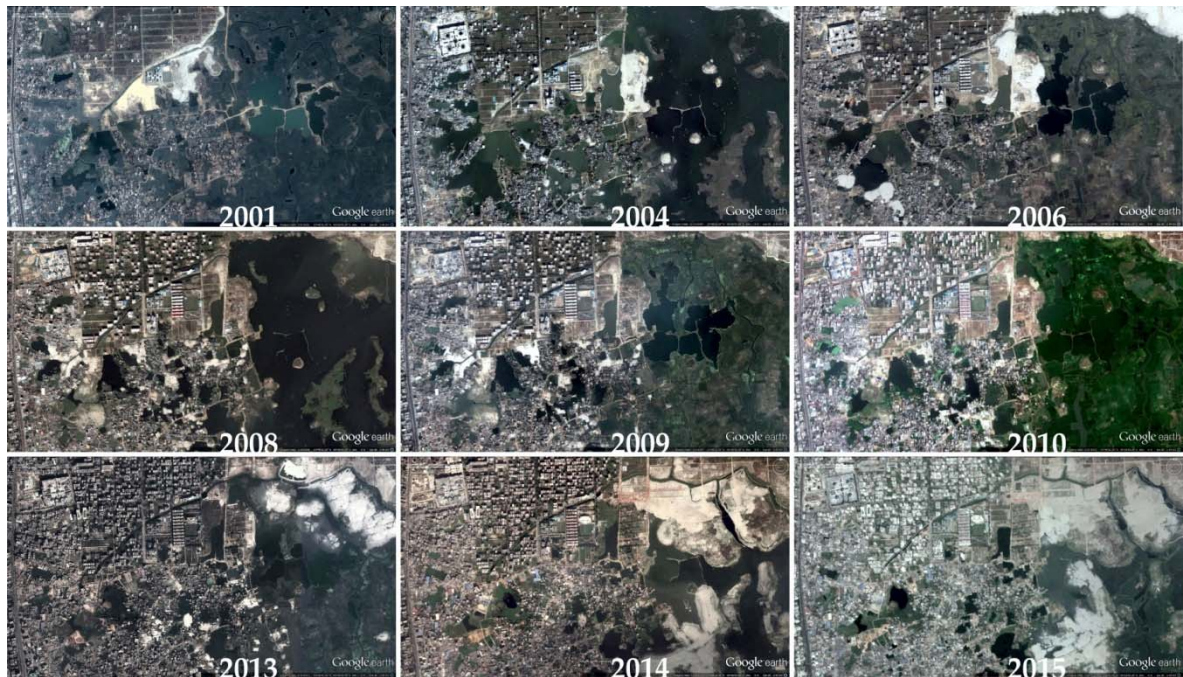


Figure 6-3: Google images showing the land use transformation at the south-west of the Bashundhara Township area between 2001 and 2015.



Figure 6-4: Google images showing the land use transformation (wetlands, agricultural lands, and villages) to urbanised land through land mass extension at the north-east of Bashundhara Township area from 2003 to 2015.

6.4 The planning process for the Bashundhara Township project

6.4.1 Initiation of the project:

The Bashundhara Residential area project was initiated in the 1980's. During the late 1980's and early 1990's the Bashundhara township project was portrayed by the media as a positive intervention. Very few experts criticised the project during its early

stages⁷. The project was seen as a model urban housing development for middle income earners by a private sector developer. During the late 1980's no other private sector firms initiated a project as large as the Bashundhara Township.

The Geological Survey of Bangladesh (GSB) was the first agency to oppose the intervention in the middle of the 1990's when it published a report on the geomorphology of Dhaka, which presented the possible implications of the Bashundhara group's landfilling on the flood plain (Asaduzzaman, Nasreen & Olsen 1999). The report identified the eastern fringe area (where the Bashundhara Township is situated) as being geologically critical, because of the fluid layers beneath the soil. The document also identified ongoing destruction of natural drainage and the flood plain during the 1990's. During the first phase of the Project planners Zahurul Huq (the chief town planner) and M. Ashraf Ali Akhand (a junior officer at the RAJUK) did not appreciate the likely implications of the project.⁸ However, the government introduced the Wetland Preservation Act in 2004, Private Sector Land Development Rules in 2000, and the Environment Act in 1995 (revised in 2000).

According to the Metropolitan Area Integrated Urban Development Plan for Dhaka, Bashundhara was identified as a possible urban expansion area (Figure 6-5) (Shankland Cox Partnership 1981). No further details were indicated in relation to these areas in terms of planning and design. Shankland Cox are a United Kingdom and Middle East based company. They collaborated with the BUET and other consultants in Bangladesh to prepare planning documents, which were presented in 1981. GoB, ADB and UNDP funded the planning initiative during the military regime of General Hossain Mohammad Ershad. The 1981 plan shows a retention pond in the eastern part of the current Bashundhara Township, and shows the rest of the Bashundhara as low lying areas to be filled (Figure 6-6). This planning document may well have encouraged the Bashundhara group, along with other land developers, to fill the flood plains and wetlands to construct new land for housing.

⁷ According to the interviewees.

⁸ According to the interviewees from BUET and RAJUK including M. Ashraf Ali Akhand.

Water was not a priority for the government, or its development agenda, during the 1980's and 1990's. Public awareness was not high, as there was little comprehension of the implications of destroying wetlands. Because flooding water was seen as a curse, and the cultural practices associated with living with water had diminished over several generations. The Bashundhara project did not consider the FAP (Flood Action Plan), which was published in 1989. On the FAP the area is shown as a retention area, flood flow and semi-flood flow zones, and canals (JICA 1989).

A grid plan was laid out from the beginning. In the first phase of the project, publicity portrayed it as a new township with all the facilities that residents could ever require. Television commercials for the Bashundhara Township were very popular during the early and mid-1990's. These advertisements explicitly displayed the new township with single unit houses and lots of open spaces. Nevertheless, all of the plots in the first phase were converted into apartments without open spaces or gardens, as is now common with property development throughout Dhaka.

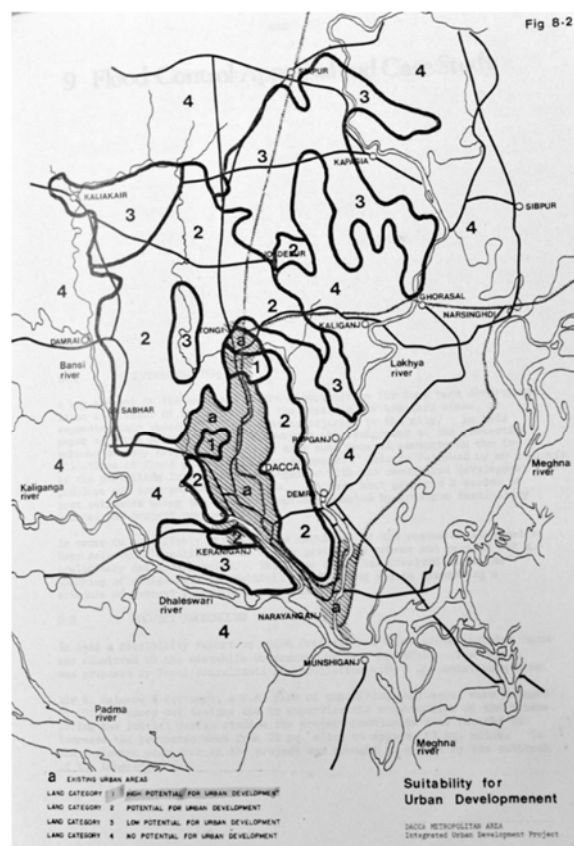


Figure 6-5: Map of Dhaka in 1881, the Metropolitan Area Integrated Urban Development Project, showing land category. On the map Bashundhara and the eastern fringe area is categorised under potential for urban development (source: Department of Urban and Regional Planning, BUET).

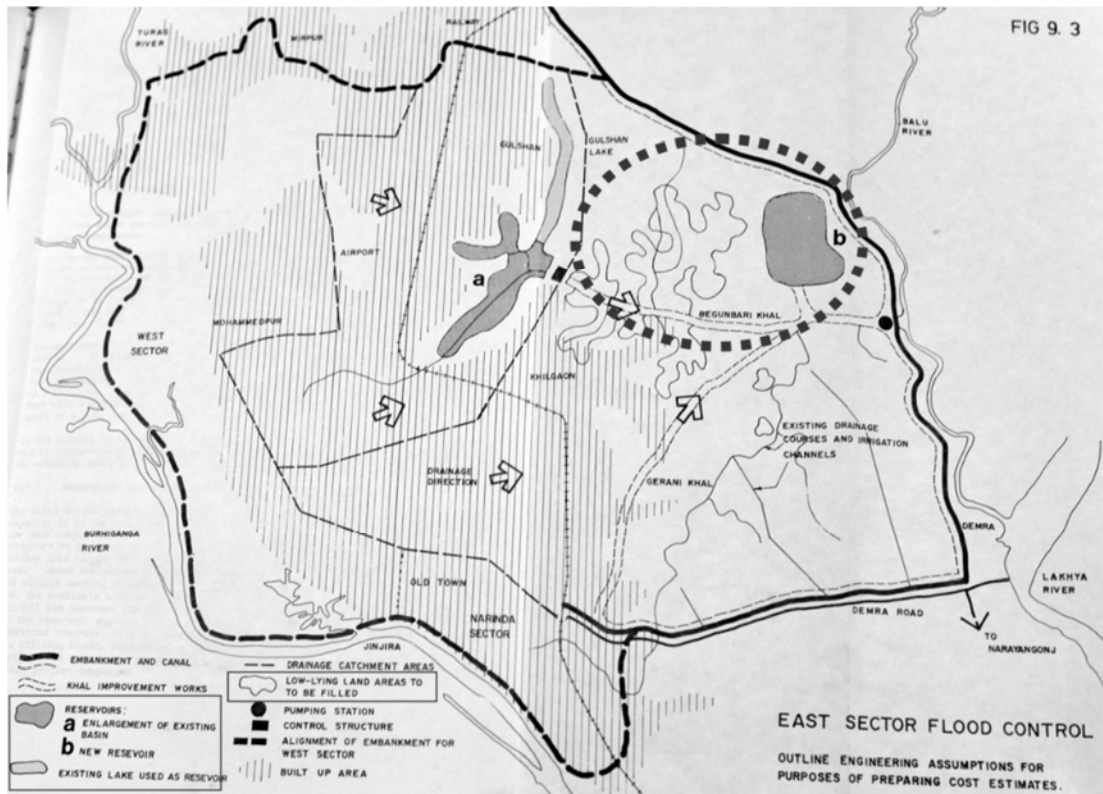


Figure 6-6: Map of the Metropolitan Area Integrated Urban Development Project, Dhaka in 1981 showing low-lying areas to fill and the retention basin in the Bashundhara area (source: Department of Urban and Regional Planning, BUET).

6.4.2 Project details and the planning process

Phase 01 of the Bashundhara project consisted of a residential area with two universities, three schools, and one hospital. The project includes multiple convention centres, a shopping complex, a mosque, and an electrical sub-station. As the area started to grow, almost all of the major Banks set up branches in the area. In addition, some commercial enterprises and offices, including the giant Grameen Phone Head Quarters, were established in the area. In contrast, the project does not have sufficient playing fields, open spaces, public activity areas, lakes, and parks. The ten square kilometre township has only one large designated playing field and one medium size park (Figure 6-1). The township also does not have any open areas for public activities. Public facilities and open spaces are disproportionately small in comparison to its developed area.

The Bashundhara group began to buy the land to initiate the project in the 1980s. In the majority of cases the land owners were directly, or indirectly, forced to sell their land to the Bashundhara group. According to different studies, around 80% of the land

was forcefully acquired by the Bashundhara group (Islam, Israt 2009; Rushi, Sharmin & Awal 2013). Experts⁹ believe that more than 50% of the land transfer process in the case study area was achieved through commissioned registration between 12:00 a.m. and 5:00 a.m.¹⁰.

According to the regulations, any land development project has to go through Nagar Unnayan Committee (City Development Committee)¹¹. To gain approval the Bashundhara group bypassed the committee. East West Development Properties' (EWDP) permission for land development was denied, or overruled, by the courts on two separate occasions¹². However, they still continued landfilling. According to experts, the initial phase permitted land use transformation, as a so-called land clearance. Nonetheless, land clearance does not mean planning approval and permission to execute the project. People were misled by the term land clearance permission, assuming it to mean planning permission to develop. The Bashundhara group sold land to buyers without approval for the plan, and then the majority of the sale price was collected from the buyers before handover of the land. The company used buyers' money to fill the rest of the land, and to construct roads and other infrastructure. After all of this people constructed buildings without legitimate approval, as RAJUK did not approve the master plan for the township.¹³ According to the land developers, most of the new owners built their houses by submitting their designs to the land developers, as a sort of approval. After the construction of the first phase, subsequent phases followed a similar process. Until 2014 major parts of the township did not have gas lines and electric connections. Moreover, according to RAJUK and other public agencies, the township does not have a proper sewerage system, or an effective drainage system.

⁹ According to the reviewees from the Department of Urban and Regional Planning BUET and reviewers of the DAP.

¹⁰ Commissioned registration is a type of land transfer process takes place other than court if the owner or buyer is unable to be present him/herself in a court and signed the documents in front of judicial official due to unavoidable circumstances. Bashundhara arranged commissioned registration process to buy the land forcefully from the land owners who does not want to sell their land.

¹¹ Nagar Unnayan Committee is consists of multiple professionals from different disciplines headed by RAJUK who are responsible to ensure if a large urban development project is eligible to have permit to operate.

¹² East West against RAJUK Case No 24/2002 Badda Thana (suburbs) and East West Vs RAJUK, Case No 41/2003 Badda Thana (suburbs) decision handed down in the Court Dhaka in 2014.

¹³ According to the planners of the private sector developers who were interviewed; and interviewees from BUET and RAJUK.

During the first Phase of the Bashundhara project, between 1996 and 2000, 2,300 hectares of land was filled by both the Bashundhara group and Bashumati (Mowla 2013). After 2000 landfilling accelerated as its profitability for developers increased. As a result, a majority of the low land in eastern Dhaka was filled up for new township developments.

According to the interviewees from private sector developers, the initial plan for a majority of the townships contained open spaces, parks, water channels, and other public amenities. However, in reality many open spaces were converted into saleable plots. Moreover, the land in the area of the township that they could not buy was marked as open space on their plans.¹⁴ Over time these open spaces became large parcels of land for buildings. The planners from the development company remarked that the company pushed them to maximise saleable land without considering adequate wetlands, infrastructure, or open spaces. According to them, in most cases the agenda of the private sector land developers is to maximise profit. Other research has found that the land developers earned USD \$900,000 profit per hectare (Islam, Israt 2009). According to the accounts of a majority of the interviewees from both public and private agencies, RAJUK was not only unable to uphold the rules, but was among a number government agencies in which it was suspected that some individual officials had collaborated with organised criminal parties engaged in land acquisition, enabling the guidelines to be violated.

The sequence of the planning process for the Bashundhara group and other land developers is ambiguous and did not follow the bylaws. In a majority of cases land was sold before land filling and site preparation took place. In many cases plots were handed over before final clearance was given by the government (plan approval). According to the law, developers cannot submit the master plan for a township to RAJUK before they own a certain amount of that land and acquire land clearance. Land can only be sold following the approval of RAJUK, DoE (Department of Environment), and other government agencies responsible for land use clearance, master plan approval, and other infrastructure authorisations.

¹⁴ Interviews of planners and marketing Personnel from the Eastern Housing Limited, Swadesh Properties Limited and East West Development Properties Private Limited.

At present the Bashundhara group is planning to connect their project with the Purbachal expressway and the eastern bypass. However, according to the consultants and reviewers of the DAP, government agencies did not plan to connect the area with these major roads. They have stated that the infrastructure project plan is not comprehensive and does not consider the surrounding areas.¹⁵ Meanwhile, experts and some government agencies have proposed constructing 30 meter (100 feet) wide canals on both sides along the Purbachal link road from Kural to the Balu River. In 2014 the Executive Committee of the National Economic Council (ECNEC), headed by the Prime Minister, sanctioned BDT (Bangladeshi currency) 55.3 billion for the project (Ahmed, Z 2015; Hasan 2015).

According to experts, including the review committee of the DAP, the main objective of the project (Purbachal expressway with 30 meter canals on both sides) is to resolve water stagnation in north eastern Dhaka (Kalachandpur, Nikunja, Joarsahara, Baridhara, DOHS, Cantonment and Hazrat Shahjalal International Airport). Experts suggest that it will increase water retention and drainage capacity. Officials at the ministry of housing and public works advised ECNEC to commission the Military to implement the plan. The government require 98.46 acres of private land and 4.59 acres of Government land to implement the project, and the funds have already been allocated by the ECNEC for land acquisition (Hasan 2015). At the same time the Bashundhara group is advocating to discontinue, or at least revise, the project. The Bashundhara group have already filled a majority of the canal area with some construction. The Bashundhara group, along with other private developers, have proposed the construction of a box-culvert along the Purbachal link expressway, which had already been dismissed by the Prime Minister of Bangladesh (Ahmed, Z 2015; Hasan 2015). According to the physical survey, in 2014 government agencies were yet to begin excavations for the canal project.

6.4.3 The Bashundhara Township project in relation to planning guidelines, bylaws, and other regulations

This section of the chapter explains the Bashundhara Township in the context of a number of planning guidelines (masterplans and other urban development laws); and recent environmental and wetland laws. Many instances of violations of regulations by

¹⁵ Interviews of architects, planners and engineers of DAP and DAP review committee.

both the private sector developers and government development agencies are evident from the field survey and literature review. A new structure plan, as a part of the Regional Development Plan (RDP) programme, transformed land use in many parts of Dhaka city, when compared to the DMDP Master plan (DMDP 1995; RAJUK 2015; Roy & Islam 2007). Both the DAP and the new Structure Plan from 2015 identify Bashundhara as a residential zone, while the 1995 DMDP identifies a majority of the area as being part of a flood plain (appendix A-9) (DAP 2011). Maps from 1960 and 1980 both show the area as waterbodies, including flood flow zones and agricultural land. While Google maps from 1998 and 2000 show a majority of the area before the landfill intervention as being a natural landscape, including canals, wetlands, agricultural fields, and rural homesteads (Figure 6-8).

The area to the east of Bashundhara is marked as a retention area on all planning documents published by the Government of Bangladesh, such as the DMDP (1995), Dhaka Metropolitan area Integrated Urban Development Project (1981), DAP (2011), and the Dhaka structure Plan (2015). 76% of the 937.22 acres (3.8 square kilometres) of retention area is occupied by Bashundhara on the eastern fringe, which is indicated as a large retention area and flood flow zone in the DAP (Komol 2014). The same study shows that 717 acres (2.86 square kilometres) of retention area has been filled by the Bashundhara group. This evidence of encroachment on such a scale appears to substantiate the repeated allegations in the literature (as noted previously) that planning regulations have been consistently and grossly violated.

The majority of landfilling by the Bashundhara group has taken place since the Private Land Development Rules (2004) and Wetland Conservation Act (2000) came into force. According to a study by the Department of Urban and Regional Planning (BUET), 333 acres of land were filled by the Bashundhara group after notification was provided in conjunction with the Detailed Area plan in 2010.¹⁶ The encroachment by the Bashundhara group forced the relocation of the proposed Khilkhet water treatment plant. In addition, the bridge over the Boalia canal became worthless as a result of the canal's width being

¹⁶ Interview of Planner Israt Islam, Associate professor, Department of Planning BUET and reviewer of Detail Area Plan Dhaka.

reduced from 80 meters to 10 meters, because of encroachment, at a cost of BDT 260 million (Komol 2014). In 2012 a parliamentary body alleged that the government had approved six private housing schemes without adhering to development guidelines.¹⁷ Ali and Hasan (2012) have stated that, according to Dhaka district administration records, Bashundhara submitted a layout (blocks A-L) of 1,435 acres, of which 234 acres are government lands, including water channels, flood flow zones, and retention ponds.

Violations by private land developers are encouraged by the actions of government development agencies, as they are also violating wetland protection and environmental acts, as, for example, in the case of new public-sector developed townships at Purbachal and Zhilmil. Such transgressions by government itself are evident from the minutes of the Ministry of Housing and Public Works dated 24th August 2014 (appendix A-8), which show that public development authorities had approved the transformation of land for building, if it belongs to an individual private property and the size of the land is equal to, or less than, 610 square meters¹⁸. Through this approval government agencies legitimised the conversion of wetlands to urbanised land through landfilling. With the collaboration of individuals and developers over time, this loophole in the development approval legislation has thereby allowed for a number of parcels of land to then be packaged into one much larger parcel feasible in scale for landfilling. This approval loophole goes against the DAP and the Wetland Conservation Act, and it was opposed by the reviewers of the DAP. According to interview respondents, who reviewed and consulted on the DAP, however, public development actors collaborated with private sector land developers, enabling land grabbers to fill up the wetlands.

In 2014 the DAP review committee¹⁹ identified major deviations in the DAP from the DMDP (1995) and the FAP (1989) (DAP 2010; DMDP 1995; RAJUK 2015; Shankland Cox Partnership 1981). For instance, flood flow zones planned in 1989 and 1995 were put forward as “urban residential zones” and “agricultural land with rural homesteads” in

¹⁷ According to the interviewees (Dr. Israt Islam, advocate Rezwana Hassan and Dr. Shakil Ahmed).

¹⁸ Minutes collected from one of the interviewee from the Department of Planning BUET who was one of the participants in the meeting of the Ministry of Housing and Public Works.

¹⁹ The DAP review committee was formed in 2012-13 to review all the detail proposals of the Detail Area Plan before implementation to ensure its credibility. The committee consists of experts from the discipline of planning, architecture, environment, engineering, law, urban design research and other groups.

the DAP. Significantly, there is no sub-flood flow zone category in the DAP. In a majority of cases in the DAP sub-flood flow zones are proposed to be urban residential zones, mixed use zones, agricultural with rural homesteads, and utility zones. The agricultural land category from the DMDP is replaced in the DAP by urban residential use, mixed use development, and industrial use. Previous planning documents designated 12% of total land area as retention areas, whereas the DAP has allocated only 5.05%. Comparison with the 1959 master plan, which designated 38.7% of its area as wetlands (Iqbal 2013), offers unequivocal confirmation of this historical trend toward wetland elimination.

According to the DAP review committee, the DAP has accommodated a majority of the unapproved, illegal projects in the fringe areas by changing the land use categories. The chief town planner of the RAJUK suggests that the DAP is, in many ways, practical, as a majority of the wetlands are already filled and the city needs more land for its people.²⁰ However, his views on the DAP have been criticised by other experts who were interviewed in this study. According to a majority of the interviewees,²¹ some of the more senior officials from RAJUK have chosen to collaborate with private sector developers rather than regulate their ambitions. Moreover, it is alleged that the current chief town planner was appointed to succeed a preceding incumbent who had been strongly against landfills and did not consider any proposals to build new townships from private sector developers in low lying areas during his tenure (2012-2014).²²

The review committee reported that, according to the DAP, Dhaka can accommodate almost 28 million people, with 250 people per acre in residential areas, 150 people per acre in mixed use areas, and 15 people per acre in agriculture with rural homestead areas (DAP 2011; DAP review report 2014). The current population of RAJUK's area of jurisdiction²³ is over 15 million, though the capacity of the infrastructure

²⁰ Interview of Sirajul Islam, chief town planner RAJUK.

²¹ According to the interviewees such as the chief executive at the Bangladesh Environmental Lawyers Association (BELA), and Prof. Dr. Israt Islam, Prof. Dr. Mohammad Shakil Akther and prof. Dr. Roxana Hafiz from BUET, planners of the private sector land developers (Table 2.4).

²² It is notable that RAJUK did not approve any plan for new townships in the flood flow and semi flood flow zones during that two-year period.

²³ DMDP (Dhaka Metropolitan Development Plan) area 1528 square kilometres.

is not sufficient to support the population. According to experts, the DAP will increase land speculation and environmental disasters.

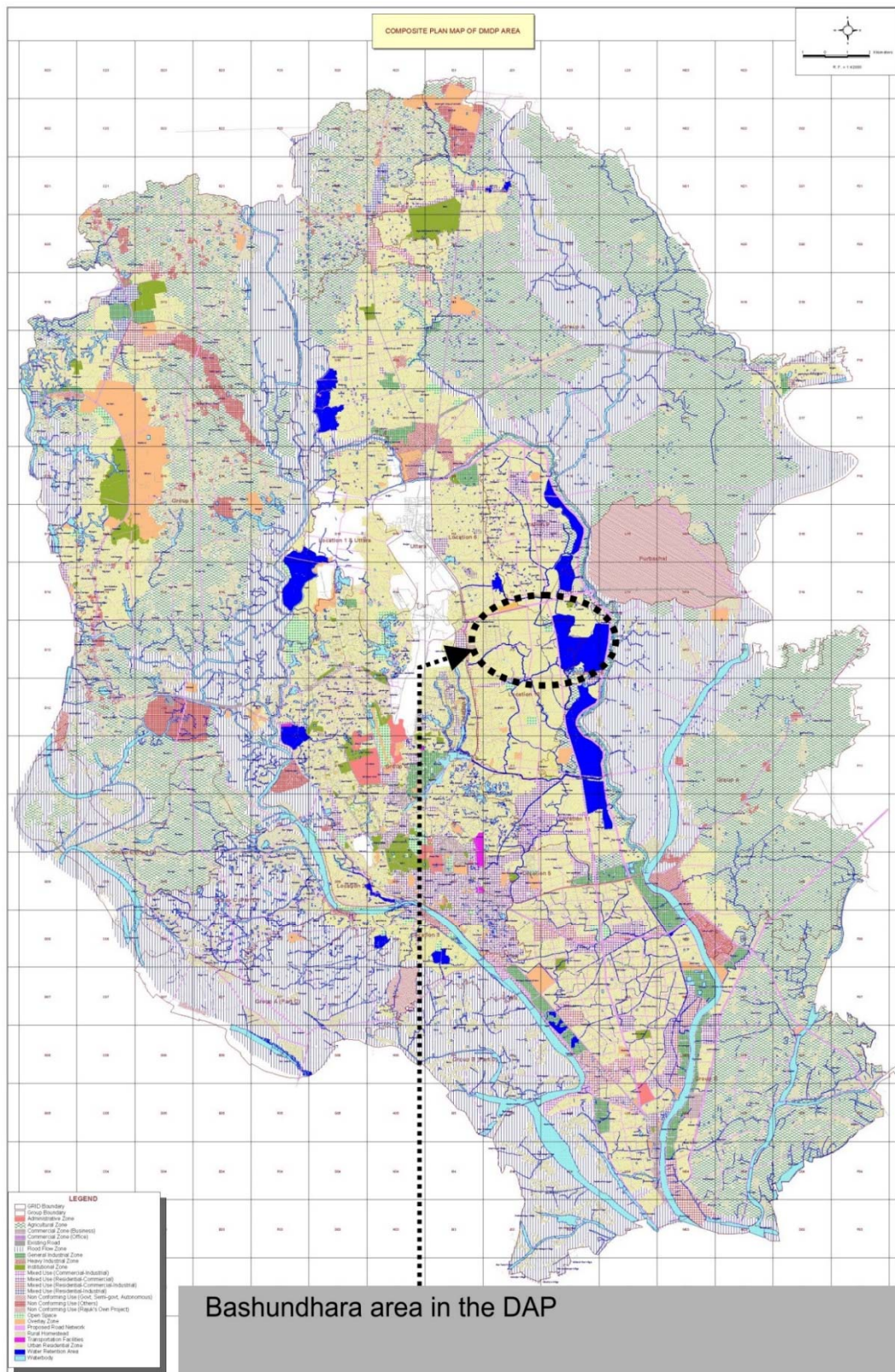


Figure 6-7: Indicating the Bashundhara area in the Detailed Area Plan (DAP) Dhaka, showing retention ponds and water channels in the area, which are mostly filled (source: DAP, RAJUK)

According to the DAP review committee, if the DAP is approved in its present form, then the following consequences are likely:

- Severe and imminent flood threat in Dhaka and proposed new towns.
- Gross violation of laws, such as the Town Improvement Act (1953), DMDP (1995), Water Body Conservation Act (2000), Environment Protection Act (1995), and RAMSAR Convention.²⁴
- Legitimacy of all illegal developments and scope for approval of many township, or housing projects, by the public and private agencies encroaching on wetlands and agricultural lands.
- Putting Dhaka's food security at stake.

The DAP review committee suggested the following immediate actions in 2014, to reconsider the issue of land use transformation.

- Postponement of decision.
- A technical committee comprised of relevant professionals and representatives from civil society organisations should be entrusted with the task of reviewing the DAP by upholding the DMDP guidelines and recommending measures for modifications of the DAP'.
- Immediate restoration of land use classification according to the DMDP.
- Effective public consultation and participation (section 73 of TI Act).
- Develop a commission under RAJUK as a 'DAP Implementation Cell' to process planning and implementation decisions.

According to the Town Improvement (TI) Act 1953, the Bashundhara Residential area is an illegal intervention. Under section 74 of the TI Act it is illegitimate for any party to use any land for any purposes other than those described in the approved Master Plan, unless they have been permitted to do so under section 75. However, under section 75 of the TI Act, analogous use of land is legitimate. The change of land classification on a large

²⁴ A treaty between countries aimed at conserving and protecting natural resources in 1971. The signing took place in a small Iranian town of Ramsar; thereafter the convention was named after the town.

scale is not permitted. According to the Wetland Conservation Act (2000), Section 5, it is an offence to transform the use of any open spaces, including natural water bodies.

The Environment Conservation Act (1995), Section 5, empowers the government to declare any area to be ecologically critical (ECA) if the state of the ecology in the area is under threat. To uphold the ECAs the government may prohibit certain activities in a given area. Section 6(e) imposes restrictions on filling up wetlands, and, under section 7, the government may direct any person responsible for causing damage to the ecology to adopt corrective measures.

According to land ownership laws, one individual (or group) other than government cannot own more than 60 bighas (nearly 10 hectares)²⁵ of land. This law was established to ensure a fair distribution of land and to avoid large land holdings by individuals or groups. The Ministry of Land can permit ownership of larger land parcels under special circumstances for special projects, but, according to the BELA,²⁶ the Bashundhara group does not have any special permission to own large parcels of land.

The first ever sanction under the Wetland Conservation Act (2000) was issued in 2009 (case no 256/2009). The court made the following decisions concerning wetland preservation against land developers, such as the Bashundhara group:

- There is no scope for the establishment of a Model Town within a sub-flood flow zone, violating the DMDP prepared under the Town Improvement Act (1953).
- Establishment of a model town within a sub-flood flow zone involves raising a huge quantity of land in that zone, resulting in its depletion.
- The adjoining area of the sub-flood flow zone, namely Dhaka City, will be inundated by water logging and the natural environmental balance will be in jeopardy.

²⁵ 1 bigha=14800 square feet (1375 square meters)

²⁶ According to the chief executive of BELA, who was interviewed during the field survey.

- Though conversion of land is permissible, it does not authorize any developers to change the nature and character of a sub-flood flow zone for establishment of model housing.
- It is a truism that right to life includes right to protection and improvement of environment and ecology.
- The court advised RAJUK and other correspondent authorities to take action against land grabbers.

6.5 Performance of land constructed through landfilling

This section of the chapter explains the consequences of the project from environmental and social perspectives. It presents respondents' impressions as captured in the questionnaire survey conducted during the field survey. This section demonstrates how a landfill intervention is understood by the people who live in affected areas.

6.5.1 Physical and environmental implications of constructed Land after a landfill project

From the above analyses it is evident that the Bashundhara area was a major flood flow zone before landfilling took place. According to the Geological Survey of Bangladesh (GSB), the area is within the vulnerable zone for any construction, due to poor geological features for building construction (Figure 6-8). A majority of the land is classified as being in the high hazard zone, where there is a high probability of ground subsidence (Asaduzzaman, Nasreen & Olsen 1999) (Figure 6-9).

The report from the GSB, as well as Google maps, both illustrate how landfilling has been destroying the natural drainage system in the north-east of Dhaka. The Bashundhara area used to provide the outlet for natural drainage towards the east: through the canals, flood-flow and sub-flood-flow zones, and retention areas. The catchment of these canals was vast and functioned through gravity drainage (Figure 6-8). As the majority of the area naturally fills with water during the monsoon, it functioned as a natural retention basin, as is evident from the field survey, historical records, and

Google maps. The southern part of the Bashundhara is inside the boundary of the Bhatara union,²⁷ wherein agricultural land has been reduced from 52% to 10% between 1975 and 2009 (Ahsan & Rahman 2013). There has been a large impact on peri-urban agriculture due to engineering interventions such as the cordon system embankment (discussed in chapter five). Subsequently, the majority of the area has been filled without any consideration for natural drainage. As a consequence, the Bashundhara and surrounding areas are subject to water clogging, because of the destruction of the drainage system, which was caused by the creation of constructed land. According to the media, Bashundhara is one of the major reasons for human induced flooding and water clogging in eastern Dhaka during monsoon season (The Daily Star 2015a).

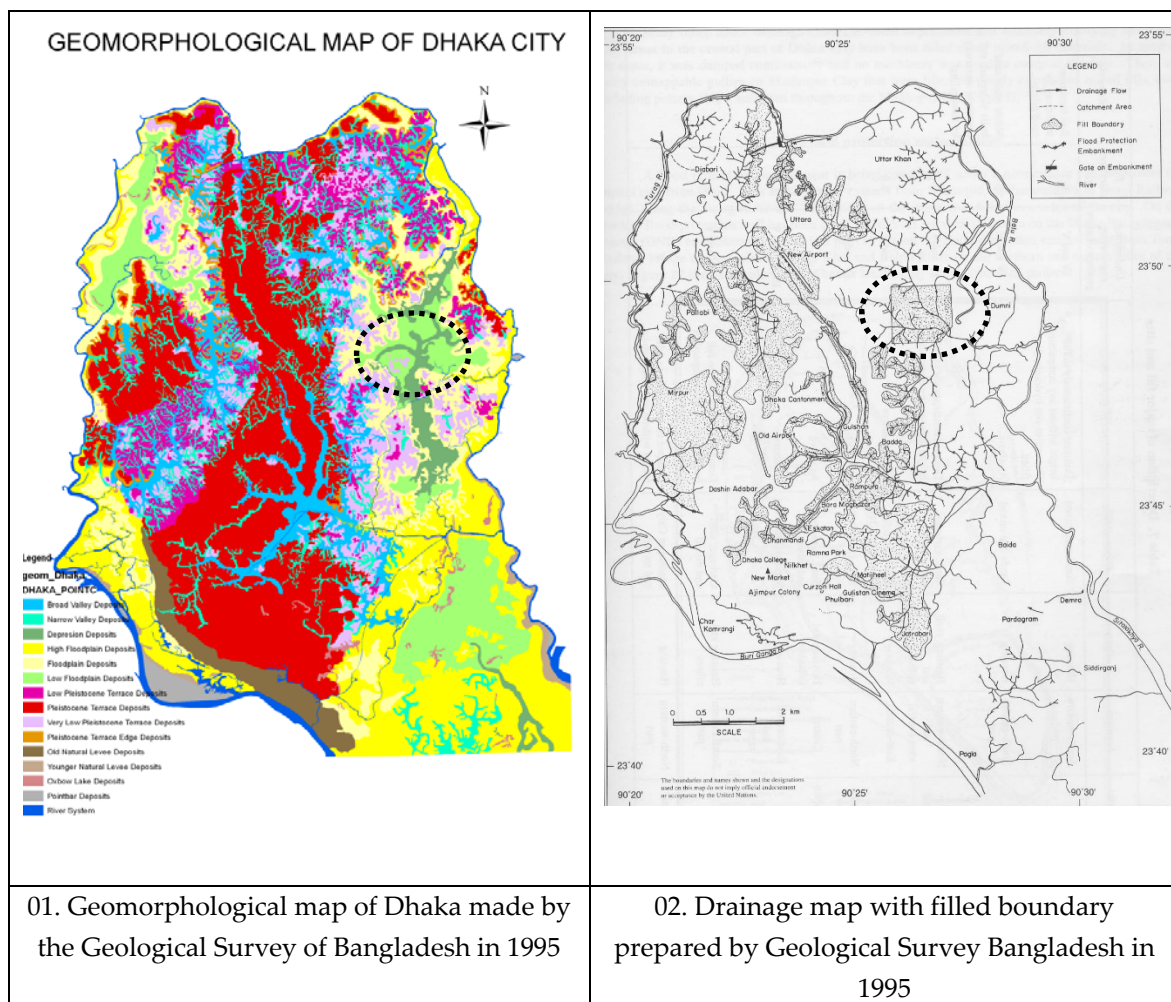


Figure 6-8: Map 01 showing geomorphology and map 02 showing drainage and filled boundary (source: Geological Survey of Bangladesh)

²⁷ Union is one of the administrative boundaries of the semi urban and rural areas in Bangladesh.

People who live in the Bashundhara area consider new townships to be a positive intervention, as they ensure their access to housing. Consequently, only 10% of the population who live in the area see water as one of the five major problems for Dhaka (Figure 6-10). The questionnaire survey revealed that a majority of the respondents in the Bashundhara area consider security, pollution, and traffic congestion as major problems in the city, even though the project claimed to be a secure residential area. As a consequence of poor accessibility, the residents of the Bashundhara area consider traffic congestion to be one of the five major issues for the city. However, the Bashundhara group have been trying to connect their township area with the Purbachal expressway and eastern bypass (as explained earlier).

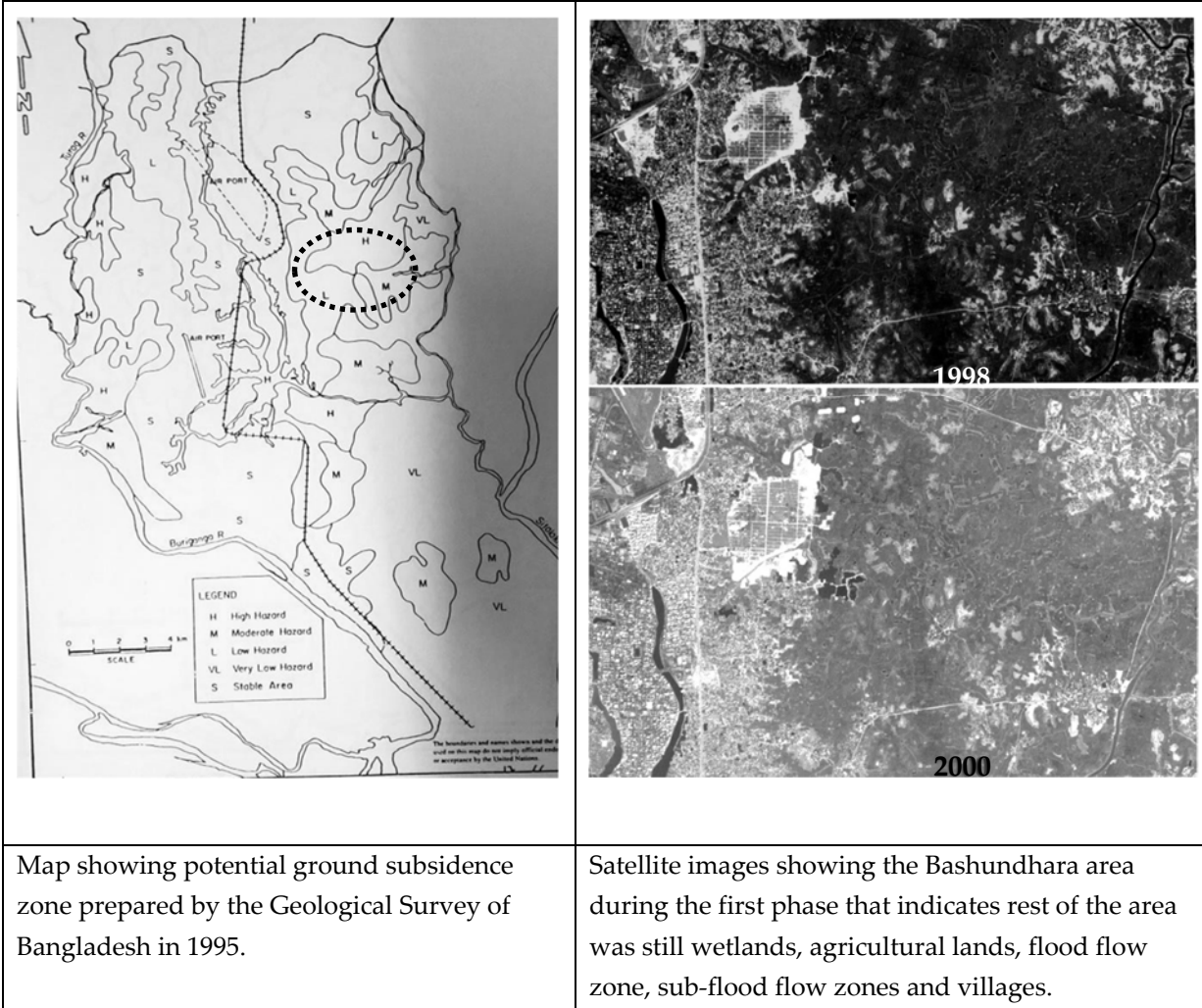


Figure 6-9: Map of potential ground subsidence zone from 1995 and satellite image from 1998 and 2000 of the Bashundhara area (source: Geological Survey Bangladesh).

86.7% of the residents who completed the questionnaire survey believe that the area provides a good living environment (Figure 6-11). Indeed, respondents prefer Bashundhara for a number of functional reasons, such as schools, work place, and shopping. For 70% of the respondents, one of the reasons to choose to live in Bashundhara is because of the parks and vegetation. In fact, these parks and vegetation are the vacant land that will be occupied by buildings in the future. It is evident from the master plan of the Bashundhara township that the area has very few public spaces, open spaces, and green areas (Figure 6-1 in page 149)

The area serves middle, higher middle, and higher income earners, and only 3.3% of residents chose to live in the area because of affordability. The developer did not consider lower-middle and lower income earners in this project. Traffic (54.2%) and accessibility (33.3%) are identified as major problems by the respondents, which suggests the plan has not been successful in terms of mobility (Figure 6-12). People are also unhappy with the level of pollution (46.7%), the sewerage network (46.7%), and water clogging (40%) in the Bashundhara area. The Bashundhara area is subject to flooding and water clogging after heavy rainfall, according to the survey respondents and newspaper reports (Islam, Israt 2009; The Daily Star 2015b).

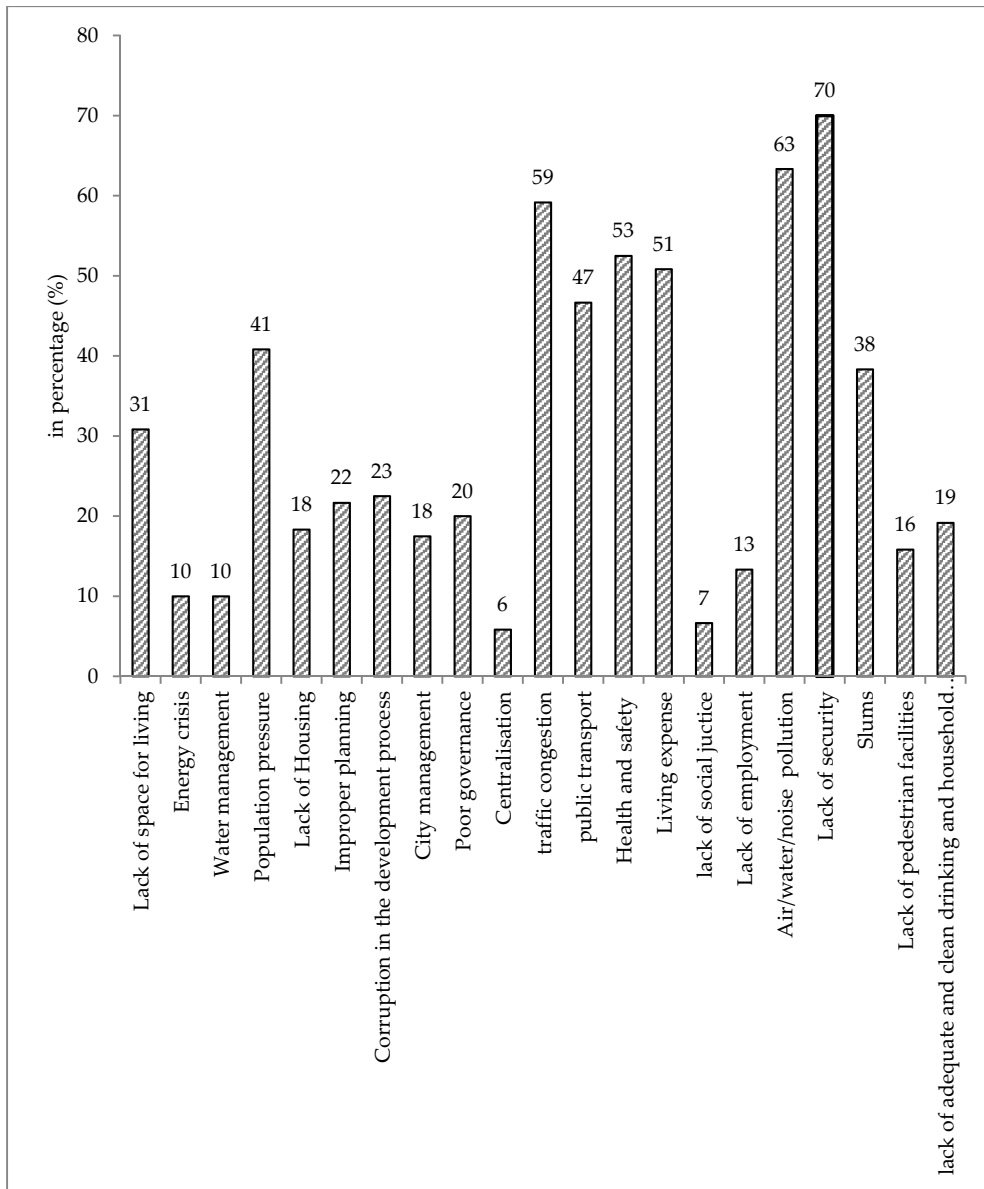


Figure 6-10: Major problems according to respondents of the Bashundhara area

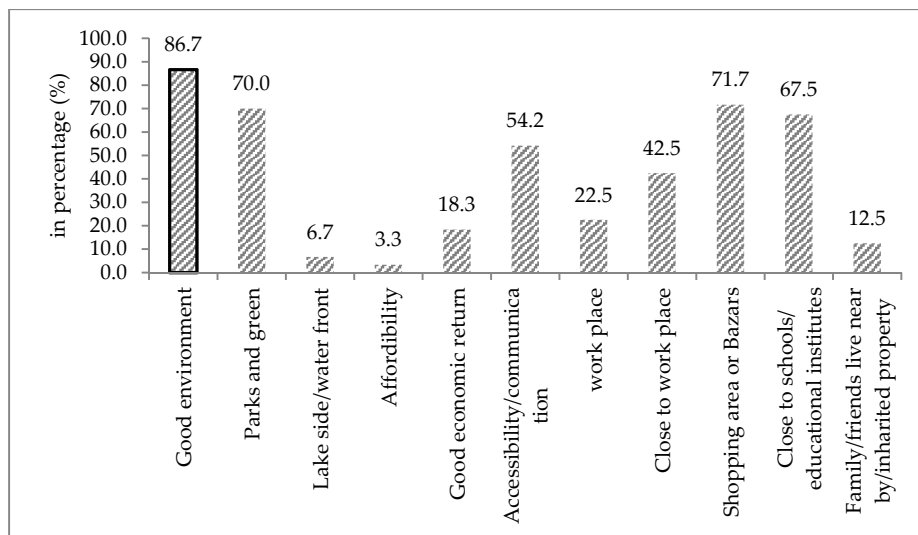


Figure 6-11: Reason for choosing the Bashundhara area to live or work

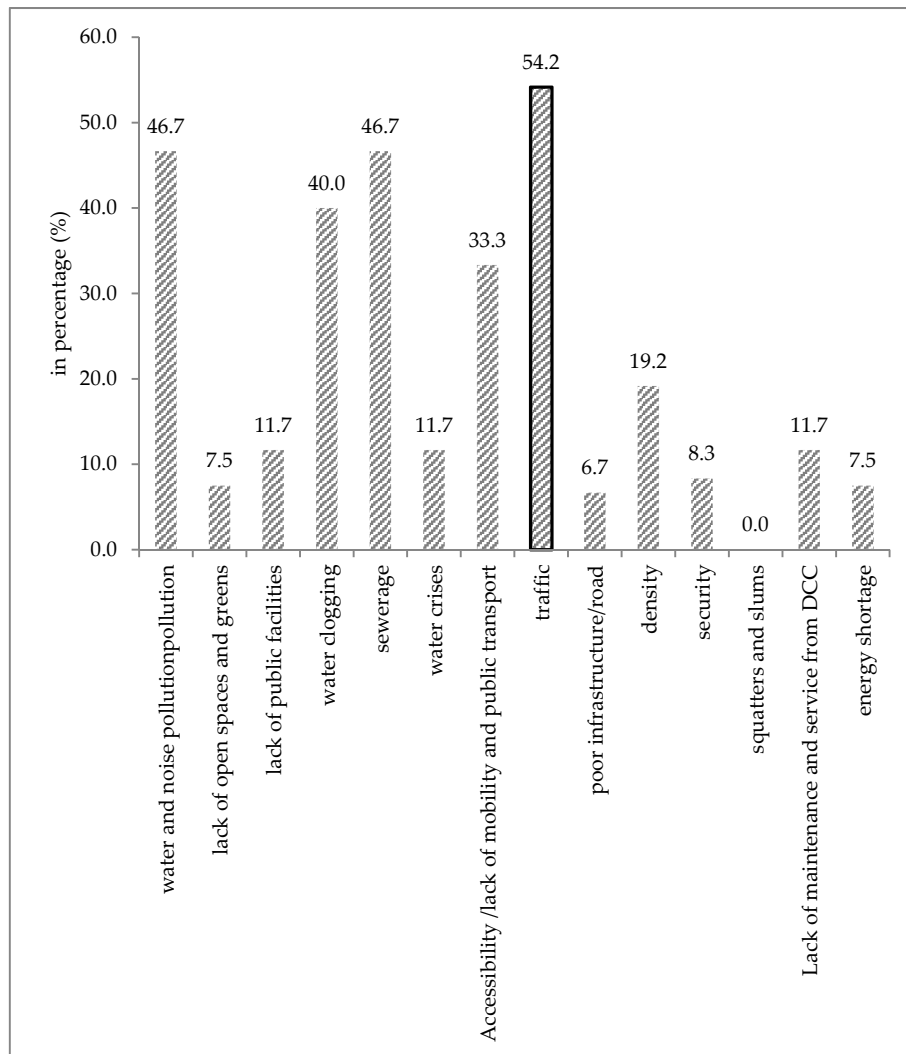


Figure 6-12: Negative aspects of Bashundhara area according to questionnaire respondents

Only 12.8% of respondents believe that the land development project shows consideration for wetlands and the natural landscape (Figure 6-13). In order to study the relationship between the two case study areas (Bashundhara and Hatirjheel) and the responses as to whether the new land developments consider the natural landscape and water bodies in their planning processes, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p=0.05$) was observed in the relationship between the responses from the two case study areas. From the responses it is evident that more of the respondents in Hatirjheel (45.2%) believe that the new land developments do not consider the natural landscape and water bodies in their planning processes, as compared to the responses from Bashundhara (30.8%). In addition, in the case of the Bashundhara area

more than half of the respondents (56.4%) are not aware of the landfilling issue, in comparison with the Hatirjheel area (41.9%). In general almost half of the respondents from the total questionnaire survey are not aware of the issue of filling up the wetlands and natural landscape to construct land. Therefore, it is evident that a large number of residents are unaware of the process and the implications of constructed land in the urban development process in Dhaka.

Do you think the new land development such as Bashundhora, Purbachal, Modhumoti etc. are considering the natural landscape and water-bodies in their planning process? Cross tabulation						
			No	Yes	Not aware	Total
Case study area	Bashundhara	Count	36	15	66	117
		% within Case study area	30.8%	12.8%	56.4%	100.0%
	Hatirjheel	Count	56	16	52	124
		% within Case study area	45.2%	12.9%	41.9%	100.0%
Total		Count	92	31	118	241
		% within Case study area	38.2%	12.9%	49.0%	100.0%

Figure 6-13: According to respondents if the new land development (landfill) projects are considering wetlands

The questionnaire survey revealed that a majority of the respondents consider poor and insufficient drainage to be one of the major reasons for water clogging (57.5%), along with poor maintenance (50%) and poor water management (49.2%) (Figure 6-14). Clearly, most of these issues are structural issues related to engineered drainage. Significantly, and perhaps ironically, only 29.2% of the respondents consider that landfill might be the cause of water clogging. A lack of knowledge, or awareness of natural drainage and the implications of landfilling, is characteristic of residents' opinions in the Bashundhara area. According to a majority of respondents, better drainage (48.3%) and regular cleaning of the drainage system (49.2%) are possible solutions for water clogging (Figure 6-14). However, around one quarter of respondents acknowledge other possibilities relating to non-structural measures, such as protection and maintenance of natural water bodies (27.5%), not using the wetlands for disposal (27.5%), and reclaiming the water bodies (25.8%) (Figure 6-15). Although the majority of residents prefer structural or engineering solutions to overcome water clogging, a reasonable number of respondents recognised that softer approaches could be explored to restore natural conditions.

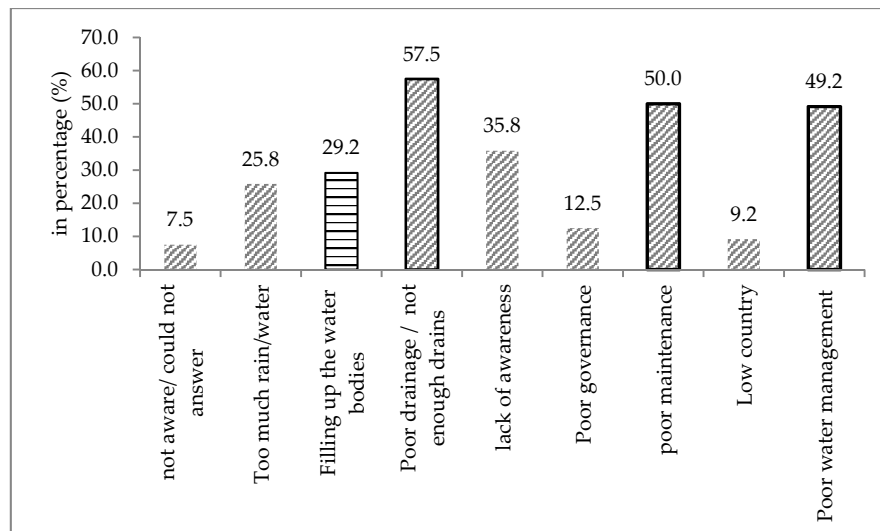


Figure 6-14: Reason for water clogging according to the respondents of the Bashundhara area

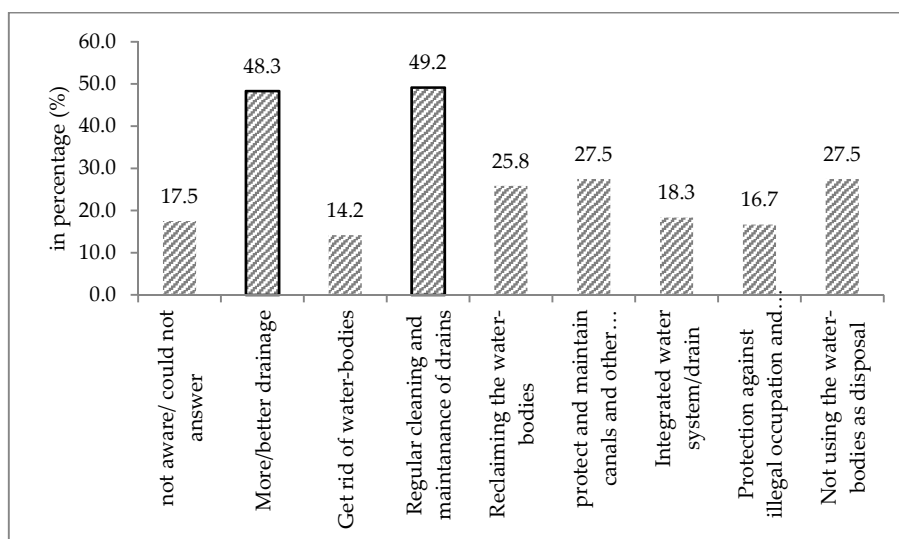


Figure 6-15: Possible explanations of water clogging according to the respondents in the Bashundhara area

The respondents' views on ensuring the protection and reclamation of water bodies are focused around awareness, planning, and law enforcement, with 58.3% of respondents agreeing that awareness is the most important factor for wetland protection and reclamation (Figure 6-16). 54.2% and 49.2% of respondents respectively believe that proper planning-implementation and strict law enforcement can save the wetlands. In contrast, only 10% are concerned that there should be meaningful stakeholder participation to ensure the protection and reclamation of wetlands. Similarly 18.3% of respondents believe that structural solutions, such as retaining walls and walkways, could be employed to protect wetlands. It is evident from the survey that none of the respondents from the Bashundhara area directly consider the issue of living with water.

However, 20.8% of respondents considered innovative design ideas, while 14.2% believe that reconstruction of wetlands combined with urban interventions can help to protect and reclaim wetlands.

