

**A STUDY ON SPATIAL DISTRIBUTION OF CLIMATE
FUND PROJECTS IN URBAN AREAS OF
BANGLADESH AND THEIR LINKAGES WITH
PLANS, POLICIES AND LOCAL CONTEXT**

by

Nawshin Tabassum

MASTER OF URBAN AND REGIONAL PLANNING



Department of Urban and Regional Planning
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

March, 2021

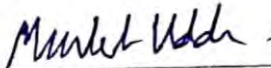
THESIS ACCEPTANCE FORM

The thesis titled "A STUDY ON SPATIAL DISTRIBUTION OF CLIMATE FUND PROJECTS IN URBAN AREAS OF BANGLADESH AND THEIR LINKAGES WITH PLANS, POLICIES AND LOCAL CONTEXT" submitted by Nawshin Tabassum, Student No. 0417152012, Session April, 2017, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of MASTER OF URBAN AND REGIONAL PLANNING by Course work and Thesis on 24/03/2021.

BOARD OF EXAMINERS

1. 
Dr. Ishrat Islam
Professor
Department of Urban and Regional Planning,
BUET, Dhaka, Bangladesh.

Chairman
(Supervisor)

2. 
Dr. Md. Musleh Uddin Hasan
Professor and Head
Department of Urban and Regional Planning,
BUET, Dhaka, Bangladesh.

Member
(Ex-officio)

3. 
Dr. Mohammad Shakil Akther
Professor
Department of Urban and Regional Planning,
BUET, Dhaka, Bangladesh.

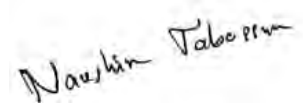
Member

4. 
Dr. Md. Monowar Hossain
Ex-Professor
Department of Water Resources Engineering,
BUET, Dhaka, Bangladesh.

Member
(External)

CANDIDATE'S DECLARATION

It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

A handwritten signature in black ink, reading "Nawshin Tabassum", is positioned above a horizontal line.

Nawshin Tabassum

DEDICATION

I dedicate this thesis to my parents.

Table of contents

Table of Content

List of Tables

List of Figures

List of Maps

List of Abbreviations of Technical Symbols and Terms

Acknowledgement

Abstract

CHAPTER 1 : Introduction 1

1.1 Background of the study	1
1.2 Research Objectives and possible outcomes.....	4
1.3 Scopes and limitations of the research	4
1.4 Organization of research.....	5

CHAPTER 2: Literature review 7

2.1 Operational definition:	7
2.1.1 Climate change risk.....	7
2.1.2 Adaptation	7
2.1.3 Mitigation	7
2.1.4 Vulnerability.....	7
2.2 Climate change induced hazards	7
2.2.1 Impacts of climate change in the urban areas at global context.....	8
2.2.2 Climate change induced hazards in the urban areas of Bangladesh.....	9
2.3 Urban climate governance and climate justice.....	11
2.4 Mainstreaming climate change in urban planning documents	12
2.5 Inclusive climate adaptation strategies.....	13
2.6 Plans and policies addressing climate change in Bangladesh	15
2.7 Climate funds in Bangladesh	17
2.8 Framework for implementing climate fund projects in Bangladesh.....	18
2.9 Summary	19

CHAPTER 3: Methodology 21

3.1 Formulation of research objectives	21
3.2 Selection of parameters	21
3.3 Selection of study area	21
3.3.1 Selection of study area to achieve 1 st and 2 nd objective.....	21
3.3.2 Selection of study area to achieve 3 rd objective.....	21
3.4 Data collection	22
3.4.1 Secondary data collection and preparation.....	22
3.4.2 Primary data collection and preparation	22

3.5 Data Analysis:	24
3.5.1 Spatial Analysis.....	24
3.5.2 Document Analysis	24
3.5.3 Quantitative Content Analysis (QCA)	25
3.5.4 PRA tools	25
CHAPTER 4: Study Area Profile.....	27
4.1 Urban areas of Bangladesh.....	27
4.2 Vulnerability of urban areas of Bangladesh considering climate change induced hazards.....	29
4.3 Selected study areas for identifying people’s perception regarding climate fund projects.....	38
4.3.1 City corporation.....	38
4.3.2 Municipalities.....	38
4.3.3 Climate change induced hazards in the selected study areas	39
4.3.4 Historic time line of disasters and climate fund projects in the municipalities	39
4.3.5 Vulnerability score of the municipalities	40
4.3.6 Venn diagram of the municipalities	41
4.4 Summary	42
CHAPTER 5: Spatial Distribution of Climate Fund Projects in Urban Areas of Bangladesh.....	43
5.1 Climate fund projects in urban areas of Bangladesh.....	43
5.2 Location of climate fund urban area projects.....	44
5.2.1 Global Environment Facility (GEF) Trust Fund.....	44
5.2.2 Green Climate Fund (GCF).....	45
5.2.3 Bangladesh Climate Change Resilience Fund (BCCRF).....	47
5.2.4 Bangladesh Climate Change Trust Fund (BCCTF)	48
5.2.5 Overall allocation of different climate fund projects in urban areas.....	51
5.3 Fund allocation in urban area projects	54
5.4 Fiscal year and status of the climate fund projects.....	60
5.5 Implementing agency and ministry of the climate fund projects	63
5.6 Summary	66
CHAPTER 6: Analysis of Urban Area Climate Fund Projects in the Light of Plan, Policies and Local Context	67
6.1 National Climate Change Plans and Policies	67
6.1.1 Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009	67
6.1.2 National Adaptation Programme of Action (NAPA), 2009	70
6.1.3 Bangladesh Climate Change Gender Action Plan (ccGAP), 2013	72
6.1.4 7 Th Five Year Plan (FYP), 2016-2020.....	72
6.1.5 Bangladesh National Action Plan (NAP) for Reducing SLCPs, 2018.....	74
6.1.6 Bangladesh Delta Plan (BDP), 2100.....	75

6.1.7 Bangladesh Country Investment Plan for Environment, Forestry and Climate Change (EFCC CIP), 2016-2021	76
6.1.8 National Plan for Disasters, 2010-2015	77
6.1.9 Intended Nationally Determined Contributions (INDC), 2015.....	78
6.1.10 National Environmental Policy (NEP), 2013.....	80
6.2 International Climate Change Plan and Policies	81
6.2.1 IPCC- Fifth Assessment Urban Area Report, 2014	81
6.2.2 Sustainable Development Goals (SDG's), 2015-2030.....	82
6.3 Overall scenario of the linkage of urban climate fund projects with plans and policies	84

CHAPTER 7: People's Perception Regarding Climate Fund Projects at Local

Context 86

7.1 Completed climate fund projects in the selected study areas	86
7.2 Description of the selected projects under BCCTF	88
7.3 Description of the selected research projects under BCCRF	91
7.4 People's perception regarding the climate change induced hazards in the study areas with BCCTF projects	92
7.4.1 Type of climate change induced hazards in the municipalities.....	92
7.4.2 Perceived impacts of the climate change induced hazards	93
7.4.3 Severity of the problems faced by the local people in different seasons .	95
7.4.4 Perceived causes and effects of the impacts of climate change induced hazards	97
7.5 People's perception regarding the BCCTF project	101
7.6 Summary	107

CHAPTER 8: Major Findings, Conclusion and Future Scope of Work 109

8.1 Major findings.....	109
8.2 Conclusion, recommendation and future scope of work.....	111

Reference

Appendix A

Appendix B

Appendix C

List of Tables

Table title	Page No
Table 2.1: Impact of climate change induced hazards in the urban sectors at global context	8
Table 2.2: Climate change induced hazards in the urban centres of Bangladesh	10
Table 2.3: Climate governance and justice in urban areas	12
Table 2.4: Mainstreaming climate change in urban planning and policies.	13
Table 2.5: Inclusive urban climate adaptation	14
Table 2.6: National plans and policies of Bangladesh	16
Table 2.7: Allocation of climate funds in Bangladesh	17
Table 2.8: The activities of institutions involved in implementing climate fund projects in Bangladesh	19
Table 3.1: Criteria for selecting urban areas to achieve 3rd objective	21
Table 3.2: Scores for calculating composite index using QCA	25
Table 4.1: Classification of urban areas based on function and size	27
Table 4.2: Classification of urban areas of Bangladesh based on urban local administrative unit	29
Table 4.3: Matrix for comparing the climate change induced hazards in CSPCM with response of a key informant	30
Table 4.4: Weight of the climate change induced hazards from KII	31
Table 4.5: Distribution of urban areas facing climate change induced hazards	33
Table 4.6: Suitable range of criteria for vector overlay analysis	34
Table 4.7: Vulnerable urban areas considering climate change induced hazards	37
Table 4.8: General information of the selected city corporations	38
Table 4.9: General information of the selected municipalities	39
Table 4.10: Climate change induced hazards in the municipalities.	39
Table 4.11: Vulnerability Score of study areas	40
Table 5.1: Distribution of urban area projects under climate funds in Bangladesh	43
Table 5.2: Distribution of GEF Trust Fund projects in urban areas	45
Table 5.3: Distribution of GCF projects in urban areas	45
Table 5.4 Distribution of BCCRF Trust Fund projects in urban areas	48
Table 5.5: Distribution and Type of BCCTF projects in urban areas	48
Table 5.6: Distribution urban area projects in different types urban areas	52
Table 5.7: Demographic profile of the urban areas without any BCCTF, BCCRF and GEF Trust fund projects	53
Table 5.8: Allocation of climate funds in urban areas	54

Table title	Page No
Table 5.9: Allocation of multilateral climate fund projects in urban area projects	55
Table 5.10: Allocation of BCCTF fund in urban areas in different vulnerable zone	55
Table 5.11: Distribution of climate funds in divisions (in lakh BDT)	58
Table 5.12: Per capita total climate fund allocation in the most vulnerable zone	59
Table 5.13: National climate fund allocation in city corporations	60
Table 5.14: Fiscal year and status of multilateral fund projects in urban areas	60
Table 5.15: Allocation of climate funds in urban areas along with initiation time	61
Table 5.16: Implementing agency of multilateral fund projects in urban areas	64
Table 6.1: Distribution of BCCTF Projects according to Pillars of BCCSAP (2009)	68
Table 6.2: Distribution of multilateral fund urban area projects on the basis of BCCSAP (2009).	69
Table 6.3: Types of strategy (mitigation/ adaptation) adopted by climate fund in urban area projects.	71
Table 6.4: Distribution of urban area climate fund projects on the basis of adaptation measures proposed in NAPA (2009)	71
Table 6.5: Distribution of urban area climate fund projects on the basis of measures proposed in 7th five-year plan (2016-2020) of Bangladesh.	73
Table 6.6: Distribution of urban area climate fund projects on the basis of urban water management strategies proposed in BDP (2100).	75
Table 6.7: Distribution of urban area climate fund projects on the basis of pillars proposed in EFCC CIP (2016-2021).	77
Table 6.8: Distribution of urban area climate fund projects on the basis of strategic goals proposed in National Plan for Disasters (2010-2015)	78
Table 6.9: Distribution of urban area climate fund projects on the basis of strategies proposed in INDC (2015)	79
Table 6.10: Allocation of climate fund for urban area projects according to National Environmental policy (2013)	80
Table 6.11: List of international plan and policies addressing the issue of climate change	81
Table 6.12: Distribution of urban area climate fund projects on the basis of strategies proposed in IPCC- Fifth Assessment Urban Area Report (2014)	82
Table 6.13: Distribution of urban area climate fund projects on the basis of SDGs (2015-2030)	83
Table 6.14: Composite score of the climate fund projects considering their linkage with national and international plans and policies	84
Table 7.1: General description of the completed climate fund projects in the selected urban areas	87

Table title	Page No
Table 7.2: Project goals and project works under the completed BCCTF projects undertaken in selected municipalities	89
Table 7.3: Project objective and outcome under the completed BCCRF projects undertaken in the study area.	91
Table 7.4: Pairwise ranking of the climate change induced hazards	93
Table 7.5: Pairwise ranking of the impacts of climate change induced hazards	94
Table 7.6: People's perception regarding the outcome of BCCTF construction projects in the municipalities	102
Table 7.7: Perception of local people regarding the projects	106
Table 8.1: Major findings of this research	109
Table 8.2: Proposals to promote climate resilient urban areas in Bangladesh	112

List of Figures

Figure title	Page No
Figure 2.1: Conceptual framework for climate change related policy and institutions in Bangladesh	18
Figure 4.1: Historic timeline showing the important events of municipalities.	40
Figure 4.2: Venn Diagram of the communities in municipalities	41
Figure 5.1: Score of areas according to National Climate Vulnerability Assessment Report (NCVAP, 2018)	53
Figure 5.2: Per capita BCCTF project fund allocation in urban areas	56
Figure 5.3: Per sq. km. BCCTF project fund allocation in different urban areas	57
Figure 5.4: Climate fund allocation in most vulnerable urban areas	58
Figure 5.5: Distribution of BCCTF urban area projects in different time frame	62
Figure 5.6: Initiation time of completed BCCTF urban area projects	62
Figure 5.7: Status of the BCCTF urban area projects	63
Figure 5.8: Implementing ministry of urban area projects under BCCTF	64
Figure 5.9: Implementing agency of urban area projects under BCCTF	65
Figure 6.1: Distribution of urban area climate fund projects on the basis of action plans proposed in NAP for Reducing SLCPs (2018)	74
Figure 7.1: Severity of the problems faced by the local people of Mongla port municipality in different seasons	95
Figure 7.2: Severity of the problems faced by the local people of Feni municipality in different seasons	96
Figure 7.3: Severity of the problems faced by the local people of Bauphal municipality in different seasons	96
Figure 7.4: Cause effect diagram of potable water scarcity in Mongla Port Municipality.	97
Figure 7.5: Cause effect diagram of waterlogging problem in Feni Municipality.	99
Figure 7.6: Cause effect diagram of waterlogging problem in Bauphal Municipality.	100

List of Maps

Map title	Page No
Map 4.1: Urban centres of Bangladesh	28
Map 4.2: Urban areas facing climate induced drought in Bangladesh	32
Map 4.3: Urban areas facing climate induced flood in Bangladesh	32
Map 4.4: Urban areas facing climate induced storm surge in Bangladesh	32
Map 4.5: Urban areas facing climate induced salinity intrusion in Bangladesh.	32
Map 4.6: Urban areas facing climate change induced temperature rise in Bangladesh.	33
Map 4.7: Urban areas facing climate change induced precipitation in Bangladesh.	33
Map 4.8: Vulnerability of urban areas of Bangladesh considering climate change induced hazards from vector overlay analysis	36
Map 4.9: Most vulnerable urban areas of Bangladesh considering climate change induced hazards from vector overlay analysis	37
Map 5.1: Urban area projects under GEF Trust Fund	44
Map 5.2: Urban area projects under GCF	46
Map 5.3: Urban area projects under BCCRF	47
Map 5.4: Urban area projects under BCCTF	49
Map 5.5: BCCTF projects in most vulnerable urban areas	50
Map 5.6: Urban areas with and without climate fund projects	51
Map 5.7: Allocation of BCCTF, BCCRF and GEF Trust Fund projects in most vulnerable zone	52
Map 5.8: Urban area projects under BCCTF	56
Map 5.9: Implementing agency of urban area projects under BCCTF	65
Map 7.1: Location of the study areas	86
Map 7.2: Hazard map showing location of water sources and waterlogged areas in Mongla Port municipality	98
Map 7.3: Hazard map showing waterlogged areas in Feni municipality	100

List of Abbreviations of Technical Symbols and Terms

AAA	Analytical and Advisory Activities
ADB	Asian Development Bank
ASAP	Adaptation for Smallholder Agriculture Programme
BCCRF	Bangladesh Climate Change Resilience Fund
BCCTF	Bangladesh Climate Change Trust Fund
BMD	Bangladesh Meteorological Department
CCA	Capital Cost Allowance
CNG	Compressed Natural Gas
DFID	Department for International Development
DNCC	Dhaka North City Corporation
DRR	Disaster Risk Reduction
DSCC	Dhaka South City Corporation
EU	European Union
FGD	Focus Group Discussion
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information Systems
GoB	Government of Bangladesh
GSB	Geological Survey of Bangladesh
IDCOL	Infrastructure Development Company Limited
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
KII	Key Informant Interview
LDCF	Least Developed Countries Fund
LGD	Local Government Division
LGED	Local Government Engineering Department
MoPEMR	Ministry of Power Energy and Mineral Resources
NGI	Norwegian Geotechnical Institute,
NGO	Non-Governmental Organization
PKSF	Palli Karma Shohayak Foundation
PPCR	Pilot Program for Climate Resilience
PRA	Participatory rural appraisal
RTHD	Road Transport and Highways Division
UNDP	United Nations Development Programme
UNREDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
WBG	World Bank Group

Acknowledgement

At first, all praises belong to Almighty Allah, for giving me the opportunity to perform the research successfully.

I would like to express profound gratitude to respected supervisor Dr. Ishrat Islam, Professor, Department of Urban and Regional Planning, BUET for her continuous guidance, supervision and suggestions at all stages of this research. I would like to express heartiest gratitude towards her for providing me motivation, encouragement and inspiration.

I would like to express my gratitude and appreciation to Dr. Nurul Quadir, Add. Secretary (PRL), Ministry of Environment, Forest & Climate change and Ms. Shakila Yasmin, Assistant Director, Bangladesh Climate Change Trust (BCCT) for their help and cooperation. I would also like to give special gratitude to experts from various organizations such as International Centre for Climate Change and Development (ICCAD), Institute of Water Modelling (IWM), Centre for Environmental and Geographic Information Services (CEGIS), Bangladesh Centre for Advanced Studies (BCAS) etc.

Finally, I would like to express my gratitude towards all who helped me conducting the survey. I am also grateful to local people of Feni, Mongla port and Bauphal municipality for their co-operation.

I humbly acknowledge that I could not complete this research without the moral support of my parents and friends.

Abstract

The urban areas of the world hold more than 50% the world's total population, most of its built assets and economic activities which contribute to high proportion of global greenhouse gas emissions generated by urban-based activities. According to IPCC (Intergovernmental Panel on Climate Change), Bangladesh is as one of the most vulnerable countries to climate change facing climate change induced flood, cyclone, sea level rise, heavy rainfall etc. which affect infrastructure, water supply, energy, transportation, housing and health sector of many cities of Bangladesh. To continue the economic growth of a country, it is important to ensure climate resilient development in the urban areas.

This research aims at investigating the allocation of different climate fund projects in the urban areas of Bangladesh for addressing the impact of climate change induced hazards in the light of plans, policies and local context. To achieve desired outcome of the research, three objectives has been formulated. The first objective is to study the spatial distribution of climate fund projects in the urban areas of Bangladesh while the second objective studies those projects in the light of national and international plans, policies and local context. The third objective analyzes the view of local people regarding some selected projects under climate funds and their association with climate change induced hazards at local context. To achieve first and second objectives, the projects under different climate funds in urban areas of Bangladesh along with the project type, location, objective, time frame, budget, stakeholders, project implementing agency and ministry, activities and expected outcome of the project, type and name of the fund etc. were studied. Urban areas of Bangladesh have been selected as a study area to achieve first and second objective while to achieve third objective, five study areas (DNCC, DSCC, Mongla Port municipality, Feni municipality and Bauphal municipality) have been selected based on allocation of completed climate fund projects and vulnerability of the urban areas.

Secondary data from different sources were collected on climate change induced drought, flood, storm surge inundation, salinity intrusion, temperature rise and excessive precipitation, climate fund projects, national and international policy documents etc. In addition, Key Informant Interview (KII) and Focus Group Discussion (FGD) have been conducted in the selected urban areas and different

Participatory Rural Appraisal (PRA) tools have been used to understand local people's view regarding the impacts of climate change induced hazards and their linkage with the projects under climate funds.

Among, 703 climate fund projects until 2019, only 245 projects have been taken in urban areas under Bangladesh Climate Change Trust Fund (BCCTF), Bangladesh Climate Change Resilience Fund (BCCRF), Green Climate Fund (GCF) and Global Environment Facility (GEF) Trust Fund with total fund of around 5,729 crore BDT. Around 50% of the total fund is allocated to address climate change impacts in Dhaka division. There are 121 urban areas without any climate fund project. The analysis of the urban area climate fund projects in the light of different national and international plans and policies showed that most of the climate fund projects in urban areas addressed infrastructural development. The projects under BCCTF in municipalities addressing waterlogging failed to solve the problem due to lack of proper maintenance of the drains, irregular cleaning, uncovered drains, solid waste dumping, lack of well-connected drains etc.

The recommendations of this research are to increase allocation of climate fund projects to address all type of climate change induced hazards in the vulnerable urban areas. The upgradation and formulation of national plans and policies should also put more focus on the impact of climate change induced hazards in the urban areas. The urban area climate fund project objectives and outcomes should not only address the issue of infrastructural development but also other strategies suggested in the national and international plans and policies. Local people need to be consulted in all phases of project planning to have better understanding of local dimensions of climate induced hazards. The findings of this research would help the policy makers, planners, engineers and other stakeholders to identify the most vulnerable urban areas facing different climate change induced hazards along with the need of climate fund allocation in those areas.

CHAPTER 1: Introduction

1.1 Background of the study

According to Intergovernmental Panel on Climate Change (IPCC) urban areas report, the urban areas of the world hold more than 50% the world's total population, most of its built assets and economic activities which causes a high proportion of global greenhouse gas emissions generated by urban-based activities and residents (Revi et al., 2014; Satterthwaite, Huq, Pelling, Reid, & Lankao, 2007). Globally a number of cities such as Greater Manchester, Dar es Salaam, Durban, London, New York city, Denver, Lagos, Santiago de Chile, Mexico City, Leicester City, Esmeraldas, Milwaukee etc. have been facing the impact of climate change on infrastructure system, water supply system, energy system, wastewater system, transportation system, housing sector, human health sector etc. and already have taken mitigation and adaptation policies, plans and programs (Revi et al., 2014; Gill, Handley, Ennos, & Pauleit, 2007; Rosenzweig, Solecki, Hammer, & Mehrotra, 2011)

The IPCC has identified Bangladesh as one of the most vulnerable countries to climate change which is facing consequent diversified natural hazards such as flood, cyclone, sea level rise, heavy rainfall etc. because of its unique physiographic feature and location (Ahmed, Alam, & Rahman, 1999; Mani, Bandyopadhyay, Chonabayashi, Markandya, & Mosier, 2018; Das & Hossain, 2017; Ayers, Huq, Faisal, & Hussain, 2014; Kabir, 2014; Ahmed, 2012; Das, 2010; Rahman & Alam, 2003; Huq, 2001). Bangladesh loses about 1.5% of its GDP (Gross Domestic Product) due to increased frequency and intensity of natural disasters as a result of climate change (Ministry of Environment and Forests, 2012). It was estimated that due to a sea level rise of 45 cm by 2050, about 35 million people will be affected in Bangladesh (Asian Development Bank, n.d.). Climate change induced hazards would affect infrastructure, water supply, energy, transportation, housing and health sector of many cities of Dhaka, Chattogram, Khulna and Barishal division of Bangladesh (Mani et al., 2018; Banks, Roy, & Hulme, 2011; Ahmed, 2015). Sustainable Development Goal 13, Seventh five-year plan (FY 2016- FY 2020), Eighth five-year plan (June 2020-July 2025), Bangladesh Delta Plan (2100) etc. also aim at taking actions to combat climate change and its impacts (United

Nations, 2015; General Economic Division, 2015; General Economic Division, 2018; General Economic Division, 2020).

About 37.2% of the total population of Bangladesh resides in 570 urban centers and the urban population will exceed rural population by 2030 (Bangladesh Bureau of Statistics, 2014; United Nations Population Division, 2019). These urban areas are classified into twelve City Corporations, 335 Municipalities and other smaller towns with Union Parishad as local government (Bangladesh Bureau of Statistics, 2011; Local Government Engineering Department, 2017; General Economic Division, 2020). About 60% of the urban population reside in the city corporations, while 40% in municipalities (Parvin, Ahsan, & Shaw, 2013; Local Government Engineering Department, 2017). The contribution of urban sectors to GDP was about 60-65% in 2012 while Dhaka, the capital of Bangladesh, consists of 9% of total population but contributes to 40% of the GDP (Ahmed & Ahmed, n.d.; Hassan & Nazem, 2016; Hassan, 2017). Moreover, climate change is likely to increase rural urban migration which would add to the existing challenges of the big cities of Bangladesh from socio-economic and environmental contexts (International Organization for Migration, 2010; Martin et al., 2013). To continue the economic growth of a country, it is important to ensure climate resilient development in the urban areas (Jabareen, 2013). Climate change related impacts in urban areas such as rising sea level and storm surges, salinity intrusion, heat stress, erratic precipitation, flooding, drought, water scarcity and air pollution are increasing with widespread negative impacts on people, their health, livelihoods, assets and also on local and national economies and ecosystems (Revi et al., 2014).

In terms of climate change adaptation specific planning, Bangladesh developed National Adaptation Programme of Action (NAPA) in 2005 and Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009 (Das & Hossain, 2017; Ayers et al., 2014). Government of Bangladesh established the Bangladesh Climate Change Trust Fund (BCCTF) and the Bangladesh Climate Change Resilience Fund (BCCRF) in 2009 to finance mitigation and adaptation programs and thereby ensure the implementation of the six pillars of BCCSAP, 2009 (Das & Hossain, 2017; Kabir, 2014). The main objectives of BCCTF and BCCRF are to address most vulnerable communities, farming communities and research activities and thereby enhance

resilience to climate shocks and ensure sustainable growth (Das & Hossain, 2017; Ministry of Environment and Forests, 2017). There have been 703 projects till 2019 under different climate funds such as BCCTF (2009-19), BCCRF (2010-14), Global Environment Facility (GEF), Green Climate Fund (GCF), Least Developed Countries Fund (LDCF), Adaptation for Smallholder Agriculture Programme (ASAP), Pilot Programme for Climate and Resilience (PPCR), United Nations- Reducing Emissions from Deforestation and Forest Degradation (UNREDD), UK's International Climate Fund etc. with a fund size of around 5,729 crore BDT for 245 urban area projects (Global Environment Facility, 2020; NDA Secretariat, 2018; Green Climate Fund Independent Evaluation Unit, 2019; International Fund for Agricultural Development, 2012; Rai & Smith, 2013; Independent Commission for Aid Impact, 2011; The World Bank, 2016; BCCT, 2019).

Climate change induced hazards and its impact in urban areas varies with location and socio-economic condition of the residents (Mani et al., 2018; Kabir, 2014; Transparency International Bangladesh, 2017; Hussain & Ahmad, 2019). Thus, it is important to study the objective, time frame, budget, implementing agency and spatial distribution of the climate fund projects in the urban areas of Bangladesh. A number of studies focused on issues such as the fund allocation process, effects of climate finance on risk appraisal, effective utilization of climate fund in adaptation programs, climate governance and involvement of stakeholders in projects under different climate funds etc. (Das & Hossain, 2017; Kabir, 2014; Transparency International Bangladesh, 2017; Hussain & Ahmad, 2019; Parvin et al., 2013). But no research has yet been done focusing on the climate fund projects in the urban centers of Bangladesh. As most of the population and income generating activities are concentrated in the urban areas, climate change would have huge impact in urban areas. This research provides a comprehensive idea about the allocation of climate fund projects in the urban areas of Bangladesh and its association with climate change induced hazards, plans, policies and local context. It also explored the local people's perception regarding the climate fund projects.

1.2 Research Objectives and possible outcomes

This study aims at investigating the allocation of climate funds in the urban areas of Bangladesh for addressing the impact of climate change induced hazards in the light of plans, policies and local context.

The objectives of the study are-

- 1.To study the spatial distribution of climate fund projects in the urban areas of Bangladesh.
- 2.To study the climate fund projects in the urban areas in the light of national and international plans, policies and local context.
- 3.To analyze the view of local people regarding the projects under climate funds and their association with climate change induced hazards at local context.

The findings of this research would guide the policy makers and other stakeholders of climate fund projects to identify the most vulnerable urban areas facing different climate change induced hazards with the availability of climate fund allocation and their linkage with national and international plans and policies. This research would also be able to help the implementing agencies of different climate fund projects to select the project objective, fund, site etc. addressing both planning documents and the need of local people at local context.

1.3 Scopes and limitations of the research

This research identified the spatial distribution of the projects taken under different climate funds (such as BCCTF, BCCRF, GCF, GEF etc.) in the urban areas of Bangladesh along with their fund size, project type, implementing agency, project status, time frame etc. This research also studied the nature of these projects in relation to the problems faced by the urban areas due to climate change induced hazards and their linkage with national and international plans and policies such as NAPA (2005), BCCSAP (2009), SDGs (2015-2030) etc. At last, the research found out the local people's perception regarding some selected urban area projects and explored whether those projects can address the impacts of climate change induced hazards in the urban areas along with suggestions from the grass root level. Farther in detail research can be done on all types of projects taken in all the urban areas of Bangladesh.

One of the limitations of this research is that, it only included the climate fund projects initiated in specific urban areas and so projects addressing different sectors such as housing sector, health sector, carbon mitigation research etc. without any specific location could not be included. As the climate fund projects has been initiated mostly in city corporations and municipalities, other small-scale urban areas such as smaller towns have not been considered. Moreover, the location of these urban areas has been collected as a point feature in Geographic Information System (GIS) shape file. For exploring the linkages of these projects with plans and policies, it was hard to identify the fund allocated for a specific theme or pillar or goal of the plans and policies. Therefore, for the projects with multiple objectives, the fund allocation has been considered for the 1st pillar or goal of the project.

1.4 Organization of the research

This research comprises of eight chapters which are organized in a systematic way. Chapter One has introduced the research work with background, intended objectives, scopes and limitations.

Chapter Two demonstrates an outline of the related research works that have been reviewed for this thesis. This chapter presents a brief description of climate change induced hazards in Bangladesh along with their impacts in the urban areas, climate fund allocation, laws and policies related to climate change and case studies from other countries to tackle climate change induced hazards in the urban areas.

Chapter Three manifests the methodology that has been followed in this research. A clear description of the section study areas, data collection process, data analysis tools etc. has been discussed in this chapter.

Chapter Four describes the study area profile of this research. This chapter discusses the status of the urban area, demographic profile, climate change induced hazards etc. Chapter Five demonstrates the number and type of urban area climate fund projects taken along with their spatial distribution in urban areas of Bangladesh, budget allocation, type of fund, time frame, status, implementing agency etc.

Chapter Six manifests the analysis of climate fund projects in urban areas of Bangladesh in the light of plan and policies such as BCCSAP (2009), SDGs (2015-2030), NAPA (2005), 7th Five Year Plan (2016-2020), BDP (2100) etc.

Chapter Seven includes in detail description of some selected projects in the urban areas of Bangladesh along with their objectives, activities, beneficiaries and local people's perception regarding the projects.

Chapter Eight describes the major findings of the research based on analyses and provides the recommendations for more efficient and effective implementation of the urban area climate fund projects along with a concluding remark.

CHAPTER 2: Literature review

This chapter starts with some operation definition of terms used in this research. A brief overview of the impact of climate change in the urban areas at global context, adaptation and mitigation policies are presented in this chapter. The impact of climate change induced hazards in Bangladesh, plans and policies taken, allocation of different types of climate funds etc. are discussed briefly.

2.1 Operational definition:

2.1.1 Climate change risk

Climate-change risk can be defined as the additional risks, both direct and indirect, to people and their livelihoods/investments due to the potential impacts of climate change. (Satterthwaite et al., 2007)

2.1.2 Adaptation

Adaptation to climate variability consists of actions to reduce vulnerability of a system or city as well as vulnerable individual or population of the city from the adverse impacts of anticipated climate change due to emission of greenhouse gases (Satterthwaite et al., 2007).

2.1.3 Mitigation

Mitigation activities of climate change considers the stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or limit GHG emissions or to enhance GHG sequestration (General Economic Division, 2012)

2.1.4 Vulnerability

Vulnerability to climate change is perceived as potential of people to be killed, injured or otherwise harmed by the direct (such as storms or floods) or indirect impacts (such as declining freshwater availability or livelihoods dependent on climate-sensitive resources) of climate change (Satterthwaite et al., 2007).

2.2 Climate change induced hazards

Based on IPCC projection, that global temperature is likely to rise by 1.4-5.8°C over the period from 1991-2100 and thereby it would cause increase of the frequency, intensity and severity of climate change induced hazards (Choudhury, Neelormi,

Quadir, Mallick, & Ahmed, 2005). IMPACT2C project provided information on the potential impacts of 2°C of global warming such as sea level rise, coastal flooding, salinity intrusion, drought, extreme precipitation, temperature change etc. by quantifying the impacts in Europe and in other vulnerable areas such as the Niger and Nile river basins in Africa, Bangladesh, Maldives etc. (Brown et al., 2015). This segment describes the climate change induced hazards affecting the urban areas both from global and national perspective.

2.2.1 Impacts of climate change in the urban areas at global context

The relationship between climate change and cities is complex as cities are often more vulnerable to the impacts of climate change. (Alam & Rabbani, 2007). Even though in 1900, only 10% of the global population were urban dwellers, now the percentage exceeds 50% and will rise even more in the next 50 years (Grimm et al., 2008).

According to the IPCC urban area report, the climatic drivers include warming, extreme temperature, extreme precipitation, damaging cyclone, drying trend, flooding, snow cover, sea level rise, storm surge, and ocean acidification which causes impacts on the lives and livelihoods of hundreds of millions of people (Revi et al., 2014). Urban areas are hot spots that play a key role in greenhouse gases generation because of the material demand of production and human consumption which alters land use and cover and generates urban waste (Revi et al., 2014; Grimm et al., 2008).

Table 2.1 describes the impacts of climate change on the urban centres of the world. Major adverse impacts have been faced due to temperature change, drought and water scarcity, coastal flooding and sea level rise, in land flooding etc. Cities such as London, Manchester, New York City, Tokyo, Delhi etc. are already facing the adverse impacts of temperature change (Revi et al., 2014).