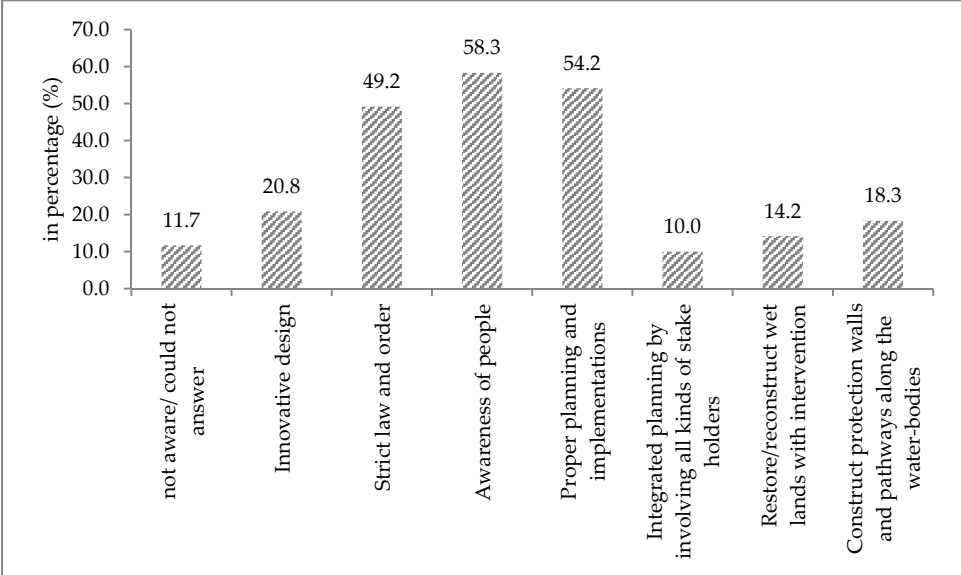


Figure 6-16: According to respondents of the Bashundhara area actions to ensure protection and reclamation of water bodies.

6.5.2 Socio-economic impact:

Significant socio-economic impacts have been observed as a result of the Bashundhara Residential project, which have larger implications in relation to national politics and the macro economy. East west properties initially sold the land for one lac (BDT 100,000) taka²⁸ per Katha (1 Katha=720 square feet) when they initiated the project.²⁹ Television commercials in the early 1990’s indicated that the booking fee (deposit) was BDT 25,000, and the monthly instalment for a 5 katha (1 katha= 720 sft) plot was initially BDT 5,000. However, the current average price for the same plots of land is 2 crores taka (BDT 20 million) per Katha,³⁰ so the land price has increased 200 times over the previous 25 years. This land speculation is the result of a black market in land and a growing property investment culture. Property investment has become common place in Dhaka, as land is one of the most profitable investments in the current economy. Both individuals

²⁸ Taka is the Bangladeshi currency in short BDT
²⁹ Website of the East West Properties (Pvt.) Limited (<http://www.ewpd.com.bd/>) and Interviews of the individual researcher and planners from the private sector developers.
³⁰ Websites advertisements for land selling (<http://bdnews24.com/land/bashundhara-baridhara-plot-price.html>).

and groups invest in, and speculate on, property in the Bashundhara area. According to Labib, Bhuiya and Rahaman (2013, p. 92), in around 60% of cases in the Bashundhara area demand is for large apartments of more than 2000 square feet (around 200 sqm). The area displays no demand for apartments smaller than 1000 square feet. In 2015 about 5000 apartment units were under construction in the Bashundhara area (Seraj 2012, p. 39), and available statistics indicate that the area is predominantly serving higher income earners.

Gentrification has emerged in conjunction with land use transformation, immaterial of whether the development is operated by public or private sector development agencies and actors. Almost 80% of land owners sold their land because of direct, or indirect, pressure applied by the developer, as is evident from the interviews and other published research (Islam, Israt 2009). Agriculture was the main source of income for the original residents in the peri-urban fringe area. Developers pay a small amount to acquire agricultural land from its original owners, and, in some cases, take the land by force (Islam, Israt 2009; Roy & Islam 2007; Rushi, Sharmin & Awal 2013). Families who have lived in the same location for generations were removed, becoming homeless and unemployed, which ultimately created social instability. Land development has become an incredibly profitable occupation for the land grabbers, who eventually find a way to legalise the illegal process. Landfill projects appear to enhance social inequality in the process of land use conversion and ownership pattern transformation.

Eventually, most of the land ends up being owned by middle, higher middle and higher income earners (Labib, Bhuiya & Rahaman 2013). According to the findings of Rushi, Sharmin and Awal (2013), based on a survey of displaced people from the Bashundhara area, almost 70% of respondents believed that wetlands had been diminished by landfill and negligence on behalf of government agencies. The fact that a majority of the people who currently live in the area are from the middle and higher economic tiers of society demonstrates that this kind of project tends to serve only upper income earners (Figure 6-17). In contrast, only 1.7% of the people who live in the area are lower income earners.

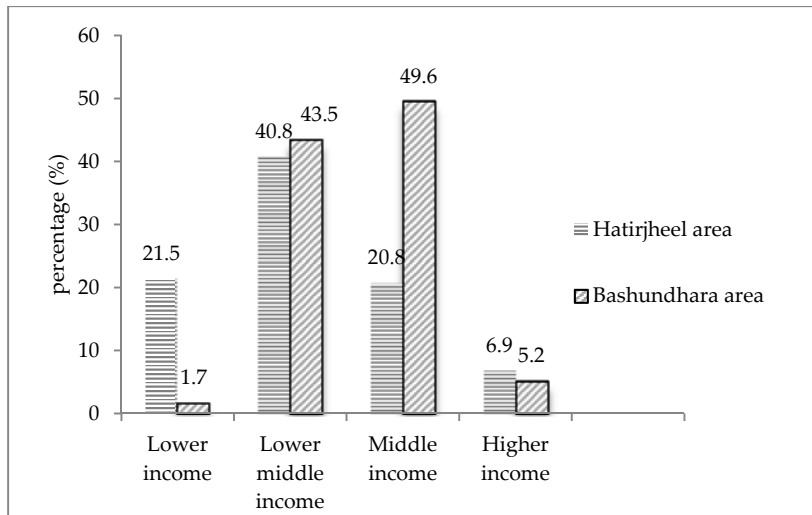


Figure 6-17: Economic strata within the case study areas (source: questionnaire survey).

6.5.3 Stakeholders (residents) perspective of the Bashundhara area

This section discusses the questionnaire survey conducted with the residents of the Bashundhara area. This survey, and subsequent analysis, presents the perspectives of the residents of the Bashundhara area and similar cases. A majority of respondents gave the Bashundhara area a moderate (40%) or good (50.8%) liveability rating (Figure 6-18), with only 5% of the respondents giving a rating of very good (Figure 6-18). None of the 120 respondents chose to give a rating of excellent, bad, very bad, or extremely poor, for liveability in the case study area. Moreover, analysis shows that property owners in the neighbourhood are happier with liveability in the area than renters (Figure 6-19). Residents who live in single family houses rate the area better than those who live in apartments (Figure 6-20). About one third (32.1%) of respondents from the Bashundhara area believe that water bodies bring negative consequences compared to 6.9% in Hatirjheel (Figure 6-21). The analysis also shows that residents who live in rental properties are less aware of the positive features of water bodies (Figure 6-22). Indeed, the survey results demonstrate that residents in the Bashundhara area are generally content with the quality of the neighbourhood. However, this opinion may change when the remaining open spaces, which are currently vacant plots, are filled in and the area becomes high density, high land coverage, with a minimum of open spaces.

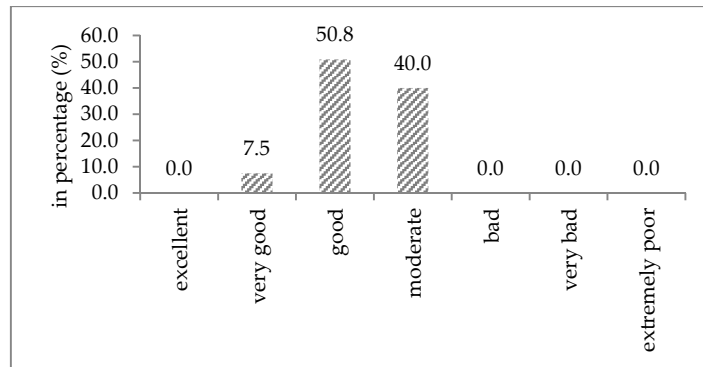


Figure 6-18: Overall rating of the neighbourhood according to questionnaire respondents in the Bashundhara area.

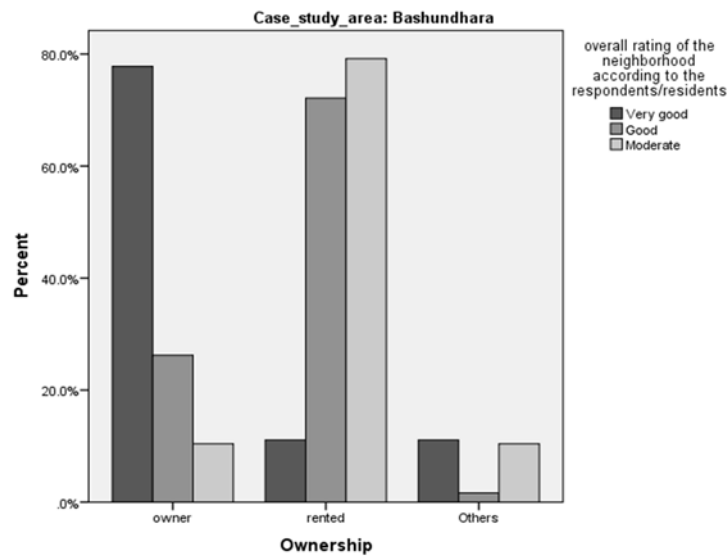


Figure 6-19: Overall rating of the neighbourhood according to the respondents including the relationship to ownership.

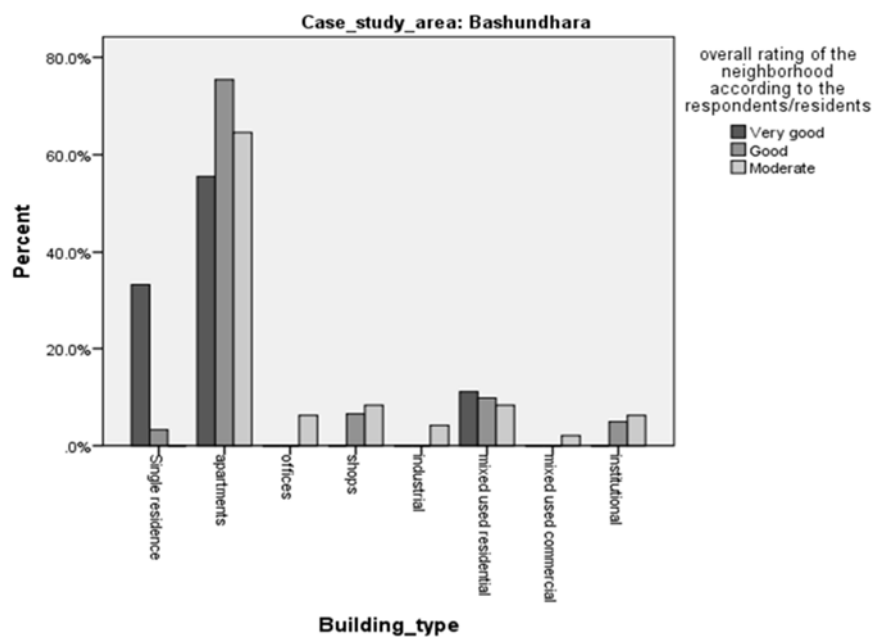


Figure 6-20: Overall rating of the neighbourhood in relation to building type

			Negative	positive	Both	Not aware	total
Case study area	Bashundhara	Count	35	40	31	3	109
		% within Case study area	32.1%	36.7%	28.4%	2.8%	100.0%
	Hatirjheel	Count	9	86	35	0	130
		% within Case study area	6.9%	66.2%	26.9%	0.0%	100.0%
Total		Count	44	126	66	3	239
		% within Case study area	18.4%	52.7%	27.6%	1.3%	100.0%

Figure 6-21: Showing whether water body brings positive/negative effects for the urban areas for both Bashundhara Township and Hatirjheel area

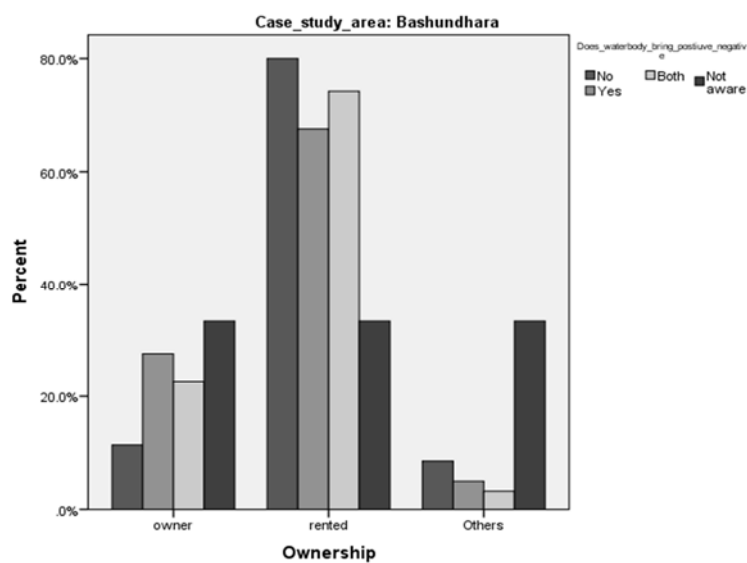


Figure 6-22: Relationship between ownership pattern and responses of the respondents to whether water bodies brings positive/negative effects (yes=positive, no=negative)

The questionnaire survey captured respondents' views concerning the positive and negative aspects of wetlands, which have been analysed and compared to other parameters, such as if they regularly visit wetland areas, or if they think water bodies should be protected and reclaimed (Figure 6-23). An SPSS analysis shows that respondents who do not visit water bodies regularly have a negative mind-set toward wetlands and water bodies (Figure 6-23). They believe water bodies do not bring positive aspects and outcomes to the city. Similarly, these respondents do not wish to protect and reclaim wetlands. In contrast, those who regularly use water bodies have a positive mind-set toward wetlands and favour protecting and reclaiming wetlands. It is evident that people who live in an urban area where the relationship between land and water has collapsed are less aware of the positive aspects of wetlands compared to areas where

wetlands are a major feature, such as in Hatirjheel (Figure 6-21). Respondents in landfill areas are less sensitive towards protecting wetlands and reclaiming water bodies, as a result of not having any relationship with wetlands. Moreover, an association with water in day-to-day life, and for recreational purposes, is absent in the Bashundhara area—due to the nature of the urban development.

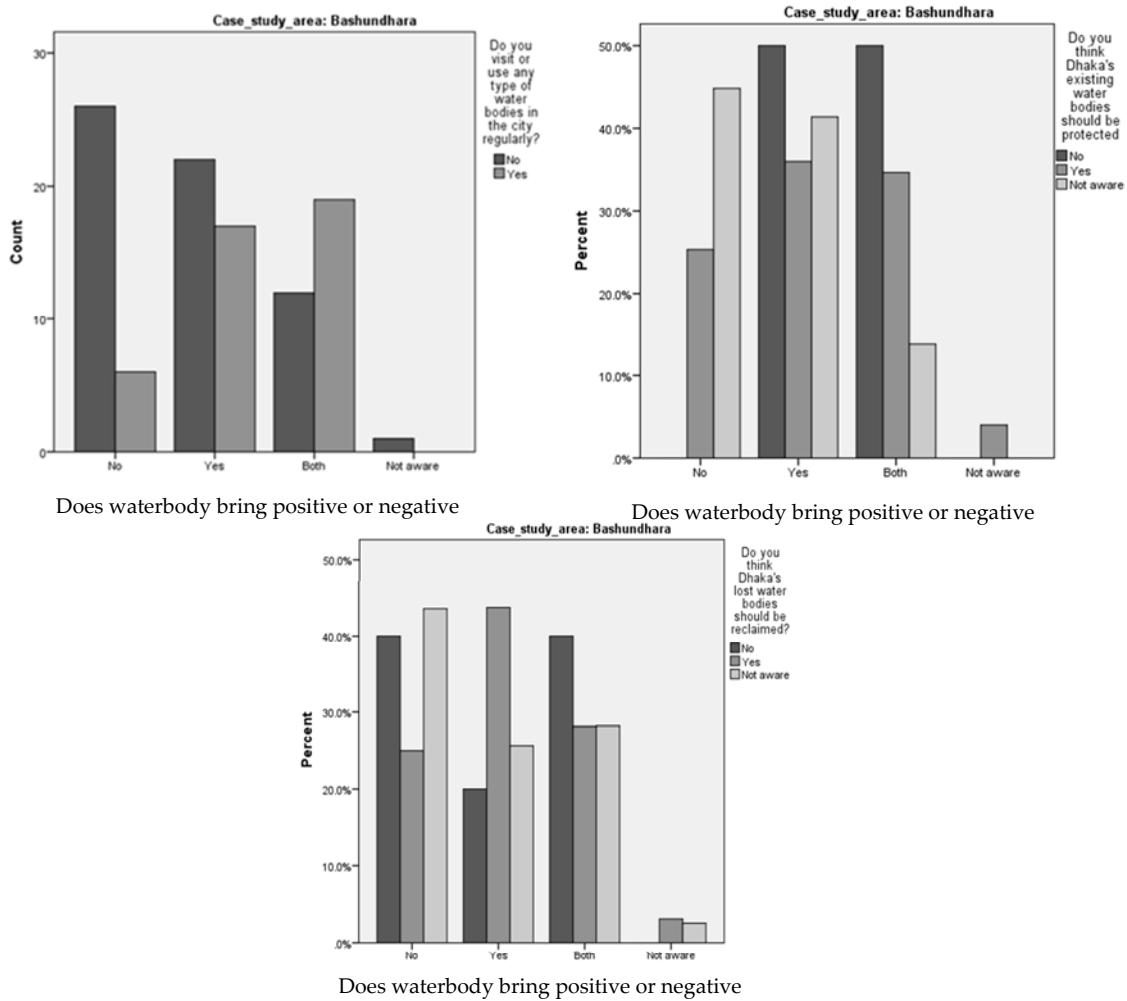


Figure 6-23: Relationship between respondents’ positive or negative views of aspects of wetlands with parameters, such as if they regularly visit wetland areas, or if they think that water bodies should be protected and reclaimed. Analysed in SPSS (yes=positive, no=negative)

The analysis of the questionnaire survey shows that respondents in the Bashundhara area believe that reconstructing wetlands will bring open spaces with public activity areas (45%) and will create a better environment (45.8%) (Figure 6-24). Further, respondents say that the wetland will add value to their properties, providing good visual aspects of the neighbourhood and better natural drainage. In contrast, a majority of the

respondents (29.2%) claim that reconstructed wetlands will create water pollution and encourage water borne diseases in their neighbourhood (Figure 6-25). Some respondents feel that wetlands will increase the rent, traffic, flooding, and density. Clearly, a group of respondents are not aware of the natural drainage issue and consequences of landfill urban development. Nevertheless, a good number of the respondents are aware of the issues concerning wetlands and their positive impacts.

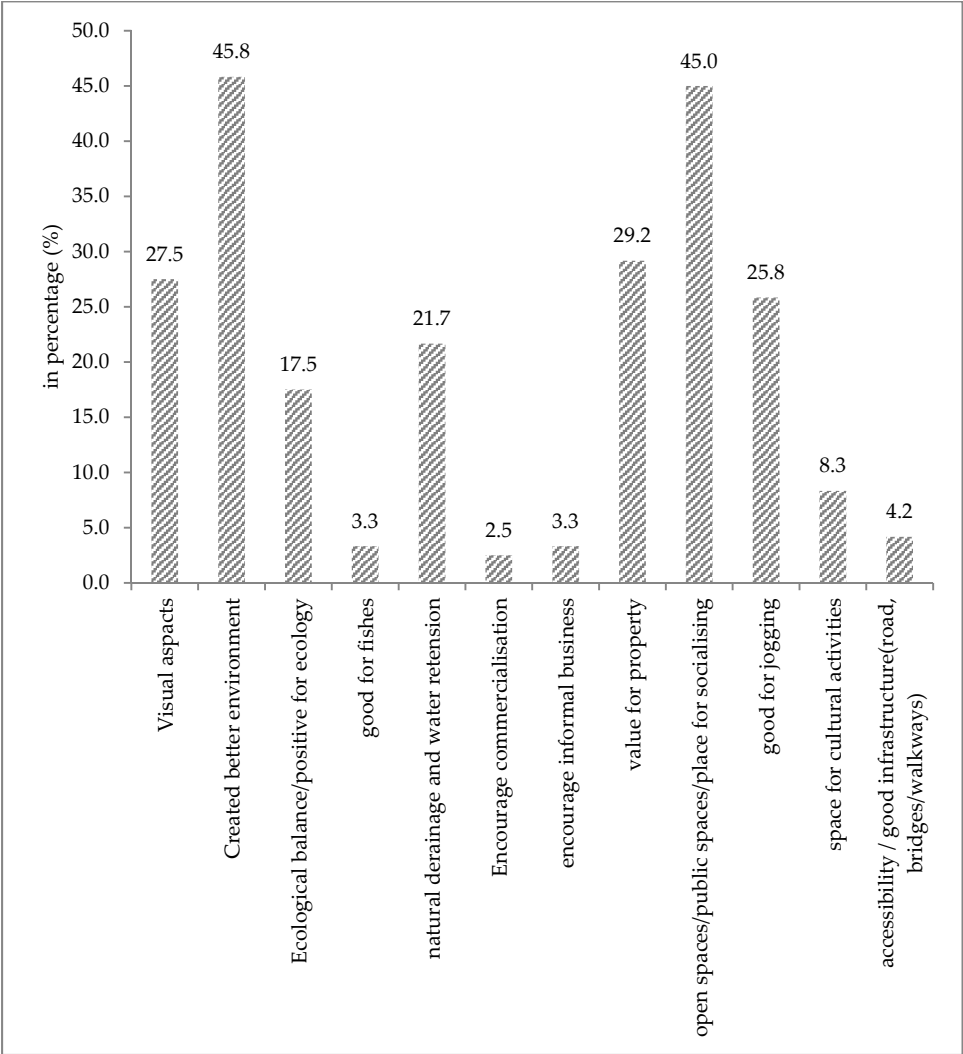


Figure 6-24: Positive aspects of reconstructed wetlands according to respondents from the Bashundhara area

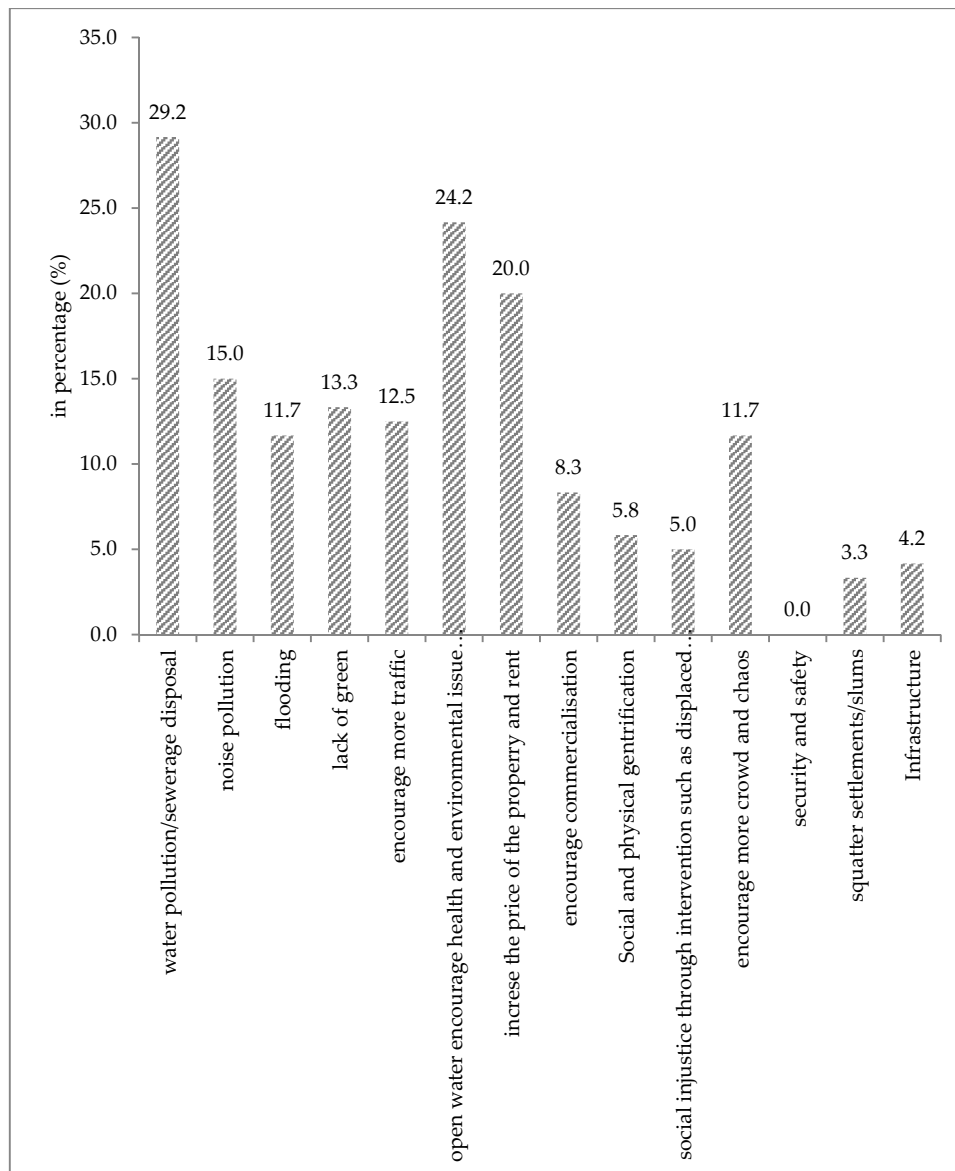


Figure 6-25 Negative aspects of reconstructed wetlands according to respondents from the Bashundhara area

6.6 Conclusion

This chapter has explained how organised development agencies and actors have been operating in the contemporary urban development, using a new township development created through landfilling as a case study. Taking the Bashundhara Township as a case study, it explains the current trends of urban development in relation to water. This chapter has interrogated the embedded administrative and bureaucratic processes of urban development in relation to landfill urbanisation through analyses of interviews and archival records. On the other hand, this chapter clearly articulates the magnitude and consequences of landfill urbanisation.

The questionnaire survey analysis presents the perspectives of respondents who live in the Bashundhara Township. The methodology of the field survey was successful in collecting a good sample of response from residents. The interviews and other sources provided additional evidence and insight to address the research questions. Collectively, these explain the perceptions that underpin the mind-sets of multiple stakeholders in relation to new township development.

This investigation of landfill urbanisation catalogues the major transformation of the urban landscape of Dhaka by private developers. In a majority of cases urban expansion through landfill has violated bylaws, showing no concern for environmental and sociocultural issues. Many of these violations have been illicitly supported by political institutions and government agencies. As a consequence, the city has lost many of its wetlands, which has in turn destroyed the natural drainage system, resulting in both natural and man-made disasters. The areas surrounding the city, which used to be agricultural lands and flood flow and semi flood flow zones, have been rapidly transformed, destroying biodiversity. Through this new form of fortification through landfilling, the city is facing a paradigm shift in urban development.

Chapter 7

Urban Regeneration Through Reconstructed Wetlands

7.1 Introduction

This Chapter explains and evaluates the process, rationale, and consequences of reconstructed wetlands as an urban design tool in Dhaka, Bangladesh. The initial part of the chapter outlines the planning process required to reconstruct a wetland, using the 'Hatirjheel-Begunbari Integrated Development Project' as an example. It investigates current planning trends in relation to reconstructed wetlands, which provide an indication of the direction and shape of urban development tendencies and development actor's mind-sets. The second part of this chapter presents different stakeholders' impressions of the project. It articulates the physical (environmental), social, and economic impacts of the intervention. This chapter incorporates analysis of interviews and the questionnaire survey, government documents, literature, and archival records to elucidate the case of the Hatirjheel project.

Managing water became a major issue in planning and design in urban development in Dhaka during the last two decades, as a result of increasingly destructive water related events. One of the two current opposing tendencies in urban development in managing water is the reconstruction, or redevelopment, of wetlands. This portion of the research critically examines this urban water intervention as a planning and design initiative to elucidate the process of design and implementation. The Hatirjheel-Begunbari Integrated Development Project in Dhaka is the primary case study for analysing reconstructed wetlands, and it is one of the largest urban development projects in the city in recent history. This project claims to be one of the most successful projects in recent times, in terms of urban water intervention, which includes drainage, open space, pedestrian and vehicular circulation, water retention, and other urban design elements.



Figure 7-1: Google image of before and after the intervention, including photographs of the site in 2014

7.2 History of the canal

Historically the Hatirjheel area was a part of the natural landscape, which included wetlands. Settlements in the case study area began during the British period in the mid-eighteenth century (Ahmed, F 2015; Haider 1966a, 1966b; Karim 1964; Mamun 2000). Until the colonial era the Hatirjheel-Begunbari canal was a part of the Nari (Pandu/Kawran/Caravan) River, flowing from the east to the west and connecting the surrounding rivers, which can be seen on Rennel's map from the 1780's (Figure 4-7 in chapter 4) and in other historical documents (Haider 1966b; Karim 1964, 2009). The name 'Hatirjheel' means lake of elephants. Elephants were brought to the canal for bathing from the Pilkhana, which was a military establishment during British rule. There was a bridge called the Amber Bridge on the Nari River, and there is evidence of another Bridge called the Hatirpul bridge, or Elephant Bridge, in the same area. The residential area in this location is presently named after the bridge. Cartographical records show that there were establishments in the Kawranbazar and Tejgaon areas in the late eighteenth century, including churches, mosques, and European gardens. In the nineteenth century the French, Dutch, and British all built factories in the Tejgaon area, near the Nari River.

Historians claim that the Kawran Bazar area beside the Kawran (Nari) river, which is currently the western part of the Hatirjheel area, was one of the major trading areas during the Mughal Period, alongside the major centre and other establishments along the River Buriganga (Dani 2009; Karim 1964, p. 6; Mamun 2000). The Mughal Mosque¹ in the area is still standing. This water channel was a major water transport corridor for people and goods. The survey maps from the 1960's show that the Hatirjheel canal was integrated with other canals and rivers, and was a part of the natural drainage. During the 1960's the eastern part of the present Hatirjheel area was mostly low lands and flood plains (Figure 4-12 in chapter 4). A tourist map from the late 1960's showing important structures (road networks, rail Lines, and major wetlands: Figure 7-2) only indicates five major water bodies, including the Buriganga River, the eastern part of the Dholai canal, Ramna Lake, Dhanmondi Lake, and the Hatirjheel-Begunbari Canal. The Hatirjheel-Begunbari wetland has been a major water channel for centuries. Moreover, this canal and surrounding low areas have played a significant role in the natural drainage system, for mobility, and for agriculture in the area, acting as a catalyst for urbanisation in this part of the city.

In more recent times, before the reconstruction of the Hatirjheel Canal, it was a drainage outlet for the surrounding urban areas. This area became a transitional location, with stilt houses and temporary informal settlements built on major parts of the land-filled wetlands. From the 1990's onwards the illegal occupants had an increasingly significant impact on the transformation of the Hatirjheel canal² (Ahmed, F 2015; Mishu, Barua & Stoican 2014; Peeters & Shannon 2011). In 1992 a survey was carried out by RAJUK (the city development authority) before preparing the master plan in 1995³. According to the 1995 DMDP structure plan and urban area plan, this wetland was supposed to be protected as a natural reservoir and for drainage (DMDP 1995). Satellite maps from the 1990's onwards show the densification and transformation of the area. In the process the wetland has been diminished and the connection with the western wetlands has been lost, because of the conversion of the

¹ The Mughal Mosque has the plinth of a water pavilion, which indicates that, historically, it was situated at the edge of water course.

² The illegal occupation described in the literature is clearly evident in Google-Earth images.

³ Information collected through Interview of the Director of the Urban Design Directorate of Bangladesh Government who was former town planner of RAJUK and in 1992 the survey of Hatirjheel-Begunbari area was conducted by him.

Kalabagan Canal into a major box-culvert road⁴ by the military regime in the late 1980's. In 2006 the Hatirjheel-Begunbari canal was almost filled in, which will be discussed later on in the planning process section of this chapter.

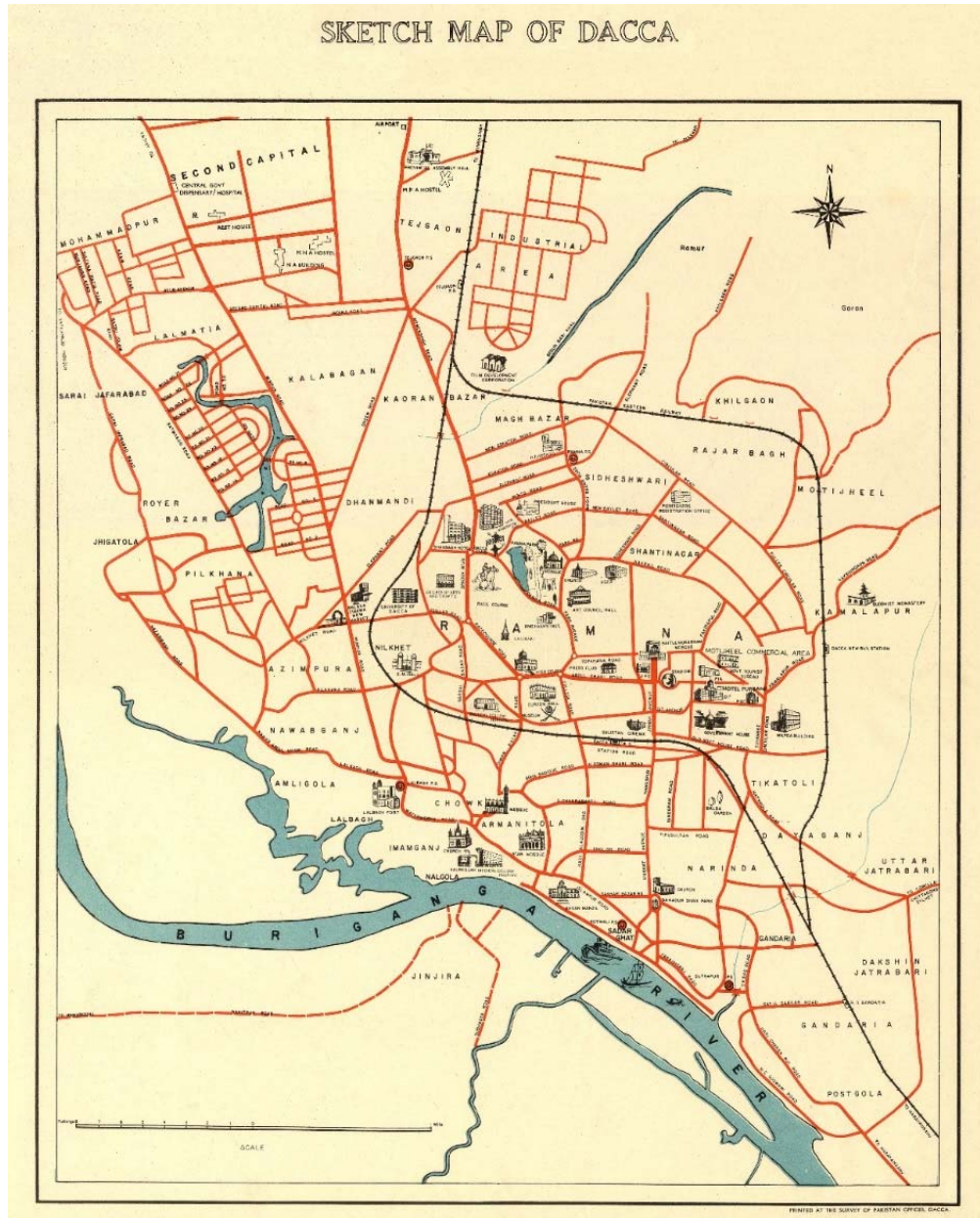


Figure 7-2: A 1960's Tourist map published by the government during the Pakistan period (Source: Department of Architecture BUET)

As a result of the consequences of human induced flooding, public awareness, and political will, the wetland was eventually recovered and reconstructed between 2009 and 2013. The current canal passes through diversified urban areas, including

⁴ The Panthopoth road was constructed by converting a major canal to create accessibility and connecting two major north-south arteries of the city. This has resulted in major changes in the urban areas including converting it as a commercial area with high-rise commercial buildings, hospitals and residential accommodations.

high and middle income residential zones, an industrial district, informal sector housing, and the Kawran Bazar business district, which were mostly developed in the post-independence era, after 1971.

7.3 The planning process

7.3.1 Background and initiation of the project

The Hatirjheel-Begunbari integrated development project is a perfect example of turning an academic exercise into a real life project. The planning process of this project was complex and many planning decisions were made on an ad-hoc basis. Nonetheless, major planning decisions were top-down in this project, while implementation decisions were made via a bottom-up process, because of the socio-political and economic circumstances.

The academic contribution to the project was significant. The project was originally designed by under-graduate students in the Department of Architecture at Bangladesh University of Engineering and Technology (BUET) in 2002. The project, called '*urban intercept*,' was designed by a student as an undergraduate final year project (Figure 7-3).

It was displayed at the 'Architecture overcoming constraints' international conference at the Hotel Sheraton Dhaka (currently the Hotel Intercontinental) in 2003, which was organised by the Department of Architecture from BUET. The local government minister was the Chief Guest at the opening ceremony, along with other ministers. The legislators were captivated by the project, and the transition from academic exercise to practical manifestation began here. However, the original concept from the academic project was not realised.

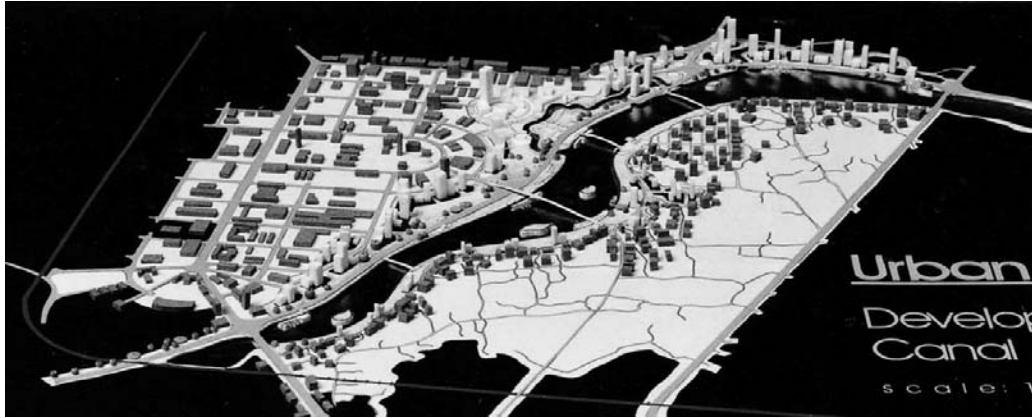


Figure 7-3: Project urban intercept by the student (Zahid Khan from Batch 95) from department of Architecture BUET exhibited in 2003 (source: Architecture department Library BUET)

Prior to the Hatirjheel-Begunbari integrated Development Project, similar smaller and medium scale developments had been built. Most of the projects were funded by the Government of Bangladesh with tax payers' money. The Dhanmondi lake development project was one of the major projects, which was built in the mid 1990's (Figure 7-4). It represented an attempt to reconstruct the ecology, incorporating public spaces to protect wetlands (Hossain, N 2009; Shannon & Nilufar 2008). It is a comprehensive intervention, including integrating the Dhanmondi residential area, with parks, public spaces, pathways, bridges, and the water retention area was re-developed. In contrast, the Gulshan-Banani-11 Bridge project was a piece-meal project, which connects the areas of Gulshan and Banani through landscape infrastructure. The architect consultant group are a common thread in all three of these projects: they have played a substantial role in conserving urban wetlands over the previous two decades.

The story of the Hatirjheel project began after the 1998 flood, when a study was conducted by BUET that recommended saving the canal and surrounding wetlands⁵. In 2000-2001 RAJUK developed a plan for commercial development to the north of the western part of the canal. A feasibility study was prepared by BUET that recommended retaining the low areas, including wetlands, for water retention and natural drainage. The report advised that to protect the wetlands it would be necessary to acquire approximately 235 acres (95 hectares) of land. However, it took until 2007 for the government and development agencies to proceed any further with the project.

⁵ Interview of Dr. Muzibur Rahman (transport engineer specialist), professor, department of Civil Engineering, BUET

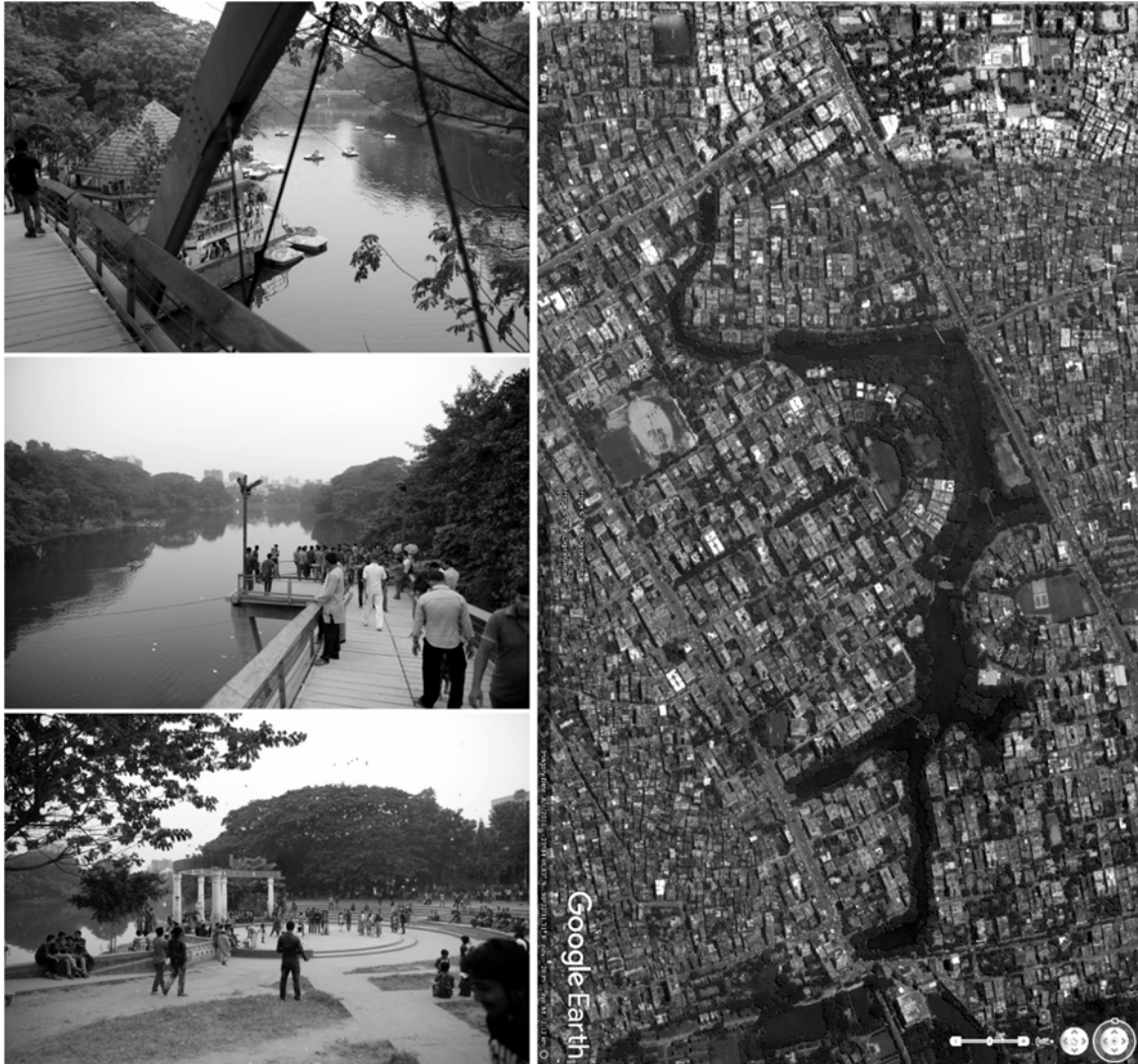


Figure 7-4: Dhanmondi Lake Development Project in 2014

Over this intervening period many illegal occupants took the opportunity to gain control over the wetlands and low areas, including the BRAC University, private land developers, BGMEA (Bangladesh Garments Manufactures and Exports Association), individuals, and influence groups. For example, the BGMEA constructed a head office (Figure 7-5) in the 1990's by filling up some parts of the canal. The High Court declared the building to be illegal, as it violated a number of laws including the building construction rules (Mahmud, Abu Hayat 2014b). A lot of land was grabbed via a variety of means, including fencing with stilt structures, extending fences, filling areas up with garbage, and finishing by filling areas with sand and soil. Major parts of the canal and low lands were occupied through these processes, mostly with temporary structures. The land grabbers rented these temporary structures out to marginalised people, who had migrated from rural areas to the city for work.



Figure 7-5: BGMEA building in 2016 (source: The Daily Star, <http://www.thedailystar.net/city/sc-upholds-bgmea-building-demolition-order-1233319>)

A meeting involving high profile personnel, and presided over by the former Local Government Minister,⁶ was held on 7 August, 2004, after the 2004 flood. Other attendees included the Mayor of Dhaka city, two other ministers,⁷ eight members of parliament,⁸ representatives of civil society, and intellectuals from academic and research institutes. At this meeting a project proposal was presented for the Hatirjheel Canal area. The project had been collaboratively designed by the RAJUK (City Development Authority), DCC (Dhaka City Corporation), and LGED (Local Government Engineering Department), including a tentative budget, without considering the wetlands. The project already had preliminary approval, and government agencies were about to finalise administrative matters, prior to final approval from the prime minister. According to the interviewees, the feasibility study was conducted by the IWM (Institute of Water Modelling). The proposition was

⁶ During 2004 local government minister was Abdul Mannan Bhuyian.

⁷ Mayor of the Dhaka city during 2004 was Sadek Hossain and other two ministers who were present in that meeting was Mirza Abbas and Quamrul Islam.

⁸ According to the interviewees, who are the consultants and designers of the Hatirjheel-Begunbari Integrated Development Project.

profoundly criticised and rejected by the experts⁹ at this meeting, as the concept did not consider socio-cultural and environmental aspects at all.

The 2004 Government development agencies proposal involved connecting the two major north-south arteries of the city, from the Rampura Bridge to the Tongi diversion road. They recommended filling-up major parts of the wetlands. In addition, a box-culvert drain-road was proposed, which would have destroyed the gravity drainage system in eastern Dhaka, as the catchment area of the Hatirjheel-Begunbari area is very extensive. The initial design proposed by the government agencies placed a commercial district in the western and northern part of the area, along with two major housing projects: one by a private developer (Eastern Housing) on 60 hectares of land, and the other by the RAJUK. The scheme proposed a 30 meter wide canal, even though the existing canal was around 100 meters in width. Ironically, this proposal discarded the master plan that had been prepared by RAJUK. Experts convinced the legislators that the project would destroy the natural drainage, and would have significant impacts on the environment. Therefore, the minister for local government dismissed the project.

After the proposal was dismissed at this meeting, a possible alternative project idea was discussed: after reclaiming and protecting the wetland a peripheral service road would be built to connect the neighbourhoods with the canal, and an elevated expressway could be built to connect the north-south arteries. Afterwards, the DCC designed an elevated expressway project with an approximate cost of BDT 60 million in the Hatirjheel area, without considering any of the other aspects that had been raised at the meeting mentioned earlier. However, the finance ministry did not approve the idea.

⁹ According to the interviewees the idea of the public development agencies was profoundly criticised by prof. Abdullal Abu Said (activist, academic and writer), prof. Nazrul Islam (Director, Centre for urban studies), prof. Muzibur Rahman (Department of Civil Engineering, BUET), Architect Ehsan Khan (former director of VITTI), and architect-activist Iqbal Habib (director of VITTI and secretary of BAPA).

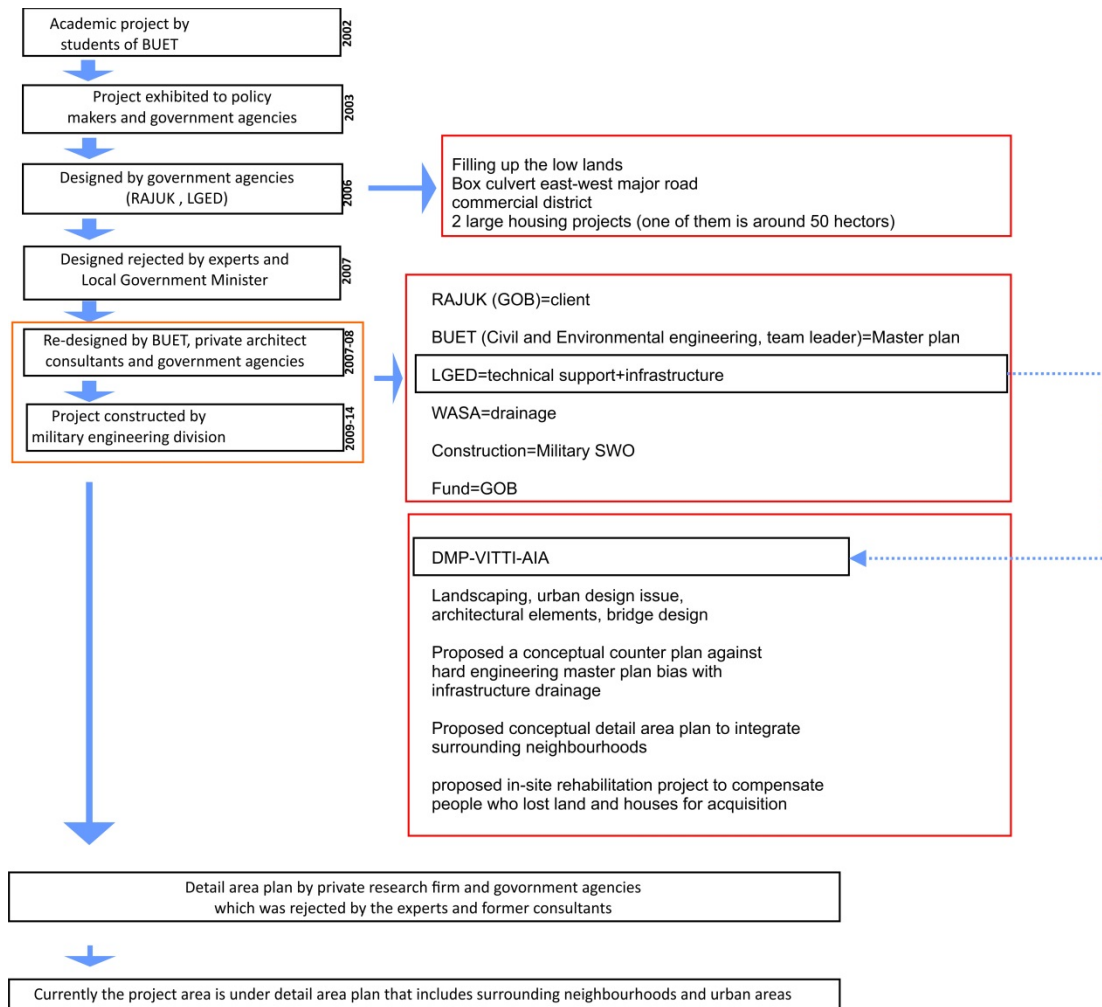


Figure 7-6: Conceptual diagram of the planning process

7.3.2 Initiation of the planning and design process

In July 2007 the advisor to the military backed caretaker government,¹⁰ who was in charge of the local government ministry, re-started the project. During this time the interim government was searching for projects that would gain them public support, so that they could stay in power longer, to reform political culture (Ahmed, F 2015; Ahmed, N 2010). One of the leading professor¹¹ of BUET was asked by the advisor to form a technical team to design the project. The government decided to make RAJUK the client of the project as a government development institute. The Development project proforma /proposal (DPP) was approved in December 2007 and

¹⁰ Between January 2007 and January 2009, a military backed caretaker government was in power in Bangladesh. The government was operated by a chief advisor as head of the government and 8 to 10 other advisors who were responsible for different ministries. Advisor Mr. Anwarul Iqbal was in charge of the local government ministry

¹¹ Professor Dr. Mujibur Rahman.

the government decided that the Bangladesh Military would be responsible for implementation of the project.

The Special Work Organisation (SWO), a part of the Bangladesh Military, was made the chief agency to execute the project on site. The Local Government Engineering Department (LGED) was given responsibility to design and supervise all infrastructure, including architectural components of the project, and Dhaka Water Supply and Sewerage Authority (DWASA) was given the job of designing drainage and sewerage for the project. The primary team from BUET consisted of the following people (Table 7-1), which mostly consisted of civil engineers with different expertise. The architect on the team was a silent team member and was not involved during the planning process¹².

BUET and DWASA planned a drainage system, which was designed to separate the sewerage system from the waste and rain water system. According to designers and experts, this separated system will never work until the entire city has a sewerage system that is separate from the waste and rain water pipes. According to DWASA, only 25% of the city is covered by separate sewerage lines, and both the population and authorities are reluctant to separate these lines in the majority of cases. In many cases people connect their sewerage line with the waste water line, due to a lack of awareness.

Table 7-1: List of team members for the Master plan of the Hatirjheel-Begunbari integrated project (source: BUET)

List of persons and their expertise in the BUET team for the Hatirjheel-Begunbari integrated development project		
	Name	expertise
1	Prof. Mujibur Rahman (team leader)	Transport (civil) engineer
2	Prof. Samsul Huq	Transport (civil) engineer
3	Prof. Ashraf Ali	Environmental (civil) engineer
4	Prof. Abdur Jabbar	Foundation and soil (civil) engineer
5	Prof. Shah Alam	Water resource engineering
6	Prof. Shahidul Ameen	Architect

¹² According to the interviewees who were involved in the project.

7.3.3 Involvement of the VITTI-DPM-AIA Consortium as design consultants in the Hatirjheel-Begunbari integrated Development Project.

The VITTI-DPM-AIA acted as consultants for the LGED, who were in charge of the design of infrastructure for the project. The VITTI Sthapati Brindo Ltd (known as VITTI) is an architectural consultancy; the DPM is an engineering consultancy; and AIA is an environmental consultancy. Owing to their previous experiences working with the LGED, they were asked to submit a proposal to design the landscape elements. VITTI and DMP had worked together with the LGED in the mid-1990's on the Dhanmondi Lake development project. In addition, VITTI was the consultant on the Gulshan- Banani-11 new bridge project, which involved water related urban design solutions.

The directors of VITTI were involved as experts and activists during the project initiation process. The consultancy group made a presentation on behalf of the entire team, and they proposed something that was beyond their scope and terms of reference. However, the design concept was appreciated by the other stakeholders with some reservations, such as occupying major areas for landscaping, vegetation, and public space. Other stakeholders were more concerned about the amount of water retention and infrastructure, rather than socio-cultural issues such as public access, integration with surrounding neighbourhoods, and creating a pedestrian friendly environment. According to the architects from VITTI¹³, they wanted to introduce urban design elements that were absent in the initial proposition.

VITTI referred to the design as the 'Hatirjheel urban district', as they wanted to preserve its urban life. The deputy team leader¹⁴ of the VITTI-DMP-AIA consortium emphasised the scope of the project, which addressed public life, a dimension that was absent in the initial master plan. In addition, a concept was proposed for the integration of surrounding neighbourhoods.¹⁵ The team consisted of architects,

¹³ Ehsan Khan and Iqbal Habib were the architects and directors of the VITTI Sthapati Brindo Limited during the project initiation phase.

¹⁴ Architect Ehsan Khan was the deputy team leader of the project during the design process.

¹⁵ The VITTI recommended a special master plan exclusively for the surrounding neighbourhoods (approximately 250 meters along the wetland)

planners, environmentalist, and engineers. An eminent architect who is an academic and researcher¹⁶ was the adviser for the VITTI-DPM-AIA consortium for this project. The major ideas that were proposed by the team are listed below.

Table 7-2: List of Ideas proposed by VITTI for the Hatirjheel-Begunbari Integrated Development Project as Hatirjheel Urban District (Source: VITTI Sthapati Brindo)

1	Urban park in three different dimensions. Large urban park with plazas, activity spaces and vegetation. Medium and small urban park. Linear urban park with minimum 3+3 meter pedestrian and cycle path
2	Mixed-use development in the area as post-industrial site in the Tejgaon industrial area
3	Generate urban front as public precinct.
4	Restrict vehicular accessibility to avoid social gentrification
5	Integrate surrounding neighbourhoods to create stewardship for the project
6	Engage local people in design and management of the project
7	Segregation of local circulation from the bypass city circulation (express traffic)
8	Design aqueducts or bridges as a connection between different types of neighbourhoods and functional urban spaces.
9	Amphitheatre for 1000 people as an urban activity space
10	Internal bus service
11	Boat service
12	Souvenir shop
13	underpass and mobile food kiosk
14	Self- sustain project where overhead cost will be covered from the income of the project

During the implementation process Principal Architect¹⁷, from VITTI-DPM-AIA consortium, became the team leader for the project. According to the architect consultants¹⁸, only 60% of their ideas were implemented. The government, along with BUET, separated out different components of the project design and implemented them according to the priorities of the government. Excluded from the final design were several key features including a large public park, a thick vegetation belt along the wetland, a wide pedestrian path with bicycle lane, and several large public plazas, all of which would have increased the water retention capacity of the project. After the first part of the scheme had been implemented, a new team designed a special master plan for the surrounding neighbourhoods, which was one of the initial ideas proposed by VITTI.

¹⁶ Architect-academic Dr. Kazi Khaleed Ashraf.

¹⁷ Architect Iqbal Habib.

¹⁸ Architect Iqbal Habib and Ehsan Khan.