Table 2.1: Impact of climate change induced hazards in the urban sectors at global context

Urban sectors	Likely impacts	Affected cities
Water Supply, Wastewater, and Sanitation	Saline ingress, reductions in groundwater and aquifer quality and uncertainty in long-term planning and investment in water and waste water systems.	Bangkok, Mexico City, Rotterdam, Indian cities including New Delhi, Mumbai, Chennai, Bangalore, Kolkata; large Andean cities; Chicago, La Ceiba.

Urban sectors	Likely impacts	Affected cities
Energy Supply	Disruption or unreliability in power or fuel supplies affecting urban businesses, infrastructure, services and residents, as well as water treatment and supply, rail-based public transport, and road traffic management.	New York City, Cities in Brazil, India, Sub-Saharan Africa.
Transportation and Telecommunications	Affect urban transportation and telecommunication infrastructure such as bridges and tunnels, roads, railways, pipelines, and port facilities, data sensors, and wire and wireless networks.	New York City, Chattogram, Dhaka, Lagos, Santa Fe, Georgetown etc.
Built Environment, Recreation and Heritage Sites	Extreme events such as cyclones and floods inflict a heavy toll on structures built with informal building materials without following safety standards.	Dhaka, New York City, Berkeley, Saint-Louis, Georgetown, Montevideo etc.
Green Infrastructure and Ecosystem Services	Alter ecosystem functions affected by changes in temperature and precipitation regimes, evaporation, humidity, soil moisture levels, vegetation growth rates, water tables and aquifer levels, and air quality.	Mombasa, New York City, Berkeley, Shanghai etc.

(Source: Table adapted from Revi et al., 2014; Bellinson & Chu, 2019; Beermann, Damodaran, Jørgensen, & Schreurs, 2016; Rajasekar, Chakraborty, & Bhat, 2018; Filho et al., 2019; Brown et al., 2015; Field & Barros, 2014;)

2.2.2 Climate change induced hazards in the urban areas of Bangladesh

In Bangladesh, there is a clear evidence of changing climate such as increased precipitation, increasing annual mean temperature and sea level rise which are affecting both ecosystems and people in rural and urban areas (Shamsuddoha & Chowdhury, 2007). Bangladesh suffered the annual loss of almost \$2.5 billion or 0.86% of annual GDP on average over the 1995-2014 period (Kreft, Eckstein, Dorsch, Fischer, & Germanwatch, 2015).

Bangladesh Delta Plan (2100) identified increasing risk of floods in inner city areas; breakdown of basic services – water supply, sanitation, waste disposal; increase in water borne diseases; contamination of surface waters; reduced re-charging of groundwater sources in the urban centres of Barishal, Chattogram, Dhaka, Khulna, Rajshahi, Sylhet districts (General Economic Division, 2018; Brown et al., 2015).

Dhaka Metropolitan area is facing urban flooding, drainage congestion and increased heat stress which is causing economic damage as well as affecting the transportation, water supply, waste water supply system (Banks et al., 2011; The World Bank, 2016; General Economic Division, 2020). On the other hand, in Chattogram, city corporation

area faces cyclones, waterlogging, landslides, excessive precipitation which causes loss of life, extensive damage to houses and food grains, displacement of many people from their homes, industrial losses, blocked road communication and utility lines etc. (Ahammad, 2011). Another research on Naopara municipality, Jessore explored and found out that Naopara, a coastal municipality of Bangladesh is facing intense rainfall, cyclones, flooding and failed to provide access to basic services such as safe water and sanitation (Alam, Alam, Rehman, & Rahman, 2016). Papa et al. (2015) quantified monthly distribution and variation of surface freshwater storage for the entire Ganges–Brahmaputra basin and showed the vulnerable zones. Khulna Water Supply Project also aimed at improving to the public water supply system as well as environmental condition of the project area in terms of enhanced access to treated water and thereby improve the quality of life for all residents and businesses in Khulna City (Khulna Water Supply and Sewerage Authority, 2018).

Following Table 2.2 shows that sea level rise, flood, cyclone, storm surge, salinity intrusion, drought, increased temperature and precipitation are the climate change induced hazards affecting the urban areas of Bangladesh. It describes that, the urban centres in coastal zones of Bangladesh are facing climate change induced sea level rise, salinity intrusion, storm surge and cyclones on the other hand north west side is facing increased temperature and drought.

Table 2.2: Climate change induced hazards in the urban centres of Bangladesh

Type	Level of impacts	Likely impacts in urban areas	Affected zones	Affected urban centres
Sea level rise	Warmed up by about 0.5°C and 0.5 m rise of sea level in the Bay of Bengal over the last 100 years.	Permanent inundation of huge land masses along the coast line, flood risk, water logging, scarcity of potable water, loss of GDP.	South western zone.	Urban centres in Khulna, Cox's bazar, Hatiya and other coastal districts.
Flood	One-fifth of the country is flooded every year, and in extreme years, two-thirds can be inundated.	Loss of life through drowning, increased prevalence of disease, destruction of property, energy sector and infrastructure.	Central region, north east region and char land.	Dhaka, Chattogram and other urban centres in flood prone zones.

Type	Level of impacts	Likely impacts in urban areas	Affected zones	Affected urban centres
Cyclone	Increase in of tropical cyclones intensity by 5% to 10% and precipitation by 20% to 30%.	Flood and wind casualties, economic loses, transport, tourism, housing, livelihood, infrastructure such as energy, transport etc.	Coastal and marine zone.	98 coastal cities in 19 coastal districts.
Storm Surge	Storm surge heights in excess of 10 m.	Settlements and activities; infrastructures.	Coastal and marine zone.	98 coastal cities in 19 coastal districts
Increased precipitation	2°C warming with a 10% increase in precipitation.	Erosion and landslides, flooding, settlements, transportation systems, infrastructure.	Coastal area, south west area.	Urban centres in coastal and south west zone.
Increased temperature	Almost double annual mean temperature rise.	Energy demands and costs, urban air quality, water sector, health sector, tourism and recreation, livelihoods.	North west	Rajshahi and other urban centres in north west zone
Salinity intrusion	Higher salinity concentration of surface water is 1.3 dS/m than earlier estimation.	Effects on water infrastructures, energy sector, human health, business	Low-lying deltaic coast.	Urban centres in Patuakhali, Satkhira, Bhola, Khulna, Bagerhat etc.
Drought	Increase in number of dry days and drought.	Reduction in groundwater table, water scarcity, livelihoods, energy generation, migration, transportation in water bodies.	North-western districts of the country.	Urban centres in Rajshahi, Dinajpur, Gaibandha, Joypurhat, Natore etc.

(Source: Table adapted from Shamsuddoha & Chowdhury, 2007; Ali, 1999; Agrawala, Ota, Ahmed, Smith, & Van Aalst, 2003; Huq and Rabbani, 2011; Satterthwaite et al., 2007; Ministry of Environment and Forests, 2009b; General Economic Division, 2012; Ahammad, 2011; Baten, Seal, & Lisa, 2015; General Economic Division, 2018; General Economic Division, 2020; Shahid et al., 2016, Brown et al., 2015)

2.3 Urban climate governance and climate justice

In detail research works including discursive analysis considering justice in the climate mitigation and adaptation plans of different cities (such as Quito, Toronto, Philadelphia, Maputo) as well as case studies of cities (municipalities of USA and German cities) promoting multilevel governance framework has been conducted (Bulkeley, Carmin, Broto, Edwards, & Fuller, 2013; Castán Broto, Oballa, & Junior, 2013; Homsy, 2018; Kemmerzell, 2018). The studies suggested promoting

Transnational Municipal Networks (TMNs), involving all affected parties in decision-making, encouraging cross-sectoral learning and promoting new funding mechanisms emphasizing co-benefits etc. (Table 2.3).

Table 2.3: Climate governance and justice in urban areas

Issues considered	Existing condition	Strategies or proposals	Source
Climate governance	• Inclusion of cities in multilevel governance structures have impact on local climate policy making.	✓ Centralization of policy component offers benefits of authority and standardization and creates challenges for public input and democratic oversight. ✓ Promote Transnational Municipal Networks (TMNs) to build capacity, share knowledge, and tackle climate challenges collectively. ✓ Encourage cross-sectoral learning and promote new funding mechanisms emphasizing co-benefits	Bulkeley, 2013; Bulkeley et al., 2013; Homsy, 2018; Bellinson and Chu, 2019.
Ensuring climate justice	• More focus on mitigation and adaptation without incorporating the social and environmental justice challenges.	✓ Consider and examine the ways in which concerns about justice are being expressed in the planning and implementation of urban climate change policy and projects. ✓ Involve all affected parties in decision-makings.	Castán Broto et al., 2013.

(Source: Table adapted from Bulkeley, 2013; Bulkeley et al., 2013; Homsy, 2018; Bellinson and Chu, 2019; Castán Broto et al., 2013)

2.4 Mainstreaming climate change in urban planning documents

A number of studies gave emphasis on incorporating climate change in urban planning documents from the perspective of different cities such as city of Montreal, California, Dhaka etc. and suggested to provide more targeted strategies within a regional plan that can reach both local and regional goals (Table 2.4). Fatemi, Okyere, Diko, & Kita (2020), proposed to establish a national financing arrangement that allows sub-national agencies to harness climate finance as well as the need to build sub-national level climate capacity with special attention to institutional coordination from the context of Dhaka.

Table 2.4: Mainstreaming climate change in urban planning and policies

Issues considered	Existing condition	Strategies or proposals	Source
Incorporating climate change risks in urban planning.	- Proposals for including the climate change in the transportation, land use, energy and finance sector in California. - Climate policy innovations in waste management of city of Montreal. - Economic co-benefits for investments in low carbon measures in Indian cities.	✓ Providing more targeted strategies within a regional plan that can reach both local and regional goals including increasing energy efficiency and developing renewable energy simultaneously.	Beermann et al., 2016; Bourgeois & Hughes, 2018; Boswell et al., 2018.
Integration of climate change issues into national, sectoral and plans.	8th five-year plan suggests to prepare and implement integrated, environmentally-sound urban planning and management incorporating climate change. - Climate change mainstreaming in development plans of Dhaka is moderate considering climate risk and opportunity assessment, institutional arrangement, and capacity building.	✓ Need to build sub-national level climate capacity in Bangladesh with special attention to institutional coordination and cooperation among agencies at different levels of development planning. ✓ Establish a national financing arrangement in Bangladesh that allows sub-national agencies to harness climate finance.	Fatemi et al., 2020; General Economic Division, 2020.

(Source: Table adapted from Beermann et al., 2016; Bourgeois & Hughes, 2018; Boswell et al., 2018; Fatemi et al., 2020; General Economic Division, 2020)

2.5 Inclusive climate adaptation strategies

Researches and studies on the impact of climate change on different stakeholders of a city described urban poor as the most vulnerable group affected by the climate change induced hazards and suggested incorporating the needs of these vulnerable group (Ahammad, 2011; Banks et al., 2011; Alam et al., 2016). For example, a research on Chattogram city suggested adaptation policies addressing the need of urban poor as well as considered the coping mechanism at the grass root level (Ahammad, 2011). Table 2.5 discusses these study findings as well as the proposals for promoting inclusion of CBOs, NGOs, local people and other stakeholders in climate adaptation and mitigation proposals.

The researchers identified the benefits and prospects of mainstreaming CBA (Community Based Adaptation) into city and national-level adaptation planning as well as inclusion of local people and other stakeholder in different urban areas such as in Dhaka, Durban, Guwahati, Quy Nhon, Copenhagen and other cities in Uruguay, Argentina, Indonesia etc. (Archer et al., 2014; Bulkeley et al., 2013; Sarzynski, 2018; Sari & Prayoga, 2018). Archer et al. (2014), also suggested integrating local knowledge in pro-poor adaptation planning as well as promote democratic and accountable local governance structures to raise awareness of risks in the context of Dhaka. A research on making the municipality of Noapara (a coastal urban area in Jessore, Bangladesh) resilient to the impacts of climate change with specific focus on the water and sanitation sectors suggested appropriate institutional support from the government and collaboration among stakeholders, including public-private partnerships and community-based organizations (Alam et al., 2016)

Table 2.5: Inclusive urban climate adaptation

Issues considered	Existing condition	Strategies or proposals	Source
Pro-poor climate change adaptation.	✓ Climate change accelerates the process of urbanization by displacing rural poor heading towards the cities and towns. ✓ Poor communities are the most ill-prepared to cope with climate shocks.	✓ Promote long-term pro poor adaptation to address the vulnerable urban poor. ✓ Not only assess future vulnerability and long-term policy on climate change at the state level but also take into account the existing coping strategies at the grassroots level. ✓ Promote inclusion and participation for a fair adaptation to climate change with the principle of putting the most vulnerable first. ✓ Integrate local knowledge in pro-poor adaptation planning, promote democratic and accountable local governance structures to raise awareness of risks and ensure their integration into land use plans.	Ahammad, 2011, Banks et al., 2011; Archer et al., 2014.
Community Based Adaptation (CBA) and inclusion of local people and other stakeholders through	✓ Lack of connection between the formal institutional structure for disaster preparedness and the most vulnerable	✓ Urban stakeholders, including government departments, private sector organizations and individuals should have particular roles for ensuring compliance with policies and plans. ✓ Need multilevel and multidimensional adaptation approach. ✓ Institutional reform as an opportunity to integrate community perspectives.	Archer et al., 2014; Bulkeley et al., 2013; Sarzynski, 2018; Sari & Prayoga, 2018; Engberg, 2018;

Issues considered	Existing condition	Strategies or proposals	Source
public participation.	groups facing extreme weather disasters.	✓ Institutionalizing new actors as a mechanism for scaling up multi-stakeholder approaches. ✓ Involvement of local government in climate policy making. ✓ Use participatory research to facilitate local communities in shaping planning processes. ✓ Enhanced community engagement through the consideration of local knowledge and social networks.	Iftikhar, Ali, & Sarzynski, 2018.

(Source: Table adapted from Ahammad, 2011; Banks et al., 2011; Archer et al., 2014; Bulkeley et al., 2013; Sarzynski, 2018; Sari & Prayoga, 2018; Engberg, 2018; Iftikhar et al., 2018)

2.6 Plans and policies addressing climate change in Bangladesh

Though a handful number of plan and policy documents of Bangladesh address the issue to climate change, Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009), National Adaptation Programme of Action (NAPA, 2005) and then updated in 2009, Bangladesh Climate Change Gender Action Plan (ccGAP: Bangladesh, 2013) has been formulated and approved solely for addressing the issue of climate change (Ayers et al., 2014; Das & Hossain, 2017; Vij, Biesbroek, Groot, & Termeer, 2018). In 2007, BCCSAP was originally developed with establishment of a trust fund for its implementation to be financed by both the national government and international donors for ensuing future sustainable development (Alam et al., 2011). Table 2.6 shows the national plan and policies addressing climate change. Most of these plan and policies address- urban waste management, supply of safe drinking water, collection and treatment of sewerage and drainage water, alternative livelihood opportunities for women affected by climate change in urban settings etc. The issue of climate change induced hazards in urban areas with likely impacts was neglected in National Plan for Disasters (Disaster Management Bureau, 2010). Though, the strategies to address climate change induced hazards in urban setting was neglected in 7th five-year plan, 8th five-year plan address the issue (General Economic Division, 2018; General Economic Division, 2020).

Table 2.6: National plans and policies of Bangladesh

Name of Plan/ Policy	Time frame	Issues discussed	Ministry/ Agency	Strategies to address climate change in urban areas
Bangladesh Climate Change Strategy and Action Plan (BCCSAP)	2009	Six pillars addressing both mitigation and adaptation measures.	Ministry of Environment and Forest.	Management of urban waste under mitigation and low carbon development pillar.
National Adaptation Programme of Action (NAPA)	2005	Fifteen adaptation measures.	Ministry of Environment and Forest.	Enhancing resilience of urban infrastructure and industries to impacts of climate change.
National Adaptation Programme of Action (NAPA)	2009	Eight adaptation measures.	Ministry of Environment and Forest.	Build climate resilient infrastructure, repair and rehabilitate existing infrastructure of urban drainage system; consider future patterns of urbanization during planning.
8 th Five Year Plan	2020-2025	Steps regarding strengthening institution, planning and community participation.	Planning Commission	Strengthen City Disaster Management Committee (CDMC) incorporating other stakeholders; develop Municipal-Community Partnership (MCP) to improve basic utilities, social services and neighborhood environment; incorporate climate change in urban planning documents.
Bangladesh Climate Change Gender Action Plan (ccGAP: Bangladesh)	2013	Action steps under four pillars of BCCSAP	Ministry of Environment and Forest.	Ensure alternative livelihood opportunities for women; inform poor women in urban areas on Disaster risk reduction (DRR) issues.
Bangladesh Delta Plan (BDP)	2100	Strategies under seven issues for urban areas	Bangladesh Planning Commission	Integral urban drainage and flood risk management; enhance urban water security and water use efficiency; conserve and preserve urban wetlands and ecosystems; develop effective urban institutions and governance; integrated and sustainable use of urban land and water resources.