7.3.4 Project details

The project consists of 40 hectares of wetlands. It has significant infrastructure including 200 kilometres of different types of roads and footpaths, 8 bridges and/or aqueducts (including one pedestrian bridge) (Figure 7-11). This area has two 2 meter diameter trunk sewerage lines, which were redesigned to go along both sides of the canal. In addition, separator devices were installed to separate water from sludge. The previous trunk sewerage line was smaller than the new one, in the middle of the wetland, and was broken, resulting in contamination of the water every monsoon season. The eastern part of the canal is connected to the Banasree-Aftabnagar Canal through the Rampura bridge, and is also connected through a sluice gate to the Banasree-Aftabnagar canal, which is connected to the Balu River (Figure 7-10). The northern part is also connected with the Banani Lake and the Gulshan-Baridhara Lake. In contrast, the western part is not linked with other canals or lakes, even though it was connected to other water bodies until the early 1990's. According to BUET, IWM, and the DWASA, the catchment area of the Hatirjheel-Begunbari including surrounding wetlands is more than 30 square kilometres. This wetland is one of the vital water retentions for the city, and plays a major role in gravity drainage for eastern Dhaka.

Even though the landscape consultant (VITTI Sthapati Brindo) proposed a soft edge between land and water for the intervention, a harder edge was created. There is a thin green belt of vegetation along the edge; however, the project does not have large Public Parks, as a result of the large amount of space required for water retention and vehicular circulation. The pedestrian path proposed by VITTI Sthapati Brindo was 6 meters in width, including a bicycle lane, but the development agencies and the team leader of the project decided on a pedestrian walk that was just 0.9 meter wide. Despite such significant revisions, however, there scheme still retained some small public plazas along the pedestrian circulation, some of which are connected with bridges, Ghats, and look-outs; features which have evidently contributed to the popular success

of the project which has become one of the major public meeting places in Dhaka city for middle and lower middle income groups.¹⁹

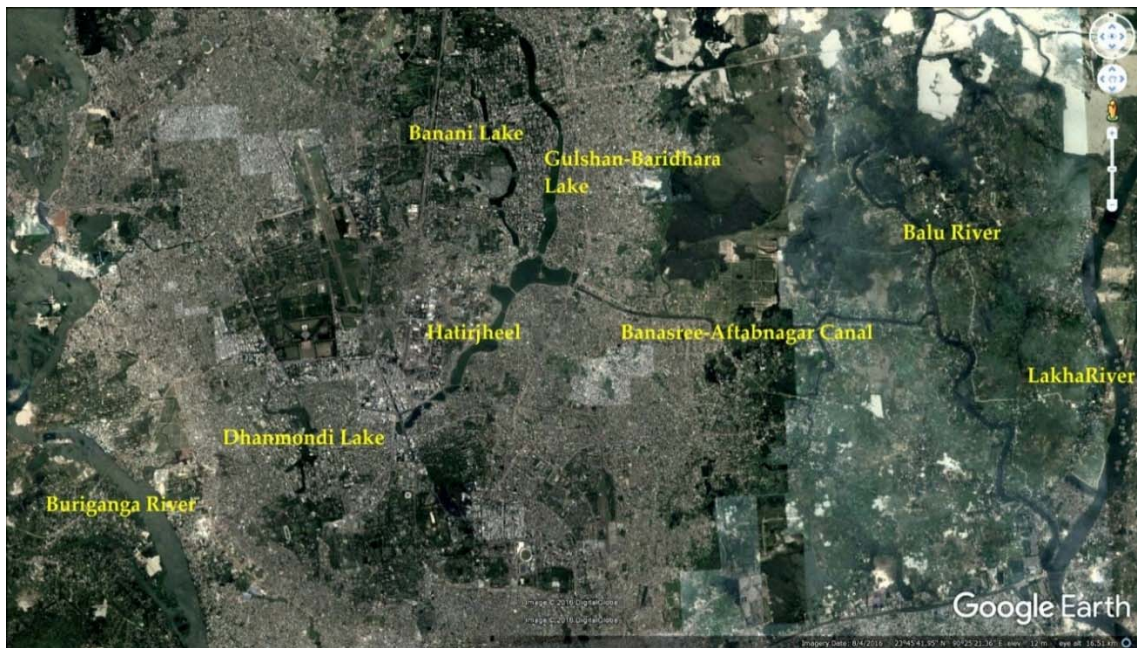


Figure 7-10: Hatirjheel and other water channel (source: Google Earth)



Figure 7-11: Photos of the Hatirjheel area (source: author and Selim Azad)

¹⁹ Findings from the interviews and physical survey.



Figure 7-12: Hatirjheel-Begunbari Integrated Development Project initial master plan with details designed by BUET (source: LGED)

Table 7-3: Project details of the initial master plan by BUET (source: LGED)

Initial project details (later modified) from the master plan by BUET (source: LGED)	
Length of the lake/wetland	6 KM
Total cost of the project	BDT 14.7359 billion
Cost of LGED part	BDT 1.7 billion
Cost of RAJUK part	BDT 12.1869 billion
Cost of DWASA part	BDT 0.7798 million
Consultancy of BUET	BDT 19.2 million
Funding	
GoB (government of Bangladesh)	BDT 13.2359 billion
Others	BDT 1.5 billion
Cost for different components	
Land acquisition cost	BDT 9.3353 billion
Total area	300 acres
Compensation of deconstruction of built environment	BDT 1.5774 billion
Cost of infrastructure development	BDT 2.8960 billion
Particulars of the project	
Peripheral road	11 km
Walkway	12 km
Connecting bridges	2
Panthopoth over pass	250 meter
Removal of sludge	57.8 million cubic meter
Construction of bus bay/bus stand	3
Parking area	2

Accessibility was one of the major priorities that this project attempted to address. Twenty-seven access points from the surrounding urban areas to the canal/lake were recommended by the BUET design team, while the consulting

landscape architects had also recommended a soft water-edge that would integrate with, and be accessed from the surrounding neighbourhoods. RAJUK nevertheless made a unilateral decision in 2014, without consulting the design team, to permit direct access to the peripheral road along the canal to two private land owners²⁰. Moreover, to control and manage such limited access more securely, the SWO and RAJUK²¹ decided to construct high solid walls along the road. Never imagined in the original scheme of the consulting designers, this hard and impermeable boundary (Figure 7-13 and Figure 7-19) segregated the project from nearby neighbourhoods contradicting the 'Integrated Development' philosophy of the project. As a consequence of the high boundary walls, the roads and footpaths within Hairjheel lost their character as streets, and their potential to be extended spaces for urban activities.

Architect consultant²² describes this controlled access approach as '*anti-public and anti-environmental*', while other critics characterise it as the obsession of a military mind-set, representing the recurring hard-line approach to water management and intervention that can be traced, as outlined in earlier chapters, throughout the urban development history of Dhaka. Urban design researchers argue that the intervention demonstrates an infrastructure bias combined with a drainage and a transport solution (Ahmed, F 2015; Ghafur 2013a). Equally disconnected, as a result, from the original natural water features of the site, as well as the surrounding neighbourhoods in any direct and therefore meaningful way, the project's critics argue that this infrastructure-intensive outcome is actually less resilient than the more organic approach originally proposed.

Nevertheless, this project is still recognised as a landmark project in the recent development of Dhaka in which it has been shown to be possible to create new public spaces and transport solutions not by eliminating, but by reclaiming wetlands. Interview respondents²³ anticipate that the Hatirjheel project, as a distinctive new

²⁰ According to the interviewees from the BUET design team both of these land owners are influential high government official

²¹ According to interviewees representing several different groups, the effective decision making and controlling authority in the current Hatirjeel project are RAJUK and the Bangladesh Military.

²² Architect Ehsan Khan.

²³ According to the architects who were involved in the design.

urban-activity sphere, will have a ripple-effect on the development of the metropolis as a whole.

7.3.5 Challenges during project implementation

Land acquisition was the major challenge for the Hatirjhel project, which has been confirmed by all of the stakeholders who were interviewed. Land owners from some of the areas²⁴ within the project area held a huge protest during the implementation, with a very large number of the protestors being residents from the Daspara neighbourhood. According to the team leader of the project, a few hundred people (along with some journalists) went to BUET to protest, as the BUET team was the leading advisor to and consultant on the project, during the initial implementation phase. The design team (along with other stakeholders) have stated that RAJUK did not want to take responsibility for critical issues and criticism during the implementation process. Eventually, initial disputes were resolved through military intervention and compensation. However, RAJUK is still facing 72 cases filed in the courts (Kumar 2012).

The development authorities had to acquire around 265 acres (107.242 hectares) of land, while Eastern Housing²⁵ planned to develop upper income housing that required 142 acres of land, and 90 acres were required for the designated wetlands, which was acquired by the government for this project. A majority of this land was grabbed by land speculators and other interested parties, who included powerful people such as political leaders, institutes, corporations, and land developers. The cost of the land acquisition was immense, being almost half of the cost of the total project.²⁶ Most of this land was under the '*court of wards*,'²⁷ originally owned by the landlord Bhawal. This land had been offered to local people as lease for free land to produce

²⁴ According to the team leader of the Hatirjheel project, residents from two suburbs or neighbourhoods profoundly protested the land acquisition.

²⁵ The Eastern Housing is of the oldest and largest private developer company in the country.

²⁶ Total project cost in the phase one was approximately USD \$ 230 million

²⁷ Land act (Act no. IX of 1879). The '*Court of Wards*' was a legal body created by the East India Company on a model similar to the '*Court of Wards*' and Liveries that had existed in England from 1540 to 1660. Its purpose was to protect heirs and their estates when the heir was deemed to be a minor and therefore incapable of acting independently.

agricultural products during the early twentieth century. One of Bhawal's gardens with a villa still exists in the Tejgaon area, now a part of the Bashar Air Base.

In cases where the legal owners of land could be identified, the government had to pay compensation, which a majority of the inhabitants believe was not enough. The VITTI Sthapati Brinda had a proposal for additional compensation: providing apartments on site along the wetlands for people who lost their houses in the process of land acquisition. 176 apartments were built by the government, in multi-storied housing units designed by a separate architectural firm. The VITTI Sthapati Brindo, BUET, and professional and activist groups applied pressure to have the illegal BGMEA (Bangladesh Garments Manufactures and Exports Association) building removed. Moreover, on several occasions the High Court issued orders to demolish the building (Hossain, M 2013; Sarkar 2011). However, the government and development control agencies were initially reluctant to take action. RAJUK finally decided to demolish the BGMEA building in 2016, after the Supreme Court issued a final order (bdnews24.com 2016; Prothom Alo 2016).

Handling the issue of displacement was another significant challenge (bdnews24.com 2016; Prothom Alo 2016). Nearly 400 informal settler families were evicted without any compensation (Ahmed, F 2015; Ghafur 2013b; Nabil 2013; The Daily Star 2008a). The informal settlers did not have legal rights over the land and they were removed by the development authorities in 2008 (Figure 7-20) (The Daily Star 2008b). Later on, in 2011 and 2012, more temporary settlements were demolished to reclaim the land and the wetland. The marginalised people did not have the power to protest against the evictions and they were displaced. At the same time the government could not remove some of the illegal occupants for a number of reasons, such as sensitive structures and disputes (Mahmud, Abu Hayat 2014a).

Constructing roads over the sludge was another major challenge, as the soil condition was bad in that area. Separating the sludge from the storm water was another major task, which was necessary to maintain water quality. Political will played a major role in the project, enabling the intervention to accomplish its purposes. It empowered the organised agencies to remove illegal land grabbers. Stakeholders had diverse priorities during the planning and implementation process, which

influenced the project. The reconstructed wetland was eventually built after overcoming many issues.

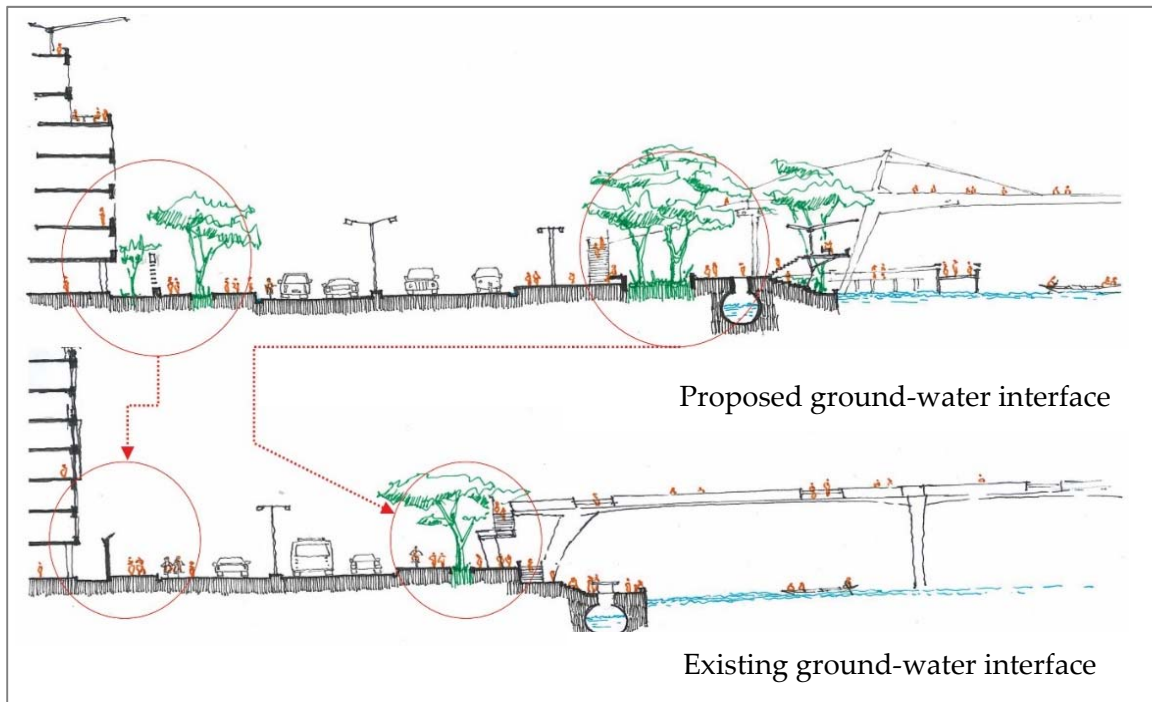


Figure 7-13: Conceptual sketch of typical canal/lake edge section as originally proposed by landscape consultants (VITTI), and as built (source: conceptual sectional analysis from the field survey findings).

7.4 Impact of the urban regeneration: Post construction scenario and findings from the field survey

This section of the chapter explains the impact of the intervention from both an environmental and socio-cultural perspective. It also presents the impressions of the questionnaire respondents from the Hatirjheel area. This part explains the post construction scenario from the findings of the field survey, which includes a physical survey, interviews, and a questionnaire survey.

7.4.1 Physical and environmental impact of the reconstructed wetland project

Actively applying the concept of water urbanism which, as discussed earlier, treats landscape as a key system of urban infrastructure (Shannon 2009; Shannon &

Moulder 2008; Shannon & Smets 2010), the Hatirjheel project has intervened in a major way in natural drainage and communication, with significant impact on both the immediate physical form of the city, and its broader environmental performance. As the retention basin is working as a part of the natural drainage system the environmental benefits are noticeable, because the project is connected with the other wetlands and major downstream outlets. According to experts, drainage has improved markedly in surrounding areas. A 5% increase in rainfall over the last fifty years, due to climate change, has had a great impact on flash flooding and water clogging in Dhaka, which have been exacerbated by rapid urbanisation and land filling of wetlands (Afrin, Islam & Rahman 2015). Conserved and partially reconstructed as the central feature of the Hatirjheel Integrated Development, the Hatirjheel-Begunbari Canal is, itself, the largest retention basin in Dhaka, with a direct catchment area of approximately 30 km² (Afrin, Islam & Rahman 2015). It therefore plays a particularly important role in natural drainage during the monsoon and flash flood season.

Among the questionnaire respondents, a majority of them believe that the project brought breathing/open space to the city (Figure 7-29). In addition, the waterfront public spaces (including the pedestrian network) encourage public activities such as walking, jogging, and socialisation. The project certainly increased accessibility, connecting different areas through vehicular roads, pedestrian paths, and bridges. The questionnaire survey also revealed that a majority of respondents (82%) in the Hatirjheel-Begunbari area consider traffic congestion to be a major problem for the city (Figure 7-14). According to the questionnaire respondents, other major problems affecting the neighbourhoods surrounding the wetland include public transport, cost of living expenses, pollution, population, energy issues, and a lack of security. It is remarkable that the water issue was not mentioned by the majority of the respondents among the five major problems that the city faces.

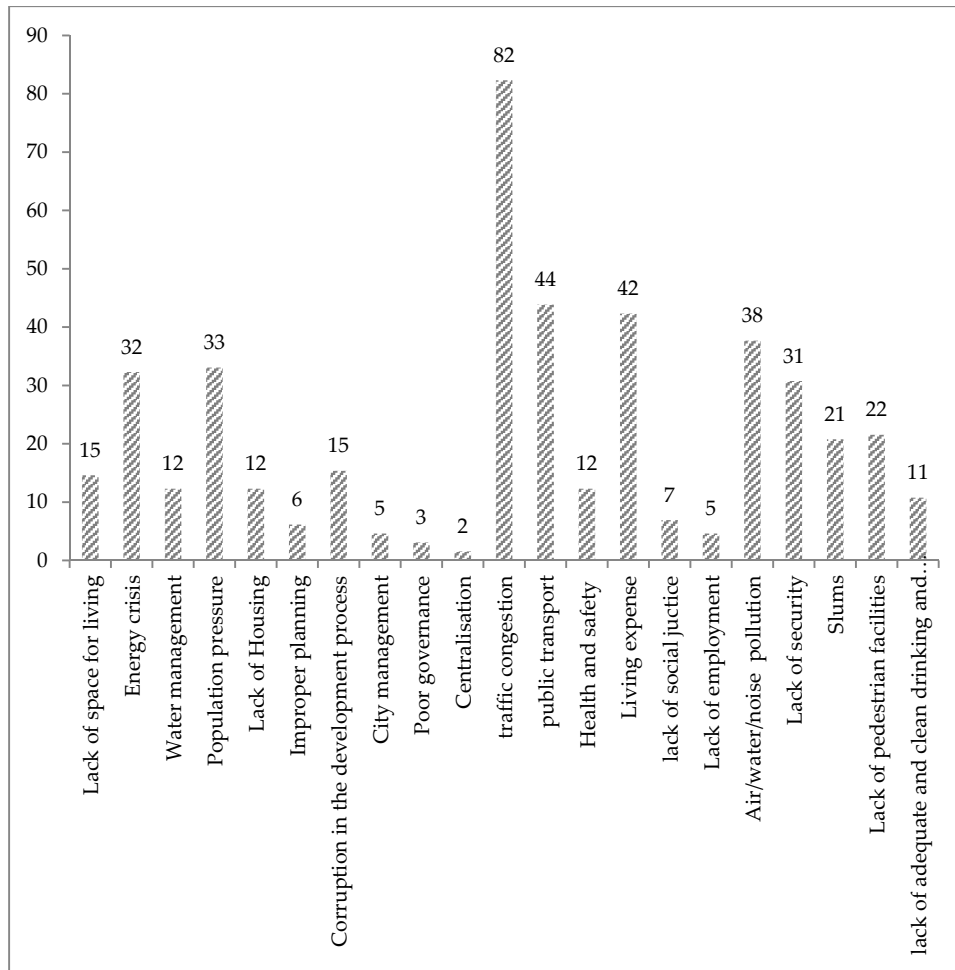


Figure 7-14: Major problems (in %) according to respondents of the Hatirjheel-Begunbari surrounding area

The majority of the respondents (87.7%) in the Hatirjheel area believe that Dhaka’s existing water bodies should be protected, compared to other areas, such as Bashundhara, where 27.2% of the respondents were not aware of the issue (Figure 7-15). The majority of the inhabitants of the Hatirjheel area were concerned with issues that impact on wetlands and drainage: poor drainage (70%), filling up the wetlands (27.7%), maintenance (24.6%), and management (16.2%) (Figure 7-17). According to experts these are the issues that contribute to water clogging as a result of rapid urbanisation. A majority of the respondents believe that to solve water clogging, the city needs a better (52.3%) and integrated (27.7%) drainage system (Figure 7-18). This illustrates that the population of Hatirjheel are conscious of drainage issues. In addition, a majority of the respondents in the Hatirjheel area believe that reclaiming the wetland is an important intervention for sustaining the natural environment.

			Do you think Dhaka's existing water bodies should be protected			Total
			No	Yes	Not aware	
Case study area	Bashundhara	Count	2	81	31	114
		% within case study area	1.8%	71.1%	27.2%	100.0%
	Hatirjheel	Count	3	114	13	130
		% within case study area	2.3%	87.7%	10.0%	100.0%
Total		Count	5	195	44	244
		% within case study area	2.0%	79.9%	18.0%	100.0%

Figure 7-15: According to the respondents do Dhaka's water bodies should be protected

			Do you think Dhaka's lost water bodies should be reclaimed?			Total
			No	Yes	Not aware	
Case_study area	Bashundhara	Count	7	67	42	116
		% within Case_study_area	6.0%	57.8%	36.2%	100.0%
	Hatirjheel	Count	18	77	32	127
		% within Case_study_area	14.2%	60.6%	25.2%	100.0%
Total		Count	25	144	74	243
		% within Case_study_area	10.3%	59.3%	30.5%	100.0%

Figure 7-16: Relationship between case study area and the response of the respondents on whether they think Dhaka's lost water bodies should be reclaimed.

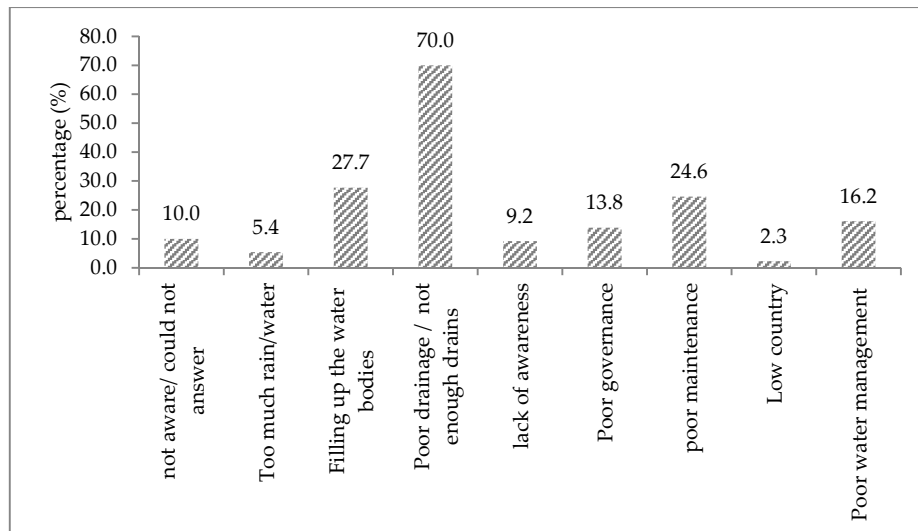


Figure 7-17: Reasons for water clogging, according to the residents of the Hatirjheel-Begunbari and surrounding areas

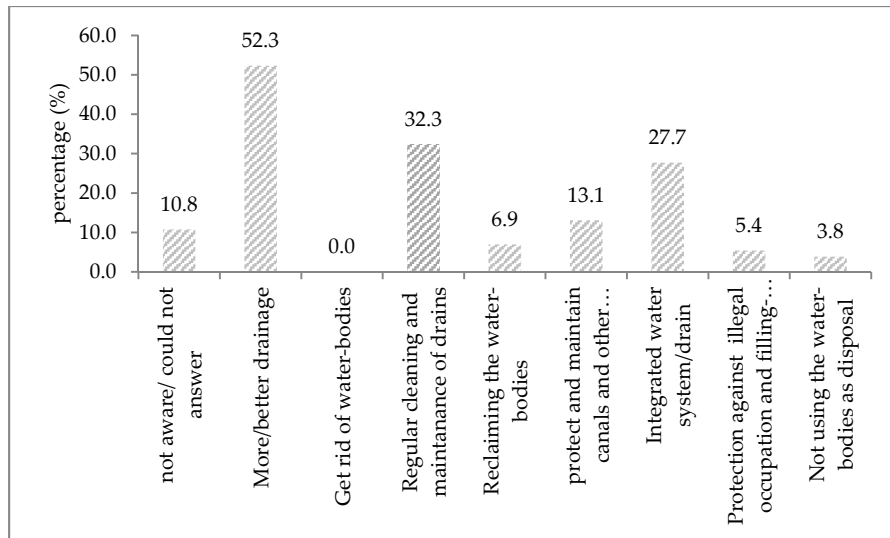


Figure 7-18: Possible elucidate of water clogging according to the respondents in the Hatirjheel-Begunbari area

This research found that the reclamation of wetlands depends on a combination of people's awareness, political will, and the mind-set of development agencies. The study found that 59.3% of respondents in the Hatirjheel area consider that Dhaka's lost water bodies should be reclaimed (Figure 7-17). Moreover, respondents from other case study areas, such as Bashundhara, have a similar point of view. About 57.8% of respondents in the Bashundhara area believe that water bodies should be reclaimed to restore natural drainage. Still, it is notable that substantial proportions of the people surveyed are not aware of these issues in either Hatirjheel (25.2%) or Bashundhara (36.2%).

7.4.2 Socio-economic aspects of the post construction scenario

The Hatirjheel-Begunbari Integrated Development project has impacted on socio-cultural and economic aspects of inhabitant's lives. According to the experts,²⁸ land ownership is being transformed, which has led to land speculation and social gentrification. Experts believe that major residential neighbourhoods within the Hatirjheel area might be converted into mixed used high-rise residential areas with more commercial enterprises, which will lead to significant levels of social gentrification. A similar transformation was observed after the Dhanmondi Lake

²⁸ According to the interviewees who are experts on this projects.

Development Project. According to the questionnaire survey, in 2014 a majority of the buildings were single residences (73.6%) in the Hatirjheel area (Figure 7-21), and only 10.7% of the buildings in the Hatirjheel area were apartments. Urban design researchers believe that the current development trend will cause the area to be transformed more quickly as a result of real-estate development. Many billboards were observed in slums and on vacant land during the field survey, advertising mixed use projects in place of single unit residences (Figure 7-19).

Many informal settlers and land owners were displaced as a result of this project. In addition, this project removed 200 small businesses and shops during construction without proper compensation (Kumar 2012). The government compensation was 86,000 BDT, while the actual value of the land was at least twenty times more than what the government paid. In many cases the high court issued stay orders, but during 2008 and 2009 the military backed interim government used the SWO (a unit of the Bangladesh Military) to acquire this land.



Figure 7-19: Example of gentrification through transformation of land use and the boundary between neighbourhoods and the project.



Figure 7-20: Hatirjheel area during the construction in 2011, eviction of informal housing (source: Prof. Dr. Shayer Ghafur)

			Building type									Total
			Single residence apartments	offices	shops	industrial	mixed used residential	mixed used commercial	institutional	Others		
Case study area	Bashundhara	Count	5	83	3	9	2	11	1	6	0	120
		% within Case study area	4.2%	69.2%	2.5%	7.5%	1.7%	9.2%	0.8%	5.0%	0.0%	100.0%
	Hatirjheel	Count	89	13	2	0	1	7	0	2	7	121
		% within Case study area	73.6%	10.7%	1.7%	0.0%	0.8%	5.8%	0.0%	1.7%	5.8%	100.0%
Total		Count	94	96	5	9	3	18	1	8	7	241
		% within Case study area	39.0%	39.8%	2.1%	3.7%	1.2%	7.5%	0.4%	3.3%	2.9%	100.0%

Figure 7-21: Relationship between the case study area and building type

21.5% of respondents are from the lower income group in the Hatirjheel area compared to the planned Bashundhara residential area. In addition, a large portion (40.8%) of respondents belong to the lower middle income group (Figure 7-23).

According to the experts, this demography may change as a consequence of the real estate venture. Experts believe that this intervention will increase both formal and informal economic activity. Meanwhile, the lower income group will most likely be forced to move from the area as they find themselves priced out of the property market. Indeed, 9.2% of the respondents (Figure 7-30) believed that the intervention had increased the cost of rent and property, which encourages redevelopment. In terms of ownership patterns, the majority of respondents are property owners, and most of the houses are single family dwellings rather than apartments, which would

most likely be rented in Dhaka (Figure 7-21). If the single unit residences are transformed into multi-story housing with commercial enterprises, it will have an immense impact on traffic, energy demand, infrastructure capacity, and living conditions.

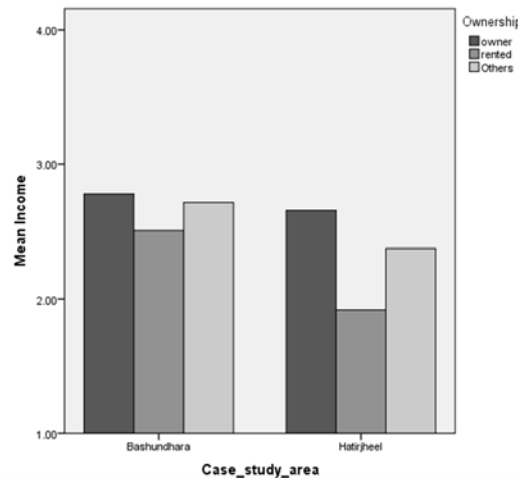


Figure 7-22: Ownership patterns in the case study areas

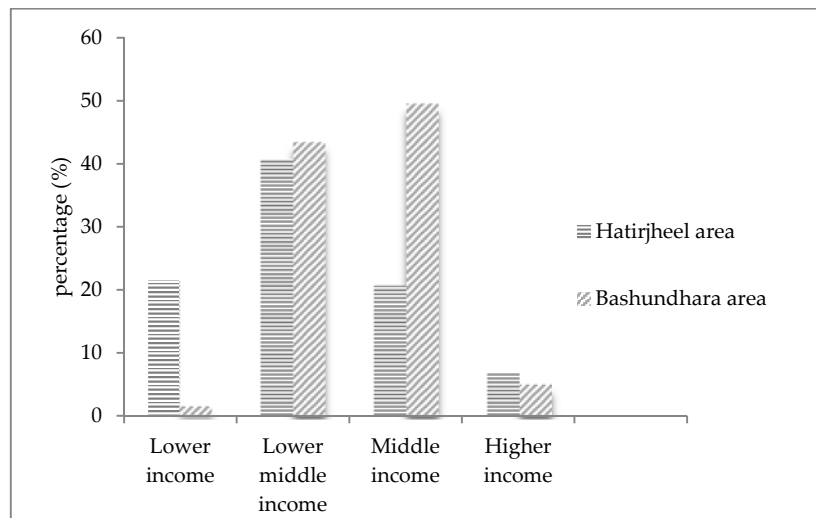


Figure 7-23: Economic strata within the case study areas

Hatirheel brought public space and breathing space back to the city, so people from the surrounding areas visit the public area around the wetland more frequently for a variety of purposes. In order to analyse the relationship between the two case study areas, Bashundhara and Hatirjheel, and the responses to whether the respondents visit, or use, any type of water bodies in the city regularly, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p= 0.00$) was observed in the relationship between the two case study areas and the responses.

Respondents in the Hatirjheel (76%) area visit, or use, water body areas in the city more frequently compared to the respondents from Bashundhara (40%) area (Figure 7-24). During the field survey it was evident that the public spaces along the hatirjheel-begunbari canal are used extensively by different groups of people for multiple purposes, such as walking, jogging, meeting people, relaxing, cycling, playing (Figure 7-25), and some of the larger public spaces are used for different cultural activities. The intervention supports people who are part of the informal economy, such as mobile food vendors and other hawkers. According to the interviewees and physical survey, the surrounding areas are in the process of economic growth, as the waterfront features and improved accessibility will encourage people to transform their land use patterns into more profit driven activities.

			Do you visit or use any type of water bodies in the city regularly?		Total
			No	Yes	
Case study area	Bashundhara	Count	66	44	110
		% within Case study area	60.0%	40.0%	100.0%
	Hatirjheel	Count	31	98	129
		% within Case study area	24.0%	76.0%	100.0%
Total		Count	97	142	239
		% within Case study area	40.6%	59.4%	100.0%

Figure 7-24: Percentage of people using or visiting wetlands in both Hatirjheel and Bashundhara area



Figure 7-25: Informal economy and public activities in the Hatirjheel-Begunbari area (source: author and BDnews)

7.4.3 Impressions of the residents around the Hatirjheel project

Research discovered the perspectives of the respondents in the Hatirjheel area through the questionnaire survey. The questionnaire survey found that 38.5% of respondents were living in these neighbourhoods as a consequence of having inherited property from their ancestors, or because members of their family live in the same area. A majority of respondents live in these neighbourhoods for functional reasons, typically for ease of accessibility (22.3%), and closeness to work (32.3%) and school (17.7%) (Figure 7-26). 15.4% of the respondents identified economic factors, such as affordability, for choosing the neighbourhoods. However, only 13.8% of the respondents acknowledged environmental factors for living in these areas, such as a good environment, water front living, availability of open space, and parks. Through the questionnaire survey it was found that functional and socio-economic reasons were more important than environmental factors for the residents.

Even though the reconstructed wetlands have roads, infrastructure, and drainage, the residents have complaints about poor infrastructure (29.2%), including for water clogging (28.5%), noise and water pollution (23.8%), squatter settlements (26.2%), the sewerage system (23.8%), and lots of other issues (Figure 7-27 and Figure 7-28). The questionnaire survey outcomes represent the day to day experiences of the residents, which reflect how the intervention impacts on residents in these neighbourhoods. Residents of the Hatirjheel area feel that the water body brings positive impacts to these urban areas. Residents were asked about their impressions of the project, and 66.2% of respondents believe that it has a positive influence on their neighbourhoods and on the city (Figure 7-28). While 26.9% of respondents believe that the project has both positive and negative aspects to it, only 6.9% of respondents perceive that the project has a purely negative impact on their neighbourhoods. A majority of the respondents in the Hatirjheel area believe that high traffic intensity in the area poses a threat to pedestrians. As a result of poor physical and visual

permeability of the canal side public area in relation to the surrounding neighbourhoods, due to solid walls, many cases of vandalism have been reported.²⁹

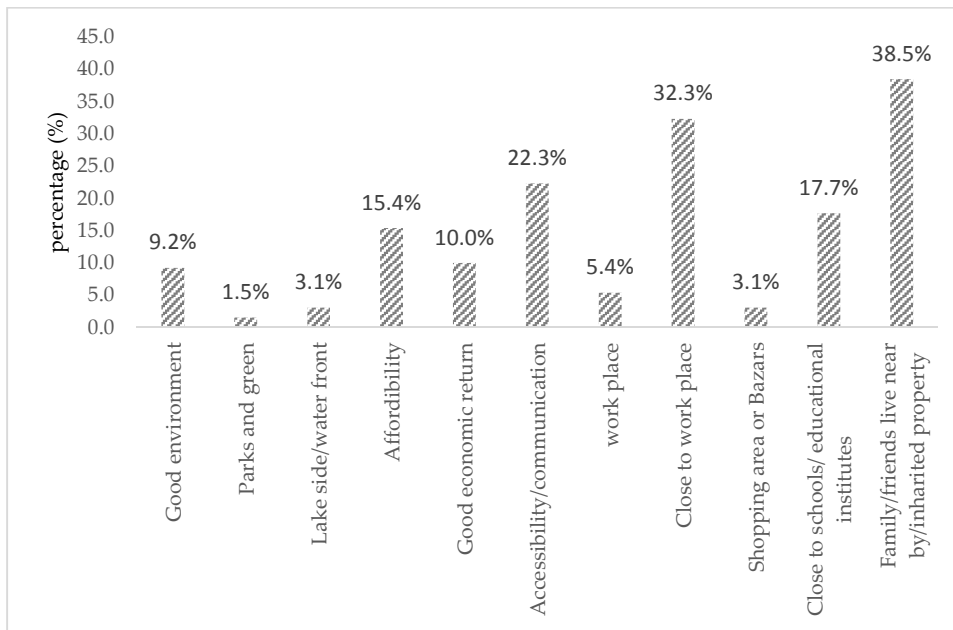


Figure 7-26: Residents' reasons for choosing the neighbourhoods, or positive aspects of the neighbourhoods for the Hatirjheel-Begunbari area

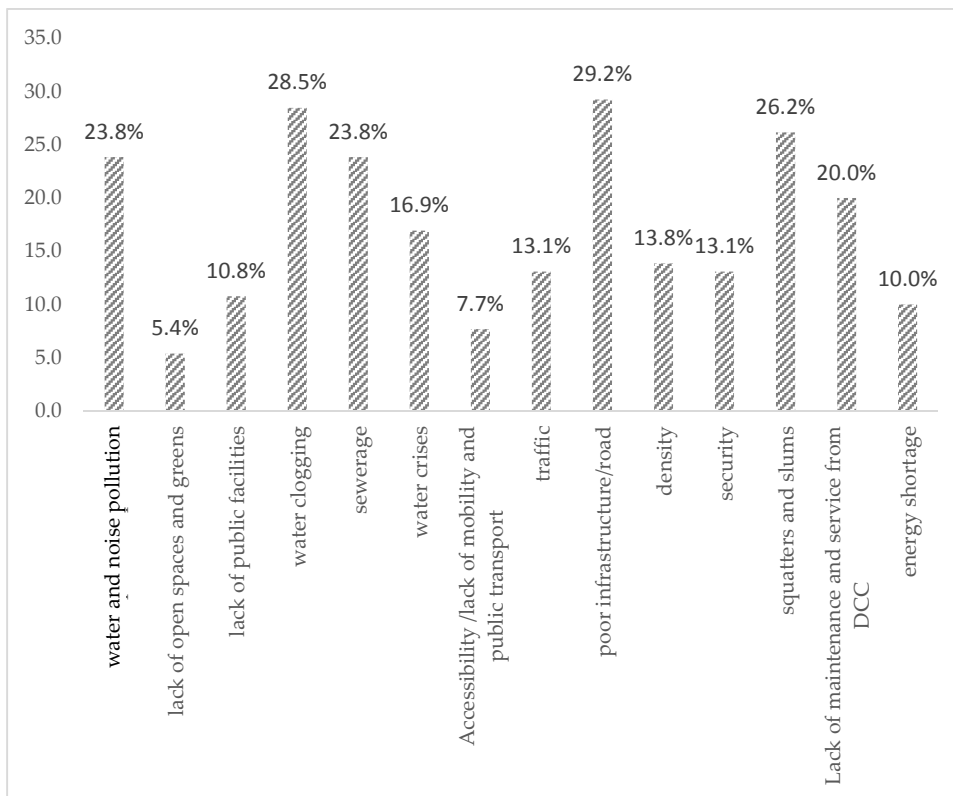


Figure 7-27: Residents' negative perceptions of the neighbourhoods

²⁹ A majority of the interviewees commented on the vandalism issue in the Hatirjheel area such as mugging. On top of that, during questionnaire survey many respondents expressed their concern about the issue when they were asked about the negative features of the intervention.

It has been observed from the questionnaire survey findings that people in the Hatirjheel area have a greater association with water compared to other urban areas where water is not part of the neighbourhood. In order to study the relationship between the two case study areas, the Bashundhara Township and the Hatirjheel neighbourhoods, and the responses on whether water bodies bring positive or negative effects, a cross-tabulation was, once again, conducted in SPSS. A statistically significant difference ($p= 0.00$) was observed in the relationship between the two case study areas and the responses of the residents on whether water bodies bring positive or negative effects. About 32.1% of the respondents in the Bashudhara Township expressed that water bodies do not bring any positive aspects, whereas, as previously noted, only 6.9% of the residents in the Hatirjheel area expressed a negative perception of water (Figure 7-28). It is clear that the population of the Hatirjheel area are more aware of the positive aspects of the wetland as they are experiencing the impacts first-hand. In contrast, people who live in the Bashundhara Township, which was basically built by filling up the low lands, do not have any attachment to any wetlands. As a result, most of the people in this area are not aware of the positive aspects of wetlands, as they only experience the flooding and water clogging caused by the destruction of wetlands (as explained in the previous chapter).

According to the respondents in the Hatirjheel area, visual aspects and open space are the two most positive outcomes of the project (Figure 7-29). 64.6% of the respondents claim that the project gave these neighbourhoods a face-lift. In addition, 60.8% of people feel that the project introduced open public spaces for diverse public activities. Respondents were also concerned with environmental and accessibility issues, which improved after the intervention, while only 2.3% of respondents commented on drainage after the wetland intervention (Figure 7-27). 28.5% of respondents claim water clogging is still a major problem, even though development actors claim that the project solved a major water drainage problem. Critics argue that the drainage solution for the Hatirjheel-Begunbari Integrated Development Project is not comprehensive enough, unless the project integrates with the entire drainage system, and unless the entire water drainage system is separated from the Sewerage

system in Dhaka. The questionnaire survey discovered that the perspectives of respondents in the Hatirjheel area differ significantly from the experts and development actors.

		Negative	positive	Both	Not aware	total	
Case study area	Bashundhara	Count	35	40	31	3	109
		% within Case study area	32.1%	36.7%	28.4%	2.8%	100.0%
	Hatirjheel	Count	9	86	35	0	130
		% within Case study area	6.9%	66.2%	26.9%	0.0%	100.0%
Total		Count	44	126	66	3	239
		% within Case study area	18.4%	52.7%	27.6%	1.3%	100.0%

Figure 7-28: Relationship between case study area and whether water body brings positive/negative effects.

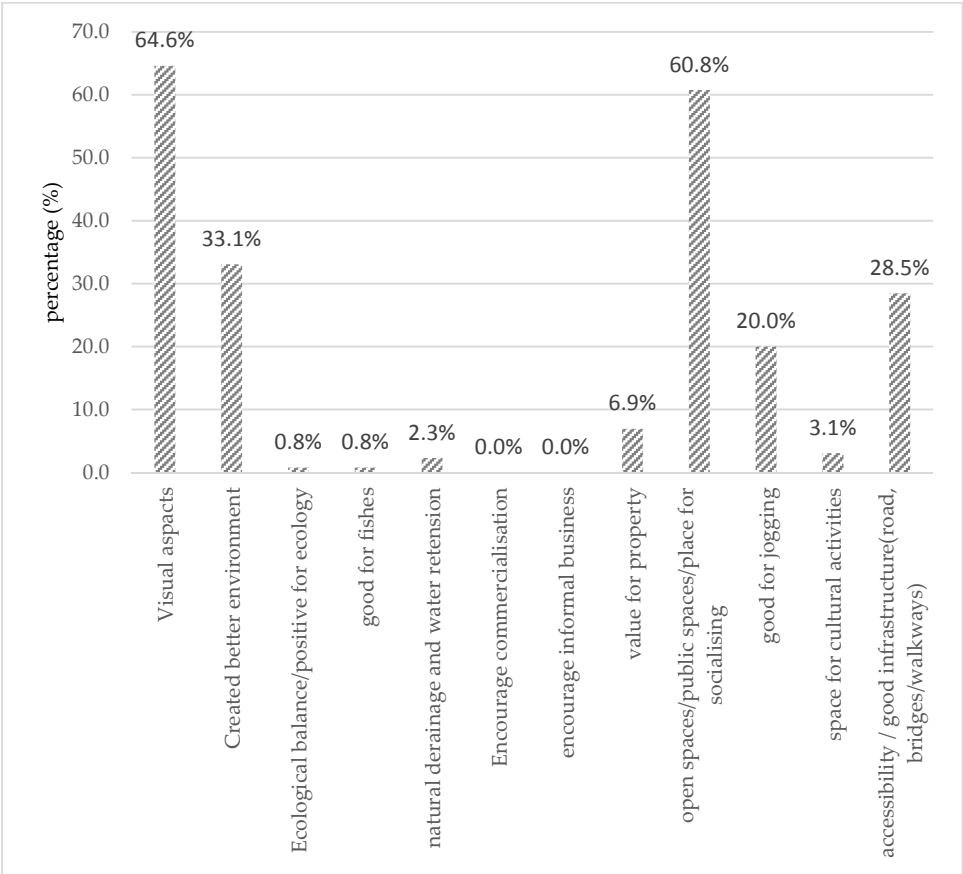


Figure 7-29: Positive aspects of the reconstructed wetlands according to residents.

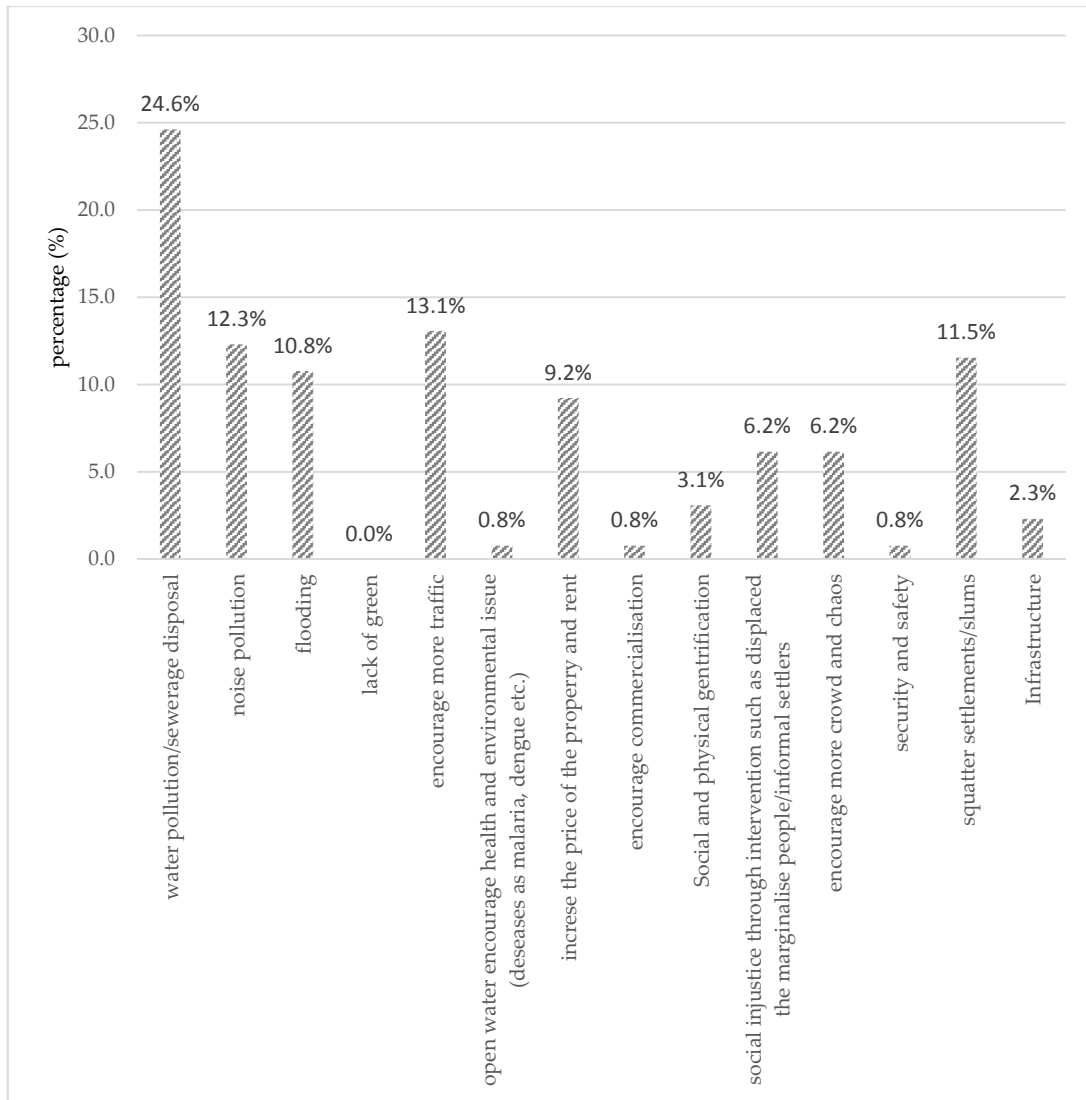


Figure 7-30: Negative aspects of the reconstructed wetland according to residents.

7.5 Future scope for Hatirjheel

The project has plenty of opportunities to perform better in terms of environmental, economic, and social outcomes. The second phase of the project is very important, because it could help to sustain the area in the future, as the experts expressed in their interviews. The project is currently in its second phase of design and implementation, which began in 2014. In addition, a special detailed area plan to integrate the wetland with the surrounding neighbourhoods is currently being designed. At present the project is under the control of the RAJUK and the Bangladeshi Military, who have been making decisions about the second phase since 2014 without

consulting with the original designers.³⁰ As a consequence, some top down decisions have been made, and many of their decisions have been criticised and rejected by both experts and residents of the neighbourhoods. For instance, a special detailed area plan was commissioned from Ahsanullah University of Science and Technology, and they presented the project concept in 2014. The idea was rejected by the experts in the meeting. According to the interviewees who were present in the proposal presentation, the main reason for the dismissal was shallow planning, which did not consider the stakeholders. The experts discarded the proposal as, from their perspective, it was superficial and unrealistic. One of the ideas was to have more transparent built forms for visual accessibility, with staggered buildings. According to the experts, the concept did not offer a working solution, and there was minimal input from architects, planners, sociologist, and environmentalists. The initial team only consisted of engineers, even though the project is a planning and urban design venture. As the proposition was not accepted by the professionals, the design of the second phase is under scrutiny. After the first presentation the team involved experts and designers from other disciplines. However, people from other disciplines, such as architects, planners, and environmentalists, have had minimal involvement in the planning process.³¹

Though several aspects of the project have been successful, through investigation weaknesses have been identified. A more holistic focus on ‘water culture’ has led to Hatirjheel becoming a major open public space for the city. The Hatirjheel-Begunbari integrated development project demonstrates the future possibilities of reclaiming wetlands for drainage and integrating them with open public spaces, green spaces, and major infrastructure in similar contexts. Activists and professionals have been advocating for similar projects with more comprehensive solutions, which could play major roles in natural drainage and open public spaces, to restore ecological diversity.

³⁰ According to the interviewees of the stakeholders of the project.

³¹ According to the interviews who were involved in the project and one current member of the master plan designer of the Hatirjheel area.

7.6 Conclusion

This chapter has examined recent urban development processes in Dhaka from the perspective of wetland conservation and reconstruction. It identified the significance of the embedded factor of the planning process in realising successful urban development through this approach, focusing on the case of the Hatirjheel-Begunbari Integrated Development Project, which was undertaken by organised government controlled development agencies and actors under a particular political regime. This chapter presented the collected evidence of the physical survey and questionnaire-based sampling of the impressions of the reconstructed wetland by respondents from the surrounding neighbourhoods. Through investigation, this chapter demonstrated the impacts of such interventions on the environment and society.

Admittedly, the initiation of the Hatirjheel project represents a substantial intervention in recent urban development history, which is a reflection of collective awareness and political will. The project offers a designed landscape infrastructure that enhances the efficiency and quality of urban life. Moreover, this development scheme can work as a continuous ecological corridor, along with being an integrated drainage network, if incorporated with other wetlands and green networks in the future. However, the project has many major drawbacks, such as displacement, a hard-engineering intervention with infrastructure bias, and social gentrification. The government and development actors orchestrated the project as a model of urban development. It is certain that the intervention is a major example for future development of similar cases. The project became an inspiration for the city, stimulating public and political awareness and thereby re-establishing the importance of wetlands, natural drainage, and water culture, which may be needed to sustain Dhaka in the future.

Chapter 8

Discussion and Comparative Analysis of the Case Studies

8.1. Introduction

This chapter discusses the major findings of this study, and how these may be interpreted to answer the primary research question, which was the following: ‘Is ‘water-urbanism’ – a ‘wet’ approach to urban design and planning – a more sustainable paradigm for the future development of low-lying mega-cities like Dhaka than prevailing ‘dry’ approaches?’

Considering the assembled evidence, past and present, the discussion seeks to review and articulate more clearly the key factors and their respective logics that can explain the historical transformation of Dhaka from a traditional water-based settlement to an increasingly ‘high-and-dry’ modern metropolis. Reviewing, moreover, the specific cultural and institutional practices relating to water management that have been observed under different regimes between the colonial and contemporary era, the discussion proceeds to articulate and interpret influential factors that have become embedded in the institutional frameworks and culture of the plan-making process itself, and how these have influenced the different modes of water intervention observed.

The two contemporary case studies and the longer-term pattern of preceding colonial and modern developments presented in the previous chapters illustrate three different modes of intervention through which water has been managed in Dhaka, historically. Viewed from a macroscopic perspective, the first intervention involves the taming of natural flows of waterways via engineered embankments and further fortification of natural watercourses such as box culverts. The second intervention involves the construction of new lands by land filling within the wetlands and low areas (flood flow and sub-flood flow zones). The third intervention involves the reconstruction and/or restoration of wetlands. All three modes of intervention are evidently interrelated, however, some being the consequences of others. This penultimate chapter of the thesis therefore seeks to make clearer some of these ambiguous but important complexities and contradictions in recent perception and practice, beginning by resuming and extending the comparative analysis and

discussion of the findings from the case studies of the two competing paradigms in Dhaka's current urban development – constructed land, and reconstructed wetlands.

8.2. Constructed land versus reconstructed wetland: a comparative analysis of contemporary approaches towards urban development

This section focuses on a comparative analysis of the two contemporary urban developments in Dhaka outlined in the previous two chapters. This section illustrates how people's perception and impression of water and wetlands in Dhaka vary depending on the type of urban development. It is evident from the field survey that people's attitude towards water varies, depending upon the type of neighbourhoods in which they live. The findings from the questionnaire survey explain how water is situated in the mind of the stakeholders who live in the city.

The field survey comprised a pair of sub-studies focusing on two very different kinds of urban development. One type – ostensibly influenced by theories of 'water-urbanism' current in contemporary international urban and landscape design discourse – is creating value by creating water through reconstruction (restoring) or re-development of the wetlands, reclaiming or protecting lakes, canals and other water-bodies (i.e. Hatirjheel-Begunbari Integrated Development Project). The second type of intervention is creating value by filling in surviving water bodies and lowlands to construct new building sites (i.e. the Bashundhara area). But value is measured by profit in both cases. Apart from environmental and social factors, both types of urban development are also influenced, as discussed in the previous chapters, by powerful real estate and political interests.

Environmental concerns, such as water drainage and mobility, are some of the major considerations for the reconstruction of wetlands in the Hatirjheel-Begunbari integrated development project. However, the Bashundhara is developed as a gridiron pattern without considering the natural features. By contrast, half of the surrounding areas or neighbourhoods of the Hatirjheel have developed spontaneously. As those

areas developed in a very different way in relation to the wetlands, residents in Hatirjheel and Bashundhar value water differently.

In order to study the relationship between the two case study areas (Bashundhara and Hatirjheel), and the responses as to whether the new land developments consider the natural landscape and water bodies in their planning processes, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p=0.05$) was observed between the two case study areas and the responses. From the responses it was found that more of the respondents in Hatirjheel (45.2%) considered that the land developments (new townships) developed via landfills do not consider the natural landscape and water bodies in their planning processes, as compared to the responses from Bashundhara (30.8%). In addition, in the case of the Bashundhara area more than half of the respondents (56.4%) are not aware of the landfill issue compared to the Hatirjheel area (41.9%). In general, almost half of the respondents from the total questionnaire survey are not aware of the issue of filling up the wetlands and natural landscape in order to construct land for development projects. Therefore, it is evident that a large number of residents are unaware of the process and implications of constructed land, which have destroyed natural drainage and the eco-system, and displaced many people.

		No	Yes	Not aware	Total
Case study area	Bashundhara	Count	36	15	66
		% within Case study area	30.8%	12.8%	56.4%
	Hatirjheel	Count	56	16	52
		% within Case study area	45.2%	12.9%	41.9%
Total	Count	92	31	118	
	% within Case study area	38.2%	12.9%	49.0%	100.0%

Figure 8-1: According to respondents if the new land development (landfill) projects are considering wetlands

The majority of the residents in both the case study areas opted to protect Dhaka’s existing water bodies. In order to study the relationship between the two case study areas and the responses on whether the respondents think Dhaka’s existing water bodies should be protected, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p= 0.002$) was observed in the relationship between the two case study areas. From the responses, it was found that more of the

respondents in the Hatirjheel area (87.7%) considered that Dhaka’s existing water bodies should be protected as compared to the responses from Bashundhara (71.1%) (Figure 8-2). In contrast, negative answers were negligible from the respondents from both of the areas. In the case of the Bashundhara residential area 27.2% of respondents are not aware of the wetland protection issue, which explains their view concerning the constructed land, as they are the residents of a land-filled area that does not have any direct relationship with water.

A further question considered the reclamation of lost water bodies in the two case study areas, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p= 0.041$) was observed in the relationship between the two case study areas (Figure 8-3). More than half (57.8% in the Bashundhara and 60.6% in Hatirjheel) of the respondents believe that wetlands should be reclaimed to restore the natural features. In comparison, a significant number of respondents (36.2% in the Bashundhara and 25.2% in Hatirjheel) are not aware of the phenomena of reclamation or reconstruction of wetlands.

Do you think Dhaka's existing water bodies should be protected?		No	Yes	Not aware	total	
Case study area	Bashundhara	Count	2	81	31	114
		% within Case study area	1.8%	71.1%	27.2%	100.0%
	Hatirjheel	Count	3	114	13	130
		% within Case study area	2.3%	87.7%	10.0%	100.0%
Total		Count	5	195	44	244
		% within Case study area	2.0%	79.9%	18.0%	100.0%

Figure 8-2: Relationship between case study area and the response of the respondents on whether they think Dhaka’s existing water bodies should be protected (cross-tab analysis)

Do you think Dhaka's lost water bodies should be reclaimed?		No	Yes	Not aware	total	
Case study area	Bashundhara	Count	7	67	42	116
		% within case study area	6.0%	57.8%	36.2%	100.0%
	Hatirjheel	Count	18	77	32	127
		% within case study area	14.2%	60.6%	25.2%	100.0%
Total		Count	25	144	74	243
		% within case study area	10.3%	59.3%	30.5%	100.0%

Figure 8-3: Relationship between case study area and the response of the respondents on whether they think Dhaka’s lost water bodies should be reclaimed (cross-tab analysis)

The study revealed that a majority of the questionnaire respondents consider that it is important to protect and reclaim the water bodies, regardless of their income group (Figure 8-4). It is evident from the field survey that respondents from the middle and lower middle-income groups are more aware of the issue of protection and reclamation of wetlands and natural features compared to the higher income group. During the field survey it was observed that this is best explained by the fact that lower income people spend more time outdoors (as a part of their recreation) and are more aware of the wetland areas (Figure 8-5).