Name of Plan/Policy	Time frame	Issues discussed	Ministry/Agency	Strategies to address climate change in urban areas
Bangladesh Environment, Forestry and Climate Change Country Investment Plan (EFCC CIP)	2016-2021	Four pillars of priority investment to tackle climate change	Ministry of Environment and Forest	Reduce municipal and household pollution by management and treatment of solid waste; improve the supply of safe drinking water; increase the collection and treatment of sewerage; improve sanitation at the community level.
Intended Nationally Determined Contributions (INDC)	2015	Identifies strategies for both adaptation and mitigation measures	Ministry of Environment and Forest	Improvement of urban resilience through upgrading of drainage system to address urban flood; management of urban waste.

(Source: Table adapted from General Economic Division, 2018; General Economic Division, 2020; Ministry of Environment and Forests, 2005; Ministry of Environment and Forests, 2009a; Ministry of Environment and Forests, 2009b; Ministry of Environment and Forests, 2013a; Ministry of Environment and Forests, 2015; Ministry of Environment and Forests, 2017)

2.7 Climate funds in Bangladesh

After the preparation of BCCSAP (2009) and NAPA (2005), the government of Bangladesh established BCCTF in 2009 and BCCRF in 2010 with enactment of the Climate Change Trust Act 2010 (Transparency International Bangladesh, 2017; Haq and Rabbani, 2011). Apart from these two climate funds, projects have been undertaken in Bangladesh under other multilateral and bilateral climate funds such as ASAP, GEF 4-6, GCF, LDCF, PPCR, and UNREDD (Transparency International Bangladesh, 2017). Table 2.7 shows the fund allocation of these climate funds.

Table 2.7: Allocation of climate funds in Bangladesh

Name of the fund		Fund in million BDT	Suggestions regarding the utilization of fund
International climate funds	LDCF	23835.02 (till 2017)	- Improve fund utilization capacity, transparency in allocation as well as monitoring and evaluation system for current and forthcoming climate funds. - Show the requirements, capacity along with the transparent mechanisms and feasibility of the proposed program and project to ensure better access to international climate funds.
	GEF Trust Fund		
	GCF		
	ASAP		
	PPCR		
	UK's International Climate Fund		
	UNREDD		
National climate funds	BCCTF	310748420 (till 2019)	- Prevent corruption in financial issues. - Need transparency regarding allocating and disbursing fund.
	BCCRF	6046.05	

Name of the fund		Fund in million BDT	Suggestions regarding the utilization of fund
		(till 2016)	• Remove political influence and nepotism during climate change project selection for NGOs. • Ensure access to information of funded projects. • Fund allocation need to consider the vulnerability of the region.

(Source: Table adapted from Transparency International Bangladesh, 2017; The World Bank, 2016; BCCT, 2019; Rahman, Ahmad, & Alam, 2016; Ayers & Huq, 2009; Transparency International Bangladesh, 2013; Rahman & Ahmad, 2016)

[*Here, 1\$=85 BDT exchange rate has been used]

2.8 Framework for implementing climate fund projects in Bangladesh

Haque and Rabbani (2011) illustrated the way Ministry of Environment, Forest and Climate Change (MoEF) is acting on tackling climate change and implementing projects and programmes under NAPA (2009) and BCCSAP (2009) at the community level with the association with the line ministries and civil society organizations through Climate Change Unit (Figure 2.1).

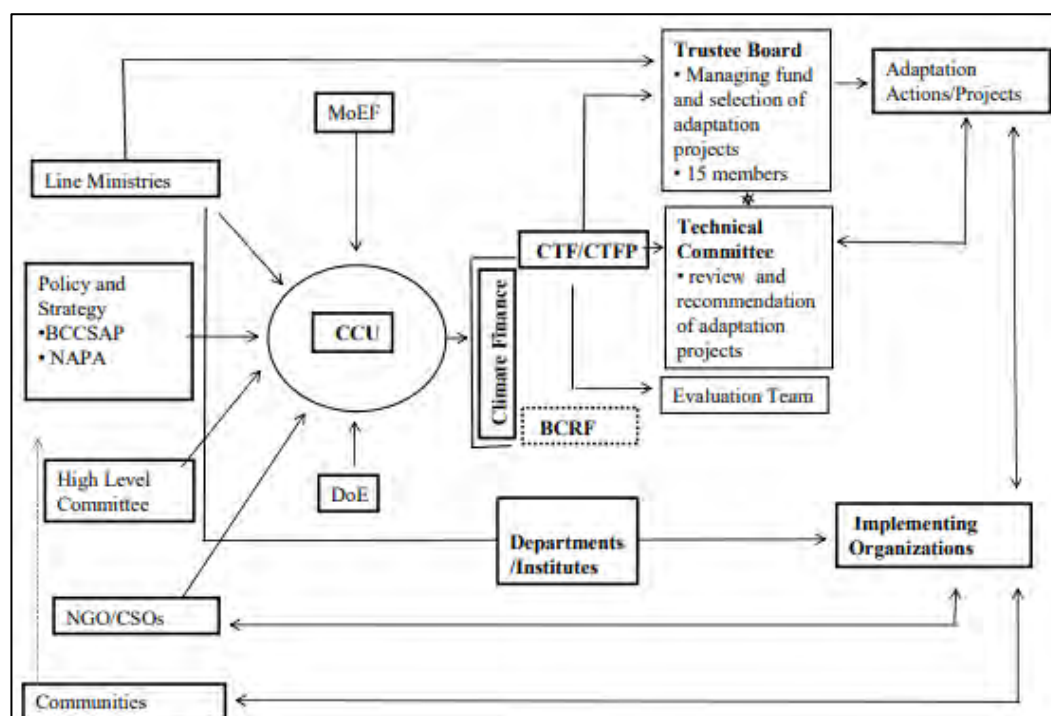


Figure 2.1: Conceptual framework for climate change related policy and institutions in Bangladesh (Source: Haq & Rabbani, 2011)

Figure 2.1 describes the responsibilities and activities of government bodies, climate change unit, academic institutions, NGOs etc. According to Table 2.8, MoEF is the lead government body for managing of national communication, formulation of adaptation programmes, providing approval of Clean Development Mechanism (CDM) projects, leading international negotiations, facilitating mainstreaming climate change at sectoral level etc.

Table 2.8: The activities of institutions involved in implementing climate fund projects in Bangladesh

Institutions	Activities and responsibilities
Ministry of Environment and Forests (MoEF)	• Taken a number of policy and institutional decisions to address climate change and climate variability issues in Bangladesh. • Taken the lead on discussing planning and developing policies and programmes on climate change issues in the government system. • Taken the climate change issue forward at the global level as an operational focal point of United Nations Framework Convention on Climate Change (UNFCCC) and Global Environment Facility (GEF).
Climate Change Unit (CCU)	The unit is equipped with nine senior officers and 33 general staff, which manage the climate related funds of the government.
NGOs and other institutions	Local, national and international level climate change research, capacity building, policy/advocacy, modeling, monitoring and evaluation and community level demonstration on adaptation projects, implementation of the projects at local level.

(Source: Table adapted from Haq & Rabbani, 2011)

Different organizations such as Bangladesh Centre for Advanced Studies (BCAS), Centre for Environment and Geographic Information Services (CEGIS), Institute of Water Modeling (IWM), Bangladesh Unnayan Parishad (BUP), Centre for Natural Resources Studies (CNRS), Oxfam International, Action Aid-Bangladesh, Practical Action, Christian Aid Bangladesh, Caritas Bangladesh, Islamic Relief Bangladesh etc. are involved in climate change research, capacity building, monitoring and evaluation and community level demonstration on adaptation projects (Haq & Rabbani, 2011).

2.9 Summary

Research has been conducted both in Bangladesh and other countries on climate governance and justice in cities, inclusive urban adaptation, formulation and upgradation of plans and policy instruments to address climate change etc. These research works focus mostly on global or big American cities, German cities, Indian cities, African cities etc., while other small scale urban areas or municipalities are neglected in this arena. National plans and policies addresses the issue of waste collection, water supply,

sanitation, drainage system of the urban areas of Bangladesh. No research has yet been done focusing on the urban area climate fund projects of Bangladesh along with their linkage with national and international plans and policies at local context. For efficient and effective utilization of both national and international climate funds, the needs and expectations of the local people from grass-root level has to be addressed.

CHAPTER 3: Methodology

In order to fulfill the research objectives, the research has been conducted following an orderly step by step process. This chapter discusses research objectives, selection of parameters for achieving those objectives, selection of study areas, data collection process, methods of data analysis etc.

3.1 Formulation of research objectives

The aim of this research is to investigate the allocation of different urban area climate fund projects of Bangladesh for addressing the impact of climate change induced hazards in the light of plans, policies and local context. To achieve desired outcome of the research, three objectives has been formulated.

3.2 Selection of parameters

A co-ordination schema has been prepared showing the parameters selected along with the data type and source for achieving each objective (See Appendices Table A1).

3.3 Selection of study area

3.3.1 Selection of study area to achieve 1st and 2nd objective

All urban areas of Bangladesh are covered for objective 1 and 2.

3.3.2 Selection of study area to achieve 3rd objective

To understand the view of local people regarding some completed climate fund urban area projects, five study areas has been selected. Table 3.1 shows the criteria for selecting these study areas.

Table 3.1: Criteria for selecting urban areas to achieve 3rd objective

Criteria for selection	Description
Vulnerability of urban areas considering climate change induced hazards	Most vulnerable or vulnerable urban areas.
Type of urban area	City corporation or A, B and C class municipality
Project's status	Completed project
Project fund name and size	Fund allocated under BCCTF, BCCRF, GCF or GEF Trust fund

Based on the above-mentioned selection criteria, two City corporations -Dhaka North and South City Corporation, three municipalities- Feni, Bauphal and Mongla Port have

been selected as study areas. Detail description of the selection process has been discussed in chapter 4.

3.4. Data collection

3.4.1 Secondary data collection and preparation

To identify the spatial distribution of climate fund projects in urban areas of Bangladesh, maps showing climate change induced drought, flood, storm surge inundation, salinity intrusion, change in temperature and precipitation have been collected from General Economic Division (2018), Savage, Mujica, Chiappe, & Ross (2015), Rabbani & Haq (2016) and Alauddin & Mallick (2010). GIS Shape file showing the urban areas of Bangladesh along with the type of urban area, name, area etc. also has been collected from Rahman, Mohiuddin, Kafy, Sheel, & Di (2019). Municipality map of Mongla Port municipality, Bauphal municipality and Feni municipality also have been collected from respective municipality offices. Demographic profile of these selected urban areas was collected from Bangladesh Bureau of Statistics (BBS) and municipality websites.

To identify and study the projects under climate funds in the urban areas of Bangladesh from locational perspective, some variables such as project name, type, location, objective, time frame, status, budget, project implementing agency and ministry, activities and expected outcome of the project, name of the fund and thematic area of BCCSAP, 2009 addressed etc. have been collected from Bangladesh Climate Change Trust (BCCT), The World Bank and different multilateral climate fund websites etc. Plan and policy documents such as BCCSAP (2009), NAPA (2009), 7th Five Year Plan (2016-2020), ccGAP Bangladesh (2013), BDP (2100), EFCC CIP (2016-2021), etc. has been collected from Ministry of Environment and Forest, Planning Commission, Disaster Management Bureau etc.

3.4.2 Primary data collection and preparation

Key Informant Interview (KII) and Focus Group Discussion (FGD) has been conducted in the selected urban areas and different Participatory Rural Appraisal (PRA) tools has been used to understand local people's view regarding the climate change induced hazards and their linkage with projects under climate change funds.

3.4.2.1 Key Informant Interview (KII)

An ideal key informant can be expert source of information who have five characteristics such as their role in community, knowledge, willingness, communicability and impartiality (Marshall, 1998; Tremblay, 1957; Kumar, 1989). Key Informant Interview (KII) involves qualitative in-depth interviews of wide range of people such as community leaders, professionals, academics, or residents who have first-hand in depth knowledge about the topic (Kumar, 1989; UCLA Center for Health Policy Research, n.d.; University of Illinois Extension—Program Planning and Assessment, n.d). In this research, a handful number of KII has been done with different academics, researchers, local people, government officials etc. to understand the likely impact of climate change induced hazards and their intensity, different climate fund allocation in Bangladesh, outcome of the selected urban area projects, suggestions regarding effective implementation of the projects etc. (See the list of Key informants in Appendices Table A2).

3.4.2.2 Focus Group Discussion (FGD)

A focus group discussion is a form of group interviewing in which a small group – usually 10 to 12 people whose present characteristics are defined with respect to the size and composition– is led by a moderator (interviewer) in a loosely structured discussion of various topics of interest, thereby ensures interaction inside the group where the participants influence each other through their answers to the ideas (Mishra, 2016). In this research, FGDs has been done with local people regarding the impacts of climate change induced hazards in their locality, their view regarding the climate fund projects taken such as project objective, site, fund, outcome etc.

3.4.2.3 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) is known as one of the most suitable and appropriate methods to identify the existing situation of the community which emphasizes on local knowledge and enables local people to do their own appraisal, analysis and planning (Uddin & Anjuman, 2013; Chambers, 1992). The applications of PRA comprise of need assessment, investigation of a specific topic or problem, feasibility study, identification and establishment of priorities for development, monitoring and evaluation of development or research activities and identification of conflicting interests between groups etc. (Uddin & Anjuman, 2013). In this research

different PRA tools such as Venn diagram, seasonal diagram, historic timeline, pair wise ranking, cause effect diagram etc. has been used to identify the major climate change induced hazards, their intensity and seasonal occurrence, history of occurrence, possible impacts etc.

3.5 Data Analysis:

3.5.1 Spatial Analysis

Spatial data consists of locational as well as attribute information (Fotheringham & Rogerson, 2008). Spatial analysis can be defined as a technique to manipulate spatial data using a set of largely deterministic functions including basic spatial queries, buffering, overlay and the calculation of derivatives on surfaces such as slope and aspect (Unwin, 1996). In this research, spatial analysis for identifying the urban centers located in the vulnerable zones considering climate change induced hazards along with spatial distribution of different climate fund projects, their fund size, implementing agency etc. has been done using ArcGIS software. Spatial data exploration and spatial data manipulation have been used for identifying the urban centers having multiple projects under different climate funds.

3.5.2 Document Analysis

Document analysis is a systematic procedure to extract information from documents (both printed and electronic) as well as to provide a general data compression facility along with reviewing and evaluating those documents (Wong, Casey, & Wahl, 1982; Bowen, 2009). To achieve second objective, the project details has been reviewed from different projects files from BCCT and websites of other climate fund projects. In case of BCCTF projects, the projects needed to address specific themes and pillars of BCCSAP (2009) before getting approval from the ministry. But for other climate fund projects such as GCF, BCCRF, GEF Trust fund, the objectives of those projects have been reviewed. For identifying the linkage of these urban area climate fund projects with other national and international plan and policy documents apart from BCCSAP (2009), the project objectives have been compared with the pillars, goals, strategies etc. of those plans and policies. Frequency distribution, descriptive statistics, cross tabulation etc. have been performed on the data collected from document analysis.

3.5.3 Quantitative Content Analysis (QCA)

Quantitative Content Analysis (QCA) is a research technique used for the systematic, objective and quantitative description of the manifest content of communication which performs segmenting communication content into units, assigning each unit to a category, and providing tallies for each category (Rourke & Anderson, 2004; Fatemi et al., 2020). Quantitative Content Analysis (QCA) has been used to identify the overall scenario of the linkage of different climate fund urban area projects with different national and international plans and policies. Here, scores have been assigned based on Fatemi et al. (2020) as follows-

Table 3.2: Scores for calculating composite index using QCA

Level	Score/ point	Description
Not present	0	Project failed to address any of the strategies, goals, pillars, themes of the plans and policies
Low	1	Project addressed only one of the strategies, goals, pillars, themes of the plans and policies.
Medium	2	Project addressed two of the strategies, goals, pillars, themes of the plans and policies.
High	3	Project objectives addressed more than two of the strategies, goals, pillars, themes of the plans and policies.

(Source: Fatemi et al., 2020)

3.5.4 PRA tools

To achieve third objective, primary data collected through KII, FGD and PRA method has been analyzed using different PRA tools such as hazard mapping, seasonal diagram, historic timeline, Venn diagram, pair wise raking, cause effect diagram etc. These PRA tools have been discussed below in short:

3.5.4.1 Risk or Hazard mapping

Risk or hazard mapping is a more elaborate and comprehensive way to assess dangers and trends of a community which involves meetings with different groups of people in the community who can identify and highlight main hazards they face in the community (Van Aalst, Cannon, & Burton, 2008). To identify the vulnerable zones facing major climate change induced hazards in the selected urban areas, risk mapping has been used in this research.

3.5.4.2 Historic timeline

Historical Timelines involves the analysis of past events such as conflicts, natural disasters such as floods, droughts, cyclones etc., changes in the natural, social or

economic environment (Uddin & Anjuman, 2013). In this research, the history of occurrence of different climate change induced hazards in the selected municipalities was identified and depicted in timeline.

3.5.4.3 Seasonal diagram

Seasonal diagram is used to explore seasonal changes such as the distribution of rainfall patterns, income, food consumption, gender-specific workload, migration etc. in a given community depicted in calendars (Chambers, 1992; Uddin & Anjuman, 2013). Seasonal variation on the intensity of the impacts of climate change induced hazards in the selected municipalities have been depicted in seasonal diagram through consultation with local people through FGDs.

3.5.4.4 Venn diagram

The Venn diagram studies institutional relationships of a community and depicts institutions, organizations, groups and important individuals found in the community, as well as the peoples view of their importance in the community (Kumar, 2002). In this research, Venn diagram has been used to identify the influential institutions as well as key persons along with their importance in the selected urban areas.

3.5.4.5 Pair wise ranking

This PRA method is used to identify the preferences or priorities of people regarding problems, needs, actions etc. by ranking those by comparing their attributes and factors at a time (Kumar, 2002). At first, the ranking of different climate change induced hazards such as flood, salinity intrusion, storm surge, drought etc. faced by the local people of the study areas has been done through KII and FGD in this research. Then different types of effects of these climate change induced hazards have been identified from various stakeholders. After identifying, the impacts were prioritized by pair-wise ranking technique and compared all the identified impacts in a pair-wise ranking matrix.

3.5.4.6 Cause effect diagram

A cause effect diagram is a visual representation of people's perceptions of the causes and effects of a problem, linkages between causes and effects of problems with their solutions (Kumar, 2002; Quang Ngai Province, 2007). In this research, cause effect diagram has been prepared for the impacts of different climate change induced hazards in the selected municipalities.

CHAPTER 4: Study Area Profile

This chapter provides a short description of the urban areas of Bangladesh as well as the selected urban areas for understanding the local people's perception regarding the BCCTF projects. This chapter provides an overview of all the urban areas of Bangladesh as all the urban areas has been selected as study area for achieving first and second objectives. Then, the urban areas selected for achieving third objectives has been discussed in detail.

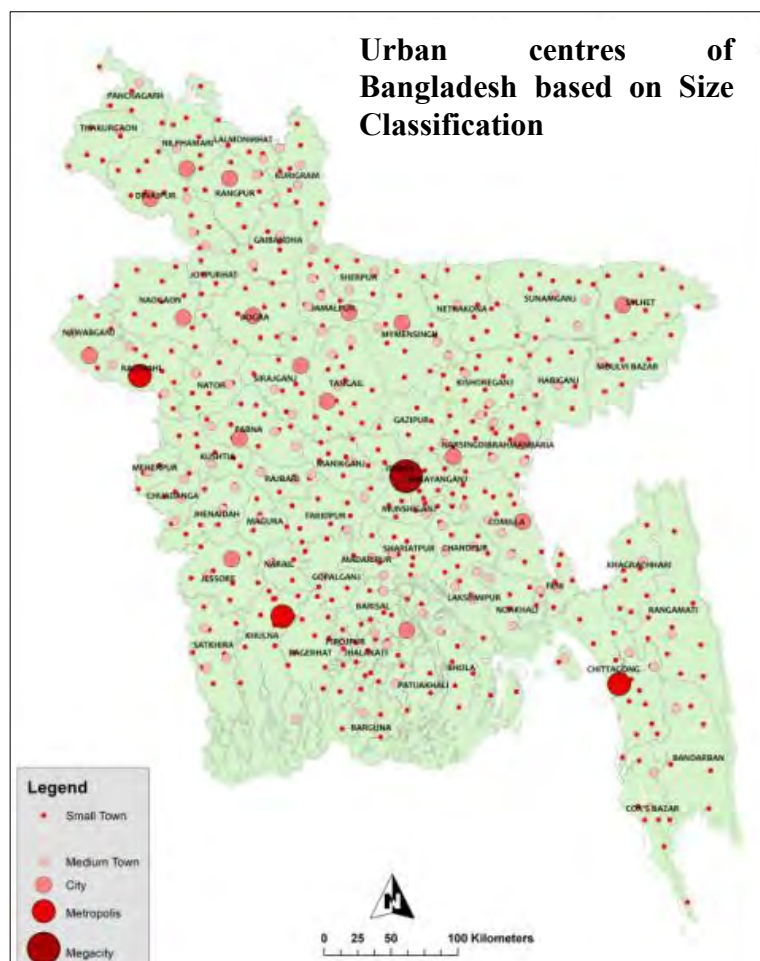
4.1 Urban areas of Bangladesh

Around 37.2% of the total population in Bangladesh resides in 570 urban centres which contributes to 60-65% of the GDP and the urban population will exceed rural population by 2030 (Bangladesh Bureau of Statistics, 2014; United Nations Population Division, 2019; Hassan & Nazem, 2016). Dhaka, the capital of Bangladesh contributes to 40% of the GDP (Ahmed & Ahmed, n.d.). Following table 4.1 and map 4.1 shows the classification of urban areas of Bangladesh. There are six types of urban areas based on functions and size. Among the 570 urban centres of Bangladesh, Dhaka is the megacity, four metropolitan areas (Chattogram, Khulna, Rajshahi and Sylhet), 25 cities and the rest are smaller towns (Rahman, n.d.). Bangladesh's six largest cities contain more than half of the national urban population and the four largest metropolitan cities (Dhaka, Chattogram, Khulna and Rajshahi) held 46% of Bangladesh's urban population in 1991 (Banks et al., 2011).

Table 4.1: Classification of urban areas based on function and size

Classification based on	Type with definition
Functions and sizes.	Mega City: It is metropolitan area having population 5 million or more.
	City Corporation: It includes city corporations incorporated and administered by the Ministry of Local Government under City Corporation Act, 2009.
	Paurashava/Municipality Area (PSA): It includes paurashavas incorporated and administered by local government under Paurashava Ordinance, 1977.
	City: It is an urban area having population 1,00,000 and above
	Other Urban Area (OUA): It includes those upazila headquarters which are not Paurashavas. The only exception is the 17 unions adjacent to Dhaka City Corporation under Dhaka Metropolitan Area. These unions are treated as other urban areas on the basis of their urban characteristics.
	Town: It is an urban area having population less than 1,00,000

(Source: Table combined from Bangladesh Bureau of Statistics, 2014)



Map 4.1: Urban centres of Bangladesh (Source: Rahman, n.d.)

Urban areas are classified into twelve City Corporations, 335 Municipalities and other smaller towns with Union Parishad as local government (Local Government Engineering Department, 2017; General Economic Division, 2012; General Economic Division, 2020). Twelve city corporations accommodate about 60% of the urban population while the rest reside in municipalities (Parvin et al., 2013; Local Government Engineering Department, 2017). According to General Economic Division (2020), the Paurashavas have been classified into three types (A, B and C class) based on the minimum of annual revenues collected over last three years (table 4.2). The city corporations are- Chattogram City Corporation (CCC), Cumilla City Corporation (COCC), Dhaka North City Corporation (DNCC), Dhaka South City Corporation (DSCC), Gazipur City Corporation (GCC), Narayanganj City Corporation (NCC), Barishal City Corporation (BCC), Khulna City Corporation

(KCC), Cox's bazar City Corporation, Rajshahi City Corporation (RCC), Rangpur City Corporation (RACC) and Sylhet City Corporation (SCC) (Rahman et al., 2019).

Table 4.2: Classification of urban areas of Bangladesh based on urban local administrative unit

Classification based on	Type with definition		Number
Urban local administrative unit	City Corporation		12
	Paurashava/ Municipality	A class: income more than 8 million BDT	156
		B Class: income 4 to 8 million BDT	104
		C Class: income 2 to 4 million BDT	65

(Source: table adapted from General Economic Division, 2012; Local Government Engineering Department, 2017; Rahman et al., 2019; General Economic Division, 2020)

4.2 Vulnerability of urban areas of Bangladesh considering climate change induced hazards

For identifying the vulnerable urban areas of Bangladesh considering different climate change induced hazards such as flood, drought, salinity intrusion, storm surge, excessive precipitation and temperature change, vector overlay analysis has been performed. For detecting the weightage of specific type of climate change induced hazard during vector overlay analysis, ten key informants from different backgrounds and professions have been interviewed. These key informants were engineers, planners, researchers, officials etc. engaged in climate change related projects in different universities, research institutes, government offices etc. (See the list of Key informants in Appendices Table A2). The Constant-Sum Paired-Comparison Method (CPSM) method has been used to analyze the information collected via KII.

4.2.1 The Constant-Sum Paired-Comparison Method (CSPCM) for identifying the weight of different climate change induced hazards

The Constant-Sum Paired-Comparison Method (CSPCM) is a systematic way for determining the relative importance of a large number of factors individually by giving a ranking of the factors according to their importance as well as obtaining the weight for an individual factor with respect to other factors (Khisty, 1994; Zafri, Sameen, Jahangir, Tabassum, & Hasan, 2020). In this research, CSPCM method has been used to identify the rank or weight of the climate change induced flood, drought, salinity intrusion, storm surge, precipitation and temperature change based on their impacts in

the urban areas of Bangladesh. The procedure includes four consequent steps as follows:

Step 1: Creating a matrix: A sample matrix is created by making all possible pair comparisons for the climate change induced hazards such as climate change induced flood (F), salinity intrusion (S), storm surge (SS), drought (D), change in precipitation (R) and temperature (T) to determine their relative importance (Appendices Table A3).

Step 2: Rating cells in each pair comparison: In the KIIs, every interviewee was asked to deliver a pair comparison by providing a constant bundle of values in the scale of 10 for each climate change induced hazards based on their relative importance or perceived impact on urban areas of Bangladesh. In table 4.3, an interviewee compared between climate change induced flood (F) and salinity intrusion (S) and he found S to be far more important than F, then assign the value 6 to S (in row 2, column 1), signifying the highest importance, and 4 to F (in row 1, column 2), signifying the lowest importance. In this way, the values of all cells are provided except for the cells with same row and column numbers as similar factors are compared in these cells (For example, in row 1 and column 1, factor F is compared with F).

Table 4.3: Matrix for comparing the climate change induced hazards in CSPCM with response of a key informant

Climate change induced Hazard type	Flood (F)	Salinity intrusion (S)	Storm surge (SS)	Change in precipitation (R)	Change in temperature (T)	Drought (D)	Score	Weight
Flood (F)	X	4	4	4	2	4	18	0.12
Salinity intrusion (S)	6	X	6	5	4	5	26	0.17
Storm surge (SS)	6	4	X	6	3	4	23	0.15
Change in precipitation (R)	6	5	4	X	4	7	26	0.17
Change in temperature (T)	8	6	7	6	X	3	30	0.20
Drought (D)	6	5	6	3	7	X	27	0.18
Total							150	1

(Source: KII with a respondent, 2019)

Step 3: Calculating the score for each factor: The sum of cells' values for each row is calculated in this step. In table 4.3, the sum of row 1 is 18 (4+4+4+2+4 =18) for

Climate change induced flood (F). All the summed value has been calculated in the same way.

Step 4: Determining the relative normalized weight of each factor: In this step, the summed values for all the rows are summed again ($18 + 26 + 23 + 26 + 30 + 27 = 150$). Subsequently, to normalize the sum of individual rows, score of a particular factor is divided by the sum of all rows (For this KII, the weightage of climate change induced flood (F) is $18/150 = 0.12$). This value forms the relative weight of that factor for an individual key informant (table 4.3).

After calculating the relative normalized weight of each climate change induced hazards for each key informant, the average value has been calculated for all key informants to understand the overall weight of each climate change induced hazards (table 4.4). Table 4.4 also describes that climate change induced salinity intrusion and storm surge have an average weight of 0.19, and therefore have the most influence in the urban areas of Bangladesh.

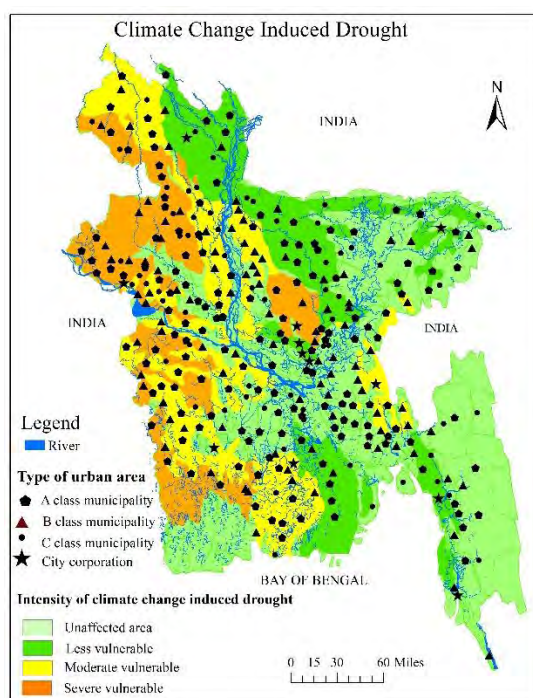
Table 4.4: Weight of the climate change induced hazards from KII

Climate change induced hazards	Individual Key Informant Interview (KII)										Average Weight
	KII 1	KII 2	KII 3	KII 4	KII 5	KII 6	KII 7	KII 8	KII 9	KII 10	
Flood (F)	0.23	0.16	0.11	0.12	0.19	0.12	0.15	0.15	0.16	0.10	0.15
Salinity intrusion (S)	0.15	0.21	0.21	0.17	0.17	0.21	0.18	0.21	0.19	0.21	0.19
Storm surge (SS)	0.23	0.23	0.20	0.15	0.19	0.16	0.19	0.17	0.19	0.19	0.19
Change in precipitation (R)	0.11	0.13	0.09	0.17	0.14	0.19	0.14	0.11	0.13	0.24	0.15
Change in temperature (T)	0.17	0.10	0.14	0.20	0.11	0.20	0.18	0.18	0.18	0.15	0.16
Drought (D)	0.11	0.17	0.24	0.18	0.19	0.12	0.16	0.17	0.15	0.11	0.16

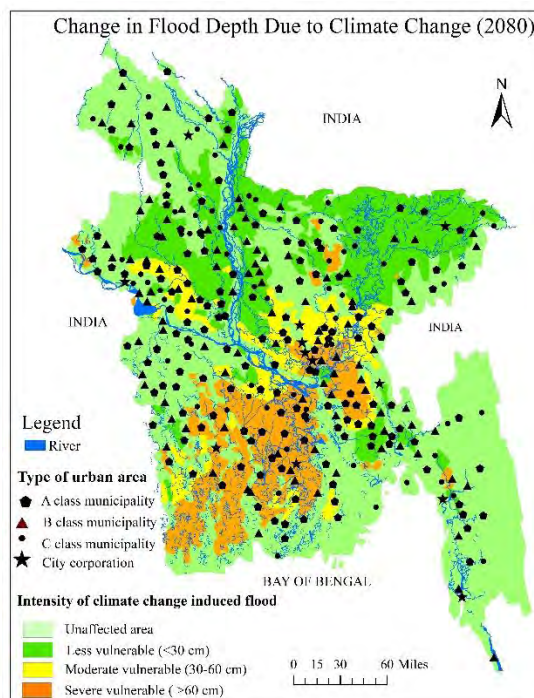
(Source: KII, 2019)

4.2.2 Overlay Analysis for identifying most climate vulnerable zones

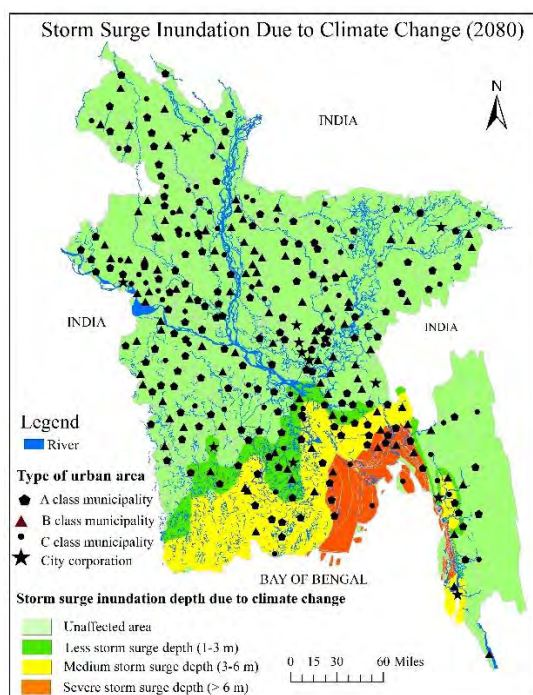
Overlay analysis is a spatial analysis function of GIS that deals with massive data and involves the spatial overlay analysis of different data layers and their attributes in the target area by connecting multiple spatial objects from multiple data sets, creating a new clip data set, quantitatively analyzing the spatial range and characteristics of the interactions among different types of spatial objects (Zhao et al., 2019).