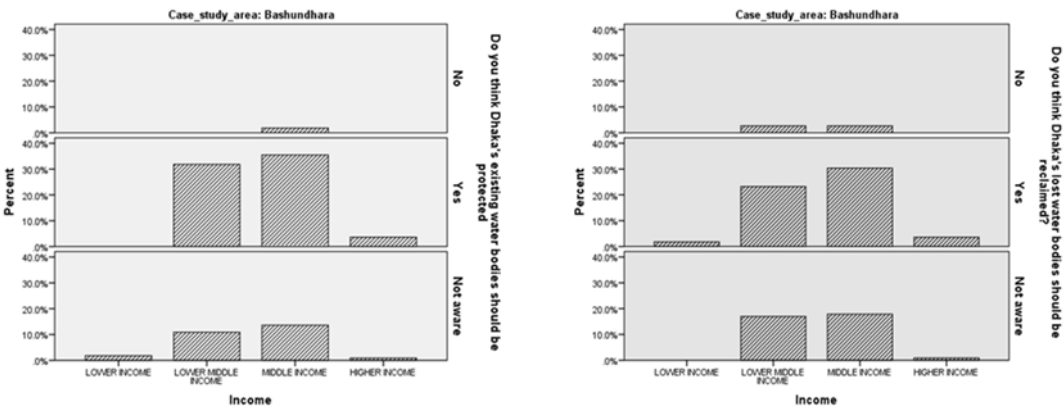


Figure 8-4: Relationship between income group and respondents views on protection and reclamation of water bodies in the Bashundhara area as a result of its water bodies and prefer lower housing density



Figure 8-5: Images showing public activities (walking, playing football, temporary vendors, meeting people etc.) in the Hatirjheel area along the canal (photos taken in 2014 during the field survey)

Hatirjheel brought public areas and breathing space to the city; hence, people around the area visit the wetlands more frequently for different purposes. In order to study the relationship between the two case study areas, Bashundhara and Hatirjheel, and the responses on whether the respondents visit or use any type of water bodies in

the city regularly, a cross-tabulation was conducted in SPSS. A statistically significant difference ($p= 0.00$) was observed in the relationship between the two case study areas and the responses. From the responses, it was found that more of the respondents in Hatirjheel (76%) considered that they visited or used some type of water body in the city more frequently as compared to the responses from Bashundhara (40%) (Figure 8-6). During the field survey it was evident that the public space along the Hatirjheel-Begunbari canal has been used extensively by people for multiple purposes, such as walking, jogging, meeting people, relaxing, cycling, skating etc. (Figure 8-5). Moreover, some of the larger public spaces have been used for different cultural activities and for alternative artists. In addition, the area supports people who are part of the informal economy, such as mobile food vendors and other hawkers. The surrounding area will experience economic stimulation as the waterfront features encourage accessibility and people transform their land use to more profitable ventures. At the same time, these phenomena will transform the area, which could lead to social gentrification.

Do you visit or use any type of water bodies in the city regularly?		No	Yes	total	
Case study area	Bashundhara	Count	66	44	110
		% within Case study area	60.0%	40.0%	100.0%
	Hatirjheel	Count	31	98	129
		% within Case study area	24.0%	76.0%	100.0%
Total		Count	97	142	239
		% within Case study area	40.6%	59.4%	100.0%

Figure 8-6: Percentage of people use or visit wetlands in both Hatirjheel and Bashundhara area

The study shows that people are more aware of the wetlands when they live within close proximity, or when they visit water front areas more frequently. In addition, those who have greater access to wetland areas visit them more frequently than other people. The study demonstrates that people who associate more frequently with wetlands are more optimistic about these water bodies. The following three cross tabulations from SPSS show the relationship between the responses of two different questions in both the Bashundhara and Hatirjheel area (Figure 8-7, Figure 8-8 and Figure 8-9). A statistically substantial difference was observed between the two case study areas. It is evident from the difference between the two areas that people's viewpoints are influenced due to the relationship between their neighbourhoods and wetlands. Indeed, water culture is absent when people have no chance to engage with

the water system. This is the case for many who live in neighbourhoods isolated from natural water features.

In the contemporary context, water-culture refers to predominantly open space and recreational areas, rather than day-to-day use of water (including water transport). In contrast, as discussed at length in previous chapters, water was integrally associated with settlement in the historical past¹. Further analysis shows that people who are concerned about water bodies believe that they positively impact upon nearby residents' lives, and that they are consequently more concerned about protecting and restoring wetlands. From the analysis, it can be argued that, because of the Hatirjheel project, people are more aware of natural drainage, wetland conservation, ecology; and public spaces and neighbourhood associations with water features. In contrast, projects such as Bashundhara disassociate people from water culture, as well as bringing negative environmental consequences. Undoubtedly, people who use water bodies in their daily life are more sensitive about natural drainage, retention, water pollution, and the importance of protecting and reclaiming the wetlands.

¹ Historically, water provided major transport and trade routes, military control, access to different urban areas and major building structures, drinking and washing, agriculture, industrial use and natural drainage.

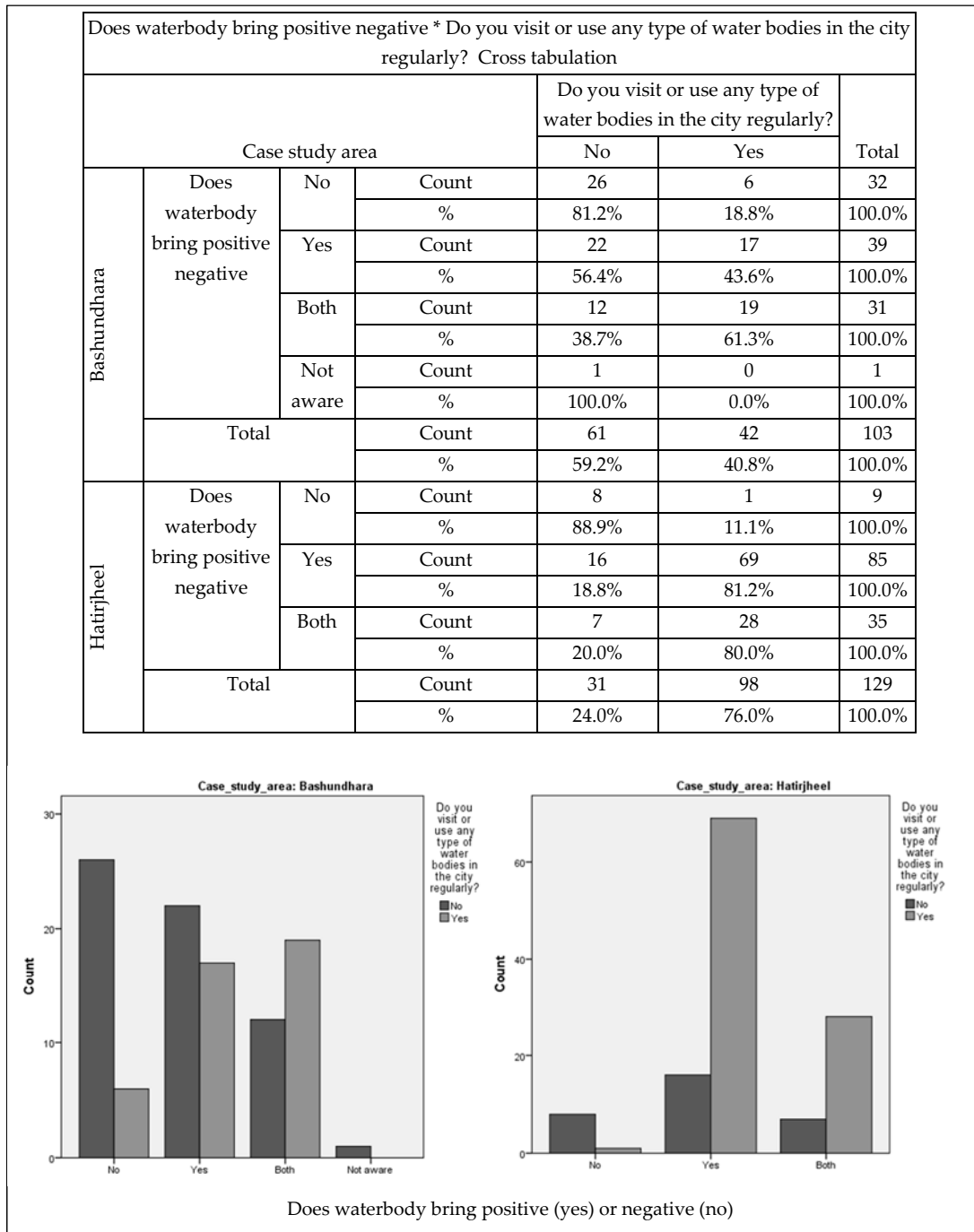


Figure 8-7: Cross tab between does the water body bring positive or negative outcomes for the neighbourhood, and do the respondents regularly use/visit any type of water bodies in both Bashundhara and Hatirjheel

Does waterbody bring positive negative * Do you think Dhaka's existing water bodies should be protected Cross tabulation							
Case_study_area				Do you think Dhaka's existing water bodies should be protected			Total
				No	Yes	Not aware	
Bashundhara	Does waterbody bring positive negative	No	Count	0	19	13	32
			%	0.0%	59.4%	40.6%	100.0%
		Yes	Count	1	27	12	40
			%	2.5%	67.5%	30.0%	100.0%
	Both	Count	1	26	4	31	
		%	3.2%	83.9%	12.9%	100.0%	
	Not aware	Count	0	3	0	3	
		%	0.0%	100.0%	0.0%	100.0%	
Total		Count	2	75	29	106	
		%	1.9%	70.8%	27.4%	100.0%	
Hatirjheel	Does waterbody bring positive negative	No	Count	0	6	3	9
			%	0.0%	66.7%	33.3%	100.0%
		Yes	Count	2	77	7	86
			%	2.3%	89.5%	8.1%	100.0%
	Both	Count	1	31	3	35	
		%	2.9%	88.6%	8.6%	100.0%	
	Total		Count	3	114	13	130
			%	2.3%	87.7%	10.0%	100.0%

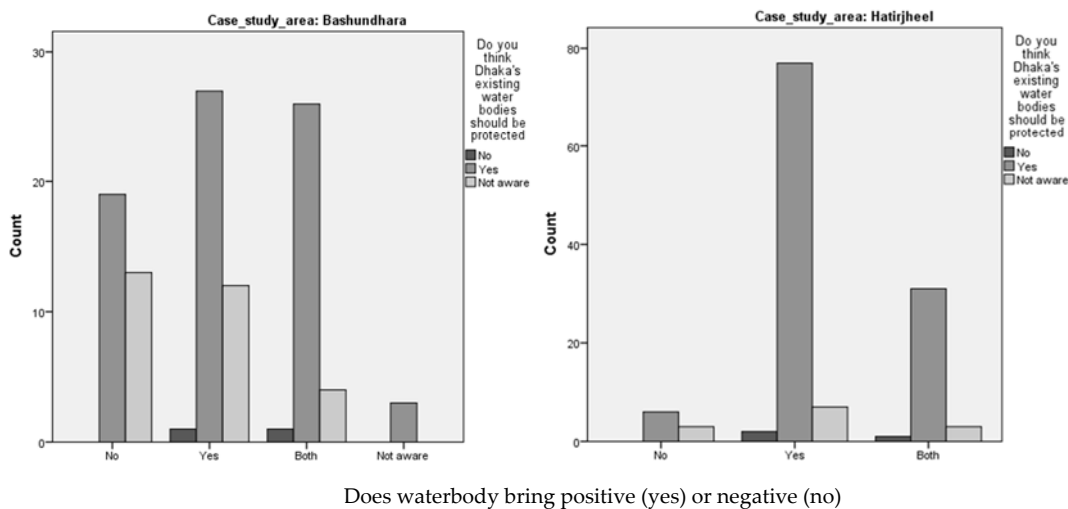


Figure 8-8: Cross tab between questions: “does the water body contribute positively or negatively to the neighbourhood?” and “do the respondents think water bodies should be protected for both the Bashundhara and Hatirjheel areas?”

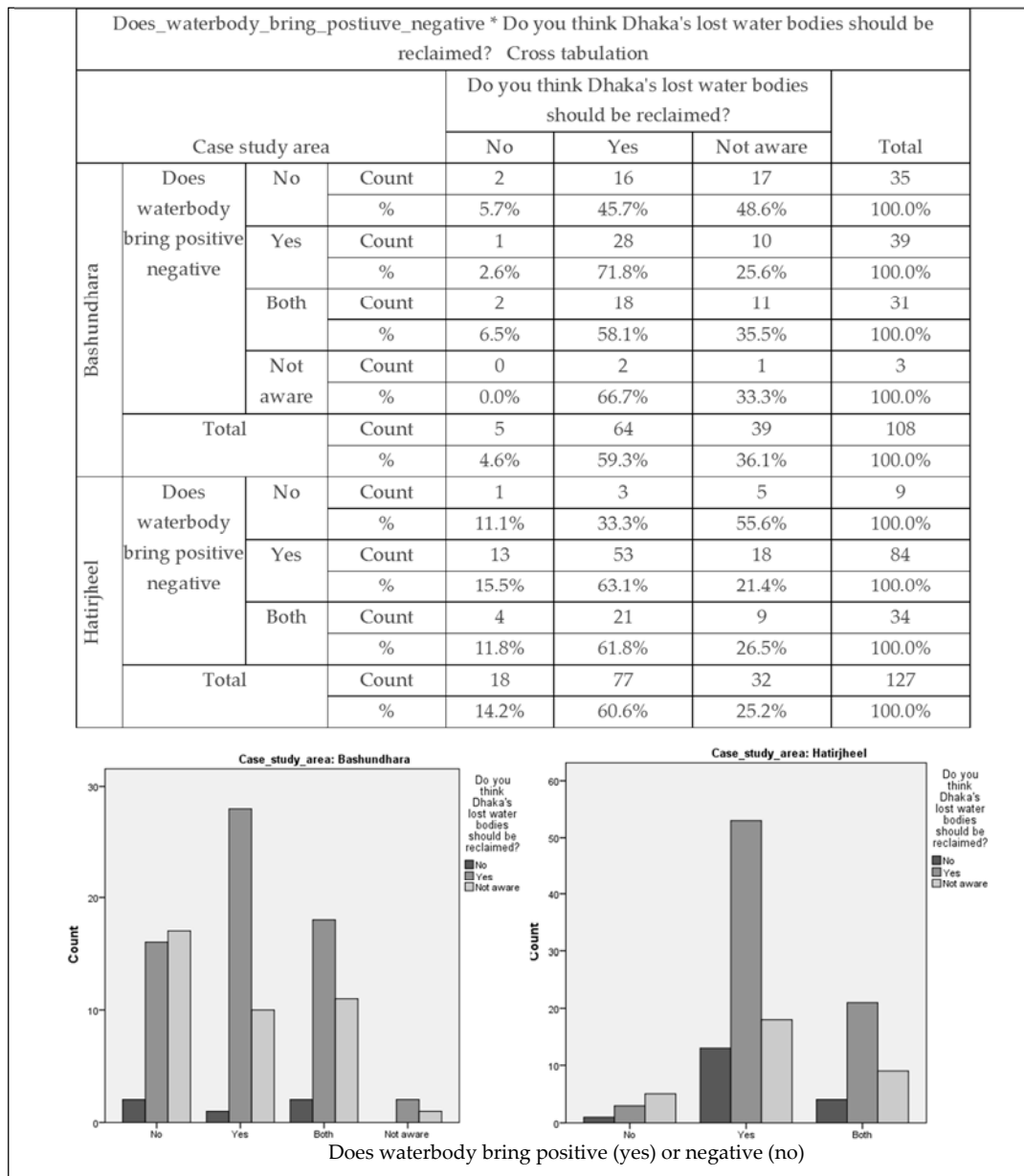


Figure 8-9 Cross tab between questions: “does the water body contribute positively or negatively to the neighbourhood?” and “do the respondents think water bodies should be reclaimed”

Cross-tabulation analyses were conducted in SPSS to analyse the respondents’ rating of their neighbourhoods in relation to the ownership pattern and building type (Figure 8-10). According to the questionnaire survey, the ratings obtained from the neighbourhoods are quite diverse, particularly in the Hatirjheel area, due to the diversity of the urban area surrounding the wetlands. In contrast, the Bashundhara area is homogeneous compared to Hatirjheel. The majority of the respondents rated their neighbourhoods “good or moderate”. In both cases, owners are comparatively happier than the renters. Moreover, people who live in the single dwelling and apartments are more positive about their neighbourhood environment in comparison

to those who live in mixed-use projects, such as large mixed commercial and residential buildings. However, recent development has been characterised by the common practice of developers building apartments, or mixed use apartments, to maximise the profit from the land.

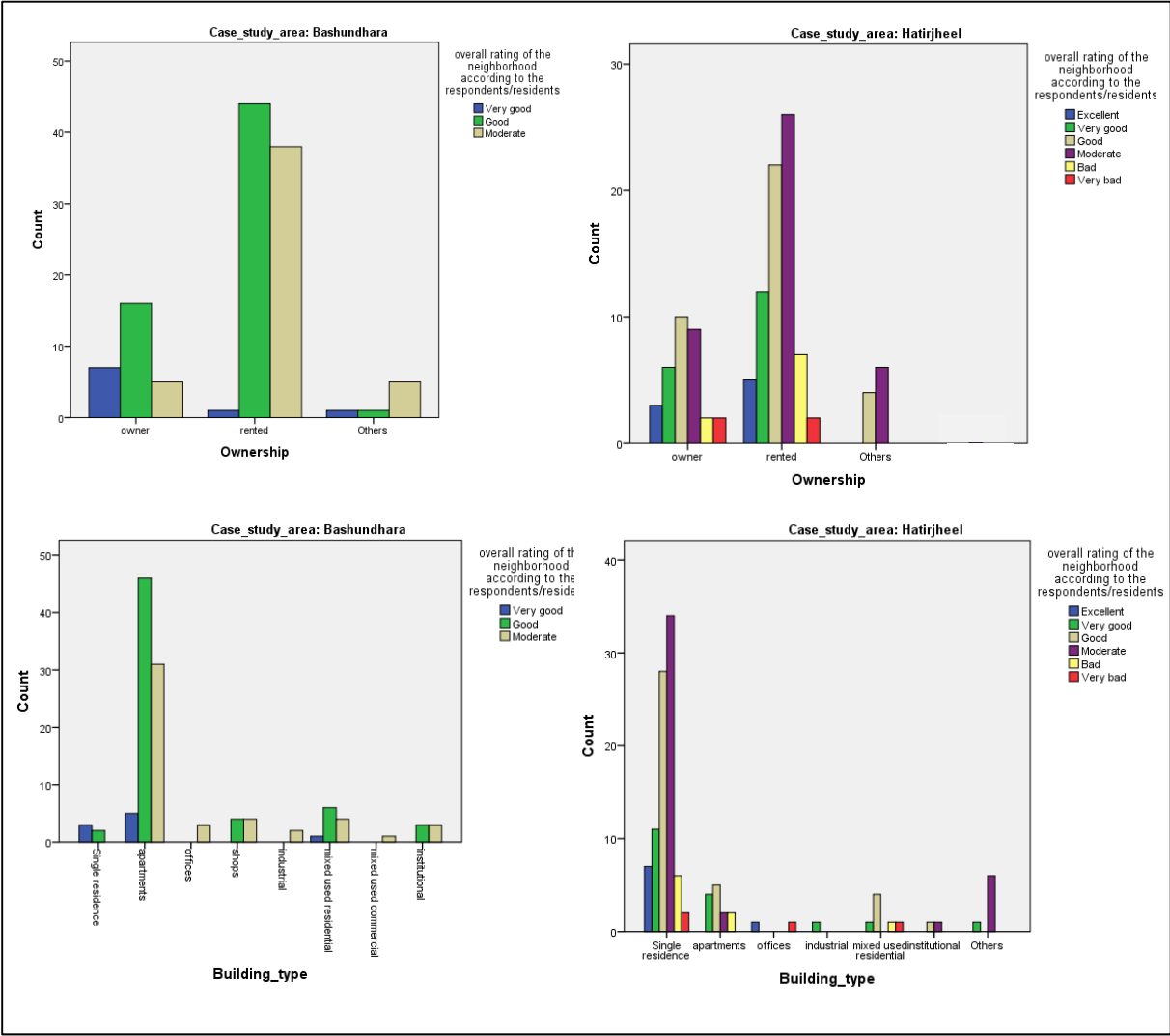


Figure 8-10: Rating of the urban area in both Bashundhara and Hatirjheel areas in relation to the ownership pattern and building type

8.2.1 Project details and findings from the Comparative analysis of Hatirjheel and Bashundhara

Both the projects are large-scale urban developments in terms of area, the involvement of multiple development agencies, and the impacts on the city. Though the two contemporary cases are dissimilar from each other, both projects were developed for profit, but were conceived in different ways. The comparisons of the case histories are examined below, and are the direct result of the field survey and

analysis (Table 8-1). The table also illustrates both the projects in relation to their planning and design policies, bylaws, environmental and social considerations, and feedback from various stakeholders.

Table 8-1: The Table showing the comparison of two current case histories in terms of various aspects, including project details, planning policies, and consequences.

Project name	Hatirjheel-Begunbari	Bashundhara
Type of projects	Restoring wetlands / reconstruction of wetlands	Constructed land for development / landfill urban extension
Area of the projects	40 hectares of wetlands, urban open spaces, roads, bridges and surrounding neighbourhoods. In total four (4) square kilometres of area approximately.	Ten (10) square kilometres (approximately)
Project initiator/promoters	Government	Private sector developer
Is project was initiated through collective awareness from people/user/inhabitants /professionals	Yes	no
Project concept	Drainage, infrastructure (east west road), accessibility and urban open spaces along with public activity spaces.	Housing with supporting facilities as a satellite town
Brief programme of the projects	Natural drainage system development Sewerage management Retention area increase Mobility of east-west direction both high speed and local roads Controlled connection between different wetlands through gates and pump. Recreational area with pedestrian links	Tabula rasa (grid-iron) plan to maximise sellable land for profit
Finance	Government of Bangladesh	Public sector
Master plan/ designed by	BUET, LGED, WASA and VITTI	East West Properties Limited (Bashundhara group)
User groups of the projects	Public	Public/land owners
How water is managed in the project	Through wetland reclamation and restoration Separating water with sewage (trunk sewage line) Aqueducts Regulators and sluice gate Guide walls along water	Filling up low lands and flood plains Filling up canals and other water reservoirs except one.

Amount of water bodies in the project	Major part is the water (40 hectares)	Bare minimum, which was originally lowlands with canals.
Major water bodies and their network	Hatirjheel- Begunbari canal and controlled connection with other wetlands and canals in the north and east.	Major water network is filled for buildable lands including low areas.
Flood plain	Yes, as wetland retention and water channel	Yes, was flood plain before it was filled
Ecological consideration	Yes but not comprehensive	No
Social consideration	Yes but superficially	No
Green	Minimum green along the wetland	Green only along the primary roads and very few parks
Accessibility/ mobility	The project increased accessibility. But accessibility was not designed comprehensively to connects with its surrounding neighbourhoods properly	Yes but incomplete
Infrastructure plan for the projects	Organised development agencies supported by the private consultants and research institutes	Ad-hoc basis planned by the developer in different phases
Project documents		
Project drawings	Detail design and drawings were produced before and during the construction by the design team (mostly prepared by VITTI and BUET)	Proper design and detail drawings were not produced before starting of the project. Ad-hoc basis brief drawings were made to construct the project
Reports	Detail study conducted by the government agencies and academic institutes	Some preliminary and superficial study was conducted to validate the land filling
Case histories according to the policy instruments		
Relationship with DMDP	Consistent in terms of wetland; though the proposition is not considering all the aspects.	Development totally violated the DMDP.
Relationship with DAP	Consistent with DAP; however special detail area plan was on process for the surrounding areas.	DAP has been manipulated by the private sector developers leading by the Bashundhara group. Yet the project is not considering the DAP.
According to wetland policy	Consistent to the wetland policy	In contradiction of the wetland policy
According to land development policy	N/A	In contradiction to land development policy
Feedback		
Positive features of the project (interview and questionnaire respondents)	Increased retention area. Increased accessibility Drainage system improved Created public open spaces	Created land for development Created opportunity to invest in the land market

		Provided housing stock in the city
Negative features of this project (interview and questionnaire respondents)	Not properly integrated with the surrounding neighbourhood Project is not comprehensive enough to support a comprehensive natural drainage plan Created social exclusion and displaced people Hard engineering interventions	Destroyed natural water channels including low areas and agriculture lands Destroyed natural eco-system Displaced many people Created poor planning for a township with lack of open spaces, public activity facilities and infrastructure
How to address this type of project in planning and implementation according to the interview respondents	Comprehensive and more inclusive planning Softer engineering approach with resilient and flexible design Integration with surroundings	Respecting natural features such as wetlands Inclusive and comprehensive design strategy Design with living with water

8.3. Factors influencing water intervention in the urban development of Dhaka

Four key factors have been identified in this study (chapters 5-7) that have had a major influence on the way recent urban development culture and practice in Dhaka has intervened in the management of water. The first is *flooding*, including both the natural phenomenon and the increasingly chronic issue of endemic human-made inundations.

The second factor is the *politics* of water management in such a vulnerable deltaic context, where large-scale urban water projects can be orchestrated to manipulate and manage public support for other political purposes. The Western Embankment and Hatirjheel projects are some of the more recent products of such political factors. The Flood Action Plan (FAP) of the late 1980's was another significant instance. In that earlier case, the authoritarian military regime of the day sought to gain better public support for the political legitimacy of its rule by initiating projects entailing significant commitments of military and other technical resources to protect the residents of vulnerable settlement areas from floodwater. Those developments also succeeded in attracting significant funding from International aid organizations. Similar political factors were also highly influential in the even earlier (1960's) Sher-E-

Bangla Nagar project (second capital) designed by Louis I. Khan for the Pakistani Military Junta, and cannot be discounted in the case of the Hatirjheel project, which was initiated in 2007 by the military-backed caretaker government.

The third factor that this study has identified as influential in water related urban development and intervention is the *mind-set* of the development agencies and expert actors engaged.

Last, but not least, the fourth influential factor is the changing *life-style driven demand* for appropriate and reliable modern water infrastructure to support contemporary life and work in a globally engaged metropolis.

The case studies have also revealed the influence of additional factors including political economy, population influx, international funding organisations, and profit venture initiatives by the development actors (both public and private sector), that must be taken into account in the interpretation of the evidence.

Table 8-2: List of factors influencing the urban development in relation to its water

	Factors influencing the urban development in relation to its water	Projects directly influenced by the factor
	Major influences to initiate and construct urban development associated with water	
1	Flooding	<ol style="list-style-type: none"> 1. embankments 2. box culvert/drainage intervention 3. reconstruction of wetlands
2	Politics	<ol style="list-style-type: none"> 1. embankments 2. landfill projects and 3. reconstruction of wetlands
3	Mind-set of the development agencies and actors	<ol style="list-style-type: none"> 1. embankments, 2. box culvert/drainage intervention 3. landfill projects and 4. reconstruction of wetlands
4	Life-style-driven demand	<ol style="list-style-type: none"> 1. embankments 2. box culvert/drainage intervention 3. landfill projects and 4. reconstruction of wetlands
	Other influences to initiate and construct urban development associated with water	
5	International funding organisations and global politics	<ol style="list-style-type: none"> 1. embankments 2. box culvert/drainage intervention,

6	Political economy and profit venture initiatives	<ol style="list-style-type: none"> 1. Landfill project (new township) 2. reconstruction of wetlands
7	Population influx (climate and economic migration)	<ol style="list-style-type: none"> 1. land fill projects

Radical changes can be observed in the case histories, due to political shifts. Looking back to the historical patterns and developments examined in earlier chapters, the research has shown that different regimes have had different impacts on urban development over subsequent eras. The colonial regime introduced a new set of administrative systems in the second half of the nineteenth century. In order to modernise Bengal and other regions of its empire, the British Indian regime established institutional agencies, many of which were incorporated within the framework of the Public Works Department system, to develop the infrastructure, buildings and urban forms needed to support their modernising vision. As we have seen in the previous discussion of this era of early-modern development, by the late colonial period, these progressively harder and more invasive interventions had already begun to transform traditional water civilisation of the Bengal Delta, and the attitude towards water of those who lived in it and managed the built environment.

The case histories presented in chapters four to six illustrate the intentions behind the planning and implementation processes of urban development projects. In a majority of the cases, political will is an important factor for large-scale projects, which were built during the military regimes. In contrast, since the 1990's the democratic government has mainly embarked on landfill projects for new townships. The recent military-backed interim government acted against the land developers who had been filling up the wetlands. According to the critics and interviewees, most of the large interventions by the pro-military regimes were manifested to gain public support, as explained in chapters four, five and six.

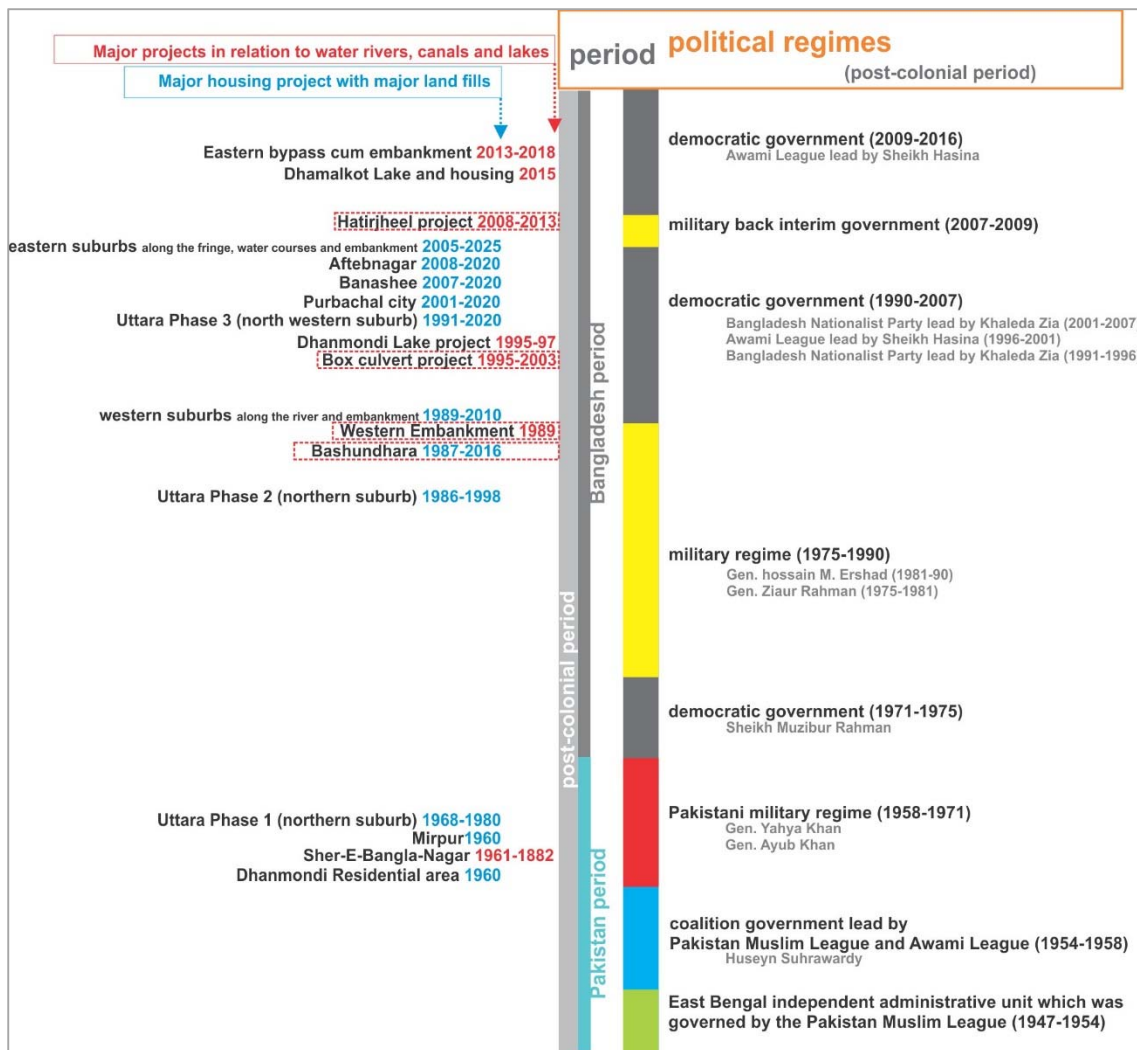


Figure 8-11: Timeline chart of regimes and major urban development events (after 1947 post-colonial period)

By contrast, democratic governments have tended to support the land developers in a quest for profit. The military regime introduced the western embankment because of floods; subsequently, democratic governments have opened up the land market (and economy), resulting in private sector enterprise flourishing. These two events, allied with rapid urbanisation from the 1990's, have encouraged land developers to fill up the low-lying lands. However, population influx has played an important role along with the political economy. The new era of industrialisation, such as manufacturing of garments, has influenced the population influx and urbanisation rate in and around Dhaka.

Modern interventions are truly market biased, with complex influences over the so-called democratic society. However, democratic institutions failed to listen and/or respond to the voices of the people in an equitable way in relation to urban

development. Democratic institutions frequently impose autocratic decisions over people's wishes. As a democratic process, denationalisation of many sectors (including land development) influenced the pace of development after the 1980's (Paul 2016). GDP growth has increased since the 1990's, due to privatisation, industrialisation, and urbanisation. As a result, rapid urbanisation has transformed the wetlands and natural landscape. Land development through landfill has become a common way to keep up with the pace of urbanisation and land speculation. At the same time, many people have been investing in the land market, as it is a sector where there is little chance of loss. Many external investors (primarily Bangladeshis living outside Bangladesh) have also put money into land development.

8.4. Major investigation outcomes

As a result of the field survey, analysis, and findings, the research supports the claims made in previous chapters.

8.4.1 Scale of the urban development

The Bengal delta is a hydraulic region that experiences massive fluctuations in water flow over the annual cycle. In addition, there is a great deal of evidence concerning the natural fluctuation of water courses, which adversely impacts on human settlement and activity (discussed in chapters three and four). Throughout the 19th and early 20th-century small-scale urban settlements were established in Dhaka. In the late 19th and early 20th-century urban development in Dhaka reflected the European ideas and biases of the colonial administration concerning how to control water flows. In the second half of the 20th-century there was a huge shift in the scale of urban development. In addition, established agencies have been working in a particular way since the late 20th century with a certain mind-set and institutional framework. The modern approach to development, along with modern mobility and infrastructure, transformed the natural landscape (water, vegetation, and agricultural land) into built-up land. However, it is important to recognise the twenty-first-century city is very different from its historical counterpart, in terms of its size (population and area),

infrastructure and mobility, and life-style. Indeed, the historic interventions applied to the city during its earlier history may not be relevant in the present context.



Figure 8-12: Figure showing morphological transformation between 1960's and 2017 (source: Muntasir Mamum and Google Earth)

Morphological transformation is evident in the historical development of modern Dhaka with the increasing scale of the city and changing approaches towards urban development by different regimes (Figure 8-12). As a result, the relationship between built environment and water has been transformed over this period and the dialogue between Dhaka and its people with its water bodies has shifted in a new direction.

With the shift of the scale of urban development, the relationship between land and water has been drastically transformed. The introduction of the cordon system has played a significant role, hardening the city with constructed land through landfills. The manifestation of the modern city through modern infrastructure was undertaken in order to support a twenty-first-century metropolis. By contrast, some critiques currently postulate how to handle the city as a water civilisation, using new-engineered urban landscape techniques. According to some experts, Dhaka needs its infrastructure to be designed and operated in a way where the intervention is more flexible and resilient. Therefore, the balance between urbanisation and wetness in urban development is advocated and discussed with reference to the views of experts, as reported in the field survey findings and the case study analyses.

8.4.2 Influences of modernity

The modernising vision of the British colonial regime, as well as the post-colonial administration, have had a great impact on the shape of post-colonial Dhaka. The British first introduced the constructed landscape in the form of excavated canals for irrigation, riverside developments for industrial sites, and waterfront developments for the elites and public realms. Furthermore, as described in chapters three and four, they brought together colonial gardens, mansions, and public built forms by transforming the natural and traditional landscapes. In the traditional city, the edge between land and water was fluid and soft compared to the modern hard boundary. The relationship between land and water was transformed through the modernising agenda, instrumentalised by the engineered (constructed) urban landscape.

The dialogue between water and city underwent a paradigm shift with the introduction of colonial modernity. Institutional frameworks introduced in the colonial

era, but which were largely reproduced or transferred in terms of technocratic culture to the development agencies of the post-colonial and contemporary period, have underpinned this paradigm shift. This modernising mind-set enabled Dhaka to introduce a system that aimed to be free from river flooding, with a modern transport and infrastructure system. Nevertheless, most recently, we can observe the beginnings of a recognition of the consequences of this dry approach, where the tolerance and relative resilience of 'wetness' inherent in a traditional water civilisation is missing. A new water culture is evidently emerging in Dhaka, spearheaded by the redevelopment of wetlands, that is enabling the city to re-appreciate (if not return to) its earlier historical adaptation to its regional milieu as a water civilisation.

During the post-colonial era, the legacy of the colonial institutional framework and governmentality continued in the urban development agencies. Hence, the interventions were highly influenced by development actors with western development philosophies: in the form of cordon systems and fortification mechanisms to control flooding in order to make the city dry and safe. According to Home (1996) the developing countries and cities of the contemporary world are the product of colonial planning. But even after the end of formal European colonial rule, Western educated bureaucrats and engineers tended to display euro-centric views on urban development during the post-colonial era. The case of Dhaka echoes patterns and practices that have been closely and comparatively studied in the urban development histories of similar cities throughout the Indian Sub-Continent (Chattopadhyay 2011; Chopra 2011; Dossal 2010; Glover 2007; Karim 2010; Kusno 2010; Prakash 1995; Scriver (ed.) 2007; Scriver 2007b; Scriver, PC & Prakash, V 2007). As we have discussed, post-colonial scholarship on urbanism has also identified euro-centric practices in the process of urban development in post-colonial cities, such as Delhi, Kolkata, Mumbai, Jakarta, Singapore, and Dhaka (Chattopadhyay 2007; Hogan 2003; Pieris 2010; Scriver (ed.) 2007; Scriver 1994, 2007a, 2007b, 2010; Scriver, P & Prakash, Ve 2007; Scriver, PC & Prakash, V 2007). Major post-colonial development was based on these colonial notions, on top of which development actors mostly followed the western development models of modernisation for urban development.

8.4.3 Water culture transformation

Historically people's association with water was very different from today, as water was an everyday part of life. Traditionally water was strongly connected with socio-economic factors, as it was used for household work (washing, cleaning, and bathing), religious rituals, trade, mobility, agriculture, navigation, control, and natural drainage. Primary access throughout the city was via water. Water culture has transformed over time, with the transformation to modern lifestyle, mobility, contemporary infrastructure, and industrialisation. At present, in the case of internal water bodies in Dhaka (which have recently been reconstructed/redeveloped), water culture is subject to water drainage, infrastructure, and recreational use. Examples include the Dhanmondi lake redevelopment, Gulshan-Banani Lake, and Hatirjheel-Begunbari Integrated Development Project. In contrast, outer waterways, such as the Buriganga river, still serve as major transport corridors for both people and goods. As there are few bridges over the Buriganga River, small boats are used extensively to get people back and forth across the river for work, shopping, and school. The inner water bodies are less functional in their current context, as they are no longer integrated, and many of them have been filled-in with urbanisation and have therefore disappeared altogether.

Historically, this region was primarily agricultural and partially industrialised, with water being a useful resource throughout. The research demonstrates that the current scenario of renewed water culture as described in the case histories is unlike the traditional water culture of the past, where water was the lifeline of the settlements. The modern city is completely different, but it still has to deal with water when it becomes a threat. For the majority of Dhaka, water culture has disappeared. Developments like Hatirjheel represent an attempt to bring back the water culture. The project re-created the water bodies, and people relate to water in certain ways, but these are very different to the traditional water-culture. Traditional and modern urban development have distinct differences in terms of handling water. Field survey findings show that at present, people use wetland areas more for recreational purposes rather than day-to-day traditional use along with regular commuting via water (Figure 8-13). However, people who visit or use those areas for mobility are not travelling on

the water, but are instead commuting along roads over wetlands. According to interview respondents, the major objective of the development agencies is to ensure drainage and water retention, along with ensuring open spaces for the city.

Traditionally, living with water was the main idea. This meant using water in everyday life (i.e. communication, commercial, and household purposes), and dealing with its natural rise and fall. By contrast, modern urban development is dry and water is controlled through fortification, such as in Hatirjheel and the Burigange river embankment. The direct association with water has become incidental in many cases. Re-creating the traditional water culture today is not conceivable, as the life pattern and built environment of the contemporary mega-city has almost totally changed. Rather than going back to traditional water-culture, we need to examine the city’s relationship with water in the light of current environmental, social, and economic needs.

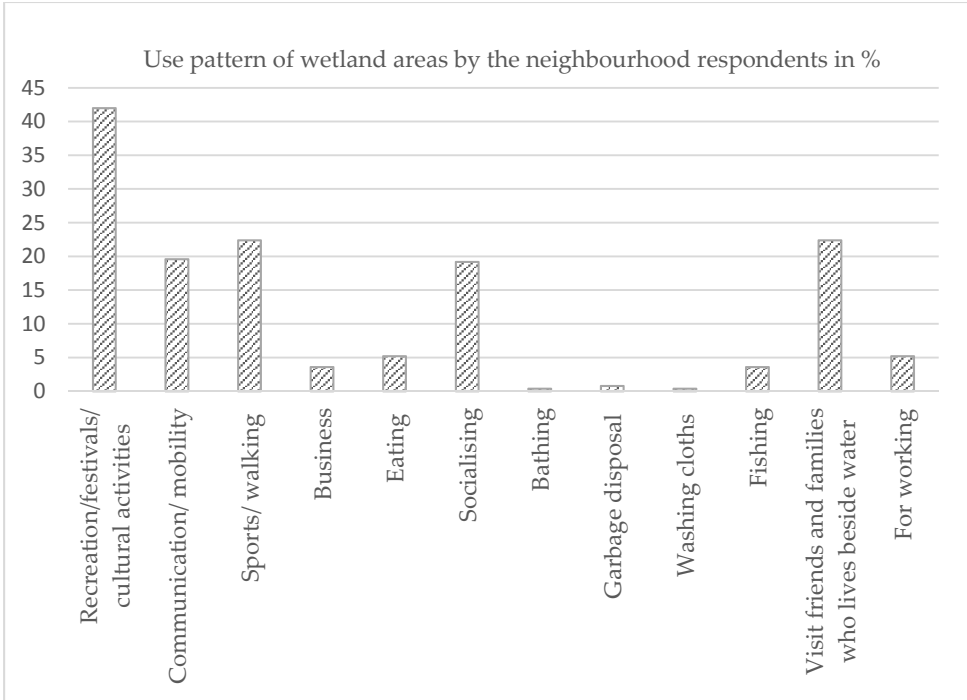


Figure 8-13: Use pattern of wetland areas by the respondents of Hatirjheel and Bashundhara areas

8.4.4 Urban sprawl, or land mass extension, through landfilling

Modern developments such as Bashundhara in Dhaka, which totally ignore the existence of water, illustrate a further important issue. In the case of these landfill

projects, political influence (and power) contradicts common sense and social justice. Many of the recent projects reveal multilevel environmental, economic, and socio-political complexities (as discussed in chapter six). These landfill phenomena demonstrate the struggle between two opposing perspectives. One perspective is concerned with maintaining the natural landscape in the interest of sustainability and ecological balance. The other is concerned with political favour and commercially driven urbanisation, in order to cater for population growth. Despite the opposition to the land acquisition for Bashundhara, Purbachal² and other real-estate developers' projects in recent years, both public and private sector agencies are using landfilling. People's traditional livelihoods, which were directly associated with the water and land, have been transformed through these development actions.

In the era of modern landscape urbanism, landfill urbanisation has been a common approach to generate urban sprawl, particularly in Asian cities³. In the majority of these cities, the landfilling has impacted on natural landscape, agricultural flood-plains, and water-sheds. The works of Shannon, Talwar, Chopra, Ashraf, and other scholars reviewed earlier, demonstrates that new land development in many developing regions takes place through the landfill process. Similarly, land filling is a common phenomenon in Dhaka, where it has underpinned extraordinary urbanisation since the late twentieth century onwards (explained in chapter six).

New urban extensions in post-colonial Dhaka were developed as a tabula-rasa concept for elite neighbourhoods. The approach was originally initiated during the late colonial period to build new public and institutional buildings, and housing for both local and colonial elites, as well as for military establishments outside/north of the old city ⁴(Figure 8-14). Therefore, new township development in the late 20th and early 21st century followed the same conceptual template found in the field survey. Recent interventions are of a more robust size, with higher density and higher land coverage, in order to maximise profit and to provide housing for excess population. These projects are undertaken using dredged sand for landfill, in order to make new

² The largest township to date under construction by the public development agency.

³ Asian cities such as Shanghai, Kolkata, Mumbai, Delhi, Dhaka, Cantho, Phnom Penh, and Jakarta

⁴ Colonial establishments such as in Paltan (military establishment and public buildings with gardens), Ramna (gardens, garden house, public buildings and racecourse) and Wari (housing for local elites and colonisers).

foundations for new urbanisation. Through this process, wetlands have been destroyed and marginalised people have been forced from their traditional settlements.

For people subjected to the immediate consequences of climate change, landfill is a blessing and water is a curse. A large portion of the city's population have migrated from more vulnerable areas of Bangladesh, because of river erosion and rising sea levels in the coastal areas. Climate refugees have been a common phenomenon in Bangladesh for a long time (McPherson 2015). For Dhaka, such 'climate migration' has acted as a catalyst for urban growth, especially after Dhaka became the capital of independent Bangladesh in 1971. Internal migration is a common phenomenon in major cities across the developing world, because of the mono-centric political-economy, and lack of decentralisation typical of cities such as Dhaka (Dewan & Yamaguchi 2009; Islam, N 1996, 2001, 2006, 2011). The population of the city has increased massively as people have migrated for work, education, health, and security, amongst other reasons.



Figure 8-14 Map indicating late colonial city, north of historical city, with rail road, garden city, and grid iron pattern suburbs (source: Dhaka City Museum, DCC)

8.4.5 Reconstruction or redevelopment of wetlands

Along with landfill urbanisation, wetland reclamation projects have also been undertaken in these same urban centres in order to restore water bodies for various reasons, such as drainage-retention and water front development. The new paradigm of water urbanism has created value by recreating a new kind of urban wetness, through engineered interventions such as the Hatirjheel in Dhaka. This phenomenon has consequences in the form of social gentrification, environmental transformation, and socio-economic change (as discussed in chapter six).

Urban water interventions in Dhaka are not integrated and holistic, but are instead ad-hoc. Hatirjheel can be considered as a fragmented and comparatively large water urbanism intervention. These developments do not reflect traditional water culture within this water civilisation. Rather, this represents a return to a harder engineered form of water urbanism. Hatirjheel can be conceived as a modern extension of water based culture. Nevertheless, the project can only be viewed as environmentally sustainable if it is integrated with other water channels and surrounding urban features in a more comprehensive way, which would allow for effective flow and drainage.

Hatirjheel is similar to the concept outlined by Corner, Waldheim and Wall (which was discussed in chapter three). In its first stage the project reclaimed the ground plane; it then reframed the natural and/or constructed landscape; and finally it re-implanted vegetation, ecological, and other natural features. However, the project has many infrastructure features compared to its natural attributes. As discussed by Shannon, the Hatirjheel approach is an urban water development used as a hybrid infrastructure, functional and ecological space. The project allows human interface with landscape, such as in other similar urban water intervention projects. For example, the Dhanmondi Lake development project in Dhaka, the Cheonggyecheon project in Seoul, and the Sabarmati river front project in Ahmedabad. But the interface is less about day to day living and transportation; and more about recreation and aesthetics.

8.4.6 Governance and institutional framework

It is evident that bureaucrats, politicians, and powerful developers control development practices in Dhaka. Moreover, the institutional framework of the public development agencies is highly influenced by the contemporaneous political regime and private sector developers. As new political boundaries were established, the long established institutional framework continued to manage the agencies for the re-development mission after the colonial period. During the post-colonial period the Pakistani regime deconstructed the local government institutional framework and introduced parallel agencies for development control, such as the DIT (Dhaka Improvement Trust, which was later transformed into the RAJUK). The legacy of the urban development mind-set continued in these agencies, even after the British left the Indian Sub-Continent. As a consequence, local government became less accountable in planning, development, and building construction.

According to the urban historians, the power of the local government was reduced to uphold the central government bureaucrats' supremacy⁵. The Improvement trust for the city functioned as an analogous agency controlled by one group of bureaucrats, rather than technocrats or professionals. However, the RAJUK (previously the DIT) was not under the municipality (now Dhaka City Corporation) from the 1960's onwards. Moreover, at present the DCC does not have any control over the development framework of the city. Owing to this framework, the Mayor of a city of more than fifteen million people has insufficient power to control urban development. On top of that, 56 authorities are responsible for different aspects of Dhaka's development, and a majority of them are not accountable to the Mayor. The Dhaka City Corporation does not have the authority to prepare the master plan for the city, as planning is under a different organisation. Similarly, categories of water-bodies are controlled by different organisations, such as WASA, DWDB, BWITA, and PWD. Without proper urban governance the city is growing on an ad-hoc basis, which results in many cases of unsustainable development.

⁵ Part of admin wing of government's ministries in Bangladesh.

The interview analysis presented in chapters six and seven demonstrates that governance is a challenge for Dhaka's urban development. Moreover, scholars have indicated major problems with the governance system in respect to urban development due to multiple factors such as the institutional framework, corruption, responsibility, violation of bylaws, and poor implementation of planning schemes (Ashraf 2012; Islam, I 2009; Islam, N 1996, 2001, 2006, 2011; Jahan 2011; Rahman 2008; Shohag 2013). Initially during the post-colonial period, there was a lack of legislation. Later, in the late 20th and early 21st centuries reasonable legislation was promulgated in the form of new building rules, wetland protection acts, and private sector housing acts illustrated in the diagram (Figure 8-15). The diagram illustrates urban development intervention timeline in relation to the policy instruments introduced from the 19th century to the contemporary period. However, these laws were not respected, and in many cases misused by the development agencies, corporations, and individuals as is evident from the case studies.



Figure 8-15: The urban development intervention timeline in relation to the policy instruments introduced from the 19th century to the contemporary period

Every development agency wanted to lead the development process, which made the process ineffective in many cases. This led to a lack of coordination between agencies. As a result, private sector development agencies, with their powerful political and economic support, did not consider themselves accountable through the bylaws or legislation. Therefore, urbanisation occurred without full enforcement of the bylaws. Furthermore, government turned a blind eye to 'black money' investment in the land market. In addition,⁶ the development control authorities do not have the resources necessary to control the huge city⁷. There is a strong case for a framework of development agencies with a hierarchy of power and responsibilities to protect the city from lawbreakers and land grabbers.

8.4.7 Bylaws and corruption

According to the wetland protection law, it is illegal to dump landfill in water channels, flood-flow, and sub-flood-flow zones. Yet, alongside the eastern fringe of the Balu River new townships are being developed through landfill. It is a complete violation of the Detail Area Plan (explained in chapter six). In contrast, many projects undertaken during the post-colonial era reflect new policy and planning initiatives. Projects such as the Sher-E-Bangla-Nagar housing at Mirpur, or Uttara Phase one in new Dhaka, were developed during the second half of the twentieth century and gave careful consideration to flood plains and natural water bodies.

Recently, private sector developers have been advocating to modify the Detail Area Plan, along with some other planning guidelines, which could enable them to continue the landfills and other developments in the flood flow zones illustrated in chapter six. Conversely, professional groups and experts have been arguing to uphold the bylaws. According to environmental lawyers, there are substantial regulations to control this unprecedented development. Some experts suggest that bylaws on environmental issues including wetlands are more protection oriented, rather than conservation oriented. The law aims to ensure that the natural environment is neither encroached upon nor altered, thus protecting wetlands, flood flow, and sub flood flow

⁶ Resources in terms of manpower and logistics.

⁷ City over 17 million people and 1528 km² (DMDP area) in size.

zones of water channels. Meanwhile, environmental law does not explain how natural features should be conserved, such as how to manage human use of natural resources, restoration of natural environments and ecological communities, and integration of water with urban development.

8.4.8 The impact of military dictatorship during the post-colonial era, and the influences of the military on contemporary urban development

The military dictatorships often introduced hard-line interventions that have significantly affected the city. Nonetheless, these military regimes played significant roles in initiating major urban development projects relating to water. Although military dictatorships have made undemocratic choices, major propositions were realised to extend the defence mechanism against the natural flow and to control flooding and other disasters. In addition, military governments have accomplished these projects without any opposition from illegal encroachers.

The military played a major role in constructing large urban water interventions, both during the military and democratic eras. The engineering division of the army has acted as both a contractor and management organisation, and has constructed major public infrastructure projects in Dhaka and other areas during the post-military regime period, such as embankments⁸, the Hatirjheel project, and flyovers in Dhaka. The SWO (military engineering division) is considered to be one of the most efficient and effective construction units in developing large-scale public infrastructure projects in Dhaka.

8.4.9 Engineering intervention of water management in design: a solution or a problem?

New urban landscapes during the colonial and early post-colonial period began to address the relationship between human settlements and watercourses in the traditional water civilisation in a modern way. Later, during the post-colonial era,

⁸ Military engineering division constructed the western embankment and embankment around the international airport in Dhaka in 1989. Moreover, the eastern embankment that is currently under construction is by the military.

similar approaches sought to re-establish the relationship between built form and wetlands and water channels, such as the She-E-Bangla-Nagar, the Banani-Gulshan Lake project, the Dhanmondi Lake development project, and the Hatirjheel-Begunbari integrated development project. However, not necessarily all of these interventions managed to re-establish the symbiotic relationship between land and water.

The majority of these urban developments involve technical management of water, rather than encompassing a strong ecological approach, involving flexibility and/or urban resilience. Much of this is due to the mind-set of the development actors. Environmentally committed ideologies were absent in the post-colonial 20th and 21st century developments described in the case history analyses. Technocratic management of water may work if it is a comprehensive approach. In this case both design and implementation should integrate engineering, environmental, and social factors, incorporating mobility and water network (such as in the Dutch system). However, this would alter the traditional water culture.

In the majority of cases these interventions were engineering solutions, with major infrastructures such as embankments, aqueducts, roads, and drainage to manage water in urban design. Some critiques consider these interventions as hard engineering approaches; yet in many cases, the designs incorporate wetlands, public places and vegetation. For instance, the priority of the Hatirjheel project, when the project was initiated, was drainage and infrastructure, rather than environmental and social factors. However, the landscape architectural consultants, VITTI, introduced other components such as pedestrian and cycle paths, public spaces, vegetation, and potential for a special master plan for the surrounding neighbourhoods. This master plan aimed to integrate the whole area with its wetland, along with providing housing for 176 families from the displaced population.

The idea of soft engineering approaches has been considered by numerous scholars from the disciplines of architecture, planning, engineering, environment, social-science, geography, and urban history. According to these experts, Dhaka needs to adopt a soft engineering approach to address the interdependent relationships between land and water. Water has been sacrificed for the sake of urban development, which has created major problems in Dhaka in terms of water management, as well as

environmental and social issues. According to experts, Dhaka needs to rethink the edge between land and water (Ashraf 2010, 2012; Feyen, Shannon & Neville 2009; Peeters & Shannon 2011; Shannon & Moulder 2008). They suggest that the boundary between land and water should blend, rather than being in opposition to each other. Hard engineering approaches oppose blending nature with human-made interventions. Therefore, some experts and scholars advocate to design with water, rather than to see design as a defence mechanism against water. They suggest introducing a comprehensive intervention that advocate soft engineering approaches.

8.4.10 Isolation and compartmentalisation of water

Re-development and re-construction of wetlands became more common in recent times, following the trend-setting example of the Hatirjheel-Begunbari integrated development project. However, many new urban water interventions are not serving the purpose of flow. Rather multiple development actors subsequent to Hatirjheel have demonstrated fortification and isolation. Hatirjheel is a joint venture project with a complex planning process, operated by multiple actors, such as research institutes, design firms, government development agencies, and the military construction unit. The project displays some social and environmental aspects.

By contrast, a new intervention under complete military authority in the military area is typically an isolation of the wetland and construction of dryland. The project at the Dhamalkot and Bhashantek area in Dhaka was completed in 2015 (Figure 8-16). Though the project is influenced by the recent Hatirjheel project, the proposition is a superficial interpretation of the Hatirjheel concept. Rather than flowing water, a pond surrounded by modern high-rise housing with gardens has been built for the Bangladesh Army. The water body does not contribute to, or benefit from, natural drainage. The area was converted from an informal sector of housing along a natural depression into a high-rise housing project with open spaces, a pond, and other infrastructure for an exclusive group (Figure 8-16). The scheme only serves as beautification, via open space for recreational purposes other than housing. Certainly, this kind of proposition is not inclusive. It is best described as an exclusive water front

project rather than water urbanism. The project displaced marginalised people and did not address many social and environmental issues.

Military interventions are tidy and prefer a controlled environment within a defined boundary. Flow versus isolation is visible in many military interventions from the colonial to the present day. Hatirjheel is the initial attempt on a larger scale to link the water channels to flow through engineered interventions, including regenerating water retention. Yet when this kind of project is under full control of the military, it tends to become an isolated hard engineering intervention, as evident from the Dhamalkot project (Figure 8-17). Military approaches favour exclusive built environments far from water urbanism. Indeed, the executive power and logic of military dictatorship is comparable to the hard-line mode of intervention in water management that has been observed in this study to have periodically characterised Dhaka's urban development. Yet, urban water intervention needs to be inclusive, flexible and resilient if it is going to address the challenge of more sustainable development in future.



Figure 8-16: Transformation of the part of Dhamalkot and Bhashantek area from 2006 to 2015 (clockwise) to introduce military housing with reconstructed wetland as water front project through displacement of informal sector housing (Source: Google Earth image).



Figure 8-17: The Dhamalkot military residential development (source: Bangladesh Airforce)

8.5. Conclusion

Reconstructed wetland represents a pragmatic solution to re-define water urbanism in a modern way. Meanwhile, the constructed land phenomenon is problematic in terms of restricting the natural flow of water. Therefore, landfills in low areas create multiple uncertainties in terms of environmental, social, and economic factors. So far, the majority of the new land development (new township/ expansion of urban areas) projects are not environmentally committed or socially inclusive. The Hatirjheel improved the flow and retention of water, in order to reduce flooding and water clogging, as well as benefiting recreational and circulation purposes. In addition, it influenced people's perception of the environmental, aesthetic, and recreational value of water within dense urban developments. It is a big step forward towards flow, through a designed and engineered approach. Yet the intervention needs more flexibility, inclusiveness, and comprehensiveness.

This is an ongoing debate about how to intervene and handle the water in a modern twenty-first century megacity, where historically there has been a symbiotic relationship between human settlements and water. The aim must be to make the environment more resilient, and able to cope with both natural phenomena, and urbanisation.

This chapter has discussed and interpreted the key findings from the field surveys and comparative analyses of the case studies examined, which reveals the functionality and dysfunctionality in urban development processes, as well as the hidden structures and biases inherent in the planning process. It has identified how close examination of the issues surrounding water intervention and management in past and present Dhaka provide a critical perspective on the dynamics of urban development and urban governance more generally. According to the research findings, governance is one of the major factors that influences and shapes urban development through the mind-sets, practices and organisational cultures of the various development agencies and actors by whom the planning process is operated.

In recent times, professionals and urban development researchers have advocated for government to re-structure the development agencies to pursue more efficient and effective urban governance. Diversified professional groups arguing for sustainable planning and design, including addressing the water system, created an urban forum in 2012. Apart from that, proper urban governance with a proper hierarchy of development agencies has been suggested. However, other than governance, the mind-set of development agencies, and the planning process, we need to comprehend how the water is situated from the perspective of the people of Dhaka. Experts suggest the city needs to rejuvenate its water culture, to make the water system an integral part of the city in a way that supports modern life style and infrastructure.

Chapter 9

Conclusion

9.1. Summary

Water is an ever present issue in Dhaka. In conceptualizing '*Water urbanism*', this research interrogates the state of urban development, water culture and urban governance through historiographical investigations and case history analyses. Both scholarship and practice on water urbanism are far from comprehensive discourses in Dhaka. This research has sought to unpack the urban history of Dhaka and its region through an examination of the development of the city and its infrastructure, within the context of specific administrative regimes, professional attitudes, and those of its inhabitants to generate a new dimension of understanding of the city's history and its relationship with water over time.

Initial literature research set up the history, perception and practice of *Water Urbanism*. Moreover, it identified how water was situated in the colonial and post-colonial urban development discourses. This study demonstrated attitudes towards urban development and the management of the tension between water and urban settlement over four centuries under different regimes. Furthermore, it explained the nature of urban change from a traditional to a modern system in response to violent natural phenomena as either an attempt to seek human control over nature or to survive and cope with natural forces. Through the history of hydrology and urbanisation, the research demonstrates the transformation of Dhaka and its larger context, the Bengal Delta.

Traditional water culture has shifted towards a new modern water culture. However, traditional water culture is still active in many parts of the historical city along the River Buriganga and other peri-urban areas as explained in chapters four and five. But elsewhere in the city, a new kind of lifestyle has developed, which in some instance, as in the case of the Hatirjheel area, relates to water. But we see a transformation in terms of people's relationship with water which is explained in chapters four to eight through case history analysis. What we observe from the current history as explained in chapters five to seven, water culture is no longer the predominant life style of citizens of Dhaka as they turn to modern lifestyles in a modern city.

The question of flow versus fortification is complex and has resulted in a new infrastructure landscape, as explained in the case histories. Formalised modern planning as initiated by the British was the dawn of the shift from the traditional to a modern approach to

urbanisation in this delta in the mid-19th century. Dhaka has subsequently largely followed western development models in its recent history. Therefore, the city shifted from historically living, coping with and exploiting water to a fortification approach where water was viewed as a threat requiring defensive action. Modern fortification approaches were applied in Dhaka to protect the city from flood and to support modern living as is demonstrated in chapters five and six. The inquiry reconnoitres the rationality of technology transfer from other cultures such as the Dutch system of modern water infrastructure management, and the consequences of this approach for the Dhaka region. The dike system as fortification during the post-independence era is identified as a major shift in urban development history, as it promoted fortification against the natural flow of water. However, in many cases fortification has not been done comprehensively. Where it exists in some cases, it has been compromised by landfilling activities much of which has taken place illegally and in contravention of existing legislation designed to protect wetlands. As a result, the fortification approach has not achieved its full potential.

In contrast to previous practice we increasingly observe a different approach to urban development by filling up wetlands for new urban areas or townships, effectively the constructing of land from former wetlands and watercourses such as the Bashundhara Township. In recent years demand for this kind of development has been strong regardless of its legality. This approach is discussed in chapters six and eight. It represents problematic form of development as it increases flooding and reduces people's relationship with water. Therefore, this kind of development further divorces the city and its population from its historical associations with water as represented in its Mughal, colonial and early post-colonial past as illustrated in chapters four and five. In contrast, in the case of reconstructed wetland such as the Hatirjheel-Begunbari Integrated Development Project, a relationship between city and water was re-established in a modern way incorporating engineering approaches, which ensures natural drainage, mobility and public open spaces. Both constructed land and reconstructed wetland projects are present in current urban development, and there is increasing evidence of a "hard engineering" approach to city development in its dealing with water.

The investigation answers why *water urbanism* is a fertile area for research exploration as it allows a greater understanding of the logic of urban development in relationship to this fluid

landscape. The study not only considers the physical manifestation of designing the city in relation to water, but also analyses the cultural and administrative mind-sets which have driven various interventions, and have resulted in different land use and settlement patterns. The research has identified major influences on the urban development in Dhaka that transformed the relationship of water with its urban settlements. These influences and drivers consist of natural forces (climate and floods), the shift to modern lifestyles, political power and the mind-set of development agencies and actors. Pro-military approaches by the military and military backed regimes have played a predominant role in initiating and implementing large scale urban development projects as described in this research. Some of these projects have had large impacts on the city's environmental and socio-cultural aspects. Governance and institutional framework are reflected in Dhaka's urban development history during its Mughal, colonial and post-colonial regimes. The evidence of problematic urban governance in recent history, with non-comprehensive, exclusive and non-integrated propositions that have transformed the urban morphology of Dhaka from a 'wet/soft' city to 'dry/hard' city is explained in this research.

9.2. Prospect/future of Dhaka's water urbanism

A key question facing Dhaka is how it should address its water management in future urban development. According to these research findings, water ought to be more seriously and systematically addressed in urban design in Dhaka and similar cases elsewhere. Scholars have indicated that once integrated with the landscape, infrastructure can more meaningfully integrate neighbourhoods and urban areas, reduce marginalisation and segregation, and stimulate new forms of interaction. According to the literature, a softer infrastructure approach is one of the most successful instruments of landscape and water urbanism. Experts believe, that using infrastructure as a component of landscape can resolve the tension between natural features such as water and modern development. It is believed that a comprehensive landscape infrastructure approach may fulfil the idea of fortification to its full potential, which in the case of Dhaka has never been demonstrated. The recent approach to urban development in Dhaka is not resilient, integrated and inclusive because it has not been applied comprehensively. The success of sustainable urban development depends on the integration of environmental and socio-cultural aspects in a comprehensive planning process.

Reinventing the relationship with its water channels and wetlands for Dhaka may offer hope that it can cope with the adverse effects of climate change and human induced catastrophes. Moreover, a greater balance between the development of new lands for housing and wetlands is advocated as a more sustainable approach. Prioritizing water in an historic water civilisation may ensure a better solution in cases where land mass extension is necessary. Certainly, large scale urbanisation is the reality; but it is dangerous at the cost of destroying the wetlands.

Engineered intervention as a defence mechanism may not represent a traditional dialogue between land and water in Dhaka. However, many cities have successfully introduced landscape infrastructure to reconceptualise the relationship between land and water. The prime example is of course the Netherlands. The Hatirjheel development may represent a step forward to start a new water urbanism, though the project has imperfections and weaknesses. Following this example, the city can put one step forward to comprehend the possible rejuvenation of its water system and development towards a new water/wet culture. The project has lots of aspects to offer but it also has major drawbacks as explained in chapters seven and eight. Flexible, comprehensive and inclusive design approaches with less infrastructure bias may ensure greater sustainability and a response to Dhaka's distinctive hydrological and environmental state. Apart from that, integration of the urban fabric with the existing or reconstructed or re-developed wetlands may encourage an improved relation with its wetlands, which could inspire a new water urbanism.

Development actors need more awareness to work towards sustainable urban development. Dhaka must demand more effective urban governance and development control agencies who are responsible, effective and free from corruption. The government, with the support of urban professionals and environmental activists, needs to increase social awareness to exert social pressure on development agencies to achieve more inclusive and flexible urban development. Through the collaboration of different stakeholders, including emerging social groups, professional elites and politicians, the plan making process needs to improve and become more inclusive and competent. As a result of such reforms and the application of the law, a comprehensive plan making process which addresses environmental, economic and social aspects could lead to sustainable urban development outcomes. The city's relationship with its water environment is a part of this wider and necessary reform.

9.3. Future research recommendation

This research has created a platform of water urbanism discourse and laid the foundation for further research in the disciplines of architecture, urban design and planning. As primary research on Dhaka's urban development history and water system, this work can lead to future historical investigation on Dhaka. The research findings help to comprehend the complexities of the plan making process in urban development with particular regard to the question of water. Similarly, the study not only creates a platform of discourse for Dhaka but also seeks to explain the urban development history, theory and culture of the larger context of colonial and post-colonial cities. As such it is capable of replication in other locations. Other researchers in the disciplines of architecture, history, planning and urban design might use the approach taken here, combining historical and case study analysis, for similar cases. The research also presents a useful juxtaposition of models, notably flow and fortification, which could form the basis for further work elsewhere.

This research also opens up potential research investigations for other disciplines. Research or design can be taken on re-inventing the water network for Dhaka, both at a macro and micro scale based on this research. At the macro level, research in the discipline of water resources and civil engineering may explore the potential of a fully integrated water system using either fortification or flow as a fundamental goal. On the other hand, this research can contribute significantly to future research on landscape architecture, urbanism and design at the micro scale in re-establishing the relationship between water and human settlement in a sustainable way looking at the integration of water and neighbourhoods through the lens of modern lifestyles. I hope this investigation will assist future research and design, and contribute to the re-construction of an integrated water network that can aid natural drainage, integrated water transport, urban amenity and bio-diversity protection for Dhaka and elsewhere.

This study informs both present and future practice by unfolding the urban development history of water management in Dhaka. The study demonstrates the consequences of different urban development approaches on environment, society and economy and so may assist future practice. It may contribute to development practice and government policy. It enlightens us about future strategy and demonstrates how policy makers, planners, architects and urban designers may frame future practices in reconceptualising water.

Investigating Dhaka, which is an extreme example, may enable future sustainable growth of cities in similar circumstances.

Bibliography

- Abbott, C 2004, 'Urbanism and Environment in Portland's Sense of Place', Yearbook of the Association of Pacific Coast Geographers, vol. 66, no. 1, pp. 120-127.
- Abdullah, M, Das, SK & Tatsuo, O 2014, 'Urbanization and sustainability challenges in Dhaka city, Bangladesh', 2nd international conference on civil engineering for sustainable development, Khulna, Bangladesh.
- Acciavatti, A 2010, 'Changes of State: Slow-Motion Trauma in the Gangetic Plains of India', Architectural Design, vol. 80, no. 5, pp. 44-49.
- Acciavatti, A, Bierig, A & Corrigan, D 2015, Ganges Water Machine: Designing New India's Ancient River.
- Adel, MM 2001, 'Effect on water resources from upstream water diversion in the Ganges basin', Journal of Environmental Quality, vol. 30, no. 2, pp. 356-368.
- Afrin, S, Islam, MM & Rahman, MM 2015, 'Assessment of future flow of Hatirjheel- Begunbari drainage system due to climate change', 10th Global Engineering, Science and Technology Conference, Dhaka, Bangladesh.
- Afrin, S, Islam, MM & Rahman, MM 2015, 'Assessment of Future Flow of Hatirjheel-Begunbari Drainage System due to Climate Change', Journal of Modern Science and Technology, vol. 3, no. 1, pp. 102-116.
- Afrin, Z & Dalia, JM 2011, 'Development and connectivity index for khals in Dhaka city', Undergraduate thesis, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh.
- Afsar, R 2003, 'Internal migration and the development nexus: the case of Bangladesh', Regional Conference on Migration, Development and Pro-Poor Policy Choices in Asia, pp. 22-24.
- Ahmad, N 2014, Brahmaputra River, Encyclopedia britannica, viewed 24th February 2015, <<http://www.britannica.com/EBchecked/topic/77154/Brahmaputra-River/48055/Climate>>.
- Ahmed, AU 2002, 'Energy and Sustainable Development in Bangladesh', Sustainable Energy Watch, Helio International.
- Ahmed, F 2006, 'Re-qualifying Motijheel and Dilkusha an Urban Design Investigation into the First Central Business District of Dhaka. ', Unpublished Thesis, Katholieke Universiteit Leuven, Belgium.

- — 2009, 'The Shifting Dialogue between the Historical City of Dhaka and the River Buriganga', *Sustainable Architecture and Urban Development (SAUD)*, Tripoli, Libya, vol. 01, pp. 29-44.
- — 2012, 'Water Urbanism in case of Dhaka', *A Modernism Challenge- Asian cities and Architecture Heritage in a new Paradigm Bali, Indonesia*, pp. 204-217.
- — 2015, 'Urban regeneration through reconstructed wetlands as an urban design tool for resilience: case of Hatirjheel-Begunbari Canal Integrated Development Project in Dhaka Bangladesh', *PLEA Architecture (R)Evolution*, Bologna, Italy, pp.108-116.
- Ahmed, F, Ahmed, ZN & Majumdar, S 2011, 'An Emergency Essential Service Module for Natural Disasters', *Disaster, risk and vulnerability (DRVC 2011) conference*, India, pp. 01-06.
- Ahmed, F & Akhter, MS 2013, 'The changing face of Dhaka city seen through the eyes of satellite', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 33-38.
- Ahmed, F & Parveen, R 2007, 'Re-qualifying Mothjheel and Dilkusha; Open Space System in the first CBD of Dhaka. ', in M Rahman (ed.), *Society, Architects and Emerging issues*, Dhaka, Bangladesh, pp. 11-18.
- Ahmed, KS 1995, 'Approaches to bioclimatic urban design for the tropics with special reference to Dhaka, Bangladesh. ', London: Architectural Association School of Architecture, PhD thesis, University College of London.
- Ahmed, N 2010, 'Party politics under a non-party caretaker government in Bangladesh: the Fakhruddin interregnum (2007-09)', *Commonwealth & Comparative Politics*, vol. 48, no. 1, pp. 23-47.
- Ahmed, N & Haider, A 1966, 'Aspects of city's geography', in A Haider (ed.), *A city and its civic body*, Dhaka Municipality, Dhaka, pp. 28-31.
- Ahmed, S & Ahmed, MF 2013, 'Growth and development of Dhaka north: 1971-2011', *Journal of the Asiatic Society of Bangladesh (Hum.)*, Vol. 58(2), 2013, pp. 303-334, vol. 58(2), no. 2013, 2013, pp. 303-334.
- Ahmed, S & Lori, M 2013, 'Urban resiliency through transformative governance: an analytical review on the implication of Sen's capability approach in Dhaka', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 12-21.
- Ahmed, SJ, Bramley, G & Dewan, AM 2012, 'Exploratory growth analysis of a megacity through different spatial metrics: A case study on Dhaka, Bangladesh (1960-2005)', *URISA Journal*, vol. 24, no. 1, pp. 9-24.
- Ahmed, SU 1986, *Dacca: A study in urban history and development*, Curzon Press London.
- — 2003, *Dhaka: a study in urban history and development, 1840-1921*, Academic Press and Publishers.

- — 2009, *Dhaka Past Present Future*, 2009 edn, Asiatic Society, Dhaka.
- Ahmed, Z 2015, 'Hasina orders Kuril canal excavation braving land grabbers', *bdnews24.com*, September 22, 2015.
- Ahmed, ZN, Ahmed, F & Mujumdar, S 2011, 'Climate Change: Comparing effects on coastal and urban regions of Bangladesh,' *International Conference on Climate Change & Social Issues*, Srilanka.
- Ahsan, M, Moynul & Rahman, MH 2013, 'Environmental impact of rapid urban growth in Dhaka megacity: a case study of Bhatara union', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 99-109.
- Ahsan, R, Karuppanan, S & Kellett, J 2011, 'Climate migration and urban planning system: a study of Bangladesh', *Environmental Justice*, vol. 4, no. 3, pp. 163-170.
- Akbar, H, Minnery, JR, Van Horen, B & Smith, P 2007, 'Community water supply for the urban poor in developing countries: the case of Dhaka, Bangladesh', *Habitat International*, vol. 31, no. 1, pp. 24-35.
- Alam, H 2009a, 'Clogged drains, filled up canals blamed', *The Daily Star*, July 29, 2009.
- — 2009b, 'Roads made on 10 Dhaka canals: The suicidal decision created scope for water logging', July 10, 2009.
- Alam, H 2016, 'Box culverts choking city's lifelines', *The Daily Star*, July 29, 2016.
- Alam, K 2011, 'Public attitudes toward restoration of impaired river ecosystems: Does residents' attachment to place matter?', *Urban Ecosystems*, vol. 14, no. 4, pp. 635-653.
- Alam, M & Rabbani, MG 2007, 'Vulnerabilities and responses to climate change for Dhaka', *Environment and Urbanization*, vol. 19, no. 1, pp. 81-97.
- Alam, MJ & Ahmad, MM 2011, 'Impacts of environmental laws on land development and developers in Dhaka City, Bangladesh', *International Journal of Environment and Sustainable Development*, vol. 10, no. 2, pp. 169-188.
- Alam, MJB, Hoque, M & Ahmed, M 2000, 'Traffic induced noise pollution in Dhaka City', *Bangladesh Environment 2000*, pp. 77-83.
- Alexandru, B 2011, 'Introduction: Urbanism and Sustainability', *Development*, vol. 54, no. 3, pp. 293-300.
- Ali, AMS 2007, 'September 2004 flood event in southwestern Bangladesh: a study of its nature, causes, and human perception and adjustments to a new hazard', *Natural Hazards*, vol. 40, no. 1, pp. 89-111.
- Ali, T 2011, 'Dhaka Rivers to get thinner', *The Daily Star*, April 12 2011.

- Ali, T 2013, 'A new Dhaka is possible with revived rivers, canals', *The Daily Star*, February 08 2013.
- Ali, T & Hasan, R 2012, 'JS body finds anomalies', *The Daily Star*, November 7 2012.
- Alliance, C 2014, 'Climate migration drives slum growth in Dhaka', *Cities Alliance*.
- Allison, MA 1998a, 'Geologic framework and environmental status of the Ganges-Brahmaputra Delta', *Journal of Coastal Research*, pp. 827-836.
- — 1998b, 'Historical changes in the Ganges-Brahmaputra delta front', *Journal of Coastal Research*, pp. 1269-1275.
- Amin, IE 2014, 'Sustainable landscapes. Dhaka, an urban and architectural strategy for high density city', Master's Thesis, National University of Singapore.
- Anand, P & Seetharam, K 2011, 'Climate Change and Living Cities: Global Problems with Local Solutions', Springer Netherlands, Dordrecht, pp. 21-35.
- Anonymous 2005, 'Water and City-Environmental History of Water and Sanitation Services in Tampere, Finland, 1835-1921', *Environmental History*, vol. 10, no. 2, p. 365.
- Ansary, MA & Jahan, I 2013, 'Risk due to natural disasters in Dhaka and measures for mitigation', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 49-70.
- Arias-Barreiro, CR, Nishizaki, H, Okubo, K, Aoyama, I & Mori, IC 2010, 'Eco-toxicological characterization of tannery wastewater in Dhaka, Bangladesh', *Journal of environmental biology / Academy of Environmental Biology, India*, vol. 31, no. 4, pp. 471-475.
- Arne, R 2010, 'Fluid Urbanism', *Rigas Tehniskas Universitates Zinatniskie Raksti*, vol. 4, no. 1, pp. 90-98.
- Asad, R & Ahsan, R 2012, 'Structuring Urban Sustainability with Water: A Case of Kamrangir Chor, Dhaka, Bangladesh', *Journal of Social and Development Sciences*, vol. 3, no. 8, pp. 293-303.
- Asaduzzaman, A, Nasreen, N & Olsen, H 1999, 'Urban geology of Dhaka, Bangladesh', paper presented at *Atlas of urban geology*.
- Ashraf, KK 1997, 'Land, water and man in Bengal: themes of deltaic architecture', in F Ameen (ed.), *Contemporary Architecture and City Form: the south Asian Paradigm*, Marg, Mumbai, India, pp. 25-39.
- — 2010, 'A New Dhaka Possible', *Forum: a monthly publication of The Daily Star*, vol. 3, no. 3, pp. 1-22.
- — 2011, 'Designing Dhaka: history of a future', in AM Choudhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 447-468.

- — 2012, *Designing Dhaka: a Manifesto for a better city*, Loka Press, Dhaka.
- Ashworth, PJ, Best, JL, Roden, JE, Bristow, CS & Klaassen, GJ 2000, 'Morphological evolution and dynamics of a large, sand braid-bar, Jamuna River, Bangladesh', *Sedimentology*, vol. 47, no. 3, pp. 533-555.
- Ayutthayā, N & Jumsāi, S 1997, *Naga: cultural origins in Siam and the West Pacific/Sumet Jumsai*; with contributions by R. Buckminster Fuller, Chalermnit Press and DD Books.
- Azharul, HK 2006, 'Water management in Dhaka', *Water Resources Development*, vol. 22, no. 2, pp. 291-311.
- Bala, SK, Islam, A, Chowdhury, JU, Rahman, MR, Haque, MA, Khan, MSA & Salehin, M 2009, 'Performance of flood control works around Dhaka city during major floods in Bangladesh', A paper presented in the 2nd international conference on water and flood management, Dhaka.
- Barry Lawrence Rudeman antique maps 1991a, Barry Lawrence Rudeman antique maps inc., viewed 17 February 2015, <http://www.raremaps.com/gallery/detail/25152/Magni_Mogolis_Imperium/Jansson.html>.
- — 1991b, *Nouvelle Carte Du Royaume De Bengale*, Germany, viewed 17 February 2015, <https://www.raremaps.com/gallery/detail/0134gh/Nouvelle_Carte_Du_Royaume_De_Bengale/Bellin.html>.
- Bartholomew, JG 1922, 'Times survey atlas of the world'.
- Barton, DP & Lyon, TP 2012, 'Environmental Governance', in P Basnal & AJ Hoffman (eds), *Business and Natural Environment*, pp. 122-200.
- Barua, S 2008, 'Towards interactive urban flood management: a case of Dhaka Bangladesh.', Faculty of Social Sciences, Erasmus Centre for Sustainability & Management, Master thesis, Erasmus University Rotterdam, The Netherlands.
- BBS 2011, BBS (Bangladesh Bureau of Statistics), Bangladesh Government (BG) press, Dhaka, Bangladesh.
- bdnews24.com 2016, 'Top court orders BGMEA to demolish its 16-storey office building immediately', bdnews24.com, November 8, 2016.
- Beatley, T 1999, *Green Urbanism: Learning from European Cities*, Island Press.
- Beatley, T 2008, *Green Urbanism Down Under: Learning from Sustainable Communities in Australia* (2nd Edition), Island Press.
- Beatley, T & Newman, P 2009, *Green urbanism down under: learning from sustainable communities in Australia*, Island, Washington, D.C.
- Begum, A 2007, 'Urban housing as an issue of redistribution through planning? The case of Dhaka city', *Social Policy & Administration*, vol. 41, no. 4, pp. 410-418.

- Bélanger, P 2007, 'Underground landscape: The urbanism and infrastructure of Toronto's downtown pedestrian network', *Tunnelling and Underground Space Technology incorporating Trenchless Technology Research*, vol. 22, no. 3, pp. 272-292.
- Berney, R 2011, 'Pedagogical Urbanism: Creating Citizen Space in Bogota, Colombia', *Planning Theory*, vol. 10, no. 1, pp. 16-34.
- Bertuzzo, E, Islam, N, Nest, G & Shafi, S 2008, *Smooth and Striated, City and Water*, Dhaka/Berlin, Goethe Institute Bangladesh and Habitat Forum Berlin, Dhaka.
- Best, JL, Ashworth, PJ, Bristow, CS & Roden, J 2003, 'Three-dimensional sedimentary architecture of a large, mid-channel sand braid bar, Jamuna River, Bangladesh', *Journal of Sedimentary Research*, vol. 73, no. 4, pp. 516-530.
- Bhatt, V & Scriver, P 1990, *After the Masters: Contemporary Indian architecture*, Mapin Pub., Ahmedabad.
- Bhuiyan, SH 2003, 'The caretaker government in Bangladesh: an appraisal of its formation', *Politics Administration and Change*, vol. 40, pp. 33-51.
- Biswas, PM 2014, 'Global warming and the position of Bangladesh', *Equality in the city: making cities socially cohesive*, Dhaka, pp. 1-10.
- Bitton, G 2011, *Wastewater microbiology*, 4th edn, Wiley-Blackwell, Hoboken, NJ.
- Bottazzi, R 2012, 'Ecological Urbanism', vol. 83, no. Generic, Liverpool University Press (UK), Liverpool, pp. 124-132
- Brammer, H 1990, 'Floods in Bangladesh: geographical background to the 1987 and 1988 floods', *Geographical journal*, pp. 12-22.
- Brammer, H 1993, 'Geographical complexities of detailed impact assessment for the Ganges-Brahmaputra-Meghna delta of Bangladesh', *Climate and Sea Level Change: Observations, Projections and Implications*, Cambridge University Press, Cambridge, pp. 246-262.
- Brichieri-Colombi, S & Bradnock, RW 2003, 'Geopolitics, water and development in South Asia: cooperative development in the Ganges-Brahmaputra delta', *The Geographical Journal*, vol. 169, no. 1, pp. 43-64.
- Bridge, JS & Leeder, MR 1979, 'A simulation model of alluvial stratigraphy', *Sedimentology*, vol. 26, no. 5, pp. 617-644.
- Bristow, CS 2009, 'Gradual avulsion, river metamorphosis and reworking by underfit streams: a modern example from the Brahmaputra River in Bangladesh and a possible ancient example in the Spanish Pyrenees', *International Association of Sedimentologists Special Publication*, vol. 28, pp. 221-230.
- — 2012, 'Brahmaputra River: channel migration and deposition', *The Society of Economic Paleontologists and Mineralogists (SEPM)*, pp. 63-74.

- Bryman, A & Cramer, D 2002, *Quantitative data analysis with SPSS release 10 for Windows: a guide for social scientists*, Routledge.
- Bulkeley, H & Betsill, M 2005, 'Rethinking sustainable cities: multilevel governance and the urban politics of climate change', *Environmental politics*, vol. 14, no. 1, pp. 42-63.
- Burton, E, Jenks, M & Williams, K 2004, *The compact city: a sustainable urban form?*, Routledge.
- Business News 24 2013, '700 acres land of Bhawal Raj, Dhaka nawab estate grabbed by relatives', *Business news 24*, November 12, 2015.
- Byomkesh, T, Nakagoshi, N & Dewan, AM 2012, 'Urbanization and green space dynamics in Greater Dhaka, Bangladesh', *Landscape and Ecological Engineering*, vol. 8, no. 1, pp. 45-58.
- Cai, XD, Guo, HB & Huang, M 2011, 'Periodical Urban Morphology Evolution Research of Representative City in Songhua River Basin', *Advanced Materials Research*, vol. 250, pp. 2872-2876.
- Calthorpe, P 2010, *Urbanism in the Age of Climate Change*, Island Press.
- Campanella, R 2010, 'Delta urbanism: lessons from New Orleans', vol. 76, no. 1, p. 24, <http://adelaide.summon.serialssolutions.com/link/0/eLvHCXMwVZ27DQJBDES3AUKIaeCk857Xvo0RJwq4Brz-kBHRvzCIACpwNM8eaUYu5axka4K_Ve2DFhriSsyWJizWIFP8JQI_aL4dy75d98tt-v4BmO7YIK3SYJOO2jV3uzhwXjUU5OaedGXWAKCwaNVjYI6sYKLDf5wDeYZTOcg7Lv54fmp19gKBcCof>.
- Campbell, S 1996, 'Green cities, growing cities, just cities?: Urban planning and the contradictions of sustainable development', *Journal of the American Planning Association*, vol. 62, no. 3, pp. 296-312.
- Catherine, B 2009, 'The Potential of New Urbanism in Vilnius', *Mokslas: Lietuvos Ateitis*, vol. 1, no. 2, pp. 45-52.
- CEGIS 2014, *Trend and impact analysis of internal displacement due to the impacts of disaster and climate change*, Government of Bangladesh, Dhaka.
- Chakrabarty, P 2008, *Construction act and rules*, Book pavilion Dhaka
- Chang, J-H 2007, "'Natural' traditions: constructing tropical architecture in transnational Malaysia and Singapore', *Explorations*, vol. 7, no. 1, pp. 1-22.
- Chase, J, Crawford, M & Kaliski, J 1999, *Everyday urbanism: featuring John Chase*, Monacelli Press, New York.
- Chattopadhyay, S 2000, 'Blurring boundaries: the limits of "White Town" in colonial Calcutta', *Journal of the Society of Architectural Historians*, vol. 59, no. 2, pp. 154-179.
- — 2005, *Representing Calcutta: Modernity, nationalism and the colonial uncanny*, vol. 2, Routledge.

- — 2007, 'The other face of Primitivization: the Garden House of British Colonial Bengal', in P Scriver & V Prakash (eds), *Colonial Modernities: Building, Dwelling and Architecture in British India and Ceylon*, Routledge, London, pp. 151-168.
- — 2011, 'Urbanism, Colonialism and Sustainability', in TJ Edensor & M Jayne (eds), *Urban Theory Beyond the West: a world of cities*, Routledge.
- — 2014, *Unlearning the City: Infrastructure in a New Optical Field*, Minneapolis: University of Minnesota Press, USA.
- Chattopadhyay, S & Sarkar, B 2005, 'Introduction: The Subaltern and the Popular', *Postcolonial Studies*, vol. 8, no. 4, pp. 357-363.
- Chen, X, Wang, L & Kundu, R 2009, 'Localizing the production of global cities: A comparison of new town developments around Shanghai and Kolkata', *City & Community*, vol. 8, no. 4, pp. 433-465.
- Chopra, P 2011, *A Joint Enterprise: Indian Elites and the Making of British Bombay*, University of Minnesota Press.
- Chowdhury, AM & Faruqui, S 2009, 'Physical growth of Dhaka city', in SU Ahmed (ed.), *Dhaka Past Present Future*, Asiatic Society, Dhaka, pp. 56-76.
- Chowdhury, MA & Shahidul, H 2011, 'Growth of capital Dhaka 1608-2010', in AM Chowdhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 267-480.
- Christopher, BL 2011, 'Green urbanism: Urbanism in the Age of Climate Change', vol. 27, no. Generic, *National Academy of Sciences*.
- Christopher, K 2009, 'The rise & fall of new left urbanism', *Daedalus*, vol. 138, no. 2, pp. 73-82.
- Cities Alliance 2014, *Climate migration drives slum growth in Dhaka*, UNOPS, viewed Feb 20 2014, <<http://www.citiesalliance.org/node/420>>.
- Coleman, JM 1969, 'Brahmaputra River: channel processes and sedimentation', *Sedimentary Geology*, vol. 3, no. 2, pp. 129-239.
- Congress for the New Urbanism 2000, 'Charter of the New Urbanism', *Bulletin of Science, Technology & Society*, vol. 20, no. 4, pp. 339-341.
- Cordua, HC 2009, *Manifestos and transformations in the early modern city*, Ashgate Publisher Limited, England.
- Corner, J 1999, *Recovering Landscape: essays in contemporary landscape architecture*, *Recovering Landscape: Essays in Contemporary Landscape Theory*, Princeton Architectural Press.
- — 2003, 'Landscape urbanism', *Landscape urbanism: a manual for the machinic landscape*. Architectural Association, London.

- Coutts, AM, Beringer, J & Tapper, NJ 2008, 'Investigating the climatic impact of urban planning strategies through the use of regional climate modelling: a case study for Melbourne, Australia', *International Journal of Climatology*, vol. 28, no. 14, pp. 1943-1957.
- Cox, W 2016, *Demographia World Urban Areas, Built Up Urban Areas or World Agglomerations*.
- Cunningham, MA, Menking, KM, Gillikin, DP, Smith, KC, Freimuth, CP, Belli, SL, Pregnall, AM, Schlessman, MA & Batur, P 2010, 'Influence of open space on water quality in an urban stream', *PHYSICAL GEOGRAPHY*, vol. 31, no. 4, pp. 336-356.
- Dani, AH 2009, *Dhaka a Record of its Changing Fortune*, 2 edn, Asiatic Society Bangladesh., Dhaka, Bangladesh.
- DAP 2010, *Detail Area Plan (DAP)*, Government of Bangladesh, Dhaka.
- — 2011, *Detail Area Plan*, Government of Bangladesh, Dhaka.
- DAP review report 2014, *Report on DAP (Detail Area Plan) for Dhaka*, Dhaka.
- Das, B & Islam, I 2010, 'Analyzing the Proposals of FAP 8B Project of Dhaka and Present Context of Retention Pond Areas and Canals', *Journal of Bangladesh Institute of Planners*, vol. 3, pp. 89-102.
- Das, P & Tamminga, KR 2012, 'The Ganges and the GAP: An assessment of efforts to clean a sacred river', *Sustainability*, vol. 4, no. 8, pp. 1647-1668.
- David, B 2004, 'Mexico City's Water Crisis', *NACLA Report on the Americas*, vol. 24, no. 1, pp. 38-50.
- David Rumsey Map Collection 2006, Bengal and Bihar,
<<http://www.davidrumsey.com/luna/servlet/allCollections>>.
- DCC 2014, Dhaka City Corporation, viewed 18/02/2014 2014,
<http://www.dhakasouthcity.gov.bd/Page/About/Link/2/List_id/220/Ward_no_&_Area_>.
- De Meulder, B, Loeckx, A & Shannon, K 2004, 'A project of projects', in A. Loeckx (ed.) *Urban Dialogues: Visions, Projects, Co-productions*, pp. 186-197
- De Vaus, D 2002, *Analyzing Social Science Data: 50 key Problems in Data Analysis*, Sage.
- Delli Priscoli, J 2000, 'Water and civilization: using history to reframe water policy debates and to build a new ecological realism', *Water Policy*, vol. 1, no. 6, pp. 623-636.
- Department of Environment and Heritage 2010, *Summary of Submission report*, Government of South Australia, viewed 22 February 2012, <Error! Hyperlink reference not valid..>
- Department of Geography and Environment & University of Dhaka 2011, *Environmental report on Dhaka city*, Dhaka.

- Desai, R 2012, 'Governing the urban poor: riverfront development, slum resettlement and the politics of inclusion in Ahmedabad', *Economic and Political Weekly*, vol. 47, no. 2, pp. 49-56.
- — 2014, 'Municipal Politics, Court Sympathy and Housing Rights: A Post-Mortem of Displacement and Resettlement under the Sabarmati Riverfront Project, Ahmedabad', *Centre for Urban Equity Working Paper*, vol. 23.
- Dewan, A, Nishigaki, M & Komatsu, M 2004, 'DEM based flood extent delineation in Dhaka City, Bangladesh', *Journal of the Faculty of Environmental Science and Technology*, vol. 19, no. 1, pp. 99-110.
- Dewan, AM 2013, 'Vulnerability of a Megacity to Flood: A Case Study of Dhaka', *Floods in a Megacity*, Springer, pp. 75-101.
- Dewan, AM, Islam, MM, Kumamoto, T & Nishigaki, M 2007, 'Evaluating flood hazard for land-use planning in Greater Dhaka of Bangladesh using remote sensing and GIS techniques', *Water Resources Management*, vol. 21, no. 9, pp. 1601-1612.
- Dewan, AM, Kumamoto, T & Nishigaki, M 2006, 'Flood hazard delineation in greater Dhaka, Bangladesh using an Integrated GIS and remote sensing approach', *Geocarto International*, vol. 21, no. 2, pp. 33-38.
- Dewan, AM & Yamaguchi, Y 2009, 'Land use and land cover change in Greater Dhaka, Bangladesh: using remote sensing to promote sustainable urbanization', *Applied Geography*, vol. 29, no. 3, pp. 390-401.
- Dewan Ashraf M., YY, Rahman Md. Ziaur 2010, 'Dynamics of land use/cover changes and the analysis of landscape fragmentation in Dhaka Metropolitan, Bangladesh', *Geo Journal*, pp. 317-330.
- DMDP, GoB 1995, *Dhaka Metropolitan Development Plan 1995-2015*, Government Press, Dhaka.
- Donadieu, P 2006, 'Landscape urbanism in Europe: from brownfields to sustainable urban development', *Journal of Landscape Architecture*, vol. 1, no. 2, pp. 36-45.
- Donofrio, J, Kuhn, Y, McWalter, K & Winsor, M 2009, 'Water-sensitive urban design: an emerging model in sustainable design and comprehensive water-cycle management', *Environmental Practice*, vol. 11, no. 03, pp. 179-189.
- Dossal, M 2010, 'Theatre of conflict, city of hope: Mumbai 1660 to present times', *OUP Catalogue*.
- Douglas, I 1976, 'Urban Hydrology', *The Geographical Journal*, vol. 142, no. 1, pp. 65-72.
- Doyle, SE 2012, 'City of Water: Architecture, Urbanism and the Floods of Phnom Penh', *Nakhara: Journal of Environmental Design and Planning*, vol. 8.
- Doyly, C 1991, *Antiquities of Dacca*, trans. SMN Alam, Academic Press and Publishers Dhaka.

- Drakakis-Smith, D 1995, 'Third World cities: sustainable urban development, 1', *Urban Studies*, vol. 32, no. 4-5, pp. 659-677.
- Droege, P 2006, 'The renewable city: dawn of an urban revolution', *Bulletin of Science, Technology & Society*, vol. 26, no. 2, pp. 141-150.
- DWASA 2011, *Report of DWASA 2011*, BG (Bangladesh Government) Press Dhaka.
- — 2014, *Drainage master plan of Dhaka 2014*, BG (Bangladesh Government) Press Dhaka.
- Economist Intelligence Unit 2012, *A Summary of the Liveability Ranking and Overview August 2012*, The Economist Intelligence Unit Limited, London, viewed 2 April 2013, <http://www.eiu.com/public/thankyou_download.aspx?activity=download&campaignid=Liveability2012>.
- Edensor, TJ & Jayne, M 2011, *Urban theory beyond the West: a world of cities*, Routledge.
- Eisen, JB 1995, 'Toward a sustainable urbanism: Lessons from federal regulation of urban storm water runoff', *Washington University Journal of Urban and Contemporary Law*, vol. 48, pp. 1-84.
- Ekattor TV 2014, 'History of Dhaka', Youtube, <<https://www.youtube.com/watch?v=mgYDCmplVx4>>.
- Ellis, DC & Sisco, J 2014, 'Chapter Three, Understanding Megacities-RSI-Dhaka's Design as an Expression of Culture & Politics', in C Ehlschlaeger (ed.), *Understanding Megacities with the Reconnaissance, Surveillance, and Intelligence Paradigm*, pp. 24-32.
- Erickson, DL 2006, *Metrogreen: connecting open space in North American cities*, Island Press, Washington, D.C.
- Evans, DH, Fletcher, RJ, Pottier, C, Chevance, J-B, Soutif, D, Tan, BS, Im, S, Ea, D, Tin, T & Kim, S 2013, 'Uncovering archaeological landscapes at Angkor using lidar', *Proceedings of the National Academy of Sciences*, vol. 110, no. 31, pp. 12595-12600.
- Faisal, I, Kabir, M & Nishat, A 1999, 'Non-structural flood mitigation measures for Dhaka City', *Urban water*, vol. 1, no. 2, pp. 145-153.
- — 2003, 'The disastrous flood of 1998 and long term mitigation strategies for Dhaka City', *Flood Problem and Management in South Asia*, Springer, pp. 85-99.
- Farr, D 2012, *Sustainable urbanism: urban design with nature*, John Wiley & Sons.
- Ferdous, F 2007, 'Extermination of Jinjira Canal – The Southern Fringe of Buriganga', in M Rahman (ed.), *Society, Architects and Emerging issues*, Dhaka Bangladesh, pp. 35-42.
- — 2012, 'The spatial analysis and morphological evolution of the 'Bazaar Streets' and urban structure of Dhaka city', *Urban Design International*, vol. 17, no. 3, pp. 206-220.
- Feyen, J, Shannon, K & Neville, M 2009, *Water and Urban Development Paradigms: Towards an Integration of Engineering, Design and Management Approaches*, International Urban Water Conference, eds J Feyen, K Shannon & M Neville, CRC Press, Heverlee.

- Gallagher, R 2011, 'Evolution of transport in Dhaka since 1947', in AM Choudhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 267-480.
- Gandy, M 2004, 'Water, modernity and emancipatory urbanism', *The Emancipatory City*. London: Sage, pp. 178-191.
- Garde, AM 2004, 'New urbanism as sustainable growth: a supply side story and its implications for public policy', *Journal of Planning Education and Research*, vol. 24, no. 2, pp. 154-170.
- Garschagen, M & Kraas, F 2011, 'Urban climate change adaptation in the context of transformation: lessons from Vietnam', *Resilient Cities*, Springer, pp. 131-139.
- Geddes, P 1990, *Report on Dhaka city planning 1917*, ed. A Mohaimen, Dhaka city museum, Dhaka.
- Ghafur, S 2004, 'Undoing Heroicization of Louis Kahn in Bangladesh', *Protibesh: the Environment*, vol. 6, no. 1, pp. 52-54.
- — 2006a, 'Review of cities in transition', *Global Built Environment Review*, vol. 5(2), January 2003, pp. 76-78.
- — 2006b, 'Social exclusion and residential densification: Implications for integration of the urban poor in Dhaka, Bangladesh', *Protibesh: the Environment*, vol. 10, no. 1, pp. 2-14.
- — 2011a, 'Climate refugees' at home in neo-liberal Dhaka', paper presented at Urbanisation and climate change: urban disaster and poor habitation, Dhaka, 13 October 2011.
- — 2011b, 'Imprints of the Changing Doctrines on Housing in Dhaka', in R Hafiz & G Rabbani (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 153-168.
- — 2013, 'Prospects of Hatirjheel as a desiring-machine', *New Age*, December 2 2013.
- — 2016, 'Re-imagining the urban', *New Age*, October 21, 2016.
- Ginnetti, j & Lavell, C 2015, *The risk of disaster-induced displacement in South Asia*, International Displacement Monitoring Centre, Switzerland.
- Girling, C & Kellett, R 2005, *Skinny streets and green neighbourhoods: design for environment and community*, Island Press.
- Glover, W 2007, 'Making Lahore Modern: Constructing and Imagining a Modern City', Minneapolis: University of Minnesota Press.
- Goldman, M 2011, 'Speculative Urbanism and the Making of the Next World City', *International Journal of Urban and Regional Research*, vol. 35, no. 3, pp. 555-581.
- Grace, VM 2004, 'Applying integrated urban water management concepts: a review of Australian experience', *Review of Australian, UWM Experience*, 2004, pp. 590-605.

- Graham, L 2009, 'A look at landscape urbanism', *The Canadian Architect*, vol. 54, no. 11, pp. 45-54.
- Griffiths, P, Hostert, P, Gruebner, O & der Linden, Sv 2010, 'Mapping megacity growth with multi-sensor data', *Remote Sensing of Environment*, vol. 114, no. 2, pp. 426-439.
- Groat, L & Wang, D 2002, *Architectural research methods*, Springer.
- Habib, K & De Meulder, B 2011, 'Representation and public contestation: The post-colonial public spaces of Dhaka', in AM Chowdhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 263-276.
- Habib, KMN 2002, *Evaluation of planning options to alleviate traffic congestion and resulting air pollution in Dhaka City, Bangladesh University of Engineering and Technology (BUET), M. Sc. Engg thesis, Department of Civil Engineering, BUET, Dhaka, Bangladesh.*
- Habitat, U 2009a, 'Planning sustainable cities—Global report on human settlements 2009', Earthscan, London.
- — 2009b, 'State of World cities 2008-2009: Harmonious Cities', London, Royaume-Uni, Etats-Unis: UN-Habitat.
- — 2011, 'Cities and climate change: Global report on human settlements 2011', London, Royaume-Uni, Etats-Unis: UN-Habitat.
- Hafiz, R 2001, 'The urban frontiers of Dhaka: creating space above the water.'
- Haider, A 1966a, *A concise history of Dhaka municipality (1864-1964) Dhaka municipality, Dhaka.*
- — 1966b, 'Dacca through ages', in A Haider (ed.), *A city and its civic body, Dhaka Municipality, Dhaka*, pp. 1-13.
- Haider, MH 2015, 'The lost panorama', *The Daily Star*, July 28, 2015.
- Halcrow Group Limited 2006, *Updating/upgrading the feasibility study of Dhaka integrated flood control embankment cum eastern bypass road multipurpose project, Government of Bangladesh, Dhaka.*
- Hall, P 1988, *Cities of tomorrow*, Blackwell Publishers.
- Haq, KA 2006, 'Water management in Dhaka', *INTERNATIONAL JOURNAL OF WATER RESOURCES DEVELOPMENT*, vol. 22, no. 2, pp. 291-311.
- Haque, CE & Zaman, MQ 1989, 'Coping with riverbank erosion hazard and displacement in Bangladesh: survival strategies and adjustments', *Disasters*, vol. 13, no. 4, pp. 300-314.
- Harris, A 2012, 'The Metonymic Urbanism of Twenty-first-century Mumbai', *Urban Studies*, vol. 49, no. 13, pp. 2955-2973.

- Hasan, M 2010, 'A question mark on urbanisation', *The Daily Star*, February 24, 2010.
- Hasan, M 2015, 'Canals along Purbachal link road: Govt. decides to implement Tk 5,530cr project thru Army ', *The New Age*, October 31, 2015.
- Hasan, R 2010, '39 canals meet 1,000 grabbers: JS body asks DCs to serve notice on encroachers', *The Daily Star*, April 21, 2010.
- Hasan, S & Mulamoottil, G 1994, 'Environmental problems of Dhaka city', *CITIES*, vol. 11, no. 3, pp. 195-200.
- Hassan, R 2014, Promoting environmental justice, YouTube, viewed November 23 2015, <<https://www.youtube.com/watch?v=2W9BrZgsMK8>>.
- Houghton, G 1997, 'Developing sustainable urban development models', *CITIES*, vol. 14, no. 4, pp. 189-195.
- Hays, PA 2004, 'Case study research', in Dk Marrais & SD Lapan (eds), *Foundations for research: Methods of inquiry in education and the social sciences*, pp. 217-234.
- Headrick, DR 1979, 'The Tools of Imperialism: Technology and the Expansion of European Colonial Empires in the Nineteenth Century', *The Journal of Modern History*, vol. 51, no. 2, pp. 231-263.
- — 1981, *The tools of empire: Technology and European imperialism in the nineteenth century*, Oxford University Press New York.
- Heroy, DC, Kuehl, SA & Goodbred, SL 2003, 'Mineralogy of the Ganges and Brahmaputra Rivers: implications for river switching and Late Quaternary climate change', *Sedimentary Geology*, vol. 155, no. 3, pp. 343-359.
- Hill, K 2009, 'Urban design and urban water ecosystems', in LA Backer (ed.), *The water environment of cities*, Springer, pp. 141-170.
- Hodson, M, Marvin, S, Robinson, B & Swilling, M 2012, 'Reshaping Urban Infrastructure: Material Flow Analysis and Transitions Analysis in an Urban Context', *Journal of Industrial Ecology*, vol. 16, no. 6, pp. 789-800.
- Hoek, L 2012, 'Mofussil Metropolis: Civil sites, uncivil cinema and provinciality in Dhaka city', *Ethnography*, vol. 13, no. 1, pp. 28-42.
- Hofer, T & Messerli, B 1997, *Floods in Bangladesh, A synthesis Paper*. University of Bern, United Nations University Press.
- Hogan, T 2003, 'Postcolonial Cities: A View from Jakarta', *Thesis Eleven*, vol. 73, pp. 113-121.
- Hogan, T, Bunnell, T, Pow, CP, Permasari, E & Morshidi, S 2012, 'Asian urbanisms and the privatization of cities', *Cities*, vol. 29, no. 1, pp. 59-63.
- Holl, S *Urbanisms: working with doubt*, Princeton Architectural Press, New York.

- Home, RK 1996, *Of planting and planning: The making of British colonial cities*, vol. 20, Routledge.
- Hoque, MA, Hoque, MM & Ahmed, KM 2007, 'Declining groundwater level and aquifer dewatering in Dhaka metropolitan area, Bangladesh: causes and quantification', *Hydrogeology Journal*, vol. 15, no. 8, pp. 1523-1534.
- Hossain, AM & Rahman, S 2011, 'Hydrography of Dhaka city catchment and impact of urbanization on water flows: a review', *Asian Journal of Water, Environment and Pollution*, vol. 8, no. 4, pp. 27-36.
- Hossain, F, Mitra, C, Shepherd, J & Siddique-E-Akbor, A 2013, 'Water resources vulnerability in the context of rapid urbanization of Dhaka city (a South Asian megacity)'.
- Hossain, M 2013, 'HC asks govt. to demolish BGMEA Bhaban in 90 days', *The Daily Star*, March 20 2013.
- Hossain, MS 2013, 'Strategies to integrate the Mughal settlements in Old Dhaka', *Frontiers of Architectural Research*, vol. 2, no. 4, pp. 420-434.
- Hossain, N 1998, *Kingbodontir Dhaka (Kingdom of Dhaka)*, Anannya, Dhaka.
- Hossain, N 2009, 'Making an urban oasis: The use of space syntax in assessing Dhanmondi lake revitalization project in Dhaka, Bangladesh', in D Koch, L Marcus & J Steen (eds), *7th International Space Syntax Symposium*, Stockholm Sweden.
- Hossain, S 2004, 'Urban poverty and household adaptations in Dhaka city, Bangladesh', *Globalisation Section of Re-visioning Institutions: Change in the 21st Century* (CD Rom).
- — 2006, 'Rapid Mass Urbanization and its Social Consequences in Bangladesh: The Case of the Megacity of Dhaka', *16th Biennial Conference of the Asian Studies Association of Australia in Wollongong*.
- — 2007, 'Poverty and vulnerability in urban Bangladesh: the case of slum communities in Dhaka City', *International Journal of Development Issues*, vol. 6, no. 1, pp. 50-62.
- — 2008, 'Rapid urban growth and poverty in Dhaka city', *Bangladesh e-journal of sociology*, vol. 5, no. 1, pp. 1-24.
- Huq, S & Alam, M 2003, 'Flood management and vulnerability of Dhaka City', in A Kreimer, M Arnold & A Carlin (eds), *Building Safer Cities: The Future of Disaster Risk*. Washington, DC, The World Bank, USA, pp. 121-135.
- Hutton, D & Haque, CE 2004, 'Human vulnerability, dislocation and resettlement: Adaptation processes of river-bank erosion-induced displaces in Bangladesh', *Disasters*, vol. 28, no. 1, pp. 41-62.
- Imamuddin, AH 1982, 'A Study of on Urban Housing in the Context of Dhaka', Unpublished Master's dissertation, Katholieke Universiteit, Leuven.

- Imamuddin, AH & Longeteig, KR 1990, *Architecture and Urban Conservation in the Islamic World*, Aga Khan Trust for Culture, Oversea Printing, Singapore.
- Imarat Nirman Bidhimala, GoB 2008, *Building Construction rule*. Bangladesh Government (BG) Press, Dhaka.
- Iqbal, I 2013, 'First master plan for Dhaka city: An environmental exploration', *South Asia Chronicle*, vol. 3, pp. 42-61.
- — 2014, 'First Master Plan for Dhaka City', Berlin, Germany.
- Islam, I 2009, *Wetlands of Dhaka metro area: a study from social, economic and institutional perspectives*, AH development Publishing House, Dhaka.
- Islam, I 2009, *Wetlands of Dhaka Metro Area: A Study from Social, Economic, and Institutional Perspectives*, AH Development Publishing House, Dhaka.
- Islam, I, Katsuki, T & Hidehiko, K 2013, 'Socio-cultural context in conservation of wetland: a case of Dhaka metropolitan area'.
- Islam, I, Sharmin, M, Masud, F & Moniruzzaman, M 2009, 'Urban consolidation approach for Dhaka City: prospects and constraints', *Glob Built Environ Rev*, vol. 7, no. 1, pp. 50-68.
- Islam, M, Rehnuma, M, Tithi, S, Kabir, M & Sarkar, L 2015, 'Investigation of Water Quality Parameters from Ramna, Crescent and Hatirjheel Lakes in Dhaka City', *Journal of Environmental Science and Natural Resources*, vol. 8, no. 1, pp. 1-5.
- Islam, MA 2007, 'Flood hazard mapping of Dhaka-Narayanganj-Demra (DND) project using geo-informatics tools ', ICHARM, 2007.
- Islam, MR, Begum, SF, Yamaguchi, Y & Ogawa, K 1999, 'The Ganges and Brahmaputra rivers in Bangladesh: basin denudation and sedimentation', *Hydrological Processes*, vol. 13, no. 17, pp. 2907-2923.
- Islam, MS, Rahman, MR, Shahabuddin, A & Ahmed, R 2010, 'Changes in wetlands in Dhaka city: trends and physico-environmental consequences', *Journal of Life and Earth Science*, vol. 5, pp. 37-42.
- Islam, MS, Rahman, MR, Shahabuddin, AKM & Ahmed, R 2010, 'changing in wetlands in Dhaka city: Trends and Physio-environmental consequences', *Life Earth*, vol. 5, pp. 37-42.
- Islam, MS, Shahabuddin, A, Kamal, MM & Ahmed, R 2014, 'Wetlands of Dhaka City: It's Past and Present Scenario', *Journal of Life and Earth Science*, vol. 7, pp. 83-90.
- Islam, N 1990, *Dhaka metropolitan fringe land and housing development Dhaka study series 10*, ed. M Mamun, Centre for Dhaka studies, The Dhaka City Museum, Dhaka.
- Islam, N 1992, 'Indo-Bangladesh common rivers: The impact on Bangladesh', *Contemporary South Asia*, vol. 1, no. 2, pp. 203-225.

- Islam, N 1996a, Dhaka: From City to Megacity: Perspectives on People, Places, Planning, and Development Issues, Urban Studies Programme, Department of Geography, University of Dhaka.
- — 1996b, 'Sustainability issues in urban housing in a low-income country: Bangladesh', *Habitat International*, vol. 20, no. 3, pp. 377-388.
- — 2001, Urbanization Urban Planning and Development and Urban Governance, CUS (Centre for Urban Studies), Dhaka Bangladesh.
- — 2006, Dhaka Now: contemporary urban development, Bangladesh Geographical Society, Dhaka Bangladesh.
- — 2009, 'Dhaka in 2015 AD', in SU Ahmed (ed.), Dhaka Past Present Future, 2009 edn, Asiatic Society, Dhaka.
- — 2011, 'Dhaka in 2050', in R Hafiz & G Rabbani (eds), 400 Years of Capital Dhaka and Beyond, Asiatic Society Bangladesh, Dhaka, pp. 267-480.
- Islam, S 2007, 'Physical Density and Urban Sprawl: A Case of Dhaka City', M. Sc. Thesis.
- IWM 2014, Dhaka drainage master plan, Government of Bangladesh (GoB), Dhaka.
- Jahan, S 2011, 'Dhaka: an urban planning perspective', in AM Choudhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), 400 Years of Capital Dhaka and Beyond, Asiatic Society Bangladesh, Dhaka, pp. 137-152.
- Jalal, MR 2012, 'Report on Integrated Development of Hatirjheel Area including Begunbari Khal Project', Report, Bangladesh University of Engineering and Technology (BUET).
- Jenks, M & Burgess, R 2000, Compact cities: sustainable urban forms for developing countries, Taylor & Francis.
- JICA 1989, Flood Action Plan (FAP), Government of Bangladesh (GoB), Dhaka
- — 1991, Master plan for greater Dhaka protection project (study in Dhaka metropolitan area) of Bangladesh flood action plan, Government of Bangladesh (GoB), Dhaka.
- — 2006, Basic design study report on the project for improvement of storm water drainage system in Dhaka city, Government of Bangladesh, Dhaka
- Jon, C, Robert, M & Carrie, D 2012, 'Ecological Urbanism for the 21st Century', *The Chronicle of Higher Education*, vol. 58, no. 21.
- Joss, S & Molella, AP 2013, 'The Eco-City as Urban Technology: Perspectives on Caofeidian International Eco-City (China)', *Journal of Urban Technology*, vol. 20, no. 1, pp. 115-137.
- Kabir, A & Parolin, B 2010, 'Planning and development of Dhaka: a story of 400 years', International planning history society conference.
- Kabir, KH 2012, 'Presentations on personal experience of informal Architecture'.