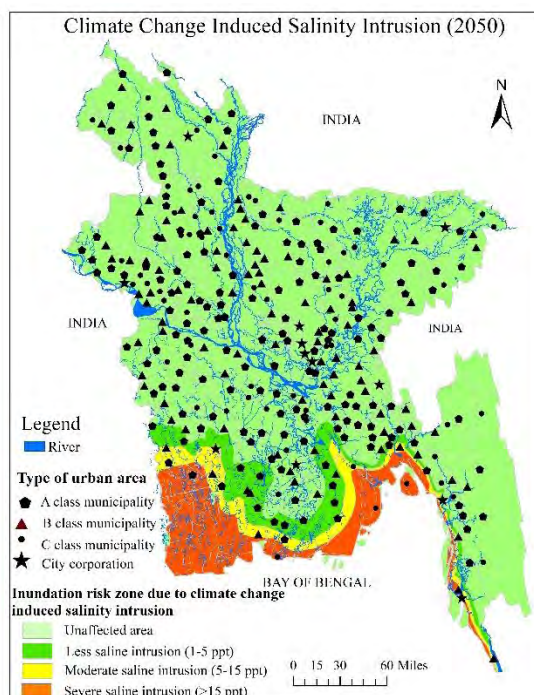
Map 4.2: Urban areas facing climate induced drought in Bangladesh. (Base map source: *Alauddin & Mallick, 2010*)



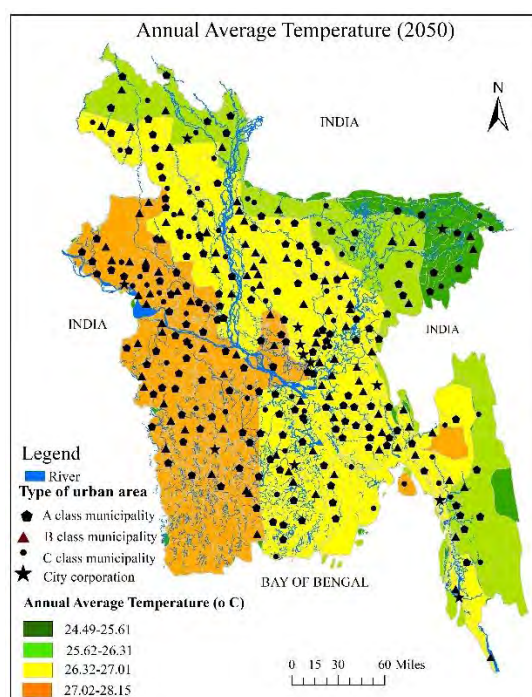
Map 4.3: Urban areas facing climate induced flood in Bangladesh. (Base map source: *Rabbani & Haq, 2016*)



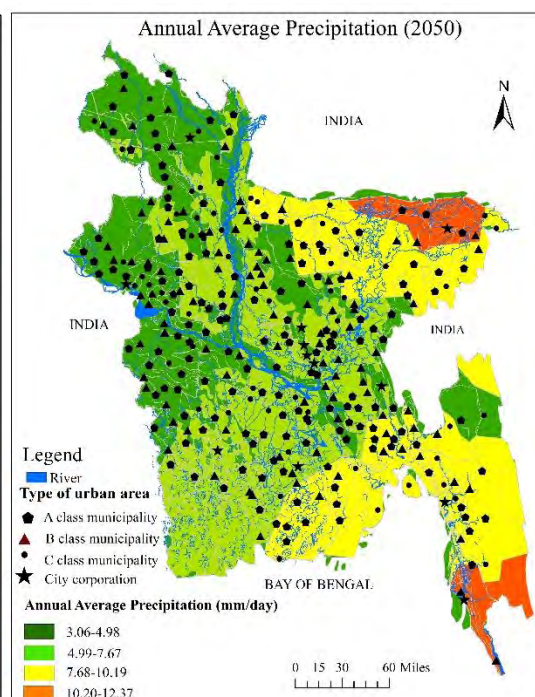
Map 4.4: Urban areas facing climate induced storm surge in Bangladesh. (Base map source: *General Economic Division, 2018*)



Map 4.5: Urban areas facing climate induced salinity intrusion in Bangladesh. (Base map source: *General Economic Division, 2018*)



Map 4.6: Urban areas facing climate change induced temperature rise in Bangladesh. (Base map source: Savage et al., 2015)



Map 4.7: Urban areas facing climate change induced precipitation in Bangladesh. (Base map source: Savage et al., 2015)

Using ArcGIS software, vector overlay analysis has been done for identifying most vulnerable urban areas of Bangladesh in terms of climate change induced hazards. Map 4.2-4.7 depicts the spatial distribution of the urban areas in different climate change induced hazard prone zones. Map 4.2 shows that the west side of Bangladesh is in the climate change induced drought prone area and 30 A class Paurashavas, 25 B class Paurashavas and 12 C class Paurashavas are situated here. Similarly, map 4.3, 4.4 and 4.5 shows that, most of the climate change induced flood, salinity intrusion and storm surge will occur in the south side of Bangladesh. Table 4.5 shows that, two city corporations face severe drought (GCC and RCC), one faces severe saline intrusion (Cox's Bazar city corporation) and two faces temperature rise (KCC and RCC).

Table 4.5: Distribution of urban areas facing climate change induced hazards

Climate change induced hazard type	Impact	Type of urban area				Total
		A	B	C	City Corporation	
Drought	Unaffected	52	39	24	3	118
	Moderate	33	10	14	5	62
	Severe	41	30	15	2	88
	Very severe	30	25	12	2	69

Climate change induced hazard type	Impact	Type of urban area				Total
		A	B	C	City Corporation	
Saline intrusion	Unaffected	138	92	60	9	299
	Less saline intrusion (1-5 ppt)	14	6	1	1	22
	Moderate saline intrusion (5-15 ppt)	3	5	1	1	10
	Severe saline intrusion (>15 ppt)	1	1	3	1	6
Flood	Unaffected	79	52	36	7	174
	Less flood depth (< 30 cm)	28	24	16	1	69
	Medium flood depth (30-60 cm)	25	14	5	1	45
	Severe storm surge (> 60 cm)	24	14	8	3	49
Storm surge	Unaffected	119	81	55	8	263
	Less storm surge depth (1-3 m)	13	7	5	3	28
	Medium surge depth (3-6 m)	16	12	3	1	32
	Severe storm surge depth (> 6 m)	8	4	2	0	14
Temperature change	Unaffected (24.49°C -25.61°C)	7	3	3	1	14
	Less (25.62°C -26.31°C)	21	10	13	1	45
	Moderate (26.32°C -27.01°C)	75	59	35	8	177
	Severe (27.02°C -28.15°C)	53	32	14	2	101
Precipitation	Less (3.06- 4.98 mm/ day)	58	39	23	5	125
	Less medium (4.99- 7.67 mm/day)	58	42	20	4	124
	Medium (7.68-10.19 mm/day)	37	19	22	1	79
	Severe (10.20-12.37 mm/day)	3	4	0	2	9

(Source: Compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010; Rahman et al., 2019)

For vector overlay analysis, climate change induced severity of drought, inundation risk zone for saline intrusion and storm surge, flood depth, annual average temperature and precipitation has been selected. Each parameter has been ranked on the scale of 0 to 3 (where 0= not vulnerable and 3= most vulnerable) considering the climate change induced hazards. Table 4.6 describes the parameters as well as indicators of that parameters, weight given on the parameters (from table 4.4), rank of the indicator of parameters etc. for vector overlay analysis. After performing vector overlay, most vulnerable urban areas due to climate change induced hazards has been identified.

Table 4.6: Suitability range of criteria for vector overlay analysis

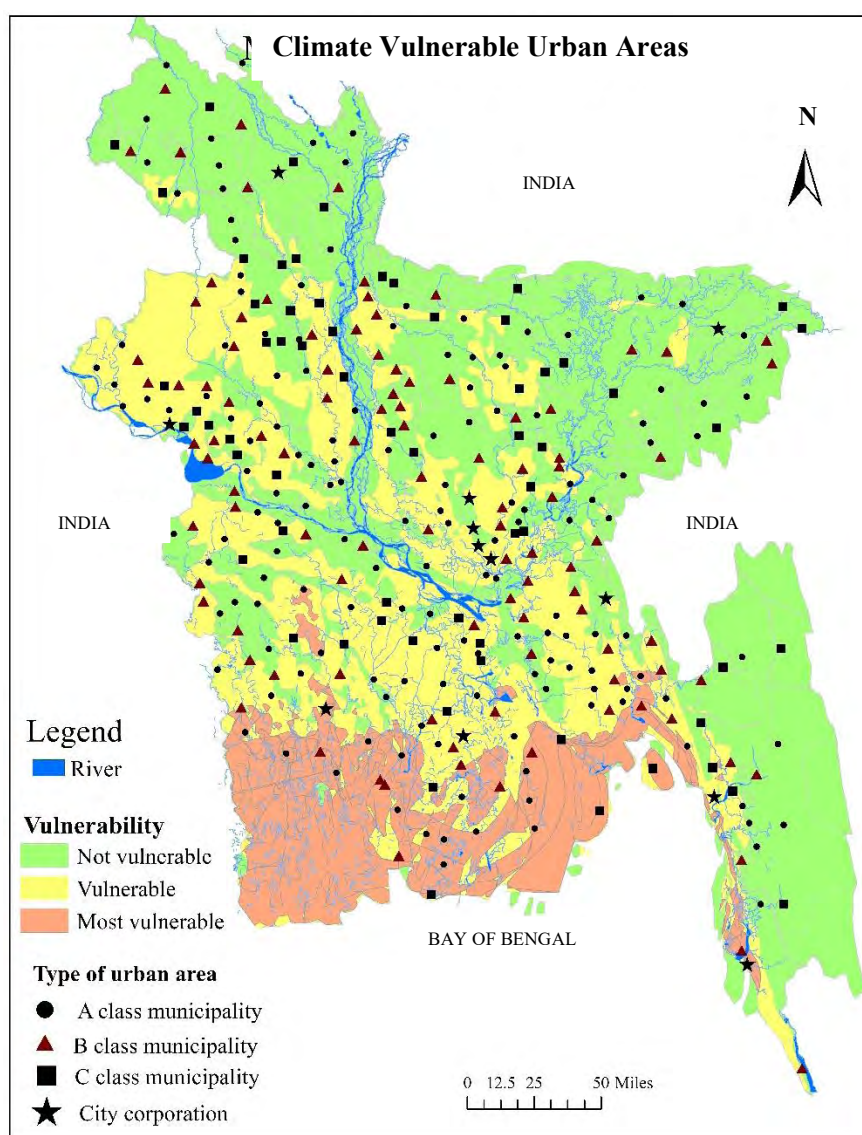
Parameter	Indicator	Weight	Types	Suitability parameter	Rank	Source
Climate change induced drought	Severity of drought	0.16	Unaffected	Not vulnerable	0	Alauddin & Mallick, 2010
			Moderate	Less vulnerable	1	
			Severe	Moderate vulnerable	2	
			Very severe	Most vulnerable	3	
Climate change	Inundation risk zone	0.19	Unaffected	Not vulnerable	0	General Economic
			1-5 ppt	Less vulnerable	1	

Parameter	Indicator	Weight	Types	Suitability parameter	R a n k	Source
induced saline intrusion			5-15 ppt	Moderate vulnerable	2	Division, 2018
			>15 ppt	Most vulnerable	3	
Climate change induced flood	Flood depth	0.15	Unaffected	Not vulnerable	0	Rabbani & Haq, 2016
			< 30 cm	Less vulnerable	1	
			30-60 cm	Moderate vulnerable	2	
			> 60 cm	Most vulnerable	3	
Climate change induced storm surge	Inundation risk zone	0.19	Unaffected	Not vulnerable	0	General Economic Division, 2018
			1-3 m	Less vulnerable	1	
			3-6 m	Moderate vulnerable	2	
			> 6 m	Most vulnerable	3	
Temperature change	Annual average temperature (in °C)	0.16	24.49 -25.61	Not vulnerable	0	Savage et al., 2015
			25.62 -26.31	Less vulnerable	1	
			26.32 -27.01	Moderate vulnerable	2	
			27.02 -28.15	Most vulnerable	3	
Climate change induced precipitation	Annual average precipitation (in mm/day)	0.15	3.06- 4.98	Not vulnerable	0	Savage et al., 2015
			4.99- 7.67	Less vulnerable	1	
			7.68-10.19	Moderate vulnerable	2	
			10.20-12.37	Most vulnerable	3	

(Source: Table adapted from Alauddin & Mallick, 2010; Savage et al., 2015; General Economic Division, 2018; Rabbani & Haq, 2016)

4.2.3 Natural Breaks Classification for identifying the clusters of vulnerability of overlay values

Jenks natural breaks classification method is a data clustering method designed to determine the best arrangement of values into different classes by reducing the variance within classes and maximizing the variance between classes (Jenks, 1967; Fariza, Abhimata, & Hasim, 2016). In this research, Natural Break (Jenks) method has been used to classify the overlay values from vector overlay analysis into less vulnerable (0-0.8), vulnerable (0.9-1.5) and most vulnerable (1.6-2.5) clusters considering all climate change induced hazards. Map 4.8 depicts the spatial distribution of the urban areas in the vulnerable zone of climate change. Here, the most vulnerable zone is situated in the south side of Bangladesh while the less vulnerable zone is situated in north and north-east side (Map 4.8).



Map 4.8: Vulnerability of urban areas of Bangladesh considering climate change induced hazards from vector overlay analysis

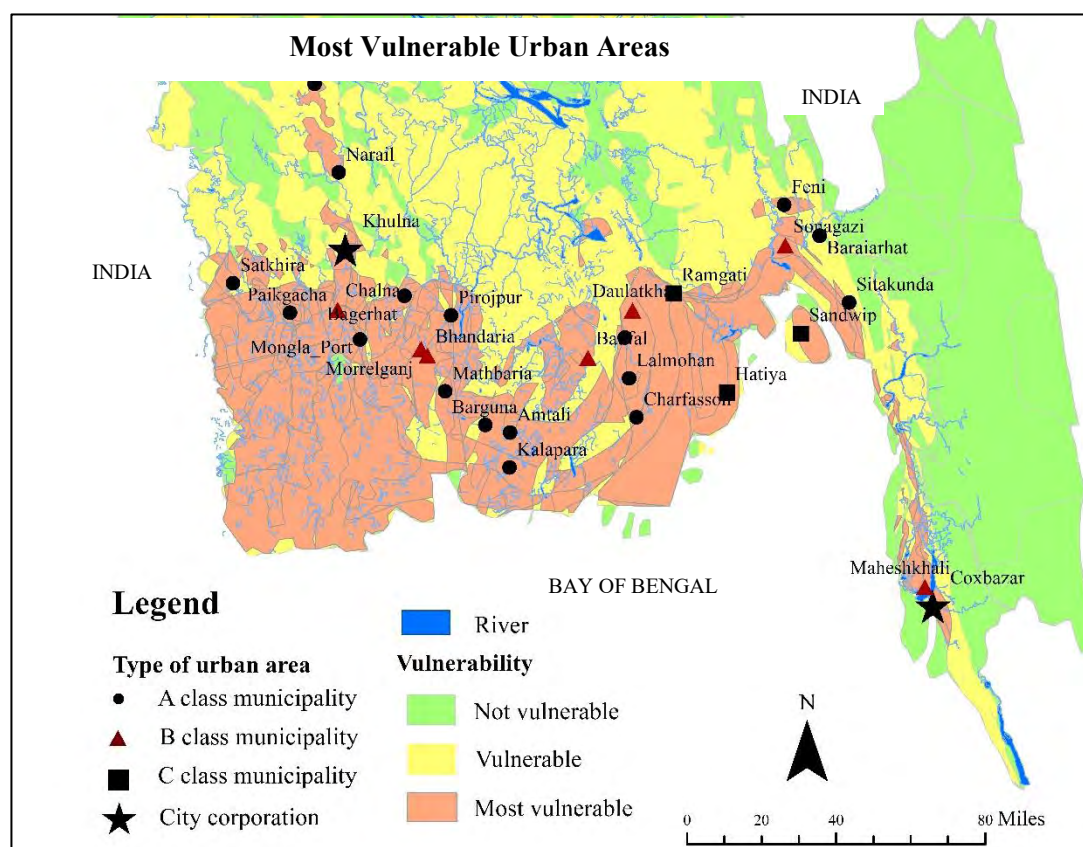
(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2018)

Table 4.7 shows the vulnerability of urban areas considering climate change induced hazards. Table 4.7 describes that, around 156 urban areas are situated in less vulnerable and 152 are situated in vulnerable zone considering climate change induced hazards. There are 29 urban areas (17 A class Paurashavas, seven B class Paurashavas, three C class Paurashavas and two city corporations) in the most vulnerable zone considering climate change.

Table 4.7: Vulnerable urban areas considering climate change induced hazards

Type of urban area	Less vulnerable (Overlay value: 0-0.8)	Vulnerable (Overlay value: 0.9-1.5)	Most vulnerable (Overlay value: 1.6-2.5)	Name of the most vulnerable urban areas (Overlay value: 1.6-2.5)
A Class Paurashavas	73	66	17	Pirojpur, Feni, Barguna, Sitakunda, Baraiahat, Charfasson, Mathbaria, Magura, Amtali, Burhanuddin, Kalapara, Lalmohan, Mongla Port, Satkhira, Bagerhat, Narail, Paikgacha
B Class Paurashavas	43	54	7	Morrelganj, Daulatkhan, Sonagazi, Bhandaria, Baufal, Dacope, Maheshkhali
C Class Paurashavas	35	27	3	Hatiya, Ramgati, Sandwip
City Corporation	5	5	2	Khulna, Cox's bazar
Total	156	152	29	

(Source: Overlay values Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

**Map 4.9: Most vulnerable urban areas of Bangladesh considering climate change induced hazards from vector overlay analysis**

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani and Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2018)

4.3 Selected study areas for identifying people's perception regarding climate fund projects

For understanding the local people's perception regarding the climate fund projects, following five study areas (two city corporations and three municipalities) has been selected.