- Kabir, MH, Endlicher, W & Jägermeyr, J 2010, 'Calculation of bright roof-tops for solar PV applications in Dhaka Megacity, Bangladesh', *Renewable Energy*, vol. 35, no. 8, pp. 1760-1764.
- Kakon, AN & Nobuo, M 2009, 'The sky view factor effect on the microclimate of a city environment: A case study of Dhaka city', 7th International Conference on Urban Climate, Yokohama, Japan.
- Kamal, AM & Midorikawa, S 2004, 'GIS-based geomorphological mapping using remote sensing data and supplementary geoinformation: A case study of the Dhaka city area, Bangladesh', *International Journal of Applied Earth Observation and Geoinformation*, vol. 6, no. 2, pp. 111-125.
- Kamol, E 2009, 'The death of canals', *The Daily Star*, May 22, 2009.
- Karim, A 1964, *Dhaka the Mughal capital*, The centre for Dhaka studies, the Dhaka city museum.
- — 2009, 'Origin and development of Mughal Dhaka', in SU Ahmed (ed.), *Dhaka Past Present Future*, 2009 edn, Asiatic Society, Dhaka.
- Karim, FS 2010, 'Making Lahore Modern: Constructing and Imagining a Colonial City [Book Review]', *Fabrications: The Journal of the Society of Architectural Historians, Australia and New Zealand*, vol. 19, no. 2, pp. 182-184.
- Karim, MM, Mannan, MS & Matsui, H 1999, 'Light Rail Transit as a sustainable Mode of Mass Transit in Dhaka Metropolitan', *Proceedings of the 6th International Conference on Computers in Urban Planning and Urban Management on the Edge of the Millenium*, CUPUM, vol. 99.
- Karim, SF 2010, 'Modernity Transfers: the MoMA and postcolonial India', in L Duanfang (ed.), *Third World Modernism: Architecture, Development and Identity*, Routledge.
- Karn, SK & Harada, H 2001, 'Surface water pollution in three urban territories of Nepal, India, and Bangladesh', *Environmental Management*, vol. 28, no. 4, pp. 483-496.
- Katz, P, Scully, VJ & Bressi, TW 1994, *The new urbanism: Toward an Architecture of Community*, vol. 10, McGraw-Hill New York.
- Kelbaugh, D & McCullough, KK 2008, *Writing Urbanism: a Design Reader*, Routledge, London.
- Khalequzzaman, M 2011, 'GIS analysis of detail area plan and eastern bypass in Dhaka city using digital elevation model data and natural drainage network'.
- Khan, MA 2014, 'Waterlogging: consequence of ill-planned urbanisation', *The Daily Star*, July 12, 2014.
- Khan, N & Nilufar, F 2009, 'Spatial Logic of Morphological Transformation', in K Daniel, M Lars & S Jesper (eds), *International Space Syntax Symposium*, Stockholm, Sweden.

- Khan, NI 2000, 'Temporal mapping and spatial analysis of land transformation due to urbanization and its impact on surface water system: A case from Dhaka metropolitan area, Bangladesh', *International Archives of Photogrammetry and Remote Sensing*, XXXIII, Part B, vol. 7, pp. 598-605.
- Khan, NI & Islam, A 2003, 'Quantification of erosion patterns in the Brahmaputra–Jamuna River using geographical information system and remote sensing techniques', *Hydrological Processes*, vol. 17, no. 5, pp. 959-966.
- Khan, NR 2002, 'National assembly building', *Architecture for Islamic Societies*, pp. 126-137.
- Khan, TA 2012, 'Urban Water Challenges', DWASA (Dhaka water supply and sewer authority), Dhaka, Bangladesh.
- — 2013, 50 years of Dhaka WASA, Dhaka Water supply and Sewerage Authority, Dhaka Bangladesh.
- Khan, TA 2014, 50 years of Dhaka WASA, Dhaka Water supply and Sewerage Authority, BG (Bangladesh Government) Press Dhaka Bangladesh.
- Kidambi, P 2013, 'Mumbai Modern Colonial Pasts and Postcolonial Predicaments', *Journal of Urban History*, vol. 39, no. 5, pp. 1003-1011.
- Kien, LC 2010, 'Southeast Asian spatial histories and historiographies: A re-examination', *Fabrications*, vol. 19, no. 2, pp. 82-105.
- King, AD 1976, *Colonial urban development: culture, social power and environment*, Cambridge University Press.
- Kirsten, H & Shahadat, H 2012, "'The organised encroachment of the powerful" - everyday practices of public space and water supply in Dhaka, Bangladesh', *Planning Theory & Practice*, vol. 13, no. 3, pp. 397-109.
- Knight, L & Riggs, W 2010, 'Nourishing urbanism: a case for a new urban paradigm', *INTERNATIONAL JOURNAL OF AGRICULTURAL SUSTAINABILITY*, vol. 8, no. 1-2, pp. 116-126.
- Koçi, V 2012, 'Lattice Durrës: Water Urbanism in peri-urban area', paper presented at (Re)writing history, Bucharest - Romania.
- Koçi, V 2005, 'Spatial transformations of the waterfront—as an urban frontier case study: Durrës a port city', Middle East Technical University.
- Komol, E 2014, 'Bashundhara co-encroaches on retention pond', *The New Age*, April 12 2014.
- Kooy, M & Bakker, K 2008, 'Technologies of government: constituting subjectivities, spaces, and infrastructures in colonial and contemporary Jakarta', *International Journal of Urban and Regional Research*, vol. 32, no. 2, pp. 375-391.
- Ksiazek, S 1993, 'Architectural culture in the fifties: Louis Kahn and the National Assembly Complex in Dhaka', *The Journal of the Society of Architectural Historians*, pp. 416-435.

- Kumar, U 2012, 'Detention and retention function of Hatirjheel integrated project and its management aspect', Report, Bangladesh University of Engineering and Technology (BUET).
- Kusno, A 1998, 'Beyond the postcolonial: architecture and political cultures in Indonesia', *public culture*, vol. 10, no. 3, pp. 549-575.
- — 2000, 'imagining regionalism: re-fashioning orientalism: some current architectural discourses in Southeast Asia', *Journal of Southeast Asian Architecture*, vol. 4, no. 1, pp. 2378-2394.
- — 2004, 'Whither nationalist urbanism? Public life in Governor Sutiyoso's Jakarta', *Urban Studies*, vol. 41, no. 12, pp. 2377-2394.
- — 2010, 'Tropics of discourse: notes on the re-invention of architectural regionalism in Southeast Asia in the 1980s', *Fabrications*, vol. 19, no. 2, pp. 58-81.
- Labib, S, Bhuiya, MMR & Rahaman, MZ 2013, 'Location and size preference for apartments in Dhaka and prospect of real estate market', *Bangladesh research publication journal*, vol. 9, no. 2, pp. 87-96.
- Lehmann, S 2010, *The principles of green urbanism: transforming the city for sustainability*, Earthscan, London.
- — 2011, 'Transforming the city for sustainability the principles of Green Urbanism', *Journal of Green Building*, vol. 6, no. 1, pp. 104-113.
- Lehmann, S & Yeang, K 2010, 'Meeting with the Green Urban Planner: A Conversation Between Ken Yeang and Steffen Lehmann on Eco-Master planning for Green Cities', *Journal of Green Building*, vol. 5, no. 1, pp. 36-40.
- Lehtovuori, P 2012, 'Towards Experiential Urbanism', *Critical Sociology*, vol. 38, no. 1, pp. 71-87.
- Leinberger, CB 2011, 'Green urbanism: Urbanism in the Age of Climate Change', vol. 27, *National Academy of Sciences*, p. 89.
- Lichtenberger, E 1970, 'The nature of European urbanism', *Geo forum*, vol. 1, no. 4, pp. 45-62.
- Lim, WSW 1984, 'Environmental identity and urbanism', *Habitat International*, vol. 8, no. 3, pp. 181-192.
- Loeckx, A 2004, *Urban Trialogues: Visions, Projects, Co-productions*, vol. 21, Un-Habitat.
- Lorenzen, DN 1978, 'Warrior ascetics in Indian history', *Journal of the American Oriental Society*, pp. 61-75.
- Lu, D 2010, *Third world modernism: architecture, development and identity*, Routledge.
- Lubell, S 2016, '7 Cities Transforming Their Rivers From Blights to Beauties', *Wired*, 8 April 2016.

- Lucas, R 2016, *Research Methods for Architecture*, Laurence king Publisher limited, London.
- Luttik, J 2000, 'The value of trees, water and open space as reflected by house prices in the Netherlands', *Landscape and Urban Planning*, vol. 48, no. 3, pp. 161-167.
- Maathuis, B, Mannaerts, C & Khan, N 1999, 'Evaluating Urban Storm water Drainage Using GIS and RS Techniques-A Case Study in Dhaka, Bangladesh', *Geocarto International*, vol. 14, no. 4, pp. 19-30.
- Macfarlane, PW 1959, *Master plan for Dhaka*, Dhaka.
- Magdaleno, J 2013, High-tech floating houses planned for Nigeria water communities, viewed 15 April 2014, <<http://thecreatorsproject.vice.com/blog/nigeria-lagos-water-communities-look-like-waterworld>>.
- Mahmud, AH 2014, 'Illegal establishment still in Hatirjheel-Begunbari canal', *Dhaka Tribune*, February 14, 2014.
- Mahmud, MA 2013, 'Hydraulic effect of urban development to flood plains in Dhaka, Bangladesh', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 86-98.
- Mahmud, MS, Masrur, A, Ishtiaque, A, Haider, F & Habiba, U 2011, 'Remote Sensing & GIS Based Spatio-Temporal Change Analysis of Wetland in Dhaka City, Bangladesh', *Journal of Water Resource and Protection*, vol. 3, no. 11, pp. 781-787.
- Mahtab-uz-Zaman, QM 2011, 'Adaptive re-use and urban regeneration in Dhaka: a theoretical exploration', *Open House International*, vol. 36, no. 2, pp. 45-58.
- Mai, MM & Rahman, M 2011, 'Cultural sustainability of residential adjustment styles of semi-urban abuja and core Dhaka neighbourhoods', *Sustainable Development and Environmental Protection*, vol. 1, no. 1, pp. 41-56.
- Malik, A 1999, 'Post-Colonial Capitals of South Asia: A Critical Analysis of Chandigarh, Dhaka and Islamabad'.
- Mamun, M 2000, *Dhaka: city of memories*, Anannya.
- — 2009, *Dhaka: city of memories, Part 2*, Anannya.
- — 2014, *Dhaka: city of memories, Part 3*, Anannya.
- Manaugh, G & Twilley, N 2006, 'On Flexible Urbanism', *Space and Culture*, vol. 9, no. 1, pp. 23-25.
- Mandeen, J 2004, *Auroville architecture: towards new forms for a new consciousness*, Prisma.
- Mark, O, Apirumanekul, C, Kamal, MM & Praydal, P 2001, 'Modelling of urban flooding in Dhaka City', *Proceedings UDM*, vol. 1, pp. 2-11.

- Masum, F 2010, 'Actors and Processes Behind Urban Fringe Development: Mechanism to Guide Urban Land Management; Study on Dhaka, Bangladesh', Technical University Lehrstuhl für Bodenordnung und Landentwicklung.
- Mathur, A & Da Cunha, D 2001, *Mississippi floods: designing a shifting landscape*, Yale University Press.
- — 2006, *Deccan traverses: the making of Bangalore's terrain*, Rupa, New Delhi.
- Mathur, N 2012, 'On the Sabarmati riverfront', *Economic and Political Weekly*, vol. 47, pp. 64-75.
- McGowan, A 2013, 'Ahmedabad's Home Remedies: Housing in the Re-Making of an Industrial City, 1920–1960', *South Asia: Journal of South Asian Studies*, vol. 36, no. 3, pp. 397-414.
- McKay, S 2011, 'Universalizing modernism', *Building Research & Information*, vol. 39, no. 6, pp. 678-682.
- McPherson, P 2015, 'Dhaka: the city where climate refugees are already a reality', *The Guardian*, December 01, 2015.
- Meier, RL & Quium, ASMA 1991, 'Planning and designing new urban settlement on estuaries: Bangladesh', *Landscape and Urban Planning*, vol. 21, no. 3, pp. 211-226.
- Meyer, H & Nijhuis, S 2013, 'Delta urbanism: planning and design in urbanized deltas—comparing the Dutch delta with the Mississippi River delta', *Journal of Urbanism: International Research on Place making and Urban Sustainability*, vol. 6, no. 2, pp. 160-191.
- Ministry of Environment and Forests of Peoples' Republic of Bangladesh 2012, *Rio + 20: National Report on Sustainable Development*, viewed 15 March 2013, <http://www.google.com.au/url?sa=t&rct=j&q=GOVERNMENT+REPORT+OF+BANGLADESH&source=web&cd=18&cad=rja&ved=0CFkQFjAHOAo&url=http%3A%2F%2Fwww.unafei.or.jp%2Fenglish%2Fpdf%2FRS_No71%2FNo71_19PA_Chowdhury.pdf&ei=YGpCUa6sFov4mAX404DoDg&usg=AFQjCNF4xgYCZ2-IEjYKsY3CXDrqaA2zDA&bvm=bv.43287494,d.dGY>.
- Ministry of Planning Bangladesh 2009, *Detail Area Plan (DAP) unpublished draft report*, Bangladesh Government (BG) press, Dhaka, Bangladesh.
- Mirjā, EMK & Mirza, MMQ 2004, *The Ganges water diversion: Environmental effects and Implications*, vol. 49, Springer Science & Business Media.
- Mirror, D 2009, 'Road made on 10 Dhaka canals: The suicidal decision created scope for water logging', *Dhaka Mirror*, July 10, 2009.
- Mirza, MMQ 1997, 'Hydrological changes in the Ganges system in Bangladesh in the post-Farakka period', *Hydrological sciences journal*, vol. 42, no. 5, pp. 613-631.
- — 1998, 'Diversion of the Ganges water at Farakka and its effects on salinity in Bangladesh', *Environmental Management*, vol. 22, no. 5, pp. 711-722.

- — 2003, 'Climate change and extreme weather events: can developing countries adapt?', *Climate policy*, vol. 3, no. 3, pp. 233-248.
- Mishu, MR, Barua, U & Stoican, I-A 2014, 'The changing nature of urban public places in Dhaka City', *Urbanism Arhitectura Constructii*, pp. 5-16.
- Moffat, D 2002, 'Allegheny Riverfront Park, Pittsburgh, Pennsylvania [EDRA/Places Awards, 2001-2002--Design]', *Places*, vol. 15, no. 1.
- Mohit, MA & Akhter, S 2000, 'Delineation of flood damaged zones of Dhaka City based on the 1998 flood by using GIS', *Engineering concerns of flood*. Bangladesh University of Engineering and Technology, Dhaka, pp303–318.
- Molyvann, V 2003, *Modern Khmer Cities*, [Published] and distribution in Cambodia, Reyum with the support of the Toyota Foundation.
- Momen, SM 2015, 'Dhaka's chronic water logging problem', *The Independent*, July 9 2015.
- Monclús, FJ & Guàrdia i Bassols, M 2006, *Culture, urbanism and planning*, Ashgate, Aldershot, UK.
- Montgomery, M 2003, *Cities transformed: demographic change and its implications in the developing world*, United States.
- Morrish, WR 2000, 'Nature in the Charter of the New Urbanism (Landscape design)', *Places-A Forum of Environmental Design*, vol. 13, no. 2, pp. 45-45.
- Morshed, A 2013, 'How compact cities can save Bangladesh', *The Daily Star*, August 05 2013.
- Morshed, A 2014, 'Why cities are the best weapon against climate change', *The Daily Star*, June 23 2014.
- Moser, S 2007, 'The landscape urbanism reader', vol. 32, *Routledge Journals*, Taylor & Francis Ltd, Abingdon, pp. 394-396.
- Mostafavi, M, Najle, C & Architectural, A 2003, *Landscape urbanism: a manual for the mechanic landscape*, Architectural Association, London.
- Mowla, KA 2013, 'Dwindling urban water bodies of Dhaka and the city fabric: a post-mortem', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 1-11.
- Mowla, QA 2010, 'Role of water bodies in Dhaka for sustainable urban design', *Jahangirnagar Planning Review*, vol. 8, pp. 1-9.
- Murshed, SB, Islam, A & Khan, MSA 2011, 'Impact of climate change on rainfall intensity in Bangladesh', *Proceedings of the 3rd International Conference on Water and Flood Management*, pp. 8-10.

- Mutton, D & Haque, CE 2004, 'Human vulnerability, dislocation and resettlement: Adaptation processes of river-bank erosion-induced displaces in Bangladesh', *Disasters*, vol. 28, no. 1, pp. 41-62.
- Nabil, ZH 2013, 'Where elephants once tread', *The Daily Star Magazine*, January 11 2013.
- Nezar, AS 2006, *Cinematic Urbanism*, vol. 1, Sage Publications, Thousand Oaks, CA.
- Nicholas, A 2013, 'Morphodynamic diversity of the world's largest rivers', *Geological Society of America*, vol. 41, no. 4, pp. 475-478.
- Nicholls, RJ 1995, 'Coastal megacities and climate change', *Geo Journal*, vol. 37, no. 3, pp. 369-379.
- Niemczynowicz, J 1996, 'Megacities from a water perspective', *WATER INTERNATIONAL*, vol. 21, no. 4, pp. 198-205.
- — 1999, 'Urban hydrology and water management ± present and future Challenges', Elsevier, no. Urban Water, pp. 1-14.
- Nilufar, F 1997, 'The spatial and social structuring of local areas in Dhaka City: a morphological study of the urban grid with reference to neighbourhood character within naturally grown areas', University College London (University of London).
- — 2004, 'Hidden Morphological Order in an Organic City', *Protibesh: the Environment*, vol. 3, no. 1, pp. 34-41.
- — 2010, 'Urban morphology of Dhaka city: spatial dynamics of growing city and the urban core', *Protibesh: the Environment*, vol. 8.
- — 2011, 'Urban morphology of Dhaka city: special dynamics of a growing city and its urban core', in AM Choudhury, R Hafiz, G Rabbani, SU Ahmed, F Mahmud & M Islam (eds), *400 Years of Capital Dhaka and Beyond*, Asiatic Society Bangladesh, Dhaka, pp. 267-480.
- Nilufar, F & Zareen, N 2012, 'Process of morphological transformation and the emerging pattern of built-form along Gulshan avenue in Dhaka', in D Milano & D Genova (eds), *Cities in transformation Research & Design*, Italy, pp. 110-113.
- Nishat, A, Reazuddin, M, Amin, R & Khan, AR 2000, *The 1998 flood: impact on environment of Dhaka city*, eds A Nishat, M Reazuddin, R Amin & AR Khan, DoE (Department of Environment, Government Republic of Bangladesh) and IUCN, Dhaka.
- Nowshin, N 2015, 'Dhaka's shameful waterlogging woes', *The Daily Star*, September 04, 2015.
- Oldenburg, VT 1979, 'Peril, pestilence, and perfidy: the making of colonial Lucknow, 1856-1877', University of Illinois at Urbana-Champaign.
- — 2014, *The making of colonial Lucknow, 1856-1877*, 2 edn, Princeton University Press, USA.
- Pacione, M 2009, *Urban geography: a global perspective*, Taylor & Francis US.

- Pallant, J 2013, *SPSS survival manual*, McGraw-Hill Education (UK).
- Papa, F, Durand, F, Rossow, WB, Rahman, A & Bala, SK 2010, 'Satellite altimeter-derived monthly discharge of the Ganga-Brahmaputra River and its seasonal to inter-annual variations from 1993 to 2008', *Journal of Geophysical Research: Oceans* (1978–2012), vol. 115, no. C12, pp. 1-9.
- Parveen, R 2012, 'Plus energy urban development', Architecture Science Association.
- Parveen, R & Ahmed, F 2007, 'The Appropriateness of the new interventions and its impact on the heterogeneity of De Coninckplein in Antwerp city, Belgium', *Protibesh: the Environment*, vol. 12, no. 01, pp. 19-27.
- Parveen, S, Sirajul Islam, M & Huq, A 1995, 'Abundance of *Aeromonas* spp. in River and Lake Waters in and Around Dhaka, Bangladesh', *Journal of Diarrhoeal Diseases Research*, vol. 13, no. 3, pp. 183-186.
- Patel, D 2012, 'Theatre of Conflict, City of Hope: Mumbai, 1600 to Present Times. By Mariam Dossal. pp. xl, 252. Oxford, Oxford University Press, 2010', *Journal of the Royal Asiatic Society (Third Series)*, vol. 22, no. 02, pp. 477-479.
- Paul, BP 2016, 'Why is the Bangladesh economy different?', *The Daily Star*, February 20 2016.
- Peeters, S & Shannon, K 2011, 'Readdressing Dhaka's Public Water Bodies: A Design Research', *Nakhara: Journal of Environmental Design and Planning*, vol. 7, pp. 25-46.
- Pender, JS 2012, 'What is climate change and how it may affect Bangladesh', Church of Bangladesh Social Development Programme, Dhaka, viewed 2 April 2013, <http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=6&cad=rja&ved=0CFwQFjAF&url=http%3A%2F%2Fwww.kirkensnodhjelp.no%2FDocuments%2FKirkens%2520N%25C3%25B8dhjelp%2FPublikasjoner%2FTemahefter%2FFINAL%2520Draft%2520WHAT%2520IS%2520CLIMATE%2520CHANGE%2520AND%2520HOW%2520IT%2520MAY%2520AFFECT%2520BANGLADESH.pdf&ei=jytaUaf1Go uDkwXQ6ICACA&usg=AFQjCNERLu_862V42MsIFYqIhkBSB-j2Lg&sig2=bMEvE6O-foivoAsIXvgmfA>.
- Pervin, I, Islam, MF, Taher, I & Khan, D 2010, '100 year flood simulation for Dhaka city using multiple models', Government of Bangladesh, Dhaka.
- Pieris, A 2010, 'South and Southeast Asia: the post-colonial legacy', *Fabrications: The journal of Society of Architecture Historians*, vol. 19, no. 2, pp. 6-33.
- Powel, K 2003, *Cities transformed: demographic change and its implications in the developing world*, United States.
- Powell, K 2000, *City transformed: urban architecture at the beginning of the 21st century*, Laurence King London.
- Prakash, G 1990, 'Writing post-orientalist histories of the Third World: perspectives from Indian historiography', *Comparative Studies in Society and History*, vol. 32, no. 2, pp. 383-408.

- — 1992, 'Science" gone native" in colonial India', *Representations*, pp. 153-178.
- — 1994, 'Subaltern studies as postcolonial criticism', *The American Historical Review*, vol. 99, no. 5, pp. 1475-1490.
- — 1995a, *After colonialism: imperial histories and postcolonial displacements*, Cambridge University Press.
- — 1995b, 'Orientalism now', *History and Theory*, pp. 199-212.
- — 1999, *Another reason: Science and the imagination of modern India*, Princeton University Press.
- — 2002, 'The urban turn', *Sarai Reader*, vol. 2, pp. 2-7.
- Prothom Alo 2016a, 'SC bans Ashiyan City project', Prothom Alo, 22 August 2016.
- — 2016b, 'SC upholds BGMEA Bhaban demolition order', Prothom Alo, June 2 2016.
- Purcell, N 1998, 'Hydrology and Urbanism', vol. 24, no. Generic, Sage publications, 2455 Teller Road, Thousand Oaks, CA 91320, pp. 278-284.
- Radheshyam, J 2011, 'Open spaces vanish, water bodies dying [Pune]', *The Times of India* December 21 2011.
- Ragunathan, TE & Grizzle, JE 1995, 'A split questionnaire survey design', *Journal of the American Statistical Association*, vol. 90, no. 429, pp. 54-63.
- Rahaman, MM, Ali, MT & Afroz, L 2015, 'Study on the Development of Water Transport Network for Passengers in the Gulshan-Banani-Hatirjheel Lake of the Capital City of Bangladesh', *Journal of Shipping and Ocean Engineering*, vol. 5, pp. 195-202.
- Rahaman, MM & Varis, O 2009, 'Integrated water management of the Brahmaputra basin: Perspectives and hope for regional development', *Natural Resources Forum*, vol. 33, pp. 60-75.
- Rahman, G 2008, *Town planning and the political culture of planning in Bangladesh*, A H Development Publishing House, Dhaka.
- Rahman, KA & Debnath, SC 2015, 'Water Logging and Losses in Ecosystem: A Case Analysis on DND Embankment, Bangladesh', *International Research Journal of Interdisciplinary & Multidisciplinary Studies (IRJIMS)*, pp. 27-33.
- Rahman, M 2008, 'An architect's Dhaka', *Star Campus*, December 07, 2008.
- — 2011, *City of an Architect*, Delvista Foundation, Dhaka, Bangladesh.
- Rahman, M, Islam, A & Zaman, KB 2014, 'Analysing the spatial development of human settlements of Dhaka', Thesis.

- Rahman, M, Pinky, N, Barsha, ST, Aktar, HM & Marshal 2015, 'Life becomes more difficult in cities, including capital Dhaka, due to water logging, particularly in the rainy season. Why? How to get rid of the perennial problem? ', New Age, July 9 2015.
- Rahman, MM (ed.) 2016, Dhaka: An Urban Reader, First edn, University Press Limited Bangladesh, Dhaka Bangladesh.
- Rahman, MM & Imon, SS 2016, 'How Can Historic Waterfront Conservation Help to Improve the Quality of Life in Old Dhaka', American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), vol. 26, no. 2, pp. 200-218.
- Rahman, S 2004, 'Clogged up canals keep city waterlogged', The Daily Star, September 22, 2004.
- Rahman, S & Hossain, F 2008, 'Spatial Assessment of Water Quality in Peripheral Rivers of Dhaka City for Optimal Relocation of Water Intake Point', Water Resources Management, vol. 22, no. 3, pp. 377-391.
- Rajagopalan, M & Desai, MS 2012, Colonial Frames, Nationalist Histories: Imperial Legacies, Architecture and Modernity, Ashgate Publishing, Ltd.
- RAJUK 2015, Dhaka Structure Plan 2016-2035, Ministry of Housing and Public Works, Government of the People's Republic of Bangladesh, Dhaka.
- Rana, MMP 2011, 'Urbanization and sustainability: challenges and strategies for sustainable urban development in Bangladesh', Environment, Development and Sustainability, vol. 13, no. 1, pp. 237-256.
- Rashid, H, Hunt, LM & Haider, W 2007, 'Urban flood problems in Dhaka, Bangladesh: slum residents' choices for relocation to flood-free areas', Environmental Management, vol. 40, no. 1, pp. 95-104.
- Rashid, K 2003, 'Open space system of Dhaka city- need and possibilities of intervention', Architecture Overcoming Constraints, Dhaka, Bangladesh, pp. 190-198.
- Rashid, T, Monsur, MH & Suzuki, S 2006, 'A review on the Quaternary characteristics of Pleistocene tracts of Bangladesh', Okayama University Earth Science Reports, vol. 13, pp. 1-13.
- Rasid, H & Mallsk, A 2009, 'Living on the edge of stagnant water: An assessment of environmental impacts of construction-phase drainage congestion along Dhaka city flood control embankment, Bangladesh.' Environmental Management Journal, pp. 89-98.
- Rasid, H & Mallsk, AU 1996, 'Living on the edge of stagnant water: an assessment of environmental impacts of construction-phase drainage congestion along Dhaka City Flood Control Embankment, Bangladesh', Environmental Management, vol. 20, no. 1, pp. 89-98.
- Razzak, NRB, Muntasir, SY, Chowdhury, S, Yuhazri, M, Sihombing, H, Yahaya, S, Nirmal, U, Lau, S & Tom, PP 2012, 'Pollution scenario of Dhaka city lakes: A case study of Dhanmondi and Ramna Lakes', Global engineers & technologists review, pp. 1-6.

- Richards, L, Anderson, G & Santore, MK 2003, 'Protecting water resources with higher density developments', *Environmental Protection*, pp. 340-368.
- Richardson, WR & Thorne, CR 2001, 'Multiple thread flow and channel bifurcation in a braided river: Brahmaputra–Jamuna River, Bangladesh', *Geomorphology*, vol. 38, no. 3, pp. 185-196.
- Riddell, R 2003, *Sustainable urban planning*, Blackwell publishing limited, England.
- Rijsberman, MA & Van De Ven, FH 2000, 'Different approaches to assessment of design and management of sustainable urban water systems', *Environmental Impact Assessment Review*, vol. 20, no. 3, pp. 333-345.
- Rousmaniere, K 2004, 'Historical Research', in Marrais, Dk & Lapan, SD (eds), *Foundations for research: Methods of inquiry in education and the social sciences*, pp. 217-234.
- Roy, A 2011a, 'Conclusion: Postcolonial urbanism: Speed, hysteria, mass dreams', *Worlding cities: Asian experiments and the art of being global*, pp. 307-335.
- — 2011b, 'Slumdog cities: rethinking subaltern urbanism', *International Journal of Urban and Regional Research*, vol. 35, no. 2, pp. 223-238.
- Roy, J 1913, *Dhakar Itihas (History of Dhaka)*, ed. K Choudhury, Mohon press, Kolkata.
- Roy, M 2009, 'Planning for sustainable urbanisation in fast growing cities: Mitigation and adaptation issues addressed in Dhaka, Bangladesh', *Habitat International*, vol. 33, no. 3, pp. 276-286.
- Roy, P 2007, 'Dhaka canals exist only in documents', *The Daily Star*, June 29, 2007.
- Roy, S & Islam, I 2007, 'A study on private residential land development activities in Dhaka and their compatibility with DMDP Structure Plan 1995–2015', Unpublished master's thesis, Department of Urban and Regional Planning. Bangladesh University of Engineering and Technology, Dhaka.
- Rumbach, A 2014, 'Do new towns increase disaster risk? Evidence from Kolkata, India', *Habitat International*, vol. 43, pp. 117-124.
- Rushi, BR, Sharmin, N & Awal, MR 2013, 'Impacts of wetland destruction in the eastern fringe area of Dhaka', Thesis, Bangladesh University of Engineering and Technology, Bangladesh University of Engineering and Technology.
- Russell, J 2001, 'Landscape urbanism - It's the future, not a contradiction', *Architectural Record*, vol. 189, no. 8, pp. 66-67.
- Russell, JS 2001, 'A new urbanism renews Dutch Docklands', *Architectural Record*, vol. 189, no. 4, pp. 94-95.
- Saha, M 2012, 'Quantification of the Environmental Degradation Due To the Urbanization of Dhaka-Naraynganj-Demra (DND) Project Area in Bangladesh', *Global Journal of Science Frontier Research*, vol. 12, no. 1-H, pp. 15-23.

- Salat, S, Labbé, F & Nowacki, C 2011, *Cities and Forms: On Sustainable Urbanism*, Hermann.
- Sander, TH 2002, 'Social Capital and New Urbanism: Leading a Civic Horse to Water?', *National Civic Review*, vol. 91, no. 3, pp. 213-234.
- Sangvai, S 1994, 'Nation, Nationalism and Mega Projects', *Economic and Political Weekly*, pp. 537-540.
- Sarin, M, Krishnaswami, S, Dilli, K, Somayajulu, B & Moore, W 1989, 'Major ion chemistry of the Ganga-Brahmaputra river system: weathering processes and fluxes to the Bay of Bengal', *Geochimica et Cosmochimica Acta*, vol. 53, no. 5, pp. 997-1009.
- Sarkar, A 2011, 'Demolish BGMEA high-rise: HC', *The Daily Star*, April 4 2011.
- Sarkar, AA & Ali, MH 2009, 'Water table dynamics of Dhaka city and its long-term trend analysis using the Omakesenso model', *Water International*, vol. 34, no. 3, pp. 373-382.
- Satterthwaite, D 1997, 'Sustainable Cities or Cities that Contribute to', *Urban Studies*, vol. 34, no. 10, pp. 1667-1691.
- — 1999, *The Earthscan reader of sustainable cities*, vol. 471, Earthscan London.
- Sayeed, SK 2012, *rio20+ sustainable Bangladesh*, Dhaka, Bangladesh.
- Schuyler, D 1997, 'The new urbanism and the modern metropolis', *Urban History*, vol. 24, no. 3, pp. 344-358.
- Scitaroci, BBO & Matuhina, N 2012, 'Landscape urbanism new spatial paradigm', *PROSTOR*, vol. 20, no. 1, pp. 106-117.
- Scriver (ed.), P 2007, *The scaffolding of empire, Fabrications: The journal of Society of Architecture Historians*, CAMEA The University of Adelaide, Adelaide, Australia.
- Scriver, P 1994, *Rationalization, standardization, and control in design: A cognitive historical study of architectural design and planning in the public works department of British India 1855-1901*, Technische Universiteit Delft.
- — 2007a, 'Empire building and thinking in the public works department of British India', in P Scriver & V Prakash (eds), *Colonial Modernities: Building, Dwelling and Architecture in British India and Ceylon*, Routledge, London, pp. ix, pp.69-89.
- — 2007b, 'Scaffolding, Empire, and After', in P Scriver (ed.), *The scaffolding of empire : 4th International Symposium of the Centre for Asian and Middle Eastern Architecture*, 4th edn, CAMEA - Centre for Asian and Middle Eastern Architecture, Adelaide, S. Aust., pp. 7-13.
- — 2010, 'Constructing colonial and contemporary South Asia: a view from down under', *Fabrications: The journal of Society of Architecture Historians*, vol. 19, no. 2, pp. 34-55.
- Scriver, P & Prakash, V 2007, 'Between Materiality and representation: farming an architectural critique of colonial South Aisa', in P Scriver & V Prakash (eds), *Colonial Modernities:*

- Building, Dwelling and Architecture in British India and Ceylon, Routledge, London, pp. 3-26.
- Scriver, P & Prakash, V 2007(eds), *Colonial Modernities: Building, Dwelling and Architecture in British India and Ceylon*, The Architect series, Routledge, London.
- Scriver, P & Srivastava, A 2015, *India: Modern Architectures in History*, Reaktion Books, USA.
- Seraj, TM 2012, *Private sector housing*, Pearl publisher, Dhaka.
- Seraj, TM & Islam, AM 2013, 'Detail Area Plan: proposal to meet housing demand in Dhaka', in S Jahan & AA Kalam (eds), *Dhaka metropolitan area and its planning: problems, issues and policies*, Bangladesh Institute of Planners (BIP), Dhaka, pp. 22-32.
- Shajahan, A & Nilufar, F 2013, 'Reviving the inland waterways of Dhaka: A morphological approach towards an integrated transportation system', paper presented at Ninth International Space Syntax Symposium, South Korea.
- Shankland Cox Partnership 1981, *Dhaka Metropolitan Area Integrated Urban Development Plan*, vol. 1-8, Government of Bangladesh, Dhaka.
- Shannon, K 2006, 'From theory to resistance: landscape urbanism in Europe', in C Waldheim (ed.), *The Landscape Urbanism Reader*, pp. 141-161.
- — 2008a, *Water Urbanism*, Amsterdam: SUN Publishers.
- — 2008b, 'Water Urbanism: Hydrological Infrastructure as Urban Frame in Vietnam', *Water and Urban Development Paradigms: Towards and Integration of Engineering, Design and Management Approaches*, pp. 55-65.
- — 2009a, 'Landscape as Urban Structure: the Case of Can-Tho, Vietnam', *Landscape—Great Idea*, pp. 54-58.
- — 2009b, 'Water urbanism: Hydrological infrastructure as an urban frame in Vietnam', *Water and urban development paradigms. Towards an integration of engineering, design and management approaches*, London.
- Shannon, K & Manawadu, S 2007, 'Indigenous Landscape Urbanism: Sri Lanka's Reservoir & Tank System', *Journal of Landscape Architecture*, vol. 2, no. 2, pp. 6-17.
- Shannon, K & Moulder, BD 2008, *Water urbanisms*, K Shannon & BD Moulder (eds), Martien de Vletter, Sun, Gent, Belgium.
- Shannon, K & Nilufar, F 2008, 'Transforming urban landscapes: Dhanmondi Lake, Dhaka, Bangladesh', *Topos: European Landscape Magazine*, no. 64, pp. 79-83.
- Shannon, K, Robles-Duran, M & Theunis, K 2005, *Urban Tissue Design Studio – Can-Tho, Vietnam*, KULeuven., Katholieke Universiteit Leuven, Belgium.
- Shannon, K & Smets, M 2010, *The landscape of Contemporary Infrastructure*, NAI Publishers.

- Shannon, SK 2004, 'Rhetorics and realities addressing landscape urbanism: Three cities in Vietnam', School of Architecture, Urbanism and strategic Planning, PhD thesis, KU Leuven.
- Shaw, R 1989, 'Living with floods in Bangladesh', *Anthropology Today*, pp. 11-13.
- Shen-Guan, S, Wan-Ying, L, Ming-Chang, W & Shi-Yen, W 'From parasitism to Mutualism - People, Earth, New Taipei City: Coexistence and regeneration on urbanism, landscape urbanism, and the future of settlements', pp. 4982-4985.
- Shohag, KH 2013, *Urbanization and governance*, A H Development Publishing House, Kolkata, India.
- Sorensen, A, Marcotullio, PJ & Grant, J 2004, *Towards sustainable cities: East Asian, North American, and European perspectives on managing urban regions*, Ashgate Publishing.
- Sowell, J & Wiedemann, N 2009, 'Sponge Urbanism: The Cellular Redevelopment of New Orleans', *Journal of Architectural Education*, vol. 62, no. 4, pp. 24-31.
- Sridharan, S 2008, 'Indigenous Modernities: Negotiating Architecture and Urbanism', *Comparative Studies of South Asia, Africa and the Middle East*, vol. 28, no. 1, pp. 213-215.
- Steele, J 1994, 'A Search for Meaning', *Architecture for Islamic societies today*, p. 29.
- Steele, J & Doshi, BV 1998, *Rethinking modernism for the developing world: The complete architecture of Balkrishna Doshi, Watson-Guptill*.
- Steger, BM & Anne, M 2011, *Global ideologies and urban landscape*, Routledge, USA.
- Steiner, F 2011, 'Landscape ecological urbanism: Origins and trajectories', *Landscape and Urban Planning*, vol. 100, no. 4, pp. 333-337.
- Stokman, A 2008, 'Water Purificative Landscapes – Constructed Ecologies and Contemporary Urbanism', *Transforming with water. Proceedings of the 45th World Congress of the International Federation of Landscape Architects IFLA 2008*, pp. 51-61.
- Sudman, S & Bradburn, NM 1982, *Asking questions: A practical guide to questionnaire design*.
- Sufi, S 2015, 'Water logging and grid lock', *Bangla News* 24, June 12 2015.
- Sultana, MS & Islam, Z 2009, 'Pre-and post-urban wetland area in Dhaka City, Bangladesh: a remote sensing and GIS analysis', *Journal of Water Resource and Protection*, vol. 2009, pp. 111-125.
- Sultana, MS, Tarekul Islam, G & Islam, Z 2009, 'Pre-and Post-Urban Wetland Area in Dhaka City, Bangladesh: A Remote Sensing and GIS Analysis', *Journal of Water Resource & Protection*, vol. 1, no. 6, pp. 414-421.
- Sumet, J 1988, *Naga: Cultural Origins in Siam and the West Pacific*, Oxford University Press, Singapore.

- Takagi, T, Oguchi, T, Matsumoto, J, Grossman, M, Sarker, M & Matin, M 2007, 'Channel braiding and stability of the Brahmaputra River, Bangladesh, since 1967: GIS and remote sensing analyses', *Geomorphology*, vol. 85, no. 3, pp. 294-305.
- Tawhid, KG 2004, 'Causes and effects of water logging in Dhaka City, Bangladesh', TRITA-LWR master thesis, Department of Land and Water Resource Engineering, Royal Institute of Technology, Stockholm.
- Tay, KS 1989, *Mega-cities in the Tropics: Towards an Architectural Agenda for the Future*, Inst of Southeast Asian Studies.
- Taylor, J 1840, *A sketch of the Topography & Statistics of Dacca*, GH Huttman, Military Orphan Press.
- The Daily Ittefaq 2013, 'The sufferings of Dhaka- Narayanganj-Demra citizens need to end', *The Daily Ittefaq*, May 26, 2013.
- The Daily Star 2008a, 'Cancel design to save 500 families', *The Daily Star*, May 8, 2008.
- — 2008b, 'Illegal structures in Hatirjheel demolished', *The Daily Star*, March 6, 2008.
- — 2009, 'Demarcate 43 Dhaka canals: National Parliament body asks land ministry to sue encroachers', *The Daily Star*, July 9, 2009.
- — 2015a, 'Dhaka Deluged: one hour's downpour stops traffic dead on its tracks, leaves people to deal with untold sufferings', *The Daily Star*, September 2, 2015.
- — 2015b, 'Rainfall causes waterlogging in capital', *The Daily Star*, June 26, 2015.
- — 2015c, 'Rainfall causes waterlogging in capital', *The daily Star*, June 26, 2015.
- — 2016a, 'HC sets aside verdict on Ashiyan City', *The Daily Star*, August 17 2016.
- — 2016b, 'Top court rules against Ashiyan City', *The Daily Star*, August 23 2016.
- The Daily Star Magazine 2013, 'Where are the Elephants', *The Daily Star*, January 11 2013.
- The News Today 2010, '\$ 1 bn annual loss for traffic congestion', July 19 2010.
- Thoren, R 2007a, 'The landscape urbanism reader', vol. 61, no. Generic, Blackwell Publishing, Oxford, pp. 70-71.
- — 2007b, 'The Landscape Urbanism Reader', in C Waldheim (ed.), vol. 61, Blackwell Publishing Inc, Malden, USA, pp. 70-71.
- Town Planning Scheme 2007, *Water Sensitive Urban Design*, City of Mandurah's Council, Mandurah.
- Ullah, MS 2002, 'Dholai Khal rehabilitation project-achivement of objectives', 28th WEDC Conference, Kolkata, India.

- UNEPA 2005, Dhaka City State of Environment Report, viewed 2 April 2013.
- UNFPA 2007, State of world population, viewed 2 March 2013.
- United Nation 2010, United Nation Economic Report Bangladesh, Dhaka.
- — 2014, World Urbanization Prospects, New York.
- United Nations 2005, Population Challenges and Development Goals, United Nations, New York, viewed 2 April 2013.
- — 2011, Are we building competitive and liveable cities? Guidelines for developing eco-efficient and socially inclusive infrastructure, United Nations, Thailand.
- Urbanski, M 2009, 'Do Landscape Architects make the Best Urban Designers? Landscape Typologies as an Engine for Urban Transformations', *Landscape—Great Idea! X-LArch III*, pp. 50-53.
- Van Rooijen, DJ, Turrall, H & Wade Biggs, T 2005, 'Sponge city: water balance of mega-city water use and wastewater use in Hyderabad, India', *Irrigation and drainage*, vol. 54, no. S1, pp. 81-91.
- Van Roon, M 2007, 'Water localisation and reclamation: Steps towards low impact urban design and development', *Journal of environmental management*, vol. 83, no. 4, pp. 437-447.
- Varis, O 2006, 'Megacities, development and water', *Water Resources Development*, vol. 22, no. 2, pp. 199-225.
- Vidyarathi, S 2010, 'Inappropriately Appropriated or Innovatively Indigenized?: Neighbourhood Unit Concept in Post-independence India', *Journal of Planning History*, vol. 9, no. 4, pp. 260-276.
- Vidyarathi, S, Hoch, C & Basmajian, C 2013, 'Making sense of India's spatial plan-making practice: Enduring approach or emergent variations?', *Planning Theory & Practice*, vol. 14, no. 1, pp. 57-74.
- Von, H, Wolfrum, S & Winfried, N 2009, *Multiple City: Urban concept 1908-2008*, in H Von, S Wolfrum & N Winfried, Jovis (eds), Netherlands.
- Vyjayanthi, R 2009, 'Embracing Urbanism: The City as Archive', *New Literary History*, vol. 40, no. 2, pp. 371-383.
- Wagner, JA 2011, 'Delta Urbanism: The Netherlands and Delta Urbanism: New Orleans', vol. 64, no. Generic, Blackwell Publishers Ltd, Oxford, UK, pp. 179-180.
- Waldheim, C 2006, *The landscape urbanism reader*, Princeton Architectural Press, New York, N.Y.
- Wall, A 1999, 'Programming the Urban Surface', in J Corner (ed.), *Recovering Landscape: Essays in Contemporary Landscape Theory*, Princeton Architectural Press.

- Wang, L & Kanehl, P 2003, 'Influences of watershed urbanization and instream habitat on macroinvertebrates in cold water streams', *JAWRA Journal of the American Water Resources Association*, vol. 39, no. 5, pp. 1181-1196.
- Wares, S 2012, '50 years of architecture in Bangladesh', in F Nilufar (ed.), *50 years of architecture in Bangladesh*, Dhaka.
- Weather Base 2013, *Weather Base*, Weather Base, viewed 2 April 2013.
- Weller, R 2008, 'Landscape (Sub)Urbanism in Theory and Practice', *Landscape Journal*, vol. 27, no. 2, pp. 247-267.
- Wescoat, JL 1993a, 'Legal Geographies series Water Law, Urbanization, and Urbanism in the American West: The "place of use" reconsidered', *Urban Geography*, vol. 14, no. 5, pp. 414-420.
- Wheeler, SM & Beatley, T 2009a, *The sustainable urban development reader*.
- — 2009b, 'The sustainable urban development reader'.
- Wong, T & Brown, R 2009, 'The water sensitive city: principles for practice', *Water science and technology*, vol. 60, no. 3, pp. 673-682.
- Wong, TH 2006a, 'An overview of water sensitive urban design practices in Australia', *Water Pract. Technol*, vol. 1, no. 1.
- — 2006b, 'Water sensitive urban design—the journey thus far', *Australian Journal of Water Resources*, vol. 10, no. 3, pp. 213-225.
- Wong, TH & Eadie, ML 2000, 'Water sensitive urban design—A paradigm shift in urban design', *Proceedings of the Xth World Water Congress*, [in CD-ROM], pp. 12-16.
- Woodcock, I, Dovey, K, Wollan, S & Beyerle, A 2010, 'Modelling the compact city: capacities and visions for Melbourne', *Australian planner*, vol. 47, no. 2, pp. 94-104.
- World Bank 2011, *Housing Demand, Expanding housing finance to the underserved in South Asia*, World Bank, Washington, DC.
- — 2012, *Economics of Adaptation to Climate Change Bangladesh*, World Bank, Washington DC, viewed 2 April 2013.
- Wright, VP & Marriott, SB 1993, 'The sequence stratigraphy of fluvial depositional systems: the role of floodplain sediment storage', *Sedimentary Geology*, vol. 86, no. 3, pp. 203-210.
- Xu, Y 2000, *The Chinese city in space and time: the development of urban form in Suzhou*, University of Hawaii Press.
- Y. Bentarzia, A, Terfousa, A, Ghenaima, A, Wankob, F, Hlawkaa & Pouleta, JB 2012, 'Hydrodynamic characteristics of a new permeable pavement material produced from recycled concrete and organic matter', *Urban Water Journal*, vol. 2012, pp. 37-41.

- Yamaguchi, AMDY 2007, 'Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960–2005', *Environment Assess*, pp. 237-249.
- Yang, W, Zong, Y, Chen, Z & Qiu, S 2010, 'Evolution of urban morphology and identification of extension direction of estuary port city', *Environmental Science and Information Application Technology (ESIAT)*, 2010 International Conference on, vol. 1, pp. 716-719.
- Yeang, K 2006, 'Eco-design: a manual for ecological design'.
- Yin, R 1994, *Case study research: Design and methods* CA: Sage publishing.
- Yokohari, M, Takeuchi, K, Watanabe, T & Yokota, S 2000, 'Beyond greenbelts and zoning: A new planning concept for the environment of Asian mega-cities', *Landscape and Urban Planning*, vol. 47, no. 3, pp. 159-171.
- Zahiruddin, SA, Imamuddin, AH & Khan, MM 1990, *Contemporary Architecture, Bangladesh*, Institute of Architects, Bangladesh.
- Zaman, MKB, Islam, MA & Mishu, MR 2014, 'Analyzing the spatial development of human settlement in Dhaka', *Bangladesh University of Engineering and Technology (BUET)*.

List of Appendices

	Page no
Appendix A-1: Ethics Approval Letters	A 1
Appendix A-2: Ethics Application Form	A 3
Appendix A-3: Information sheet for questionnaire survey participants	A 15
Appendix A-4: Information sheet for interview participants	A 17
Appendix A-5: Consent form for interview participants	A 19
Appendix A-6: Information Sheet for contacts for information on project and independent complaints procedure	A 20
Appendix A-7: Questionnaire survey form	A 21
Appendix A-8: Minutes of the Ministry of Housing and Public Works Bangladesh dated 24th August 2014	A 26
Appendix A-9: DMDP (Dhaka Metropolitan Development Plan) 1995-2015 showing flood flow and semi flood flow zones published in 1995	A 27
Appendix A-10: Current Drainage network of Dhaka	A 28
Appendix A-11: Map showing retention area (pond) in the 2014 Drainage Master Plan prepared by IWM (institute of Water Modelling)	A 29
Appendix A-12: Peer-reviewed conference paper in the PLEA conference 2015 in Bologna Italy based on one of the case study of this research	A 30
Appendix A-13: Conference paper in the ARCASIA Congress 2012 in Bali Indonesia based on the initial proposal prepared for the research before commencement of this PhD research	A 38
Appendix A-14: Historical images of Dhaka along the river Buriganga painted by unknown painter in the 1840's (source: Dhaka City Museum DCC)	A 53

Appendix A-1: Ethics Approval Letters



RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE
AND INTEGRITY

LEVEL 7, 115 GRENFELL STREET
THE UNIVERSITY OF ADELAIDE
SA 5005 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Applicant: Dr P Scriver
School: School of Architecture and Built Environment
Project Title: Water urbanism: water management in urban development in Dhaka

**The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)**

ETHICS APPROVAL No: H-2014-180 **App. No.:** 0000019156

APPROVED for the period: 20 Aug 2014 to 31 Aug 2017

Thank you for your responses dated 11.08.2014, 15.08.2014 and 20.08.2014.
The study is to be carried out by Mr Fahmid Ahmed, PhD student.

PROFESSOR RACHEL A. ANKENY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Humanities and Social Sciences and Faculty of the Professions)

ASSOCIATE PROFESSOR PAUL BABIE
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Humanities and Social Sciences and Faculty of the Professions)



THE UNIVERSITY
of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE
AND INTEGRITY

LEVEL 7, 115 GRENFELL STREET
THE UNIVERSITY OF ADELAIDE
SA 5005 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

20 August 2014

Dr P Scriver
School: School of Architecture and Built Environment

Dear Dr Scriver

ETHICS APPROVAL No: H-2014-180

PROJECT TITLE: Water urbanism: water management in urban development in Dhaka

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **20 Aug 2014**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Project Status Report* is to be used when reporting annual progress and project completion and can be downloaded at <http://www.adelaide.edu.au/ethics/human/guidelines/reporting>. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you immediately report anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

PROFESSOR RACHEL A. ANKENY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Humanities and Social Sciences and Faculty
of the Professions)

ASSOCIATE PROFESSOR PAUL BABIE
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Humanities and Social Sciences and Faculty
of the Professions)

Appendix A-2: Ethics Application Form



Human Research Ethics Committee (HREC)
2014 Application for ethics approval

Office use only	
Received:	
RM No. & Date Record Created	
Ethics Approval No:	

LEVEL OF ETHICAL REVIEW:

Indicate the level of ethical review that is being sought for this application:

<input type="checkbox"/>	Full HREC review (applies to all research involving more than "low risk research" as defined in the <u>National Statement on Ethical Conduct in Human Research</u>)
<input checked="" type="checkbox"/>	Low risk review (applies to "low risk research" as defined in the <u>National Statement on Ethical Conduct in Human Research (2007)</u>). Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information.

SECTION 1: APPLICANT, PROJECT SUMMARY AND OTHER RESEARCHERS' DETAILS

If the project is to be undertaken by a research student the student's primary or other supervisor at the University of Adelaide is the 'applicant'.

Applicant's name, title and position:	Dr. Peter Scriver		
Phone:	34586	EMPLID:	A1002464
School or Department:	Architecture and Built Environment	Campus and Institution address:	North Terrace Campus University of Adelaide Adelaide, SA 5005
Email:	Peter.scriver@adelaide.edu.au		
Qualifications and research experience relevant to the project	<p>Qualifications: PhD: <i>TU Delft</i>, Netherlands BArch: <i>McGill U</i>, Canada BScArch: <i>McGill U</i>, Canada</p> <p>Previous Experience: Dr Scriver is a South Asian expert in the field of colonial and modern architectural history with extensive experience conducting fieldwork in India and neighbouring countries, including oral historical research, and comprehensive surveys of both physical artefacts and archival documentation. He has also published extensively, with 3 books, 4 edited volumes and 34 refereed papers produced to date, largely in the field of the proposed research. He is a multiple Category 1 grant recipient and CI, including 2 ARC Discovery and 1 ARC Linkage funded research projects, and has also supervised 23 different HDR students to date, with 16 successful completions since 2002 (12 PhD, 4 Masters).</p>		

Project title:

Water urbanism: water management in urban development in Dhaka.

Proposed commencement date of activities that require human ethics approval: Note: research must not commence without the prior written approval of the HREC as retrospective approval cannot be provided.

July 2014

Estimated completion date of the project:

November 2016

Student Researcher(s):

Student's name, title:	Mr. Fahmid Ahmed	Student ID:	1633439
Program Level:	PhD	School or Department (if not same as Principal Researcher's)	
Email:	fahmid.ahmed@adelaide.edu.au	Phone/Mobile:	0420483854
Qualifications and relevant research experience	<p>Qualifications: Master of Human Settlements(MaHS) : KULeuven, Belgium Bachelor of Architecture(B.Arch) : BUET, Bangladesh</p> <p>Previous Experience: Fahmid has proven academic quantitative and qualitative research experiences through his academic degrees. In particular he has used interview techniques in his Masters course in urban studies and research methodology. Moreover, he used questionnaire survey for design and research projects to complete his Bachelor during his thesis project, seminar course and other studio projects. He also conducted studio projects during his teaching which includes interviews and questionnaire survey. In addition, he has published six papers including one journal and three refereed conferences, which also required interview techniques and questionnaire survey.</p>		

Other Researcher(s) (add extra rows to table as required):

Name(s), title(s) and position(s) <i>(for all co-supervisors & researchers external to the University of Adelaide)</i>	EMPLID(s) (if applicable)	Other researcher(s)' qualifications and experience relevant to the project
Prof. Jon Kellett		Jon is an urban planner with research interests in urban sustainability, energy and climate change. He was awarded his PhD at Sheffield Hallam University in 1983 and his Masters of Civic Design (Urban & Regional Planning) at the University of Liverpool in 1978. His first degree was in Archaeology and Ancient History from the University of Sheffield.

Source of any project funding:

Research Abroad Scholarship (RAS), school's post graduate allowance and personal finances.

Location of the research. Include details of all sites where the project will be undertaken:

Dhaka Bangladesh

Has or will this project be submitted for approval to other HRECs? Include the HREC's name and current status of the application (i.e. submitted, approved, deferred or rejected) and attach this documentation.

No



SECTION 2: NATURE OF THE PROJECT

Aims of the project: (discuss in lay terms; include the research hypothesis to be investigated, outline the values and benefits to participants)

This project aims to determine whether a water-friendly approach to urban design and planning could be a more sustainable strategy for the future development of low-lying cities like Dhaka? To achieve this, the project will address a series of associated sub-questions:

- How has the management of water in the urban design history of Dhaka changed over the course of its development?
 - What were the physical and technical factors that affected such change?
 - What were the social, political and cultural factors that affected such change?
 - What role have instrumental and institutional factors such as government regulations, planning guidelines, and routine departmental practices played in shaping these technical and cultural changes?
- How can a comparative case-study of two examples of ostensibly opposing design strategies with regard to water management in the urban development of contemporary Dhaka enhance our understanding of the relationship between technical, social and methodological factors in the urban design and development culture of Dhaka, with particular regard to the question of 'water'?
- Finally, it asks how could the findings of this case study of Dhaka be applicable to large, rapidly developing deltaic cities more generally.
- The study will also enable participants in the projected interviews and surveys to share their experiences about the city and urbanisation in relation to its water-bodies which will support to create a new piece of scholarship on water urbanism.

Rationale of the project: (explain in plain language the research methodology and its appropriateness to achieving the aims. Provide evidence of an adequate sample size to establish a valid result)

Rationale

Dhaka is an emerging mega-city situated in the delta of one of the world's largest and most extensive river systems. For this reason it is also one of the most vulnerable mega-cities in the world in relation to water where its extraordinary rate of urbanisation is matched by an exceptionally high frequency of threat from natural disasters, flooding in particular. The improved understanding that this study seeks to gain regarding Dhaka's failures and successes in the management of water in its past and present urban development is therefore timely and will, moreover, contribute potentially useful insight into the broader issues that are currently contribute to failings in the urbanisation of mega-cities across the developing world. For a low lying delta city such as Dhaka, developing a more open and objective yet critical discussion about water urbanism may be a vital step forward toward a better understanding of how a more responsive and inclusive approach to the management of water in architecture, planning and urban design might improve this megacity's resilience to future environmental stress.

This research has multifaceted significance to comprehend the water urbanism issues from historical and contemporary development trends in theories, designs and practices that will lead to a more rational and comprehensive understanding. In contemporary urban design scholarship in general the issue of sustainable water urbanism is under explored. Moreover, there is a large research gap in the study of the urban design of Dhaka in respect of its relationship to water. Despite the fact that water is one of the most significant substances determining the traditional urban character culture of this low-lying city; there are very few researchers working on water urbanism for Dhaka.

Methodology:

The study will be conducted in the following major stages.

01. Literature research:

The initial stage of the research is the background study of water urbanism and context which includes the following topics:

- a. Contemporary water urbanism theories and practices.
- b. Water related dimensions of sustainable urbanism.
- c. Colonial and post-colonial theories of urbanism relating to water in South Asian context.
- d. Current development phenomena in urban design in Dhaka relating to water.
- e. Water urbanism discourses on Dhaka.
- f. Examining policy instruments and development agencies.

This initial review and discussion of the state of knowledge and debate in the broader field will lead to the case study of Dhaka, and associated fieldwork which aim to address the identified gap in research on water related urbanism in South Asia.

02. Historical research:

Historical research will be conducted with the following objectives.

- a. To identify and interpret key historical documents associated with urban development relating to water in Dhaka from the nineteenth century to the present.
- b. To reconstruct and interpret specific sub-studies (case histories) using such historical documents, and
- c. To thereby identify and better understand the historical factors and developments that may have determined the "hard engineering" driven approach to water management in urban development in the recent past associated with government agencies and other relevant actors.
- d. To derive relevant lessons learned from these historical sub-studies about past water management practices which may be usefully applied in contemporary and future water urbanism.

This historiographically resourced research will analyse the following types of documents.

- a. Maps
- b. Images
- c. Plans
- d. Policy instruments
- e. Other development and project drawings
- f. Old government documents
- g. Bulletins
- h. Popular press

03. Physical observation

Objectives of Physical Survey

- a. To record and document objectively the existing conditions of the actual sub-study areas.
- b. To observe patterns of use, and cultural practices in relation to water in the identified sub-studies of urban development in Dhaka.

Type of physical survey

- a. Physical observation.
- b. Photographic survey.
- c. Aerial analysis and mapping using remote survey tools (eg, Google Earth) .

04. Questionnaire survey

Objective of the Questionnaire survey (questionnaire survey form is attached)

To understand how a range of different users and stakeholders perceive water-related urban development (egs land-fill projects, re-constructed/restored wetlands projects) in the designated sub-study areas.

05. Semi-structured interviews

Objectives for interview research:

- a. To better understand the perceived problems and potential for water-urbanism in Dhaka through in-depth consultation with a range of expert observers and agents of past and present water-related urban development in that city.
- b. To thereby better comprehend contemporary urban development trends in Dhaka with regard to water management, relative to historical water urbanism in Dhaka and its region, and
- c. To better understand the institutional frameworks and associated 'mind sets'; in which the policies and practices affecting water-related urban development in Dhaka are formed.

Background to the project: (briefly discuss any previous research of relevance and cite no more than 4 key references, if applicable)

Water urbanism refers to the urban development associated with water and hydrology. In addition, the concept of water urbanism integrates natural and manmade water systems in the process of developing infrastructure, landscape and built form (Shannon 2008). Water urbanism also means water sensitive urban design. The water culture of Bangladesh has necessarily been a fundamental component in the development of the typical built form and urban structures of the region as this is the land of the largest river delta in the world. The cultural practice of urban design in this region had been strongly associated to its water system with necessity. The land and water have over time been blending together in ways that functioned harmoniously. The water has played a prevailing role in shaping human settlements in Bangladesh. Dhaka had many canals and water bodies integrated into its socio-economic and cultural life even until the post-colonial period (Ashraf 2012). Water is the life line, the line of communication and ecology which eventually, over time has been in the process of dramatically diminishing. The city of over 15 million people places huge pressure on urbanisation leading to the filling-in of the low lands and the destruction of waterscape for construction of settlements in recent decades. The city has become unsustainable in the course of urbanisation with ongoing water management problems including natural drainage, floods, pollution and an unbalanced ecology.

The increasingly 'hard engineered' urban infrastructure that characterises Dhaka today reflects a longer history of development that predates the post-independence era. Generally 'hard engineering' refers to a modern bias for dry and hard urban infrastructure designed to serve the motor vehicle (Shannon 2008). Urban development practices in this region during the era of British colonial rule, in the nineteenth and early twentieth centuries, were based on military and civil engineering driven decisions focused on the development of a modern city that would be hard and dry (Chattopadhyay 2007; Prakash 1999). Even after independence from colonial rule it appears that the established institutional frameworks of the surviving urban development authorities tended to sustain a mind-set that continued to reflect and reproduce colonial attitudes toward hard engineered urban development. A growing weight of evidence suggests that such existing practices are inflexible, and at the same time non-resilient to climate change and other manmade disasters such as water clogging, pollution and environmental degradation. This research will therefore explore the question of whether a shift to 'water-urbanism' as a dominant urban design and planning paradigm could be a more sustainable approach to the future development of low-lying cities like Dhaka through a critical examination of recent urban water infrastructure development practices in Dhaka.

In the contemporary professional disciplines of architecture, urban design and planning 'water urbanism' is a relatively new term, despite the fact that the practices associated with the concept were fundamental to the urban development of many great earlier so-called 'hydrological civilisations'. Only recently, however, and primarily in post-industrial western European contexts, has the disappearance of the interface between land and water through the urbanisation process provoked a renewed focus on water urbanism. In the important work of Kelly Shannon and associated theorists and scholars, the argument for a new water urbanism has emerged as a sub-discipline of the broader movement for 'landscape urbanism' in which the dynamic systemic characteristics of growing and changing urban environments are likened to the complex organisms of natural ecologies.

The proposed field survey will comprise a pair of sub-studies focusing on two very different kinds of urban development observable in Dhaka at present. One type, ostensibly influenced by the new water-urbanism, is creating value by creating water through reconstruction (restoring) or re-development of the wetlands, reclaiming/protecting lakes, canals and other water-bodies. The second type of intervention is creating value by filling in surviving water bodies and low-lands to construct new building sites. However, value is measured in both cases by profit, and influenced by political power and real estate venture.

References:

1. Ashraf, KK 2012, *Designing Dhaka: a Manifesto for a better city*, Loka Press, Dhaka.
2. Chattopadhyay, S 2007, 'The other face of primitive accumulation: the garden house of British Colonial Bengal', in P. Scriven & V. Prakash (eds), *Colonial Modernities: Building, Dwelling and Architecture in British India and Ceylon*, Routledge.
3. Prakash, G 1999, *Another Reason; Science and the Imagination in Modern India*, Princeton University Press, Princeton, New Jersey.
4. Shannon, K 2008, *Water Urbanism*, Amsterdam: SUN Publishers.

Have there been any preliminary studies, if Yes, provide the project title and HREC approval number(s):

No



Outline the study plan and design, giving a detailed description of all planned interactions between researchers and participants. Attach copies of surveys, interview or focus group schedules, questions, and topics to be covered. Outline details of interventions or drugs to be administered (complete the Drugs to be Administered Form at <http://www.adelaide.edu.au/ethics/human/guidelines/applications/>).

This project will be conducted through field work in Bangladesh.

A number of semi-structured interviews will be conducted with different stakeholder groups. In addition a questionnaire survey will be conducted with minimal interactions between the researcher and participants. Other than interviews and the questionnaire survey some historical research (collecting historical documents such as maps, text, popular press, images etc.) and physical observation will be conducted.

The following items are attached

- a. List of interviewees with details
- b. Topics of interviews
- c. Questionnaire survey form

If research is to be conducted with or about participants living outside Australia; outline any local legislation, regulations, permissions or customs that need to be addressed before the research can commence. Outline the steps taken to ensure that this has been adequately considered and addressed. Attach authorizing correspondence, approval documentation to the application.

From the previous survey & interview experiences of the student researcher gained on several occasions for research purposes, it is known that no legal permissions or such things are needed in Bangladesh to conduct academic research. A consent form may be signed by the interviewees (form attached).

SECTION 3: PARTICIPANTS AND RECRUITMENT

Who will be the participants in this project. Participants also includes data about people or human tissue samples. Include the source and other variables of all participants.

This project will have two types of participants.

1) For semi-structured interview

Participants:

Urban development historians, bureaucrats, policy makers, architectural historians, project architects, government architects, government engineers and planners, urban activist and environmentalist, urban design researchers, real estate developers and government officials.

Source:

Selected participants are directly and indirectly related to the development process in Dhaka and sub-study projects. For participants from government officials, higher authority of the organisations will be contacted. Preferably interviewees will have more than ten years' experiences.

Number:

Maximum 20 and minimum 15 participants.

Age:

Preferably 30+

2) For questionnaire survey

Participants and Source:

- a. People who live in the new land development projects and in the surrounding neighborhoods of the constructed (restored) or redeveloped wetland projects.
- b. People who own or rented the property possibly for more than two years for residential or any other use such as shops, offices etc.
- c. Respondent must be an adult person and over 20 years of age.

Number: Total number of participants for the questionnaire survey will be 200 or more. Minimum 100 participants who live in the new constructed land and minimum 100 participants who live in the surrounding neighborhoods of the constructed (restored) or re-developed wetland projects.

Age: preferably 20+

What is the number of participants? Outline how this sample will allow the aims of the project to be achieved.

See the previous section 3 above

Age range of participants?

See the previous section 3 above

Outline the participant selection and exclusion criteria:

For participant selection see the previous section 3 above

Screening: Researcher himself and research assistants from Bangladesh University of Engineering & Technology (BUET) will conduct the screening for questionnaire survey while the researcher himself will screen the participants for semi-structured interviews.

How will initial contact be made? How and by whom will any personal information including names, and contact details (including email addresses) be accessed? Researchers must ensure that personal information is not accessed without the consent of the individual.

1) For semi-structured interviews: Prospective participants will be personally contacted by the researcher over phone. If a participant expresses positive willingness then information sheet and consent form will be sent 2 weeks prior to the interview.

2) For questionnaire survey: The questionnaire survey will be administered by the researcher himself and research assistant, however in the majority of cases the participants will be contacted through known persons who live in those neighborhoods or urban areas.

What materials will be used to recruit participants? (attach advertisements, flyers, letters/emails of introduction, copy of Facebook event pages etc.)

For interviews e-mails. (information sheet attached)

Outline the specific tasks that participants will be asked to undertake including approximate time involved? (include these details on the Participant Information Sheet)

1) For semi-structured interviews, in general, each interview should not be more than 120 minutes.

2) For questionnaire survey, participants will have to answer mostly open ended questions. Total time for this work will be approximately around 20 minutes.

If recruitment is to be conducted by a third party or another organisation, outline how this will be done?

N/A

Describe any possible risks to the participant(s) when undertaking the research including emotional, social, legal or physical (in health research this would also take into consideration exposure to radiation e.g. X-rays, toxicity, etc.).

N/A

How will these risks be addressed?

N/A

Describe any possible risks to the health or safety of the researcher(s) when undertaking the research?

Note: where interviews are to be held in participants' homes as opposed to public places provide a rationale other than convenience for why this is necessary (and outline the personal safety protocol for the researchers involved)

This is a low-risk research project, therefore no significant risk is present to the researcher's health or safety.

SECTION 4: ETHICAL CONSIDERATIONS

The University templates for participant information sheets, consent forms and independent contacts and complaints procedures are at <http://www.adelaide.edu.au/ethics/human/guidelines/applications/>. *Attach the relevant document(s) to the application.*

Describe how the likely benefits of the research will justify any risks of harm, discomfort or burden to participants.

For interviews:

None, as all of the data are about development issues related to water and are not classified documents for organisations or people.

For questionnaire survey:

Participants will share their experiences and views about the development in their neighborhoods or urban areas related to water. No potential risk or direct benefit for the participants in this case.

Outline the protocol that will be followed in the event of any adverse events? Note: an adverse event can include situations where participants may decide to withdraw themselves or their information during/after an interview or focus group.

It is unlikely that an interview participant in this particular project will decide to withdraw during/after the interview. However, since there will be multiple participants from each groups, a single withdrawal will not hamper the process.

Will participants receive any reimbursement of out of pocket expenses, or financial or other rewards as a result of participation? What is the amount or nature of the reimbursement/reward and the justification for this?

No

How and when will a written Participant Information Sheet (in plain language) be provided to potential participants? For online surveys, the information sheet may be incorporated into the survey preamble. *Attach this document or provide a copy of the online survey information to the application.*

For semi-structured interviews, the information sheet will be provided beforehand with a consent form. (attached)

For questionnaire survey, the information sheet will be included with the survey form and explained to the participants before the survey. (attached)

How will written consent be obtained from participants and any third parties?

For interview participants, the information sheet and consent form will be provided to the possible participants at least two weeks earlier. Based on the consent given, a suitable time and location for interview will be fixed. It is expected that most of the interviews will be conducted in daylight at offices or public places.

For questionnaire survey, if the participants answered, it will be considered as a consent.

How and when will you give the *Contacts for the Project and Independent Complaints Procedure Sheet*. For some projects, including online surveys, a summary of this information may be added to the survey preamble. *Attach this document to the application.*

Attached

For participants not fluent in English or who have difficulty understanding English, what arrangements will be made to ensure comprehension of the Information Sheet and Consent Form?

- **Semi-structured interviews** could be conducted in native language if needed as both the researcher and participants speak the same language.
- **Questionnaire survey** will be administered by the researcher himself and research assistants, and could be conducted in native language if needed as both the person speak the same language. Moreover the final questionnaire survey form will have both the English and Bangla (native) languages for easy administration.



SECTION 5: PROTECTION OF PRIVACY AND CONFIDENTIALITY OF INFORMATION

Which of the following statements apply to the research:

- Complete anonymity of participants? (e.g. researchers will not know the identity of participants as the participants are part of a random sample and are required to return responses with no form of personal identification)
- Non-identified samples or data? (e.g. the personal identifiers have been removed from the data and replaced by a code, there is no link between the original identifiers and the code so that it is impossible to identify the individual to whom the sample of information relates)
- Re-identifiable samples or data? (e.g. the personal identifiers are removed and replaced by a code. Those handling the data subsequently do so using the code. If necessary, it is possible to link the code to the original identifiers and re-identify the individual to whom the sample or information relates)
- Participants have the option of being identified in any publication arising from the research?
- Participants are referred to by a pseudonym in any publication arising from the research?
- Other methods of protecting the privacy of participants? *(please describe below)*

Will researchers be taking photographs or recordings of participants using audio tape, film/video, or other electronic medium and how are these to be used?

Yes,
Interviews will be recorded with a digital voice recorder. The researcher himself will record while conducting the interviews.
For physical observation, photographs will be taken in the sub-study project areas which are water bodies, street views of the neighbourhoods, public places, green etc. and are not subject to any restrictions.

How will the confidentiality of the data collected/disseminated, including the identity of participants, be assured? Where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be clearly advised of this limitation in the *Participant Information Sheet*.

Interviews will collect data that identifies participant's occupation, experiences, office and position along with the participant's name. Whether their name will be used or not depends upon the person's consent. The researcher is aware that the small number of case studies may lead to interviewees being identified through association with other data. Inclusion of direct quotes will be done with great care. For questionnaire survey participant's name will not be used in the research.

SECTION 6: DATA ANALYSIS AND STORAGE

How is the information (data) to be analysed, and who will have access?

Interview data will be transcribed and analysed with N-Vivo software.
Questionnaire survey data will be analysed with SPSS and Microsoft excel.
Only the researchers will have access to these data.

Will participants receive feedback of findings prior to any publication (including access to transcripts of interviews or drafts of reports)?

Interview data will be transcribed and post-coded. It will be included as required in the thesis. Interview participants will receive a summary and interpretation of the interview before being included in the thesis and any publication.
All data may be used in academic papers.

Will the project outcomes be made publicly accessible at the end of the project and in what forms (e.g. journal article, book, conference paper, the Media)?

Yes, journal articles, books, conference papers etc.

Outline the methods to be used for the storage, location, and access to, all records and materials (written or electronic) that have been used/collected during and after completion of the project.

The survey data will be stored in appropriate databases at both the University of Adelaide and at the researcher's personal computers and will transfer storage via portable devices. Data will be stored according to the Australian Code for Responsible Conduct of Research. The University of Adelaide ethics committee will be advised of the final storage intentions.

Outline the length of time that the records and materials will be retained by the University. (Note that the minimum period for retention of research data is 5 years from the date of any publication and varies depending on the specific type of research. For more information refer to Section 2.1 of the Australian Code for the Responsible Conduct of Research at <http://www.nhmrc.gov.au/guidelines/publications/r39>)

5 years.

SECTION 7: CONFLICT OF INTEREST OR OTHER ETHICAL ISSUES

Outline any 'conflict of interest' issues that may arise during the project?

N/A

Do the researchers expect to obtain any direct or indirect financial or other benefits from conducting this research? (Note that such benefits must be declared to the HREC and included in the *Information Sheet*.)

No

Outline any other ethical or relevant issues not discussed in this application:

N/A



SECTION 8: DECLARATION BY THE RESEARCHERS

Declaration by the researcher(s)

I/we have read the National Statement on Ethical Conduct in Human Research (2007).

I/we, the researcher(s) agree to:

- start this research project only after obtaining final approval from the Human Research Ethics Committee (HREC)
- only carry out this research project where adequate funding and personnel is available to enable the project to be carried out according to good research practice and in an ethical manner
- notify the HREC in writing in the event of any adverse or unforeseen events; amendments; completion; discontinuation of the project or changes to research personnel
- provide an annual progress report to the HREC for the duration of the research project;
- provide the HREC with a final report
- agree to participate in an audit if requested by the HREC.

In addition, as the applicant, I:

- accept responsibility for the conduct of this research project according to the *National Statement on Ethical Conduct in Human Research (2007)*
- certify that all researchers and other personnel involved in this project are appropriately qualified and experienced or will undergo appropriate training and supervision to fulfil their role in this project
- will take responsibility for the confidential maintenance of the data as per the University's Responsible Conduct of Research Policy and as required by legislation.

Signatures are required from all persons named in section 1 of this application:

Applicant's signature:	Name:	Dr. Peter Scriver	Date:	10/6/2014
Researcher's signature:	Name:	Fahmid Ahmed	Date:	10-06-2014
Researcher's signature:	Name:		Date:	
Researcher's signature:	Name:		Date:	
Researcher's signature:	Name:		Date:	
Researcher's signature:	Name:		Date:	
Researcher's signature:	Name:		Date:	

SECTION 9: CHECKLIST

The following documents are attached to this application:

Yes	No	N/A*	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Participant Information Sheet (required for all projects including on-line surveys)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Standard Consent Form for a participant in a research project (written consent is required for the majority of projects)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Third Party to Participation Form required where participants are children under 18 years or a dependent adult
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Contacts and Independent Complaints Procedure information or sheet (required for all projects, including on-line surveys)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Survey instrument/Questionnaire (include a printed copy of on-line survey)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Procedure/protocol for interviews or focus groups including topics and questions
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Recruitment advertisement, flyers, recruitment letters, social media event sites
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Adverse event procedure/interview protocol (if required)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Evidence of approval/rejection by other HRECs, including comments and requested alterations to the application
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Research with people outside Australia: Evidence of permissions, approvals from overseas authorities etc
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Administration of Drugs Form

*Not applicable

SECTION 9: CHECKLIST**SECTION 10: HOW TO SUBMIT THIS APPLICATION**

1. Print the completed form and get all signatures.
2. Scan the signed form including all attachments as **one pdf file** and email to hrec@adelaide.edu.au.
3. Submission deadlines apply to applications requiring full HREC review. Applications submitted for low risk review can be submitted at any time. Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information.

Appendix A-3: Information sheet for questionnaire survey participants



INFORMATION SHEET – FOR QUESTIONNAIRE SURVEY PARTICIPANTS

PROJECT TITLE:	Water urbanism: water management in urban development in Dhaka
PRINCIPAL INVESTIGATOR:	Dr. Peter Scriver
STUDENT RESEARCHER:	Fahmid Ahmed
STUDENT'S DEGREE:	PhD

Purpose of the Study

To understand how you as a user of this urban area appreciate water-related development

Task of the participants

Participants will be asked to answer a questionnaire survey form consisting of approximately thirty questions. The questions are mainly about relevant issues on urbanisation, impacts of urbanisation, transformation of wetlands and city, neighbourhood or urban area conditions, generic city problems etc. that have an impact on human and environment. Participants have to answer sets of close ended, open ended and multiple answers questions.

How much time will it take?

Approximately 20 minutes.

Possible benefits from the study, to the participant and/or the community

- 1) An opportunity for participants to share their views and ideas about their neighbourhoods or urban areas.
- 2) An opportunity for participants to share their experiences about the city and urbanisation in relation to its water-bodies.

Important note to the participants if they wish to withdraw from the study

Your participation is voluntary. You may withdraw from the survey whenever you desire by simply advising the researcher of your intention to do so.

Important note to the participants if they wish not to answer any question

Participants are free to not answer any question if they do not intend to do so.

Assurances of confidentiality

All details will be kept confidential. Codes will be used to identify your data. Your name will not be used anywhere. Your participation and information will be an important part of the doctoral research project, which will be used strictly for academic purposes.

Measures that will be taken in the event of an adverse event

If, at any time you experience stress in conveying your experiences, please inform the researchers and the activity will be discontinued.

What if I have a complaint or any concerns?

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2014-xxx). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. Contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au. If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

For any further information, please do not hesitate to contact us:

Sl. No	Name	Position	Contact no	E-mail
1	Dr. Peter Scriver	Principal Supervisor	Ph. +61 8 8303-4586 Fax +61 8 8303-4377	peter.scriver@adelaide.edu.au
2	Prof. Jon Kellett	Co-Supervisor	Fax +61 8 8303-4377	Jon.kellett@adelaide.edu.au
3	Mr. Fahmid Ahmed	Researcher	Ph. +61 0420483854 Fax +61 8 8303-4377	fahmid.ahmed@adelaide.edu.au

I am looking forward to receiving your positive reply and I do appreciate your participation in this research project.

Yours Sincerely,

Fahmid Ahmed |

Appendix A-4: Information sheet for interview participants



INFORMATION SHEET – FOR INTERVIEW PARTICIPANTS

PROJECT TITLE:	Water urbanism: water management in urban development in Dhaka
PRINCIPAL INVESTIGATOR:	Dr. Peter Scriver
STUDENT RESEARCHER:	Fahmid Ahmed
STUDENT'S DEGREE:	PhD

Purpose of the Study

To gather and examine the views of different stakeholder groups regarding urban development in Dhaka city related to water, from the colonial era to the present day.

Task of the participants

Participants will be asked to participate in a semi-structured interview where some questions will be mostly open ended. The topics for discussion in the interviews are primarily concerned with the professional experience and expert knowledge and theories of the participants about past and present urban development practices in Dhaka relating to water, and ranging from issues of urbanisation and governance to sustainability.

How much time will it take?

Up to 120 minutes.

Possible benefits from the study, to the participant and/or the community

- An opportunity for participants to share their experiences on contemporary urban development managing water for Dhaka in the current trends of urbanisation.
- An opportunity for participants to share their knowledge on urban development history relating to water.

Important note to the participants if they wish to withdraw from the study

Your participation is voluntary. You may withdraw from the study whenever you desire by simply advising the researcher of your intention to do so.

Important note to the participants if they wish not to answer any question

Participants are free to not answer any question if they do not intend to do so.

Assurances of confidentiality

All details will be kept confidential. Codes will be used to identify your data. Your participation and information will be an important part of the doctoral research project, which will be used strictly for academic purposes.

Measures that will be taken in the event of an adverse event

If, at any time you experience stress in conveying your experiences, please inform the researchers and the activity will be discontinued.

What if I have a complaint or any concerns?

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2014-xxx). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. Contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au. If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.



For any further information, please do not hesitate to contact us:

Sl. No	Name	Position	Contact no	E-mail
1	Dr. Peter Scriver	Principal Supervisor	Ph. +61 8 8303-4586 Fax +61 8 8303-4377	peter.scriver@adelaide.edu.au
2	Prof. Jon Kellett	Co-Supervisor	Fax +61 8 8303-4377	Jon.kellett@adelaide.edu.au
3	Mr. Fahmid Ahmed	Researcher	Ph. +61 0420483854 Fax +61 8 8303-4377	fahmid.ahmed@adelaide.edu.au

I am looking forward to receiving your positive reply and I do appreciate your participation in this research project.

Yours Sincerely,

Fahmid Ahmed

Appendix A-5: Consent form for interview participants



Human Research Ethics Committee (HRECC)

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	Water urbanism: water management in urban development in Dhaka
Ethics Approval Number:	Researcher to insert this number, allocated once the project has been approved

2. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

3. Although I understand the purpose of the research project it has also been explained that involvement may not be of any benefit to me.

4. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

5. I understand that I am free to withdraw from the project at any time.

6. I agree to the interview being audio. Yes No

7. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

8. I have my consent to quote my interview if required in the write-up of the research. Yes No

Participant to complete:

Name: _____ Signature: _____ Date: _____

Appendix A-6: Information Sheet for contacts for information on project and independent complaints procedure



The University of Adelaide

Human Research Ethics Committee (HREC)

This document is for people who are participants in a research project.

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project Title:	Water urbanism: water management in urban development in Dhaka
Approval Number:	H-2014-180

The Human Research Ethics Committee monitors all the research projects which it has approved. The committee considers it important that people participating in approved projects have an independent and confidential reporting mechanism which they can use if they have any worries or complaints about that research. This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (see <http://www.nhmrc.gov.au/publications/synopses/e72syn.htm>)

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Sl. No	Name	Position	Contact no	E-mail
1	<u>Dr. Peter Scriver</u>	Principal Supervisor	Ph. +61 8 8303-4586 Fax +61 8 8303-4377	peter.scriver@adelaide.edu.au
2	<u>Prof. Jon Kellett</u>	Co-Supervisor	Fax +61 8 8303-4377	Jon.kellett@adelaide.edu.au
3	<u>Mr. Fahmid Ahmed</u>	Researcher	Ph. +61 0420483854 Fax +61 8 8303-4377	fahmid.ahmed@adelaide.edu.au

2. If you wish to discuss with an independent person matters related to:

- making a complaint, or
- raising concerns on the conduct of the project, or
- the University policy on research involving human participants, or
- your rights as a participant,

contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au

Appendix A-7: Questionnaire survey form

School of Architecture and Built Environment



- Survey will be administered by the researcher himself or research assistant
- Questions will be asked either in English or Bangla depends on the respondents
- Majority of the questions are open ended. The respondent will not know the given answers. Given answers are only for researcher or research assistant to make the work easier and faster
- Code for open ended question is OE
- Options for have multiple answers coded with M

Questionnaire Survey Form

Section A		General information of the participants			
A1	Name :				
A2	Sex/gender	<input type="checkbox"/> Male	<input type="checkbox"/> Female	<input type="checkbox"/> Other	
A3	Age Group:	<input type="checkbox"/> Below 18 years	<input type="checkbox"/> Between 18 to 25	<input type="checkbox"/> Between 25 to 35	
		<input type="checkbox"/> Between 35 to 50	<input type="checkbox"/> Between 50 to 65	<input type="checkbox"/> 65 and over	
A4	Education:	<input type="checkbox"/> None	<input type="checkbox"/> Primary level	<input type="checkbox"/> Secondary level	
		<input type="checkbox"/> Higher secondary level	<input type="checkbox"/> Graduate	<input type="checkbox"/> Post graduate	
A5	Profession/occupation	<input type="checkbox"/> Student	<input type="checkbox"/> Government service	<input type="checkbox"/> Teaching/research	
	<input type="checkbox"/> Unemployed	<input type="checkbox"/> Doctors	<input type="checkbox"/> Technical service/traders	<input type="checkbox"/> Business	
	<input type="checkbox"/> Private service	<input type="checkbox"/> Informal sector works	<input type="checkbox"/> House wife/dependent	<input type="checkbox"/> retired/ pensioners	
	<input type="checkbox"/> Technocrats	<input type="checkbox"/> Others			
A6	Please tick which one of the following best describes the total combined monthly income in BDT by all members of your household.				
	<input type="checkbox"/> Less than 15,000	<input type="checkbox"/> 15,000-30,000	<input type="checkbox"/> 30,000-60,000	<input type="checkbox"/> 60,000-1,00,000	
	<input type="checkbox"/> 1,00,000-2,00,000	<input type="checkbox"/> 2,00,000-3,00,000	<input type="checkbox"/> More than 3,00,000	<input type="checkbox"/> I don't know	
A7	Address/Location				
	Hatirheel area <input type="checkbox"/>				
	Bashundhara <input type="checkbox"/>				
A8	What type of functions you have in this property?				
	<input type="checkbox"/> Single residence	<input type="checkbox"/> Apartments	<input type="checkbox"/> Offices	<input type="checkbox"/> Shops	
	<input type="checkbox"/> Industrial	<input type="checkbox"/> Mixed used residential	<input type="checkbox"/> Mixed used commercial	<input type="checkbox"/> Institutional	
	<input type="checkbox"/> Others				
A9	Are you the owner of the property or it is rented or you work or study here?				
	<input type="checkbox"/> Owner	<input type="checkbox"/> Rented	<input type="checkbox"/> Working place	<input type="checkbox"/> Others	
	<input type="checkbox"/> Study				
A10	If you are an owner, what kind of ownership do you have in this property?				
	<input type="checkbox"/> Not owner of the property				
	<input type="checkbox"/> land owner	<input type="checkbox"/> Apartment owner	<input type="checkbox"/> Office space owner	<input type="checkbox"/> Shop space owner	
	<input type="checkbox"/> Other commercial/ business space owner	<input type="checkbox"/> Others			
A11	Why did you choose the location to invest or live or work? (OE & M)				
	<input type="checkbox"/> For good economic return		<input type="checkbox"/> Good environment to live		
	<input type="checkbox"/> Accessibility and communication		<input type="checkbox"/> Inherited property from ancestors.		
	<input type="checkbox"/> Lake side/ water front site		<input type="checkbox"/> Easier to buy /affordable (as this property/floor space is cheaper than other area)		
	<input type="checkbox"/> Close to work place		<input type="checkbox"/> Shopping area and bazars		
	<input type="checkbox"/> Educational institute/ good schools in the area		<input type="checkbox"/> Parks and green		
	<input type="checkbox"/> Office or working place in this area		<input type="checkbox"/> Old residents who are living in the neighbourhood for long (other relatives/friends live in the same area/ sense of belongingness in the area)		
	<input type="checkbox"/> Others				
	1.				
	2.				

- Survey will be administered by the researcher himself or research assistant
- Questions will be asked either in English or Bangla depends on the respondents
- Majority of the questions are open ended. The respondent will not know the given answers. Given answers are only for researcher or research assistant to make the work easier and faster
- Code for open ended question is OE
- Options for have multiple answers coded with M

Section B		Feedbacks on neighbourhoods/urban areas			
B1	What are the positive aspects/features of the neighbourhood/ urban area you live or work? (OE & M)				
	<input type="checkbox"/> Circulation/ accessibility	<input type="checkbox"/> Good environment	<input type="checkbox"/> Open spaces	<input type="checkbox"/> Parks	
	<input type="checkbox"/> Close to work place	<input type="checkbox"/> Close to home	<input type="checkbox"/> Educational institute/ school	<input type="checkbox"/> Security	
	<input type="checkbox"/> Trade	<input type="checkbox"/> Drainage	<input type="checkbox"/> Sewer disposal	<input type="checkbox"/> Public facilities	
	<input type="checkbox"/> Hospital	<input type="checkbox"/> Mobility/ public transport	<input type="checkbox"/> Play ground	<input type="checkbox"/> Close to mosque	
	<input type="checkbox"/> Gymnasium/ indoor sports	<input type="checkbox"/> Shopping area	<input type="checkbox"/> Convenient to live due to easy access to day to day groceries (bazars/convenient stores/shopping).		
	<input type="checkbox"/> others 1. 2. 3. 4.				
B2	What are the negative aspects/features of your neighbourhood? (OE & M)				
	<input type="checkbox"/> Pollution	<input type="checkbox"/> Density	<input type="checkbox"/> Traffic	<input type="checkbox"/> Water clogging	
	<input type="checkbox"/> Energy shortage	<input type="checkbox"/> Water crises	<input type="checkbox"/> Sewerage.	<input type="checkbox"/> Lack of mobility/ public transport	
	<input type="checkbox"/> Accessibility	<input type="checkbox"/> Security	<input type="checkbox"/> Lack of public facilities	<input type="checkbox"/> Lack of open spaces and green	
	<input type="checkbox"/> Noise pollution	<input type="checkbox"/> Water pollution	<input type="checkbox"/> Poor /inadequate road infrastructure	<input type="checkbox"/> Lack of maintenance and service from DCC/ council	
	<input type="checkbox"/> Squatters/slums				
	<input type="checkbox"/> others 1. 2. 3. 4.				
B3	If they live/work beside the restored/re-constructed/re-developed water-bodies. Does the water body bring anything positive to you?				
	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> both		
B4	If yes and both, what are the positive aspects of the project restored/ re-development of the wetlands? (OE & M)				
	<input type="checkbox"/> Visual aspects	<input type="checkbox"/> Natural drainage/water retention	<input type="checkbox"/> Value for property	<input type="checkbox"/> Creates better environment	
	<input type="checkbox"/> Public space/place for socialising	<input type="checkbox"/> Encourage informal business	<input type="checkbox"/> Open spaces	<input type="checkbox"/> Good for fishes	
	<input type="checkbox"/> Positive for ecology	<input type="checkbox"/> Good for walking or jogging	<input type="checkbox"/> Space for different cultural activities	<input type="checkbox"/> Good infrastructure for water and mobility (road/aqueducts/bridges/walkways)	
	<input type="checkbox"/> Created accessibility	<input type="checkbox"/> Encouraged commercialisation	<input type="checkbox"/> Ecological balance		
	<input type="checkbox"/> others 1. 2. 3. 4.				

- Survey will be administered by the researcher himself or research assistant
- Questions will be asked either in English or Bangla depends on the respondents
- Majority of the questions are open ended. The respondent will not know the given answers. Given answers are only for researcher or research assistant to make the work easier and faster
- Code for open ended question is OE
- Options for have multiple answers coded with M

B5	If no or both, what are the negative aspects of the project re-constructed/re-development of the wetlands? (OE & M)			
	<input type="checkbox"/> Water pollution/ sewerage disposal in the water	<input type="checkbox"/> Infrastructure	<input type="checkbox"/> Encourage more traffic	<input type="checkbox"/> Increase the price of rent
	<input type="checkbox"/> Lack of green	<input type="checkbox"/> Social and physical gentrification	<input type="checkbox"/> Encouraged commercialisation	<input type="checkbox"/> Social injustice through intervention such as displaced the marginalise people/ informal settlers
	<input type="checkbox"/> Encourage more crowd and chaos	<input type="checkbox"/> Noise pollution	<input type="checkbox"/> Open water encourage environmental and health problems (diseases as malaria, dengue etc.)	<input type="checkbox"/> lack of balanced ecological system
	<input type="checkbox"/> Flooding	<input type="checkbox"/> Squatter settlements/slums		
	<input type="checkbox"/> others 1. 2. 3. 4. 5.			
B6	How in overall criteria you rate your neighbourhood/ urban area?			
	<input type="checkbox"/> Excellent	<input type="checkbox"/> Very good	<input type="checkbox"/> Good	<input type="checkbox"/> Moderate
	<input type="checkbox"/> Bad	<input type="checkbox"/> Very bad	<input type="checkbox"/> Extremely poor	
Section C		Conceptual and generic questions on water bodies and urbanisation		
C1	Are land development projects through land filling required for urbanisation?			
	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not aware of this issue	<input type="checkbox"/> Could not answer
C2	(If yes/no) Why land-filling for urbanisation is required or not required? (OE)			
	1. 2. 3. 4. 5.			
C3	Do you think the new land development such as <u>Bashundhora</u> , <u>Purbachal</u> , <u>Modhumoti</u> etc. are considering the natural landscape and water-bodies in their planning process?			
	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not aware of this issue	<input type="checkbox"/> Could not answer
C4	(If yes/no) What are the alternatives of land development projects other than land-filling to cater the growth for Dhaka city? (OE)			
	1. 2. 3. 4. 5. 6. 7.			

- Survey will be administered by the researcher himself or research assistant
- Questions will be asked either in English or Bangla depends on the respondents
- Majority of the questions are open ended. The respondent will not know the given answers. Given answers are only for researcher or research assistant to make the work easier and faster
- Code for open ended question is OE
- Options for have multiple answers coded with M

C5	Do you visit or use any type of water bodies in the city regularly?			
	<input type="checkbox"/> Yes	<input type="checkbox"/> No		
C6	If yes, for what purpose do you use or visit those places? (OE & M)			
	<input type="checkbox"/> Recreation/festivals/ cultural activities	<input type="checkbox"/> Communication/ mobility	<input type="checkbox"/> Sports/ walking	<input type="checkbox"/> Business
	<input type="checkbox"/> Eating	<input type="checkbox"/> Socialising	<input type="checkbox"/> Bathing	<input type="checkbox"/> Garbage disposal
	<input type="checkbox"/> Washing cloths	<input type="checkbox"/> Fishing	<input type="checkbox"/> Visit friends and families who lives beside water	<input type="checkbox"/> For working
	Others 1.	2.	3.	4.
C7	Why do you think water clogging happens regularly in the Dhaka city? (OE & M)			
	<input type="checkbox"/> Could not answer		<input type="checkbox"/> Not aware of this issue	
	<input type="checkbox"/> Too much rain/water	<input type="checkbox"/> Filling up the water bodies	<input type="checkbox"/> Poor drainage / not enough drains	<input type="checkbox"/> Lack of awareness
	<input type="checkbox"/> Poor governance	<input type="checkbox"/> poor maintenance	<input type="checkbox"/> Low country	<input type="checkbox"/> Poor water management
	<input type="checkbox"/> Others 1. 2. 3. 4. 5.			
C8	According to you how to solve the water clogging for Dhaka? (OE & M)			
	<input type="checkbox"/> Could not answer		<input type="checkbox"/> Not aware of this issue	
	<input type="checkbox"/> More/better drainage	<input type="checkbox"/> Get rid of water- bodies	<input type="checkbox"/> Regular cleaning of drains/ maintenance of drainage	<input type="checkbox"/> Reclaiming the water- bodies
	<input type="checkbox"/> protect and maintain canals and other water- bodies	<input type="checkbox"/> Integrated water system/drain	<input type="checkbox"/> Protection against illegal occupation and filling-up the water-bodies	<input type="checkbox"/> Not using the water- bodies as disposal
	<input type="checkbox"/> Others 1. 2. 3. 4. 5.			
C9	Do you think Dhaka's existing water bodies should be protected?			
	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Could not answer	<input type="checkbox"/> Not aware of this issue
C10	If yes or no, why? (OE)			
	1. 2. 3. 4. 5.			

- Survey will be administered by the researcher himself or research assistant
- Questions will be asked either in English or Bangla depends on the respondents
- Majority of the questions are open ended. The respondent will not know the given answers. Given answers are only for researcher or research assistant to make the work easier and faster
- Code for open ended question is OE
- Options for have multiple answers coded with M

C11	Do you think Dhaka's lost water bodies should be reclaimed?			
	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Could not answer	<input type="checkbox"/> Not aware of this issue
C12	If yes or no, why? (OE)			
	1. 2. 3. 4. 5.			
C13	How to restore and protect the water bodies If you think that is needed? (OE & M)			
	<input type="checkbox"/> Could not answer		<input type="checkbox"/> Not aware of this issue	
	<input type="checkbox"/> Innovative design	<input type="checkbox"/> Strict law and order	<input type="checkbox"/> Awareness of people	<input type="checkbox"/> Proper planning and implementations
	<input type="checkbox"/> Integrated planning by involving all kinds of stake holders	<input type="checkbox"/> Restore/reconstruct wet lands with intervention	<input type="checkbox"/> Construct protection walls and pathways along the water-bodies	
	<input type="checkbox"/> others <ol style="list-style-type: none"> 1. 2. 3. 4. 5. 			
C14	What are the 5 key problems you face living in Dhaka city? (OE & M)			
	<input type="checkbox"/> Lack of space for living	<input type="checkbox"/> Energy crisis	<input type="checkbox"/> Water management	<input type="checkbox"/> Population pressure
	<input type="checkbox"/> Lack of Housing	<input type="checkbox"/> Improper planning	<input type="checkbox"/> Corruption in the development process	<input type="checkbox"/> City management
	<input type="checkbox"/> Poor governance	<input type="checkbox"/> Centralisation	<input type="checkbox"/> Traffic congestion	<input type="checkbox"/> public transport
	<input type="checkbox"/> Health and safety	<input type="checkbox"/> Living expense	<input type="checkbox"/> Lack of social justice for poor	<input type="checkbox"/> Lack of employment
	<input type="checkbox"/> Air/water/noise pollution	<input type="checkbox"/> Lack of security	<input type="checkbox"/> Slums	<input type="checkbox"/> Lack of pedestrian facilities
	<input type="checkbox"/> lack of adequate and clean drinking and household water (water crisis)			
	<input type="checkbox"/> Others <ol style="list-style-type: none"> 1. 2. 3. 4. 5. 			

Appendix A-8: Minutes of the Ministry of Housing and Public Works Bangladesh dated 24th August 2014

ক্রমিক নং	আবেদনকারীর নাম/ঠিকানা জমির বৈশিষ্ট্য ও আয়তন দাগ নং	আলোচনা ও সিদ্ধান্ত
		<p>চিহ্নিত করা হয়েছে। সরকারি মালিকানাধীন একটি Strip এ বহু বাসিন্দার স্থাপনা বিদ্যমান। উল্লেখ্য, এয়ারপোর্ট রোডের পূর্ব পার্শ্বের রাস্তা সংলগ্ন এলাকা জায়ে Mixed Use Zone (Residential-Commercial) হিসেবে চিহ্নিত আছে।</p> <p>আবেদনকারী Strip জায়ে জমির ওপর Overlay Zone (সেমানাবাসের অর্থ) হিসেবে চিহ্নিত। উক্ত Strip এর ফোরওয়ার্ডি মালিকানাধীন জমির জুঁই ব্যবহার Overlay Zone হতে Mixed Use Zone (Residential-Commercial) এ পরিবর্তনের বিষয়টি বিবেচনা করা যাবে।</p> <p>সিদ্ধান্ত : মধ্যবর্তী সেকেন্ডারি হতে বন্দী চেয়ারম্যানবাড়ী পর্যন্ত এয়ারপোর্ট রোড ও মধ্যবর্তী স্ট্রাইটভাওয়ার পশ্চিম পার্শ্ব বিদ্যমান Strip এর ফোরওয়ার্ডি মালিকানাধীন জমির জুঁই ব্যবহার Overlay Zone হতে Mixed Use Zone (Residential-Commercial) এ পরিবর্তনের বিষয়টি অনুমোদন করা হলো।</p> <p>৮.০ নার পরিকল্পনাবিদ, রাষ্ট্রিক জ্ঞান মে, ডায়েরি জুঁই ব্যবহার পরিবর্তন সংক্রান্ত মোট ১৯টি আবেদন শর্তহীন এবং শর্তযুক্তভাবে মন্ত্রিসভা কমিটি'র ৪র্থ সভায় অনুমোদিত হয়। উক্ত সিদ্ধান্ত বাস্তবায়নের জন্য সরকারি গেজেট প্রজ্ঞাপন জারি করা প্রয়োজন। তিনি আবেদন জানান যে, মন্ত্রিসভা কমিটির ৪র্থ সভার কার্যবিবরণীতে ৮ (৭) ও ৮ (৮) নং সিদ্ধান্তে যথাক্রমে আনুমানিক ২০ কাঠা (০১ বিঘা) পর্যন্ত ব্যক্তি মালিকানাধীন জমিদার এবং উল্লু হতে ২ নং বন্দী থেকে অবসৃত করা হয়েছে। তাই গেজেট প্রকাশের মাধ্যমে উক্ত সিদ্ধান্ত কার্যকর করা হলে অনেক আবেদন স্বয়ংক্রিয়ভাবে নিষ্পন্ন হবে। এতে জনস্বার্থের ক্ষতি হবে। উদ্যোগ করে গতিশীলতা বাড়াতে বলে তিনি অভিযত নেন। সভাপতি গেজেট প্রকাশের পদ্ধতির বিষয়ে জানতে চাইলে নার পরিকল্পনাবিদ, রাষ্ট্রিক জ্ঞান মে, জুঁই ব্যবহারের বন্দী পরিবর্তনের ক্ষেত্রে মৌজার নাম ও আয়তন দাগ নম্বরসহ পূর্ণাঙ্গ তথ্যাবলী সরিয়ে দেওয়া হবে। অনেক জুঁই একাধিক মৌজার অসুবিধা দূর করা হওয়া উচিত জুঁই পরিবর্তন ও অবস্থান সুনির্দিষ্টকরণে দীর্ঘ বিবেচনা প্রয়োজন হয়। এ ক্ষেত্রে মন্ত্রিসভা কমিটি কর্তৃক অনুমোদিত প্রতিটি আবেদনের জুঁই ব্যবহারের বন্দী পরিবর্তনের ক্ষেত্রে পূর্বক সরকারি গেজেট প্রজ্ঞাপন জারি করা প্রয়োজন। সভাপতি মন্ত্রিসভা কমিটির সভায় পৃথক সাধারণ সিদ্ধান্তসমূহ এবং শর্তহীনভাবে অনুমোদিত জুঁই ব্যবহারের বন্দী পরিবর্তন এর গেজেট প্রজ্ঞাপন জারি করার অভিযত নেন। সভা এ বিষয়ে ঐকমত্য পোষণ করে।</p> <p>সিদ্ধান্ত : জাপ রিভিউ সংক্রান্ত মন্ত্রিসভা কমিটির সভায় পৃথক সাধারণ সিদ্ধান্তসমূহ এবং জুঁই ব্যবহারের বন্দী পরিবর্তনের জন্য যে সকল আবেদন শর্তহীনভাবে উক্ত কমিটিতে অনুমোদিত হয়েছে, তা সরকারি গেজেটে প্রকাশ করার জন্য প্রধান ও পদপূর্ত মন্ত্রিপালয় প্রয়োজনীয় ব্যবস্থা গ্রহণ করবে। এ বিষয়ে রাষ্ট্রিক জ্ঞান মে'র সভায় প্রধান করবে।</p> <p>৯.০ পরিচালক সভাপতি উপস্থিত সকলকে ধন্যবাদ জানিয়ে সভার কার্যক্রম সমাপ্তি ঘোষণা করেন।</p>

পাশ্চাত্যবাহী বাসগোপন সরকার প্রধান ও পদপূর্ত মন্ত্রিপালয় বাংলাদেশ প্রতিপালক, ঢাকা।

বিষয় : ডিটেইন্ড এরিয়া প্রাধান (জাপ) রিভিউকরণের দক্ষা গঠিত মন্ত্রিসভা কমিটির ৫ম সভার কার্যবিবরণী।

সভাপতি উদ্যোগ কর্তৃক (রাষ্ট্রিক) কর্তৃক গঠিত ডিটেইন্ড এরিয়া প্রাধান (জাপ) রিভিউকরণের দক্ষা গঠিত মন্ত্রিসভা কমিটির ৫ম সভা উক্ত কমিটির আহ্বানক্রমে, প্রধান ও পদপূর্ত মন্ত্রিপালয়ের গণপূর্ত বিভাগের মাননীয় সচিব ইঞ্জিনিয়ার মোবারক হোসেন, এমপি এর সভাপতিত্বে ২৫ আগস্ট ২০১৪ তারিখে প্রধান ও পদপূর্ত মন্ত্রিপালয়ের সভাকক্ষে অনুষ্ঠিত হয়। সভায় উপস্থিত কমিটির সদস্যসমূহ এবং সহযোগিতাকারী কর্মকর্তাদের তালিকা পরিলক্ষিত 'ক' তে সংযুক্ত করা হলো। প্রস্তাব সভাপতির অনুমতিক্রমে কতিপয় আবেদনকারীর প্রতিনিধি উপস্থিত ছিলেন।

২.০ সভাপতি উপস্থিত সকলকে স্বাগত জানান এবং আলোচনাসূচী অনুযায়ী বিষয়সমূহ উপস্থাপনের জ্ঞান মে সচিব, প্রধান ও পদপূর্ত মন্ত্রিপালয়ে আহ্বান জানান। সচিব, প্রধান ও পদপূর্ত মন্ত্রিপালয় বলেন যে, জাপ রিভিউ সংক্রান্ত মন্ত্রিসভা কমিটির প্রজ্ঞাপনে কনিষ্ঠ কর্তৃক প্রয়োজনে যে কাউকে কো-অপ্ট করার সুযোগ রয়েছে। চেয়ারম্যান, রাষ্ট্রিক জ্ঞান মে কমিটির সভায় ব্যবহৃত তথ্য-উপাত্ত সরবরাহ করেন এবং প্রয়োজনে তা সভায় উপস্থাপন করেন। কনিষ্ঠ সচিবের সঙ্গে প্রয়োজনীয় বিবেচনায় কনিষ্ঠ সহযোগিতাকারী কর্মকর্তা হিসেবে চেয়ারম্যান রাষ্ট্রিক-কে কো-অপ্ট করার এবং অধ্যাকার সভা থেকে তা কার্যকর করার জন্য তিনি প্রেরণ করেন। সভা এ প্রস্তাবে ঐকমত্য পোষণ করে।

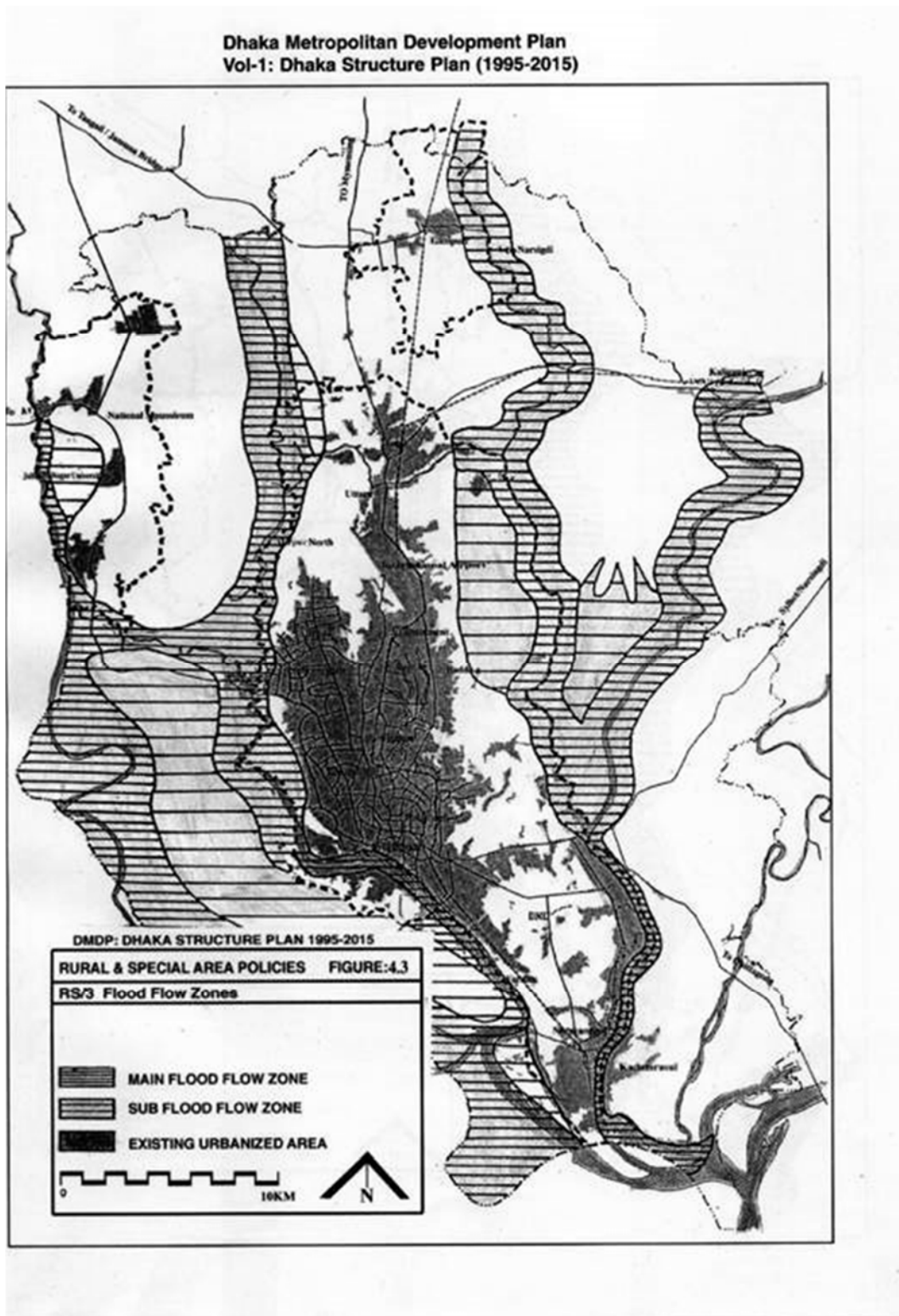
সিদ্ধান্ত : জাপ রিভিউ সংক্রান্ত মন্ত্রিসভা কমিটিতে সহযোগিতাকারী কর্মকর্তা হিসেবে চেয়ারম্যান, রাষ্ট্রিক-কে কো-অপ্ট করা হলো, যা এই সভা হতে কার্যকর হবে।

৩.০ চেয়ারম্যান, রাষ্ট্রিক আলোচনাসূচীর বিষয়সমূহ সভায় উপস্থাপনের জন্য নার পরিকল্পনাবিদ, রাষ্ট্রিক ও সহস্যা সচিব, কারিগরি কমিটি-কে আহ্বান জানান। নার পরিকল্পনাবিদ, রাষ্ট্রিক জাপ রিভিউ সংক্রান্ত মন্ত্রিসভা কমিটির ৫ম সভায় উপস্থিত ৪র্থ সভার কার্যবিবরণী পরিচয়নের জন্য সভায় উপস্থাপন করেন এবং উপস্থিত সম্মানিত সদস্যসমূহদের কাছ থেকে সন্দেহজনী প্রশ্নের আবেদন জানতে চান।

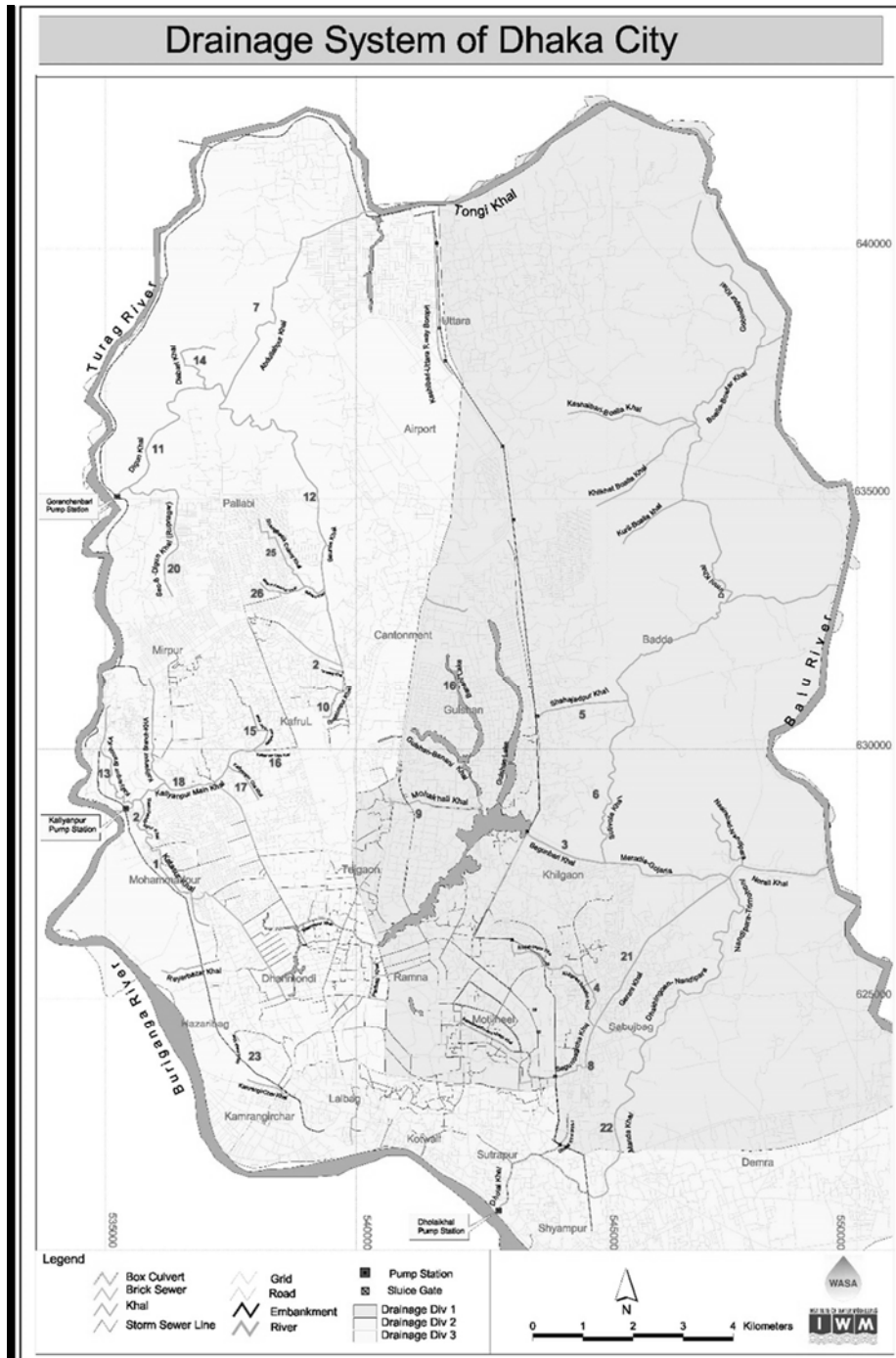
৩.১ পূর্ণাঙ্গ অফিসার হাউজিং সোসাইটি (POHS) প্রকল্পের প্রতিনিধি বলেন যে, বিগত সভার কার্যবিবরণীতে ৮ (১) নং সিদ্ধান্তে POHS প্রকল্পের Hydrological Modelling প্রতিবেদন অনুযায়ী প্রকল্প এলাকার পানি নিষ্কাশন প্রয়োজনীয় জমি সংরক্ষণসহ পানি নিষ্কাশন ব্যবস্থা নির্মিত করার শর্ত জুঁই ব্যবহারের বন্দী Urban Residential Zone এ পরিবর্তনের আবেদন সীলিতপত্র অনুমোদন করা হয়েছে। তিনি জানান যে, ডায়েরি POHS প্রকল্প এলাকার জুঁই বন্দী Urban Residential Zone হিসেবেই চিহ্নিত আছে। তাদের আবেদনে জুঁই বন্দী পরিবর্তন চাওয়া হইল। আবেদনে উল্লেখ্য POHS প্রকল্পের ২য় প্লট ডায়েরি চিহ্নিত পূর্ব-পশ্চিম বরাবর খালের পরিবর্তে উত্তর দিকের পানি নিষ্কাশনের জন্য প্রকল্পের পশ্চিম সীমানা থেকে নতুন একটি খাল বন্দন করে পশ্চিম দিকে পূর্ববর্তী সড়ক বরাবর নির্মিতব্য খালের সাথে সংযুক্ত করার প্রস্তাব করা হয়েছে। এ বিষয়ে তিনি উল্লেখ করেন যে, প্লট ০৪/২/২/০১৩ ও ১০/১/২/০১৩ জারির পূর্বের ও পদপূর্ত মন্ত্রিপালয়ের তত্ত্বাবধীন বন্দী জমির ভোগকর্তার আবেদন এর সভাপতিত্বে জাপ সংক্রান্ত কারিগরি কমিটি এবং POHS প্রকল্পের প্রতিনিধির নিয়ে অনুষ্ঠিত সভার সিদ্ধান্ত অনুযায়ী IWM এর মাধ্যমে Hydrological Modelling করা হয়েছে। উক্ত সভার পরের সুপারিশ অনুযায়ী আবেদন প্রকল্পটির উত্তর দিকের পানির উত্তর দিকে পশ্চিম সীমানা থেকে উত্তর-পশ্চিম বরাবর নতুন একটি খাল বন্দন করে পশ্চিম দিকে পূর্ববর্তী সড়ক বরাবর নির্মিতব্য খালের সাথে সংযুক্ত করার এবং প্রকল্পটির মাধ্যমে জুঁই জমির পূর্ব-পশ্চিম বরাবর জাপ চিহ্নিত খালটি জাপ থেকে বাস দেয়ার জন্য প্লট ৪র্থ সভায় সিদ্ধান্ত পৃথক হওয়াই হইলো, যা কার্যবিবরণীতে বর্ণনাযুক্তভাবে বিবরণিত করার জন্য তিনি অনুমোদন জানান। সিদ্ধান্ত আলোচনাসূচী সভা এ প্রস্তাবে ঐকমত্য পোষণ করে।