4.3.1 City corporation

Both selected city corporations are located in Dhaka division. In 1864, under District Municipal Improvement (Act III B.C. of 1864), Dhaka was established as a municipality and then after the independence (in 1971) it was declared as a capital of Bangladesh (Dhaka North City Corporation, 2020; Kabir, Sato, Habbiba, & Yousuf, 2018). Dhaka Municipal Corporation was renamed as Dhaka City Corporation (DCC) in 1978 with 10 zones and later in 2011 divided into Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC), each acting as self-governing entity with an elected mayor (Kabir et al., 2018). According to table 4.8, DSCC consists of 75 wards while DNCC has 54. Again, DNCC has an area of 196.22 sq.km while DSCC has 109.25 sq.km (See Appendices Map A1 and A2)

Table 4.8: General information of the selected city corporations

General information		Name of the City Corporation	
		DNCC	DSCC
Urban area profile	Number of Wards	54	75
	Area (in sq km)	196.22	109.25
Demographic profile	Total Population (in 2011)	4 million	3.8 million

(Source: Table adapted from Bangladesh Bureau of Statistics, 2014; Kabir et al., 2018; Dhaka North City Corporation, 2020; Dhaka South City Corporation, 2020)

4.3.2 Municipalities

Completed projects under three municipalities were selected for understanding local people's perception regarding the climate fund projects. Table 4.9 shows that, the municipalities are from Khulna, Chattogram and Barishal divisions. In terms of urban area type, both Mongla Port and Feni municipalities are A class municipality while Bauphal is a B class municipality. Feni municipality, established in 1958, is the largest one with 27.20 sq.km area and 73,182 population among the selected municipalities. While both Mongla port and Bauphal municipal areas consist of nine wards, Feni municipality has 18 wards (See Appendices Map A3-A5). All the municipalities have more than 60% literacy rate.

Table 4.9: General information of the selected municipalities

General information		Name of the municipality		
		Mongla Port	Feni	Bauphal
Location	District	Bagerhat	Feni	Patuakhali
	Division	Khulna	Chattogram	Barishal
Urban area profile	Type	A class	A class	B class
	Establishment date	1975	1958	2001
	Number of Wards	09	18	09
	Area (in sq km)	21.43	27.20	7.96
Demographic profile	Total Population	39,837	73,182	19,600
	Male	21,607	50,455	11,050
	Female	18,230	423,39	8,850
	Density per sq km	1,859	2,690	2,462
	Literacy rate in %	64.10	69.70	69.69

(Source: Table adapted from Feni Sadar Upazila, 2020; Bauphal Upazila, 2020; Mongla Port Municipality Office, 2020; Bangladesh Bureau of Statistics, 2014)

4.3.3 Climate change induced hazards in the selected study areas

Following Table 4.10 shows the climate change induced hazards faced in the selected city corporations and municipalities. Almost all the study areas face climate change induced intense rainfall for short period of time which causes waterlogging. However, Mongla Port municipality faces severe salinity intrusion and cyclone. On the other hand, Feni municipality only face intense rainfall and climate migrants from other adjacent areas facing climate change induced flood, salinity intrusion, cyclone, river erosion etc.

Table 4.10: Climate change induced hazards in the municipalities.

Name of the urban area	Type	Climate change induced hazards
Dhaka North and South city corporation	City corporation	Flood, waterlogging, intense rainfall.
Mongla port municipality	A class municipality	Salinity intrusion, flood, cyclone, extreme tide, intense rainfall, river bank erosion.
Feni municipality	A class municipality	Waterlogging due to Intense rainfall for a short period of time.
Bauphal municipality	B class municipality	Flood, Waterlogging due to Intense rainfall for a short period of time.

(Source: Table adapted from The World Bank, 2016; BCCT, 2019; Field survey, 2019)

4.3.4 Historic time line of disasters and climate fund projects in the municipalities

Historic timeline shows major natural disasters in a chronological order which have left some positive or negative impacts on the study areas from time to time.

1988	↓	Devastating flood occurs in Mongla port municipality
2007		Devastating cyclone Sidr had adverse impact on Mongla port municipality
2009		Cyclone Aila had adverse impact on Mongla port municipality
2012		Initiation of infrastructural and environmental improvement project under BCCTF in Bauphal municipality
2015		Initiation of infrastructural and environmental improvement project under BCCTF in Feni municipality
2017		Construction of embankment in Mongla port municipality. Completion of project under BCCTF in Bauphal municipality. Initiation of project to address climate change induced waterlogging in Feni municipality.
2019	↓	Cyclone Bulbul has less impact in the municipality due to the embankment in Mongla port municipal area

Figure 4.1: Historic timeline showing the important events of municipalities.

(Source: Field survey, 2019; BCCT, 2019)

Mongla Port municipality faced a devastating flood in 1988. After the establishment of the embankment, cyclones have less impact on Mongla Port municipality (Figure 4.1). First BCCTF projects has been initiated in 2012 in Bauphal municipality.

4.3.5 Vulnerability score of the municipalities

National Climate Vulnerability Assessment Report (NCVAR, 2018) identified the vulnerability score of different upazilas of Bangladesh based on their vulnerability to climate change in human, health, water, agricultural, fisheries, infrastructure etc. sectors (Goosen et al, 2018). The vulnerability scores of study areas according to NCVAR (2018) show that all of the municipalities are in the vulnerable zone considering people affected by natural disasters. Here all of the municipalities show score more than 0.6 while for Bauphal municipal area, the score is 0.72 (Table 4.11). Also, Feni municipal area is vulnerable considering ground water quality. Even the vulnerability score from overlay analysis identified the municipalities as most vulnerable ones where the score is highest for Bauphal municipality.

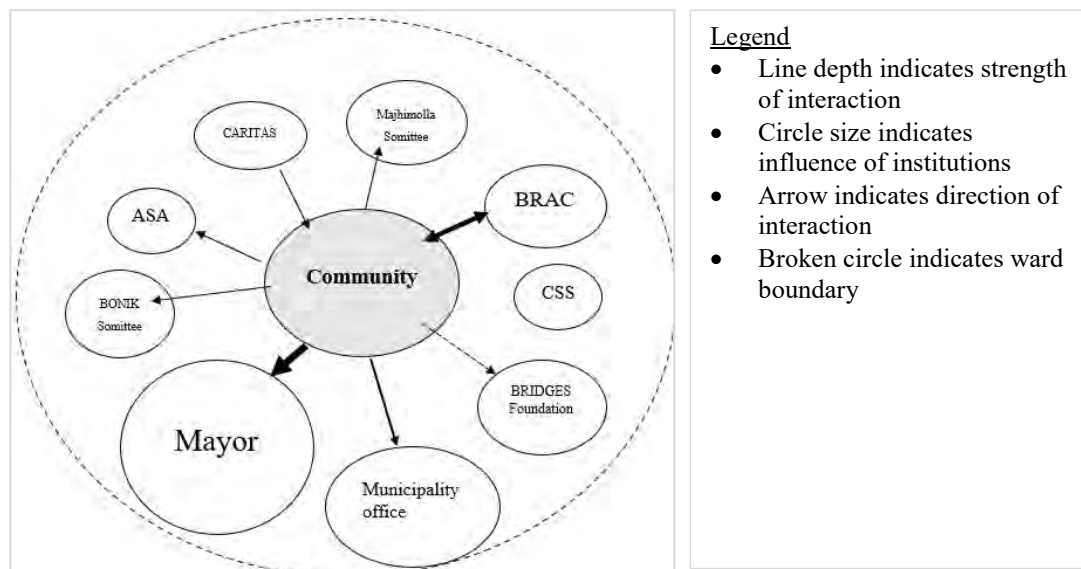
Table 4.11: Vulnerability score of study areas

Name of the municipality	Vulnerability Score according to NCVAR (2018) *				Vulnerability score from overlay analysis **
	People affected	Heat stress	Ground water quality	Road network	
Mongla Port	0.63	0.35	0.45	0.36	1.68
Bauphal	0.72	0.37	0.40	0.44	1.77
Feni	0.62	0.29	0.58	0.42	1.66

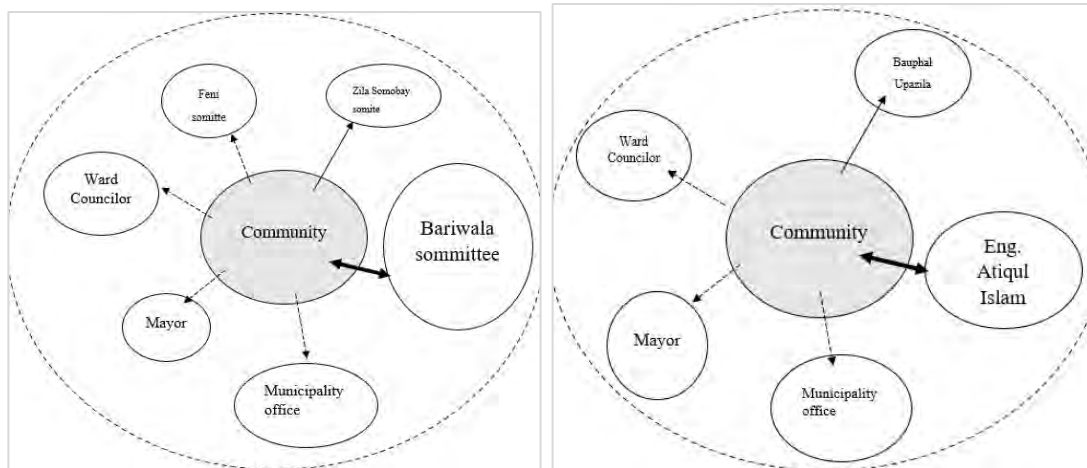
Here, *In NCVAR, 2018 (1= vulnerable, 0=not vulnerable); ** Most vulnerable vector overlay score= 1.6-2.5. (Source: Goosen et al, 2018 and Overlay values Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

4.3.6 Venn diagram of the municipalities

In this research, Venn diagram depicts the institutional relationships using circles of various sizes where, the bigger the circle, the more significant or influential the individual or institution and thickness or width of the lines between the circles represents the degree of interaction or contract between them.



a) Mongla port municipality



b) Feni municipality

c) Bauphal municipality

Figure 4.2: Venn Diagram of the communities in municipalities. (Source: Field survey, 2019)

Figure 4.2 (a, b and c) depicts the Venn diagrams of the municipalities where the Mayor of Mongla port municipality and Eng. Atikur Islam of Bauphal municipality are the most influential persons. In Feni municipal area, Bariwala Somitee, a Community Based Organization (CBO) has more influence in the community than

local municipal office or Mayor. There is a both way interaction between local people and municipal office of Mongla Port municipality. Moreover, in Mongla Port municipality, some NGOs such as Bangladesh Rural and Advancement Committee (BRAC) and Association for Social Advancement (ASA) are working on providing potable drinking water and promoting RWH (Rain Water Harvesting) system to tackle water scarcity in the municipal area. But very few local people of Mongla Port municipality can afford these. According to local people Engineer from municipality office plays the most dominant role in Bauphal municipality, which is surprisingly different from other municipalities where mayor plays the major role.

4.4 Summary

This chapter discusses the types of urban areas along with description of the selected urban areas for understanding people's perception of the completed climate fund projects. Only Bauphal is a B class municipality (established in 2001) while other two are A class municipalities. Venn diagram depicts that, only in Mongla Port municipality, the local people have both way interrelation with mayor and municipal office. Almost all the municipalities face climate change induced excessive rainfall while Mongla port municipality faces climate change induced salinity intrusion and cyclone as a coastal municipality. Even though, the local people in Feni municipality faces excessive rainfall, people migrate from other adjacent areas to this municipality to escape from climate change induced flood, cyclone, salinity intrusion etc.

CHAPTER 5: Spatial Distribution of Climate Fund Projects in Urban Areas of Bangladesh

This chapter describes the number and type of urban area projects taken under different climate funds along with their spatial distribution in urban areas of Bangladesh. This chapter explores the budget allocation, fund type, time frame, status, implementing agency of the climate fund projects etc. This chapter also identifies the urban areas with more fund allocation and also the ones without any climate fund project at all.

5.1 Climate fund projects in urban areas of Bangladesh

This segment investigates the allocation of climate fund projects in the urban areas of Bangladesh. Many international organizations such as Global Environment Facility (GEF), Department for International Development (DFID), Canadian International Development Agency (CIDA), the government of Denmark, Sweden, Switzerland etc. are financing the climate fund projects in Bangladesh (NDA Secretariat, 2018). Table 5.1 shows that total 703 projects were taken until 2019, among them, 245 projects address the impact of climate change induced hazards in the urban areas of Bangladesh. Among 85 projects under international climate funds (such as LDCF, GEF, GCF, PPCR etc.), only six projects have been taken in urban areas till 2020. There is not any fund allocation under LDCF, ASAP, PPCR, UNREDD and UK's International Climate Fund addressing climate change impacts in urban areas.

Table 5.1 Distribution of urban area climate fund projects in Bangladesh

Name of the fund		Number of projects		
		Total	Urban area	Other
International climate funds	LDCF	7	0	7
	GEF Trust Fund	8	2	6
	GCF	64	4	60
	ASAP	1	0	1
	PPCR	2	0	2
	UK's International Climate Fund	2	0	2
	UNREDD	1	0	1
	Total	85	6	79
National climate funds	BCCTF	608	237	371
	BCCRF	10	2	8
	Total	618	239	379
Total projects		703	245	458

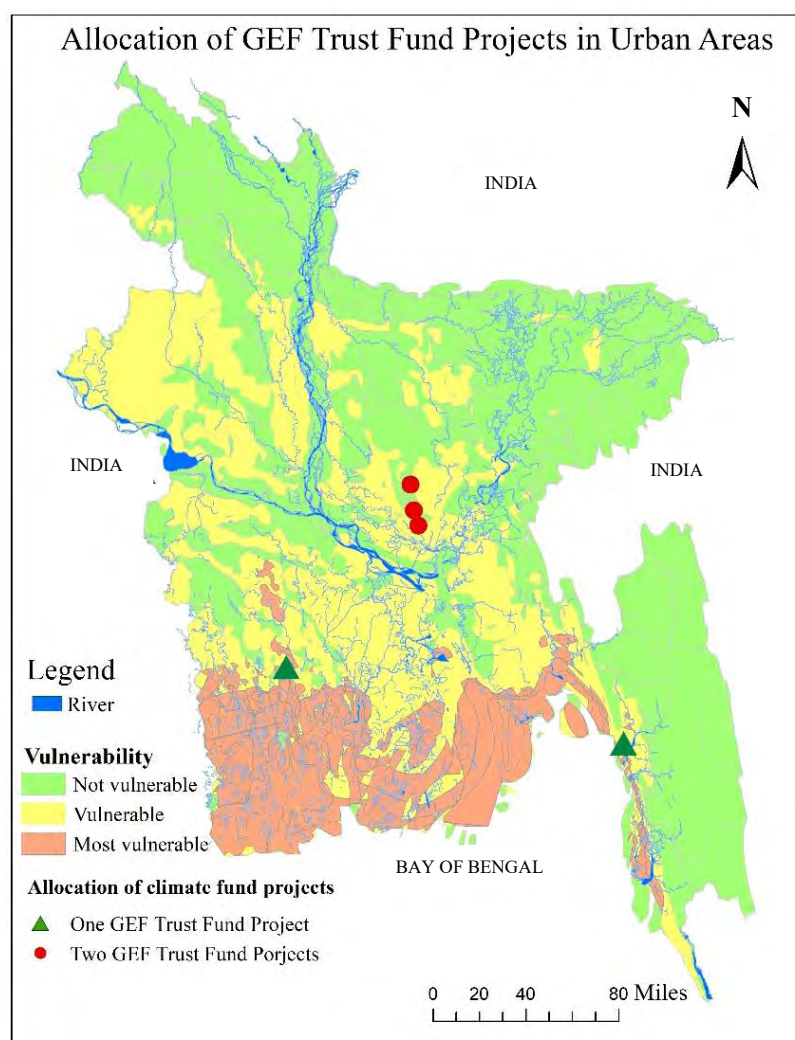
(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Green Climate Fund Independent Evaluation Unit, 2019; International Fund for Agricultural Development, 2012; Rai & Smith, 2013; Independent Commission for Aid Impact, 2011; The World Bank, 2016; BCCT, 2019)

Again, among 618 national climate fund projects, 239 projects have been taken in the urban areas facing different climate change induced hazards. Among ten BCCRF projects, two projects have been taken in Dhaka Metropolitan areas while among 608 projects under BCCTF, 237 projects have been taken in urban areas (Table 5.1).

5.2 Location of climate fund urban area projects

5.2.1 Global Environment Facility (GEF) Trust Fund

On the eve of the 1992 Rio Earth Summit, Global Environment Facility (GEF) was established to help tackle most pressing environmental problems in the world and thereby provided grants for more than 5,000 projects in 170 countries (Global Environment Facility, 2021).