৩.২ নার পরিকল্পনাবিদ, রাষ্ট্রিক জ্ঞান মে, জায়ে মৌজার নির্ধারিত জমিতে একটি University স্থাপনের দক্ষা জুঁই ব্যবহার পরিবর্তন সংক্রান্ত আবেদনের বিষয়ে প্লট সভার কার্যবিবরণীতে ৮ (১৭) নং সিদ্ধান্তে উল্লিখিত আবেদন সম্পর্কে ১০১, ১০২, ১০৩ ও ১০৪ এর ফর্ম প্রকৃৎসক আবেদন দাগ নং ২২৫২, ২২৫৩, ২২৫৪, ২২৫৫ ও ২২৫৬ এর প্রতিলিপন করে সিদ্ধান্তটি সংশোধনের জন্য ইউসিআইপিটি অব ইনফরমেশন টেকনোলজি এন্ড সার্ভিসেস (LIITS) কর্তৃক পূর্ণাঙ্গ আবেদন সংগ্রহ করা হয়েছে। সভায় এ আবেদন বিবেচনার জন্য ঐকমত্য পোষণ করা হয়।

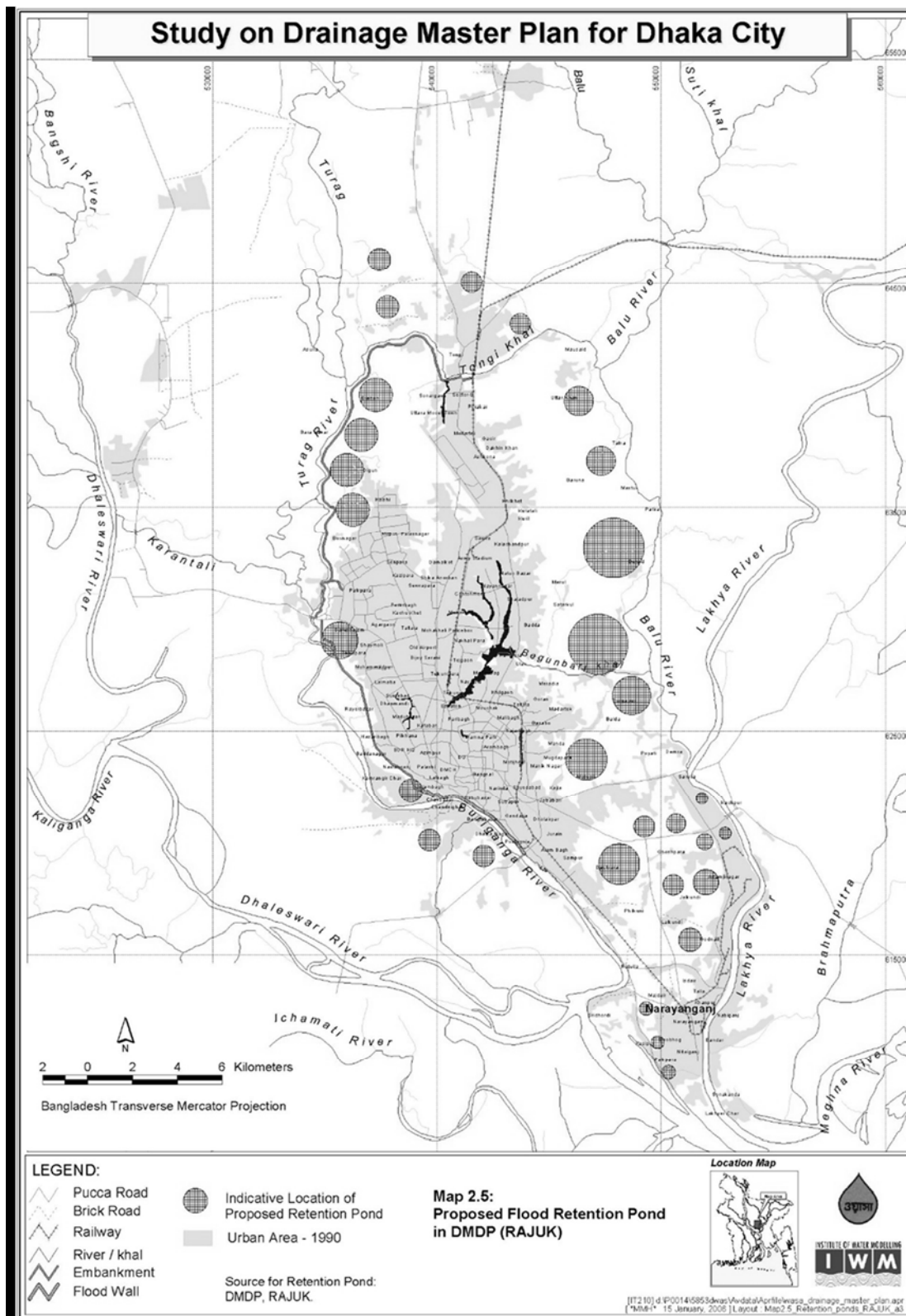
Appendix A-9: DMDP (Dhaka Metropolitan Development Plan) 1995-2015 showing flood flow and semi flood flow zones published in 1995



Appendix A-10: Current Drainage network of Dhaka in the 2014 Drainage Master Plan prepared by IWM (institute of Water Modelling)



Appendix A-11: Map showing retention area (pond) in the 2014 Drainage Master Plan prepared by IWM (institute of Water Modelling)



Appendix A-12: Peer-reviewed conference paper in the PLEA conference 2015 in Bologna Italy based on one of the case study of this research



URBAN REGENERATION THROUGH RECONSTRUCTED WETLANDS AS AN URBAN DESIGN TOOL FOR RESILIENCE: CASE OF HATIRJHEEL-BEGUNBARI CANAL INTEGRATED DEVELOPMENT PROJECT IN DHAKA BANGLADESH.

Fahmid Ahmed	The University of Adelaide Australia	fahmidahmed@gmail.com fahmid.ahmed@adelaide.edu.au
--------------	--------------------------------------	-------------------------------------------------------



Fig 1: Google image of before and after the intervention including existing photographs of the site in 2014

Research summary

This paper demonstrates the process, rationale and consequences of reconstructed wetlands as an urban design tool in Dhaka Bangladesh. Dhaka is situated in the largest delta system in the world with an extraordinary pace of urbanisation and the city has more than fifteen million people. In Dhaka managing water in urban development became a major issue in planning and design. The county is one of the most vulnerable in terms of climate change scenario as a big portion of the total population lives just few meters above the sea level with frequent extreme weather events. Besides, due to the landfills for urbanisation in the major cities; and destruction of natural wetlands and drainages including canals, flood plains, fore shores and other water bodies have been causing environmental disasters in the forms of flash flood, pollution, collapse of buildings, shortage of drinking water, obliteration of biodiversity etc. The research critically examines the urban water intervention as a planning and design initiative to comprehend the issue of sustainability in the context of Dhaka. Hatirjheel-Begunbari canal integrated project in Dhaka is the major case for analysing the reconstructed wetlands that is one of the largest urban development projects in the city in the recent history. This project claims to be one of the most successful projects in the recent times in terms of urban water intervention which includes drainage, open space, pedestrian and vehicular circulation, water retention and other urban design elements. This paper explains the development logics and post-construction scenario of the project from an urban design spectacle.

Keywords: Dhaka, Reconstructed Wetlands, Hatirjheel-Begunbari Canal, Plan Making Process.



1. Introduction

Dhaka is one of the fastest growing cities in the world; therefore the expansion of the city to cater the population growth is through landfills. Hence, the consequence is obliteration of the wetlands and rice fields. The binary reality in the recent history is the reconstructed wetlands as an urban regeneration development such as the Hatirjheel-Begunbari Canal integrated development project. This paper demonstrates the plan making process of the development agencies. Besides, this research investigates the post project scenario of the surrounding wetlands areas in terms of physical (environmental), social and economic aspects.

Historically Dhaka is situated in a major water civilisation and predominantly established along the River Buriganga for easy accessibility, trade and military reasons. At present the city is surrounded by four rivers, and there are more than twenty canals and lakes inside the city. Historian James Taylor mentioned Dhaka as the Venice of the orient during the British era (Ahmed, SU 2003; Dani 2009; Mamun 2000). In addition, city used to have more than sixty canals and lakes until the early post-colonial period (Ahmed, F 2012; DWASA 2011; Mamun 2000). Over time, the natural drainage system has been collapsed due to the manmade intervention and the Hatirjheel-Begunbari project was initiated to address such issue with substantial landscape infrastructure. The first reconstructed Dhanmondi lake development project was built in a residential area dissimilar to the Hatirjheel-Begunbari project in terms of scale and functionality. However, that project became one of the major public places for the city from the mid-90's. Admittedly, the case-study project is one of the largest urban design project costs more

than USD 235 million in the first phase (Ghafur 2013). Besides, this project is a kind of an intervention that intended to follow the concept of water urbanism and landscape infrastructure (Shannon 2009; Shannon & Moulder 2008; Shannon & Smets 2010). However, the project appears to have lots of hard engineering facts according to the critiques which contradict the concept as the elements of the intervention are less sensitive towards water and natural landscape. This paper explains the issue of resilient design along with post-construction impressions of the users and professionals through a field survey investigation.

2. History of the Canal

The settlements in the case study area were started during the British period in the mid-18th century. On the other hand, historians claim the Kawran Bazar area near the Hatirjheel was one of the major trading places during the Mughal Period other than the major centre and other establishments along the River Buriganga (Dani 2009; Karim 1964; Mamun 2000). Besides, this was a major water transport corridor for people and goods. Historically the Hatirjheel-Begunbari canal was part of the Nari (Pandu/Kawran/Caravan) River from the east to west connected the surrounding rivers which is evident from the historical map of Rennel's in 1780's and other historical documents (Haider 1966; Karim 1964). The name 'Hatirjheel' means lake of elephants; besides, elephants were travelled to the canal for bathing purpose from the Pilkhana which was a military establishment during the British rule. The area was part of the natural landscape, wetlands and rice fields before the European factories were built. The current canal is through diversified urban areas



including high and middle income residential zones, industrial district, informal sector housing and the Kawran Bazar business district. The total wetland area is forty hectares with a length of about four kilometres after the reconstruction. Project was designed with a collaboration of public sectors development agencies and private firms.

3. Methodology

This paper is part of the ongoing PhD research project at the University of Adelaide Australia. This paper explains the plan making process by the development actors and agencies, and effects of the reconstructed wetlands intervention through a more qualitative research methodology which includes number of methods such as semi-structured interviews, physical observation, collection of maps and documents, and questionnaire survey. To collect data field work conducted in Dhaka Bangladesh over three month's period during September to December 2014. Interviews were conducted among the development actors, architects, planners, engineers, activists and urban design researchers from the public and private sectors. On the other hand, 130 open ended questionnaire surveys were conducted with the residents of the Hatirjheel-Begunbari neighbourhoods during the same period. In addition, different reports and drawings analysed to comprehend the design and implementation process.

4. Plan making process

The Hatirjheel-Begunbari project was originally designed by the students as an undergraduate academic project at the Department of Architecture of Bangladesh University of

Engineering and Technology (BUET). The project was displayed in 2003 during an international event. The legislators were captivated; hereafter project was initiated. At the beginning RAJUK (City Development Authority) and LGED (Local Government Engineering Department) designed the project without considering the wetlands. The initial design was an elevated expressway connecting two major north south arteries of the city. However, the initial design proposal was to fill-up the wetlands for constructing housing and commercial district with an underground drainage system as box culvert which would destroy the gravity drainage system in the eastern Dhaka as the catchment area of the Hatirjheel-Begunbari area is very extensive (DWASA 2014; Khan 2012, 2013). In the project presentation during 2006 invited experts who were mostly architects, planners, intellectuals, environmentalists and engineers strongly opposed the proposition presented by the government development agencies collaborated with some private sector developers. The plan was highly criticised by the professionals; therefore, the minister of the local government dismissed the project just before the implementation. Eventually a new team was formed for the project with a team leader and consultants from BUET collaborated with other government agencies and private firms. Besides, RAJUK and LGED were the clients and management agencies from the government. Ultimately the responsibility of the construction work was given to the military engineering division. The construction started during the military backed interim government in 2007; hence, they could evict the illegal occupants effortlessly to acquire the lands needed for the project. Moreover, the military has reasonable logistic supports to construct such a large project. However, in 2009 when regular government came into the power, they



continued with the project though pressure was created to alter some of the planning decisions to ensure developers interest and illegal occupants associated with the political parties. The implementation agencies had to evict 400 households of informal settlers. Besides, other permanent and temporary illegal structures were demolished. On the other hand, authority could not remove the BGMEA (Bangladesh Garments Manufacturers and Exports Association) building which is an illegal construction in the middle of the canal. Moreover, notice from the High Court was issued several times to demolish the building (Hossain 2013; Sarkar 2011). However, government and development control agencies were reluctant to take action through the protest from the activists, professionals and environmentalists. By contrast, the informal settlers were evicted forcefully without a proper relocation plan (Ghafur 2013; The Daily Star 2008). Relocation for 178 families was designed; however, the project is still incomplete and none of them were

rehabilitated to date. Nevertheless, some development actors and activists are still hopeful that the issue will be resolved.

The plan making process had less involvement of stakeholders such as minimum input from the inhabitants found from the interviews and investigation of the plan making process. The stakeholders' involvements have medium level of intensity and lower level of reach. From the field survey it is evident that this project failed to involved marginalised groups in a meaningful way as the state or public sector agencies controlled the planning and implementation process with little involvement of other stakeholders. Critiques argued on this project to have exclusive and shallow plan. Interviews and documents discovered that architect consultants wanted a softer approach for the project and proposed an idea for a broader plan that is more inclusive (Fig-2). Besides, the project was lead by engineers and controlled by LGED; therefore, as a logical consequence project became more infrastructure biased (Fig-1).

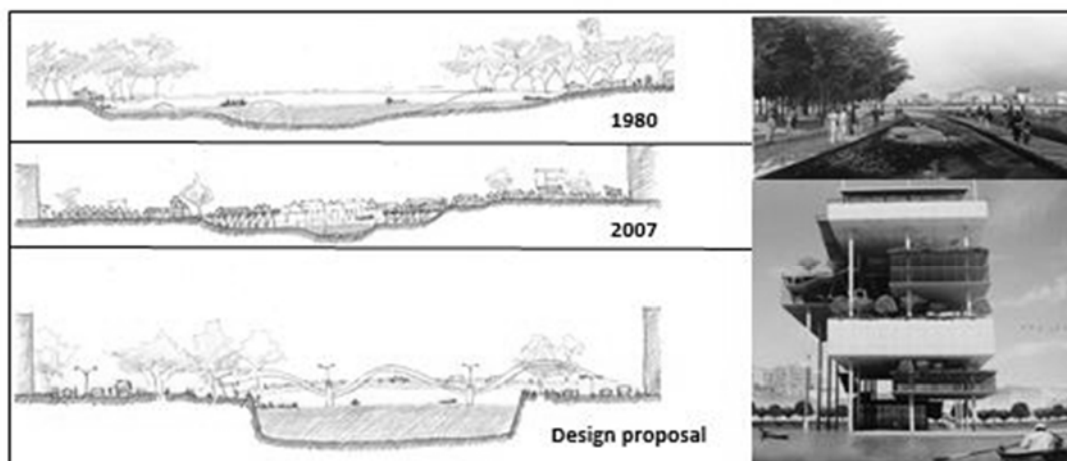


Fig 2: Images of the design idea from the architect consultant in 2007 shows that actual design was more flexible and less infrastructure bias (Source: Vitti-DPM-AIA Consortium, Architect: Ehsan Khan) and transformation of the area (sketches by the author).

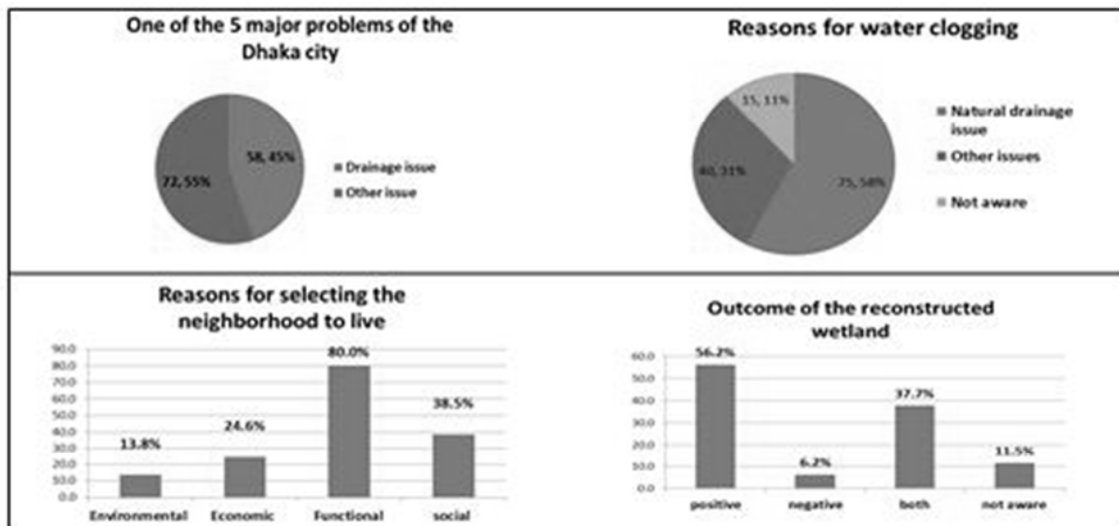


Fig 3: Findings of the questionnaire survey among 130 respondents in the case study area.

DWASA played an important role for the water and sewerage system in the project area that influenced the project with an outcome of a massive drainage infrastructure. However, according to the interview respondents plan making process of the project in the second phase is ambiguous to integrate the surrounding neighbourhoods. In addition, at present project is not in control under the previous consultants after the first phase. The design of the second phase is under scrutiny as the proposition was not accepted by the professionals. However, Development actors still claim this project as a successful outcome in spite of number of drawbacks as it has larger impacts in terms of drainage, water retention, open space and mobility.

5. Impacts of the urban regeneration: post construction scenario and findings from the field survey

The project has environmental, social and economic effects which are evident from the field survey through interviews, open ended

questionnaire survey and physical observation. The Research found that 58 (45%) respondents out of 130 identified water issues such as poor water management, water clogging, water scarcity or water pollution as one of the five major problems in the city (Fig-3). Similarly, questionnaire survey tested the respondents on choosing the Hatirjheel-Begunbari surrounding neighbourhoods to live. In addition, survey found 50 (38.5%) respondents have been residing in those neighbourhoods as they have inherited property from their ancestors or other social reasons such as other members of the family live in the same area. On the other hand, 105 (80%) respondents live in those neighbourhoods due to functional reasons typically for accessibility, close to work place and school (Fig-3). Besides, 32 (24.6%) respondents recognised the economic factors such as affordability. However, only 18 (13.8%) out of 130 respondents acknowledged environmental factors such as good environment, lake side living, availability of open spaces and parks etc. for choosing the neighbourhoods for living. Admittedly,



functional and socio-economic reasons are more imperative than environmental factors in this case. Besides, according to the interview respondents including the designers and consultants of the project, strategies were not comprehensive to address all the important issues such as comprehensive sewerage system, bio-diversity of the area, integrating different urban components etc.

Residents were questioned about their impression of the project, and 73 (56.2%) respondents believe intervention have positive impacts for the city and their neighbourhoods (Fig-3). Moreover, 49 (37.7%) respondents prefer the project have both positive and negative impacts. On the other hand, only 8 (6.2%) respondents perceive the project as a negative intervention for the neighbourhoods due high traffic intensity in the area that pose threats to the pedestrians, and the city authority could not make the place safe from vandalism. Besides, some of them had criticised as government acquired their lands from them without proper incentives.

Among positive respondents majority of them believe that the project brought breathing or open space for the city; in addition, the waterfront public spaces including pedestrian network encourage public activities. The project certainly increased accessibility and connects different areas with vehicular roads, pedestrian paths and bridges. On the other hand, a reasonable number of respondents believe it created social gentrification through land speculation and displacement. Moreover, three meters high walls along the roads and pedestrian paths work both as physical and visual barrier that encourage vandalism mostly during the after-hours and isolates the project from its surrounding neighbourhoods (Fig-1).

Questionnaire survey discovered 75 (58%) respondents out of 130 are not aware of the

landfill issue as a drainage problem (Fig-3). When they were asked about drainage problems, answers were mostly about the engineered drainage system, drainage management, cleaning etc. Besides, 40 (31%) respondents did not mention anything about natural drainage, importance of canals and water sheds. In addition, 15 (11%) respondents are not at all aware of the drainage issue. This survey certainly discovers the level of awareness among generic inhabitants though collective awareness has been increased significantly during the last decade after frequent floods, water clogging and depression of ground water level with the wetland transformation. Different studies indicated that in the last fifty years wetlands of Dhaka reduced to less than 30% and in contrast urbanised land increased more than 350% (Ahmed, SJ, Bramley & Dewan 2012; Dewan & Yamaguchi 2009). Moreover, interviews revealed that relatively a significant number of development agencies in both Public and private sectors are biased with the concept of hard engineering solution rather than concept of living with water. Besides, number of critiques and consultants have disclaimed Hatirjheel-Begunbari Canal integrated development project and argued that the intervention is infrastructure bias combined with drainage and transport solution (Ghafur 2013). According to the critiques the project is less resilient and did not incorporate the fluid landscape including other natural features such as green spaces. Nevertheless, this project is one of the landmark projects in terms of reclaiming the wetlands by creating public spaces including transport solution.



6. Suggestions

Following suggestions may propose with the outcome of the analyses and syntheses that may aid to construct the urban landscape in a more resilient way.

- a. Restructuring the institutional framework as 56 authorities are responsible for Dhaka. Development authorities and actors need proper hierarchy and responsibilities headed by the city mayor had proven to be more efficient system with distinct city government. RAJUK, the development regulatory body must not get involved in other responsibilities such as developing lands, construction of bridges and flyovers etc. which are conflicts of interest.
- b. Flexible and inclusive design approaches with less infrastructure bias ensures sustainability responds to its distinctive hydrological and environmental state.
- c. Integration of urban fabric with the reconstructed wetlands will generate sense of belongingness of the place which ensures safety and security of the site.
- d. More vegetations along the wetlands will help the eco-system. Besides, connections of other open spaces and vegetations may act as a network contentious ecological space.
- e. Government need to increase social awareness with the support of the professionals and environmental activists that will act as a social pressure for the development agencies and actors towards a more flexible urban intervention.
- f. Plan making process with through collaboration of different stakeholders including emerging social groups, professional elites and politicians will make the plan more inclusive and efficient. Moreover, in this process involvement of broad and legitimate

diverse stakeholders shapes plan's purpose and priority.

7. Conclusion

Admittedly, initiation of the Hatirjheel-Begunbari project was a substantial intervention which is the reflection of the collective awareness. Project offers a designed landscape infrastructure that enhances the efficiency and quality of urban life. Moreover, this development scheme can work as a continuous ecological corridor if integrated with other wetlands and green networks in the future. Moreover, this project is an exceptional example of converting an academic project in to reality. Certainly, the project has some drawbacks with exclusive and hard engineered design solution; however, still the intervention has lots of possibilities as the process of development is a continuous process. Besides, the second phase of the project including special detail area plan for the surrounding urban areas could play an important role to perform as a resilient city in the present realities of the climate change, extreme urbanisation, and man-made disasters along with frequent extreme weather effects. As Dhaka is situated in a chemistry of land and water, city need to design with land and water together, not land versus water (Ahmed, F 2012; Ahmed, F 2012; Ashraf 1997, 2011, 2012). Similarly, Dhaka needs to perceive as a part of the hydrological landscape. Certainly, city needs to grow; therefore, to withstand the built environment needs to integrate with the natural environment towards a resilient development.



7. Acknowledgments

Special thanks to my supervisors Dr. Peter Scriver and Prof. Jon Kallet; In addition, my sincere gratitude for all kind of support including ASI PhD funding by the University of Adelaide.

8. References

- Ahmed, F 2012, 'Water Urbanism in case of Dhaka', A Modernism Challenge- Asian cities and Architecture Heritage in a new Paradigm. Bali, Indonesia, pp. 204-217.
- Ahmed, SJ, Bramley, G & Dewan, AM 2012, 'Exploratory growth analysis of a megacity through different spatial metrics: A case study on Dhaka, Bangladesh (1960-2005)', URISA Journal, vol. 24, no. 1, //, pp. 9-24.
- Ahmed, SU 2003, Dhaka: a study in urban history and development, 1840-1921, Academic Press and Publishers.
- Ashraf, K 1997, 'Land, water and man in bengal: themes of deltaic architecture', in F Ameen (ed.), Contemporary architecture and city form: the south asian paradigm, Marg, Mumbai, India.
- Ashraf, K 2012, Designing Dhaka: a Manifesto for a better city, Loka Press, Dhaka.
- Chowdhury, AM & Faruqui, S 2009, 'Physical growth of Dhaka city', in SU Ahmed (ed.), Dhaka Past Present Future, 2009 edn, Asiatic Society, Dhaka.
- Dani, AH 2009, Dhaka a Record of its Changing Fortune, Asiatic Society Bangladesh., Dhaka, Bangladesh.
- Dewan, AM & Yamaguchi, Y 2009, 'Land use and land cover change in Greater Dhaka, Bangladesh: using remote sensing to promote sustainable urbanization', Applied Geography, vol. 29, no. 3, pp. 390-401.
- DWASA 2011, Reoport of DWASA 2011, BG (Bangladesh Government) Press Dhaka.
- DWASA 2014, Drainage master plan of Dhaka 2014, BG (Bangladesh Government) Press Dhaka.
- Ghafur, S 2013, 'Prospects of Hatirjheel as a desiring-machine', The New Age, December 02 2013.
- Haider, A 1966, 'Dacca through ages', in A Haider (ed.), A city and its civic body, Dhaka Municipality, Dhaka, pp. 1-13.
- Hossain, M 2013, 'HC asks govt to demolish BGMEA Bhaban in 90 days', The Daily Star, March 20 2013.
- Karim, A 1964, Dhaka the Mughal capital, The centre for Dhaka studies, the Dhaka city museum.
- Khan, TA 2012, 'Urban Water Challenges', DWASA (Dhaka water supply and sewer authority), Dhaka, Bangladesh.
- Khan, TA 2013, 50 years of Dhaka WASA, Dhaka Water supply and Sewerage Authority, Dhaka Bangladesh.
- Mamun, M 2000, Dhaka: city of memories, trans. F Ahmed, Anannya.
- Sarkar, A 2011, 'Demolish BGMEA highrise: HC', The Daily Star, April 4 2011.
- Shannon, K 2009, 'Landscape as Urban Structure: the Case of Cantho, Vietnam', Landscape—Great Idea, pp. 54-58.
- Shannon, K & Moulder, BD 2008, Water urbanisms, eds K Shannon & BD Moulder, Martien de Vletter, Sun, Gent, Belgium.
- Shannon, K & Smets, M 2010, The landscape of contemporary infrastructure, NAI Publishers.
- The Daily Star 2008, 'Illegal structures in Hatirjheel demolished', The Daily Star, March 6, 2008.

Appendix A-13: Conference paper in the ARCASIA Congress 2012 in Bali Indonesia based on the initial proposal prepared for the research before commencement of this PhD research



15.30 - 15.55 ROOM B

Architectural Design

Water Urbanism in case of Dhaka: Searching Urban Water Intervention Strategies for Reclaiming and Protecting the Water Bodies for an Eco-city.

Fahmid Ahmed

Assistant Professor, Department of Architecture, Bangladesh University of Engineering and Technology (BUET).

Dhaka 1000, Bangladesh

E-mail: fahmidahmed@arch.buet.ac.bd, fahmidahmed@gmail.com

ABSTRACT

Bangladesh the largest delta in the world is a land of Hydraulic civilization. The capital city Dhaka was built based on its water culture. Water culture has played powerful role shaping the histories, societies and economics. Water Urbanism is one hand is the Science of a city and on the other hand it is the discipline that holds the capacity to steer the transformation of the city and to design rational development. The huge rate of urbanization and the so-called modern city actually shattered water based city and the dialogue between water and city was collapsed. Water appears to be one such issue that is (re)conquering the cotemporary agenda of urbanism. Water bodies supposed to be the life of the city which should work as the line of communication, natural drainage and ecological space. These water bodies and surrounding area should be the major open spaces and space for recreational facilities of the city. Dhaka had many canals and water bodies integrated to its socio-economic and cultural life. Over the last few decades the cityscape of Dhaka, the capital city of Bangladesh, has been experiencing a transformation in terms of its water system due to rapid and uncontrolled urbanization. The paper will focus on understanding of water culture of the deltaic city of Dhaka and analysis the metamorphosis of water bodies of Dhaka city. There is a miss-opportunity to reinvent waterscape traditions to integrate present and future requirements of water management, ecology and open space development. How to intervene in the existing complex urbanization pattern of the city is a big concern which is discussed in this paper. Water urban intervention is needed to take in to account for the solution and traditional relationship of people with water will be reclaimed with the water-infrastructure intervention in urban areas. The ecological continuous open space system can change the qualitative aspect of natural life. These open spaces can play a vital role shaping public activity spaces and spaces for stress release. Integration of lakes with public activity spaces is the single strategy to protect water bodies against





encroachment which is a challenging issue in case of Dhaka city; what other strategies those could be adopted by the city to safeguard them against other threats posed by urban development pressures. The paper discusses the possible urban design solution in terms of water urbanism in the city in both academic research and practical level. The paper will highlight some studio exercise as example which was conducted with the fourth year studio in BUET. How the strategies of research and academic exercise can give a guideline for practical project is important. How to reconcile the need to construct networks of public open spaces along water bodies to serve social and ecological needs within the growing city which will be affordable approaches to engineer and water management systems in case of Dhaka is a major concern. The paper will conclude with possible intervention and search for bridging the gap between vision and reality. The research will give us a guideline for reclaiming and protecting the water bodies as well as possibilities for an integrated water network system. The study will enhance the dialogue between water and city such as replacing the "hard" or engineered solutions by "soft" or more flexible solutions. The design solution can create a continuous ecological space integrating people with the spaces as an urban open space which will create new environment for future generations.

Key Words:

Water Urbanism, Public Open space, Hydraulic Civilization, Water Bodies, Urbanization, Urban Design Intervention.

1. INTRODUCTION

Dhaka the capital of Bangladesh is the seventh largest populated city of the world, initially established along the river Buriganga in 14th Century. The establishment is evident from 7th century [1]. This is the only city in the earth which is surrounded by four rivers all around. The main city is bounded by three rivers. This was a city of more than sixty canals and many ponds even in the 1950's [2]. Dhaka was compared with Venice by many Europeans in the seventeenth century [3]. The huge rate of urbanization and so-called development actually encroached water based city and the dialogue between water and city is now collapsed (figure2 and 3).

As s it is mentioned "Water appears to be one such issue that is (re)conquering the cotemporary agenda of urbanism. Now it is not a surprise as we are constantly reminded of the consequences of global warming and rising of sea levels, uneven distribution of resources"^[4]. In case of Dhaka, flash floods (figure 7) due to rainfall have become a common phenomenon as retention ponds and water bodies were filled and natural





drainage is destroyed [5]. Even major part of the river is encroached and extreme pollution of water due to toxin waste of industries created major natural disaster and climate change of the region. Other cities are in the same process of destructions and most of these cities are beside rivers and sea, which is alarming for future in case of rising of sea levels. Dhaka could be a major case for Searching Urban Water Intervention strategy for reclaiming and protecting the water bodies for an eco-city as well as addressing the climate change in this region. The paper discusses about the transformation of water bodies (figure 2 and 4) and the significance with possible outcome. The studio exercise by fourth year students is also part of the paper which was conducted in 2011 in the Department of Architecture of Bangladesh University of Engineering and Technology (BUET). The methodology of the exercise with analysis of some water bodies and possible design is discussed in the paper. The paper explains the possibilities and strategies of reclaiming and protecting of water bodies for an eco-city based on its water culture.

Geo-morphological challenge of a deltaic city is important for Dhaka. The idea of the paper is to understand the need of water which is an important phenomenon in the twenty first century for water scarcity due to lowering the water level, rising of sea level, ecological imbalance due to pollutions and unplanned urbanization with land filling and so many other reasons. To address the water issue for Dhaka objectives of this research are as followings:

- a. The Research looked for the city water bodies' evolution with growth of the city and changing impact on urban life. The focus is on some specific water bodies in different urban tissue as test case in different part of the city for detail analysis and possible intervene.
- b. The Research searched for possible reclamation and protection of water bodies to develop design policies and guidelines strategies for urban water intervention for an eco-city based on its water. The study looked for an integrated water system solution which will guide the intervention for an ecological corridor. The idea is to defining a concept for the edge of water and land; identify the horizontal dynamics of water which will integrate the city with urban water intervention.
- c. The idea is to incorporate water more with the city and providing more public places by proposing new guidelines for designing and planning, based on urban water intervention including water infrastructure which will help to intervene rational water transport system as well as natural drainage system. (figure 1)





2. EXISTING SCENARIO OF WATER URBANISM AND TRANSFORMATION OF THE CITY

Dhaka is the 9th largest populated city in the world and by the year 2020 with existing urbanization rate; it will be the third largest city of the world [6]. The city has large gap between supply and demand of water, and the water level of the city is becoming lower day by day. The aquifer is becoming deeper 1.5–2.5 meter/year [7]. In a city of 15 million populations with average density of 2000 person per square kilometre with heterogeneous quality of urban life there is social injustice in terms of access to basic needs like drinking water and access to urban amenities. It was a city of 65 canals as per survey in 1912; now only existence of 26 canals with minimum 10 meter width [8]. Most of the canals are in the process of decay with land encroachments and extreme pollution. 60% of the water is polluted (figure 5 and 6) by industrial waste which is published by Dhaka WASA (Water Supply Authority). 35% of the population lives in the slums and many of them lives in the low lying area along with the edge between water and land. Hydrological cycle is also effected by filling up low lands and pollution, and ground water is also been contaminated which is evidence from the survey by Geological Department of Dhaka University and WASA. Due to concreting the outer surface with minimum recharging and extensive use of ground water, management and protection of water is hampered intensively. The city become too much urbanised with shattering image without urbanism. The mega city of developing country is a curse whereas megacity for developed country has different image. The image of the city is devastating with improper and uncontrolled urbanization. Landfill after landfill becomes a giant octopus swallowing the wetlands. As stated by Kazi Khaled Ashraf in his book *"Urbanization has come to describe the dark side of the modern city: migration, malfunction and misery"*^[9]. water was the basis of urban life has already evaporated. The river becomes large drain and canal becomes box culvert and small drain. Around 25% of the sewer is covered by city authority and rest 75% solid waste goes to storm water networks, canals and rivers which are making more water pollutions (figure 6). The river is almost dead in term of ecology and life line for usable water, fish and aqua culture. There is only one water treatment plant for the city which only treats little water, and the BOD (biological oxygen demand) and COD (chemical oxygen demand) is not at all acceptable for the rivers and most of the canals.



15th ANNUAL WORLD
OF ARCHITECTS
A MODERNISM CHALLENGE:
ASIAN CITIES AND ARCHITECTURE
HERITAGE IN A NEW PARADISE



ARCASIA CONGRESS 2012, BALI INDONESIA



Figure 1: Idea Sketches by Fahmid Ahmed

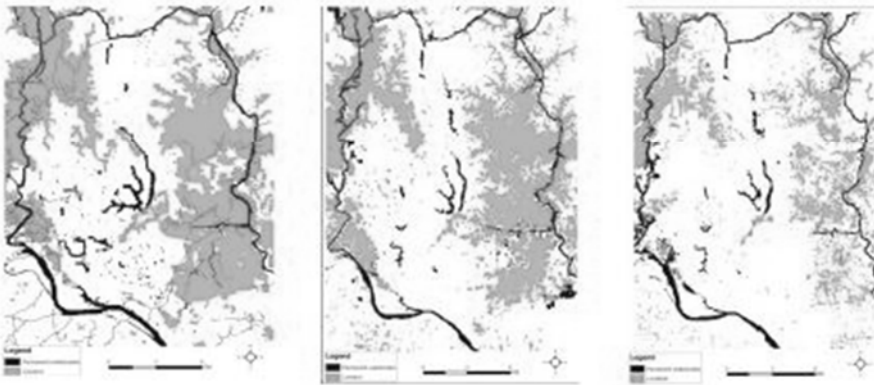


Figure 2: The transformation of water bodies and low-lands (1960, 1988 and 2008)



Figure 3: existing lakes and rivers



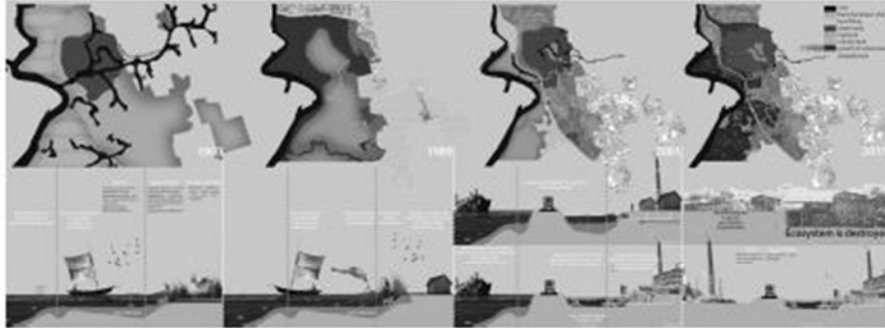


Figure 4: Transformation of Ramchandropur Canal in the central-western part of Dhaka (Nusrat Jahan)



Figure 5: Encroachments of existing low lands and canals



Figure 6: Pollution of low lands and canals





Figure 7: Water Stagnancy (The Daily Star Newspaper)

Urbanization rate is extremely high in Dhaka due to population increase and intermigration along with the major centre for all kinds of administrative and economic activities. How to revive the water system in the densely populated urbanized area is a big concern. Could water bodies can play an integrated part of the water system after reclamation and protections need to be questioned. The research will analyse how to protect the wetlands of Dhaka in the existing built city as well as peripheral part of the city which is in the process of development. The paper also discusses the possibilities of making the inner water bodies as a part of integrated transport network with water taxies acting like a transport corridors. How ecological continuous open space system can change the qualitative aspect of natural life shaping public activity spaces and spaces for stress release is important. Integration of lakes with public activity spaces is the single strategy to protect water bodies against encroachment which is a challenging issue in case of Dhaka city; what are the other strategies those could be adopted by the city to safeguard them against other threats posed by urban development pressures is discoursed in this issue.

3. SIGNIFICANCE OF WATER URBANISM FOR DHAKA

The water urbanism has significant impact on city's urban design component for sustainable urbanism as well as it has significance on people's life. Major significances of water urbanism are the followings:

- a. The research of water urbanism supports to find out the possibilities of reviving its water system which will help to reclaim the water-bodies of the city. The integrated drainage system with manmade canals, retention ponds and rivers eventually will mitigate water stagnancy and the flood due to rainfall. This water stagnancy and flood creates huge loss of infrastructure, economy, living quality and sometimes human loss (figure 04).
- b. For future sustainable development process, the research will enable to formulate guidelines for a balanced ecology. City needs continuous ecological space with water and the research of this discipline will always find solutions to intervene. These canals, water shades/retention ponds and water-infrastructure intervention could be a backbone for qualitative urban development and water control. These water bodies can play a major role for ecological balance.
- c. The reclaimed and protected water bodies can play a vital role in terms of water transport which also fulfils the goal of strategic transport planning of the government. Our city had a very bad traffic system with huge traffic jam due to lack of road, absent of proper mass communication system and poor





management. This makes annual loss of \$1.68 billion [10] due to traffic jam. The water transport can play a vital role in city's traffic integrated with other mode of transport.

- d. City needs open spaces for public activities and space for stress release. The reclaimed and protected water bodies can play a significant role in shaping city's need for open spaces. The water culture which is ruined by urbanization will be revived.
- e. For proper management of hydrological cycle of ground water as well as fulfil the basic need like access to water and maintaining ground water level water urbanism is important. For a city where annual rainfall is 2200 mm and with deep water level along with polluted surface, water demand of water for different use can be fulfilled to some extent.

4. GLOBAL AND LOCAL PERSPECTIVES

Water Urbanism is comparatively a new term or discipline in the field of Architecture and Urban Design although practice of water urbanism started a long time ago. Both empirical and theoretical researches about this topic have been done especially in last ten years. The qualitative aspects of water, related with Urban Design will be the focus of the Paper.

Prof. Kelly Shannon of Catholic University of Leuven (Belgium) explained the trends of water urbanism and possibilities to intervene in the Mekong Delta Vietnam for future city with traditional environment and enhanced density [11]. She highlighted the water culture of the delta explaining the integrated way of life with water. Vietnam is a large delta with big and small rivers including both natural and man-made canal system. The development is very much like Dhaka with blurring edge of the urban and rural character. The character is more R Urban rather than urban or rural [12]. Prof. Shanon explains the edge of water and land, and how this can be enhanced. She focused on the development with densification process coping with the urbanization without destroying the traditional system of hydrological culture of the region. The Paper focuses on the same hydrological culture of Dhaka which is similar context in terms of tropical deltaic city.

Dhaka had many canals and water bodies which is very much evident from the writings of Ahmed Dani, Prof. Sharifuddin Ahmed as well as Muntasir Mamum. The natural features, lush green spaces and water bodies surrounding the habitations that prompted historian James Taylor to remark in 1824, "*Dhaka looks like Venice of the orient*" no longer exists [13]. The historical city is a maze of crowded bazaars and narrow streets contrast to Ramna Maidan and surrounded area (the large open space and park in the





north of old city) which is the modern post-colonial area to the north, where most of the government buildings and educational institutions are located. Dhaka lies on an alluvial terrace above the northern bank of the Buriganga River, which offers access to several of the major regional rivers, including the Brahmaputra, the Meghna, and the Padma. The old town was bounded by the Dulai canal, a waterway coming from the north and curving eastward as it joins the Buriganga which is no longer exists.

The region's profits and peril are correlated with extensive system of river, canals, lakes, ponds and low land marshy areas. Heavy rain cause severe flooding in low-lying areas of Dhaka. Underutilized open spaces along with water bodies encroached by vulnerable squatter settlements ^[14].

"The common sense logics of cities and water are evident; clean water source, the possibility of transport, water as a defence mechanism, a receptacle for storm water, etc. such logics make it all the more surprising when water suddenly disappear, in the 19th century, at the moment modern urbanism emerges as a scientific discipline." ^[15]

In different edges between water and land of the city in Europe, the spaces are preferred to use as residual space which is no longer exclusively used as a mono functional purpose, but intervene with possibilities from informal social occasion to more ephemeral event as in Antwerp city ^[16]. Our spaces on the edges of wet and dry morphology need to intervene for such social activity spaces which are evidently very much absent in Dhaka. In Venice, new landscape infrastructure give new dimension to the city^[17]. In Netherlands water urbanism is becoming a major process of city expansions and development new urban areas with engineered land reclamation along with new urbanism. Polder Dikes used as Water Infrastructure to manage water and introduce new housing areas like Borneo, Sporenberg, I Berg etc.^[18] The City of Amsterdam has adopted integrated water infrastructure with city like four large booster stations used to carry waste water out of the city with eye-catching architectural structure^[19]. Almost 70% of the lands of Amsterdam are reclaimed ^[20] where major part of new housing was developed after 1970's. On one hand Old Amsterdam grew with Amstel River and canal system, on the other hand New Amsterdam is still growing with new dimension of Urban Water Intervention. Water plays a major role in the city of Amsterdam for mobility, open space as well as ecological space. Old city has alternate road and canal grid; on the contrary new city become more diverse and plays a different dialogue with the water. The solution of Amsterdam is with highly sophisticated engineering solution integrated with Urban Design decision. On the other hand traditional eastern cities like Cantho have different approaches. *"In the current*





investigations, the different elements of water infrastructure no longer relate only to their own networks defined merely by functionality and efficiency, but also to their context of culture, social and ecological process with in the urban matrix"⁽²¹⁾. In case of Dhaka it is essential to combine both traditional features with contemporary urban design decision to intervene for a sustainable solution.

5. POSSIBLE OUTCOMES

Urbanization is a visualization of the city with building, infrastructure and space. Followings are the possible outcome which may achieve through water urban intervention in Dhaka city:

- a. Introduction of urban governance will co-ordinate with local and central government. Different sectors needed for urban governance with different disciplines as needed.
- b. The first outcome will be an analysis of the transformation of water bodies in the city which will give a guideline for further research and design intervention. These analyses will also help to understand the growth pattern of the city related to its water.
- c. The research will give us a guideline for reclaiming and protecting the water bodies in Dhaka city's context as well as possibilities for an integrated water network system. The study will show us the way by which we can improve the edge conditions of these canals and other water bodies making them more accessible thereby reintegrating them to the city which will also work as natural drainage system for the city.
- d. The end outcome will be water urban intervention in specific area to enhance the dialogue between water and city such as replacing the "hard" or engineered solutions by "soft" or more flexible solutions. The research will demonstrate how water system as a hybrid built infrastructure; ecological functions and public green space can serve as fundamental components to change the urban landscape.
- e. The study will develop a policy and a guideline for urban water intervention strategy which will help the city to integrate its water with Urbanism. The dialogue between water and city will be re-established. The wet ideology of hydraulic civilization will give focus for any kinds of urban intervention. Currently, there are urban planning policies but no urban design policy for Dhaka city. The research will enable to give policies on urban design for the city.



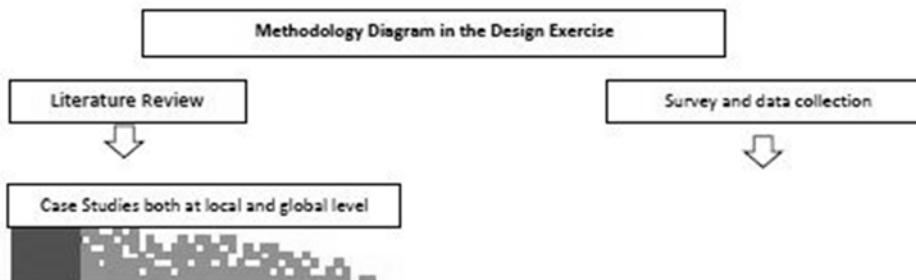


- f. The design solution can create a continuous ecological space integrating people which will act as an urban open space that will create new environment for future generations.

6. THE STUDIO EXERCISE

The studio project had multiple methodologies (figure 8) in different phases of the project in both qualitative and quantitative terms. At first phase, literature survey, site survey and data collection for understanding the existing features of the water problems. After literature survey and site survey, data mapping or generation of diagram drawings were made. For site survey different methods were used as data collection tools like reconnaissance survey, observation, interview, photographic and questionnaires etc. Data was also collected from concerned city authorities, professionals as well as city dwellers. After survey and collection of data, analysis was done for understanding the transformation of water system. With the help of maps and diagram by using different drawing tools, data was analysed with the reference of collected data from different concerned authorities and surveys. Simultaneously case studies were also done by the students. The numbers of students were forty eight and they did the exercise in group of three. Sixteen groups worked on four specific sites (four groups in each site). In each site physical, social, environmental studies were conducted with four studio teaches and external specialist of different professionals. After study, design exercise were conducted and each group did a master plan for the specific site (figure 9) highlighting the water network, open spaces, circulation and public buildings integrated with the social and physical context.

The design of landscape infrastructure with master plan was important for those projects. Some projects highlighted the contentious water network and green belt together act as an ecological corridor as well as public spaces. Some projects highlighted different public activity zones integrating new traditional and cultural space like boat museum (figure 9 and 10). One of my supervisee students did a project in 2012 of housing design in the lowlands addressing the hydro culture of this region (figure 11). The project area was in the low-lying periphery of Dhaka city where new land filling is on the way for development. The project addresses the living pattern of the people integrating the water-culture and eco-system of the deltaic city.



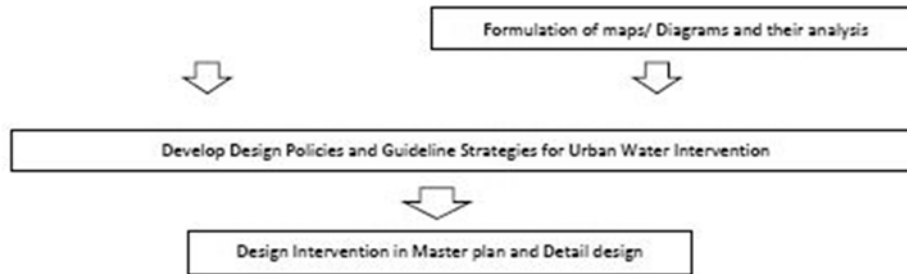


Figure 8: Methodology Diagram

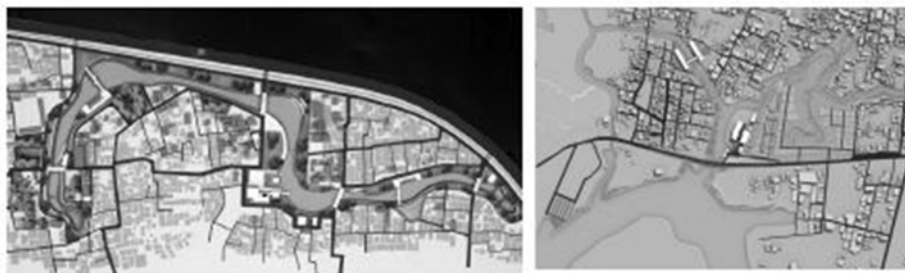


Figure 9: Design Intervention (master plans of students' projects)



Figure 10: Design Intervention (Students' Projects)





Figure 11: Living with water (Project of Labib Hossain for B.Arch Thesis in BUET)

7. CONCLUSION AND RECOMENDATION

The city needs vision for its Urbanism. Urbanization is a quantitative term rather urbanism is qualitative. Water urbanism is essential for restructuring the Dhaka city. The city needs to be a hydrological city rather than a water front city to sustain. The city needs a proper language for the edge between water and land. Water-ground relationship is important phenomenon for water urbanism or an ethos for water. The city needs a hydrological landscape for its urbanism. Our land and water is opposing each other, rather hydrological city needs land and water together. We need a wet ideology for our city, which is at present focusing on dry ideology. We had a wrong concept in mind that dry is civilized and wet is uncivilized. Rather wet theory is more appropriate for Dhaka for its hydrological dynamics. There are the possibilities for urban design, landscape urbanism and intelligent planning to take a soft engineering approach where interventions will work with nature. Our geography is fluid and it has a delta matrix where we need to embrace water for our city. Water morphology need to imagine for our city to live with the water. Rivers, Canals and retention ponds can create water adaptive cities and could create synergies with other important urban components and functions such as mobility system, serving as an open space network for social needs and balanced ecology, supply water for domestic and industrial uses as well as serving as a system for storm water retention and natural drainage. Therefore, this research will be an appropriate step to save Dhaka city from further deterioration and returning its true inherent character. To sustain city need proper urban design policy which could be formulate from these kinds of research.

ACKNOWLEDGMENT

Department of Architecture of Bangladesh University of Engineering and Technology (BUET), Students of Architecture Department (Batch 06), Dr. Zakiul Islam, Prof. Dr. Farida Nilufar, Farhan Sirajul Karim, Labib Hossain, Nusrat Jahan, Soniha Nuzrat and Rehnuma Parveen.





REFERENCES

- [1] Dani, A.H. Chowdhury, M,A (ed). DHAKA A Record of its Changing Fortune , Asiatic Society Bangladesh. 2009.
- [2] Dani, A.H. Chowdhury, M,A (ed). DHAKA- A Record of its Changing Fortune, Asiatic Society Bangladesh. 2009.
- [3] Rahman, M. City of an Architect. Delvista Foundation Bangladesh. 2011.
- [4] Meulder, B.D & Shannon, K (ed). Water Urbanism, Martin De Vletter, SUN, Netherlands. 2009.
- [5] Detail area plan unpublished draft report. Ministry of Planning, Government of Bangladesh. 2009.
- [6] Ashraf, Khaled, Kazi. Designing Dhaka: a Manifesto for a better city, Loka Press Dhaka. P-36. 2012.
- [7] Department of Environment (survey 2010), Dhaka University.
- [8] Survey of Dhaka WASA (Water Supply Authority) 2010.
- [9] Ashraf, Khaled, Kazi; Designing Dhaka: a Manifesto for a better city, Loka Press Dhaka. P-77. 2012.
- [10] The Daily Star newspaper on Tuesday, December 30, 2010. (<http://www.thedailystar.net/newDesign/news-details.php?nid=168025>)
- [11] Shannon, Kelly. Chapter 3, Landscape Urbanism, Rhetoric's and Realities, Addressing Landscape Urbanism, Three Cities in Vietnam, (Unpublished KUL Doctorate), May 2004.
- [12] Shannon, Kelly. Robles-Duran, Miguel. Theunis, Katrien. Urban Tissue Design Studio - Cantho, Vietnam, KULeuven. 2005.
- [13] Taylor, James, 1824. Coded in - Rashid, khaleda, "Open space system of Dhaka city- need and possibilities of intervention" proceedings on international seminar "architecture overcoming constraints." Department of Architecture, BUET. 11-13. P-192. June.2003.
- [14] Meulder, Bruno, D & Shannon, Kelly (ed).Water Urbanism, Martin De Vletter, SUN, Netherlands. 2009.
- [15] Meulder, Bruno, D & Shannon, Kelly (ed). Water Urbanism, Martin De Vletter, SUN, Netherlands. P-06. 2009.
- [16] Meulder, Bruno, D & Shannon, Kelly (ed). Water Urbanism, Martin De Vletter, SUN, Netherlands. P-13-17. 2009.
- [17] Vigano, Paulo. Water and Asphalt, The Project of Isotropy in the Metropolitan Region of Venice; City of Dispersal.



15th ANNUAL CONGRESS
OF ARCHITECTS
A MODERNISM CHALLENGE:
ASIAN CITIES AND ARCHITECTURE
HERITAGE IN A NEW PARADIGM



ARCASIA CONGRESS 2012, BALI INDONESIA

Architectural Design. 2008.

- [18] Waldheim, C (ed).The Landscape Urbanism Reader. New York: Princeton Architectural Press. 2006
- [19] Hooimeijer, F and Meyer, H. Atlas of Dutch Water Cities. Amsterdam SUN. 2006.
- [20] Hooimeijer, F and Meyer, H. Atlas of Dutch Water Cities. Amsterdam SUN. 2006.
- [21] Meulder, Bruno, D & Shannon, Kelly (ed). Water Urbanism, Martin De Vletter, SUN, Netherlands. P-43. 2009.



Appendix A-14: Historical images of Dhaka along the river Buriganga painted by unknown painter in the 1840's (source: Dhaka City Museum DCC)