Map 5.1: Urban area projects under GEF Trust Fund

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010; Global Environment Facility, 2020 and Rahman et al., 2019)

Map 5.1 depicts the spatial distribution of GEF Trust Fund projects. DNCC, DSCC and Gazipur City Corporation has two projects under GEF Trust Fund while Khulna City Corporation and Chattogram City Corporation has only one project.

Table 5.2 shows the distribution of projects under GEF trust fund in different urban areas of Bangladesh. Most of the urban projects under GEF Trust Fund have been taken in city corporation areas.

Table 5.2: Distribution of GEF Trust Fund projects in urban areas

Project Name	Project Location	Number of Urban Areas
Promoting Low Carbon Urban Development in Bangladesh.	City Corporation: Dhaka (Both DNCC and DSCC), Gazipur, Khulna, Chattogram.	4
ASTUD: Greater Dhaka Sustainable Urban Transport Corridor Project.	City Corporation: Dhaka (Both DNCC and DSCC), Gazipur	3

(Source: Global Environment Facility, 2020)

5.2.2 Green Climate Fund (GCF)

In 2010, The Green Climate Fund (GCF) was founded within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) to support developing countries to raise and realize their Nationally Determined Contributions (NDC) ambitions towards low-emissions, climate-resilient pathways (Green Climate Fund, n.d.).

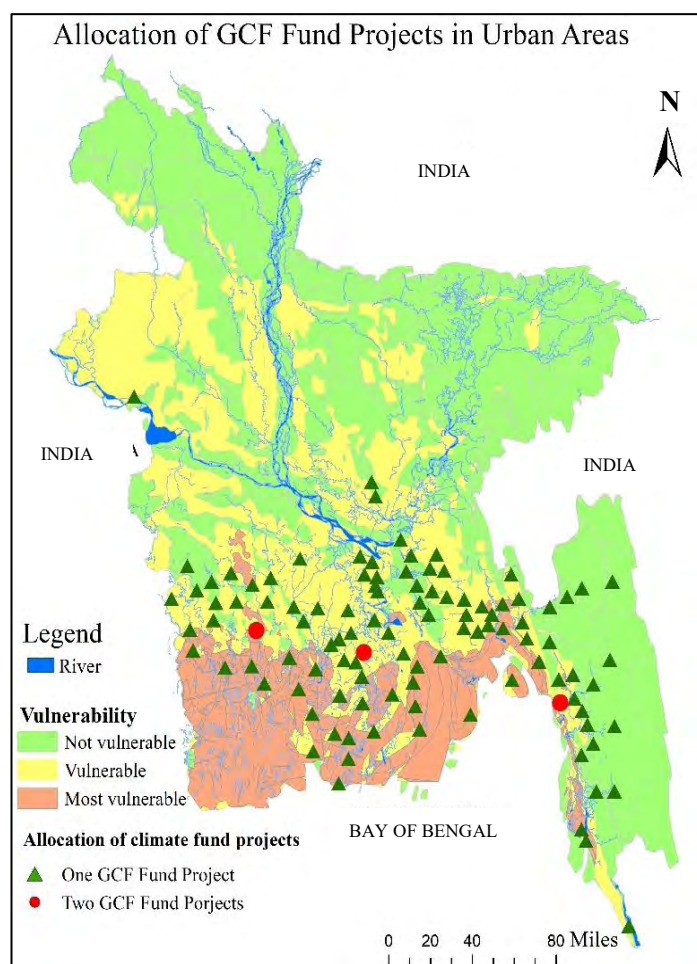
Following Table 5.3 shows that among four urban area projects under GCF, two address the issue of climate change induced hazards in municipal areas while the other two are taken in city corporation areas. The municipal areas are in the hilly zones (six municipalities under Bandarban, Rangamati and Khagrachhari district) and coastal zone (98 urban areas under 19 coastal districts). However, other two projects have been taken in Dhaka (Both DNCC and DSCC), Chattogram, Khulna, Rajshahi and Barishal City Corporation areas.

Table 5.3: Distribution of GCF projects in urban areas

Project Name	Project Location	Number of urban areas
Development of Resilience in selected Hilly Municipal Areas through an Improved Early Warning System, Geo-hazard interventions, and Awareness Raising Campaigns.	Hilly municipal areas: Bandarban (A class), Matiranga (C class), Ramgarh (B class), Rangamati (A class), Khagrachhari (A class), Lama (C class)	6

Project Name	Project Location	Number of urban areas
Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area.	Barishal City corporation	1
Enhancing Urban Resilience Program.	Urban areas under 19 Coastal districts: Jessore, Narail, Gopalganj, Shariatpur, Chandpur, Satkhira, Khulna, Bagerhat, Pirozpur, Jhalakati, Barguna, Barishal, Patuakhali, Bhola, Lakshmipur, Noakhali, Feni, Chattogram, and Cox's Bazar.	98
Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh.	City Corporation: Dhaka (Both DNCC and DSCC) Chattogram, Khulna, Rajshahi.	5

(Source: NDA Secretariat, 2018; Dasgupta, Kamal, Khan, Choudhury, & Nishat, 2014)



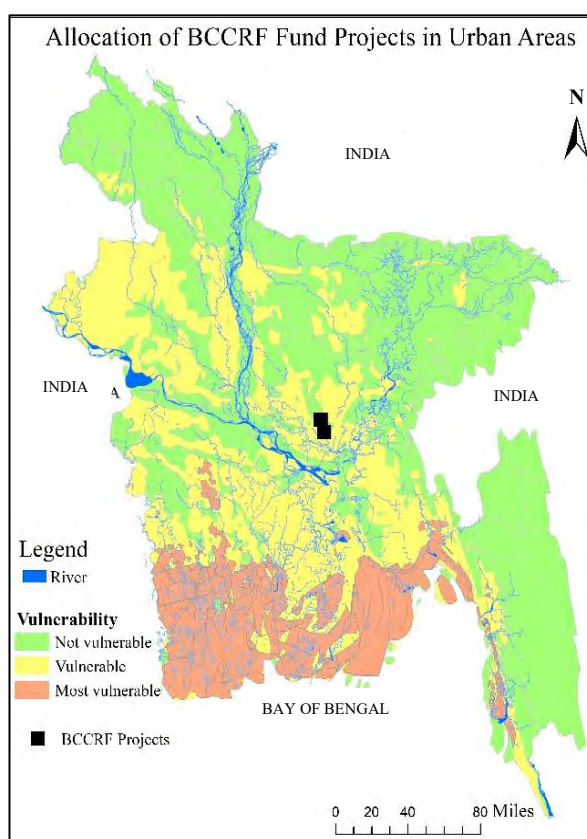
Map 5.2: Urban area projects under GCF

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016 Alauddin & Mallick, 2010; NDA Secretariat, 2018; Dasgupta et al., 2014; Rahman et al., 2019)

Map 5.2 illustrates the distribution of urban area projects under GCF in Bangladesh. Here, two projects have been taken under GCF in Khulna, Barishal and Chattogram City Corporations. The spatial distribution of the projects under GCF shows that most of the projects are initiated in the urban areas situated in the south side of Bangladesh. Development of resilience in selected hilly municipal areas through an improved early warning system, geo-hazard interventions, and awareness raising campaigns project under GCF has been taken in six hilly municipalities. Enhancing urban resilience program has been taken in 98 urban areas where 50 are A class, 29 B class, 15 C class municipalities and four city corporations (Barishal city corporation, Khulna city corporation, Chattogram city corporation and Cox's bazar city corporation).

5.2.3 Bangladesh Climate Change Resilience Fund (BCCRF)

In 2009, the government of Bangladesh set up a trust fund to create a national resource for climate change investments with the aim to support implementation of the BCCSAP by allocating about US\$100 million from the non-development budget (NDA Secretariat, 2018).



Map 5.3: Urban area projects under BCCRF

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010; The World Bank, 2016 and Rahman et al., 2019)

There are only two urban area projects located in Dhaka under BCCRF (Map 5.3). Table 5.4 represents the distribution of BCCRF projects in urban areas. Both of these projects are research projects addressing the issue of urban flooding in Dhaka.

Table 5.4: Distribution of BCCRF Trust Fund projects in urban areas

Project Name	Project Location	Number of Urban Areas
Urban Flooding of Greater Dhaka Area in a Changing Climate: Vulnerability, Adaptation and Potential Costs	City Corporation: Dhaka (Both DNCC and DSCC),	2
Innovations in Flood Risk Mitigation in Dhaka	City Corporation: Dhaka (Both DNCC and DSCC),	2

(Source: The World Bank, 2016)

5.2.4 Bangladesh Climate Change Trust Fund (BCCTF)

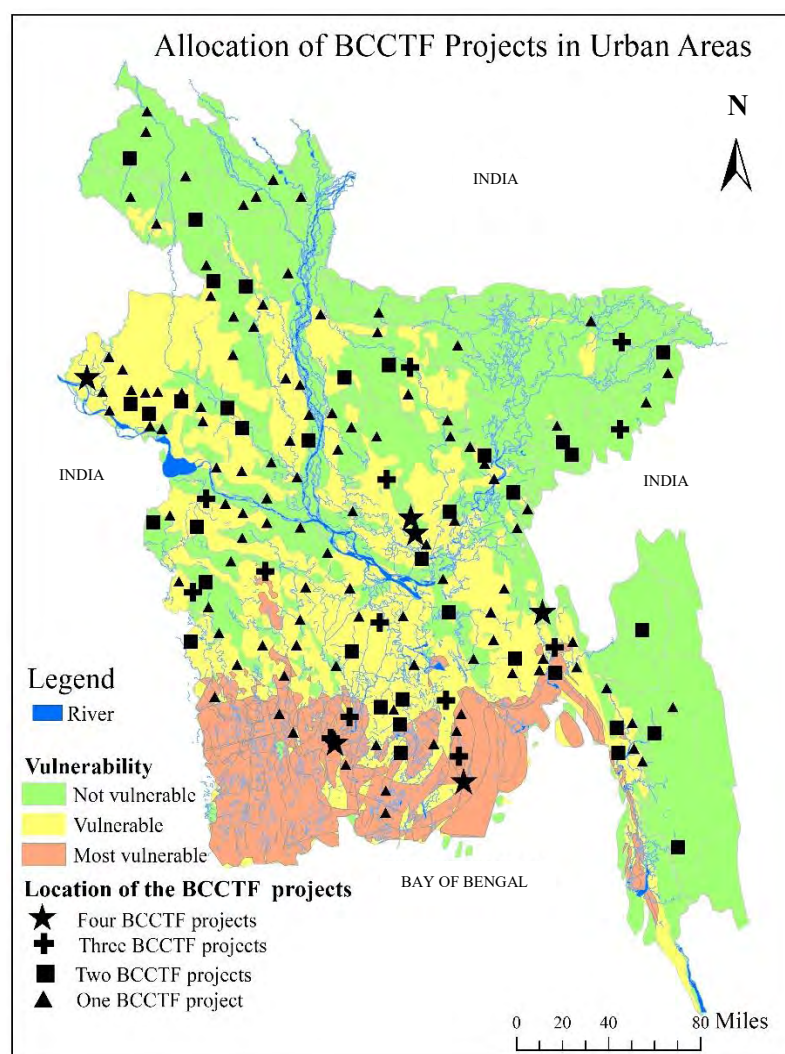
There are around 237 urban area projects under BCCTF till 2019. Six BCCTF urban area projects has been taken in city corporation areas while 16 in Sadar Upazilas and 215 in municipalities. Following table 5.5 shows the distribution of different types of urban area projects taken under BCCTF. Most of these projects have been taken for infrastructural development (25 projects, 11%), solar power street lightening system (18 projects, 8%), to tackle waterlogging and environmental improvement (94 projects, 40%), improvement of drainage (14 projects, 6%) etc. Other projects under BCCTF fund are for provision of safe drinking water, construction of eco-park, human health protection, disaster resilience housing, road development, solid waste management, river bank protection, research on climate migration etc. The projects taken in city corporation areas are mainly for research on carbon mitigation, providing solid waste management, solving waterlogging problem and improve environment.

Table 5.5: Distribution and Type of BCCTF projects in urban areas

Project type	Type of urban area	Number of projects
Carbon mitigation and environmental improvement projects	Municipality	10
Climate resilient town development projects	Municipality	7
Construction of embankment projects	Municipality and Sadar	9
Improvement of drainage system projects	Municipality	14
Improvement of drainage system and solar light installment projects	Municipality	7
Infrastructural and environmental improvement projects	Municipality	9
Infrastructural development projects	Municipality and Sadar	25

Project type	Type of urban area	Number of projects
Projects taken to re- excavation of canals	Municipality and Sadar	3
Projects to tackle river bank erosion and waterlogging problem	Municipality	5
Road development projects	Municipality	3
Projects to provide safe drinking water, construction of drain and ensure carbon mitigation	Municipality	2
Solar power street lightening system	Municipality	18
Solid waste management projects	Municipality	3
Projects taken to solve waterlogging and improve environment	Municipality and City Corporation	94
Others	Municipality and City Corporation	28
Total		237

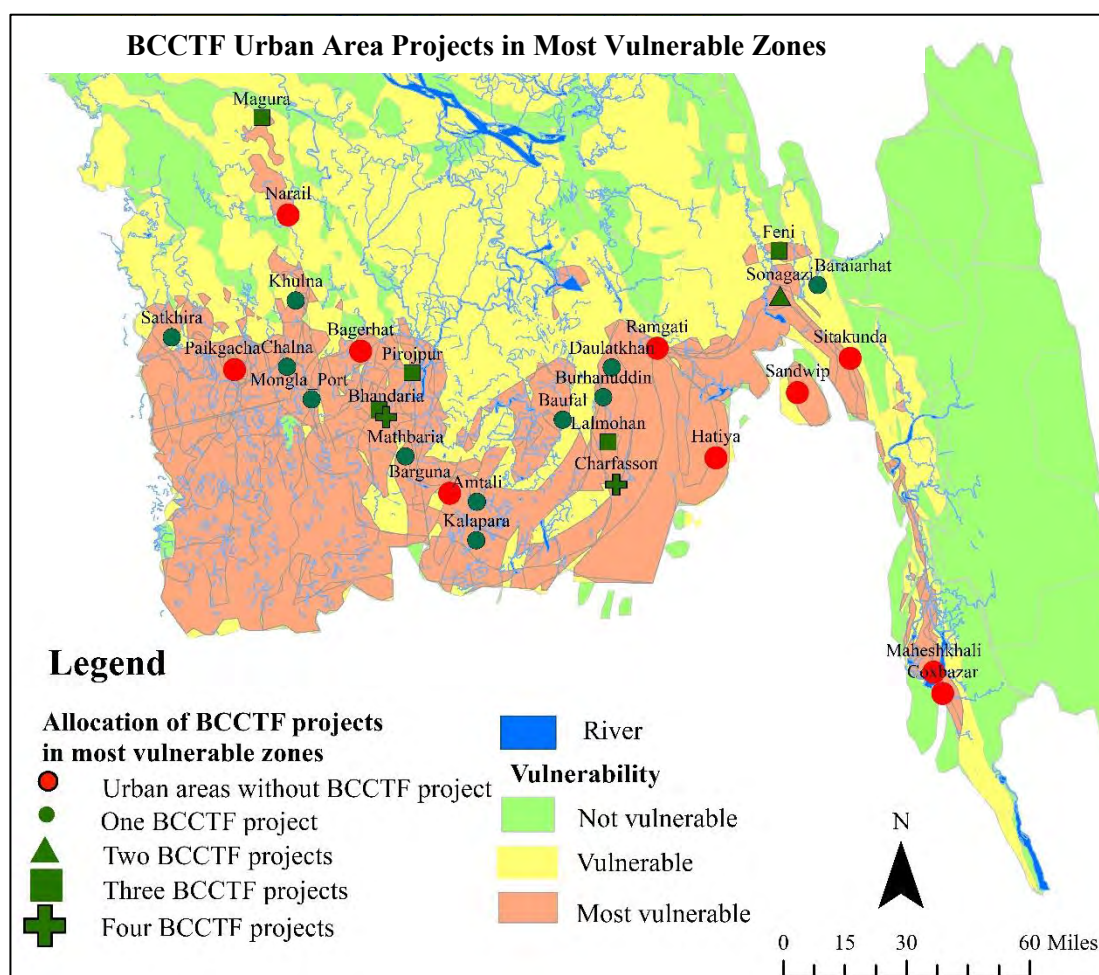
(Source: BCCT, 2019)



Map 5.4: Urban area projects under BCCTF

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

Map 5.4 portrays the spatial distribution of the urban area projects taken under BCCTF. The spatial distribution shows that 171 urban areas do not have any projects under BCCTF (Map 5.5). Among these 171 urban areas, three are city corporations- Cumilla City Corporation, Cox's Bazar City Corporation and Gazipur City Corporation and other are municipalities (64 A class, 60 B class and 44 C class municipalities). However, six urban areas (three A class, one B class and two city corporations) have four projects under BCCTF. These urban areas are- Shibganj municipality, Chaudhgram municipality, Bhandaria municipality, Charfasson municipality, DNCC and DSCC. Three BCCTF urban area projects have been undertaken in 14 urban areas (Nine A class, three B class, one C class and one city corporation). Around 36 urban areas have two projects under BCCTF and 110 urban areas have one BCCTF project.



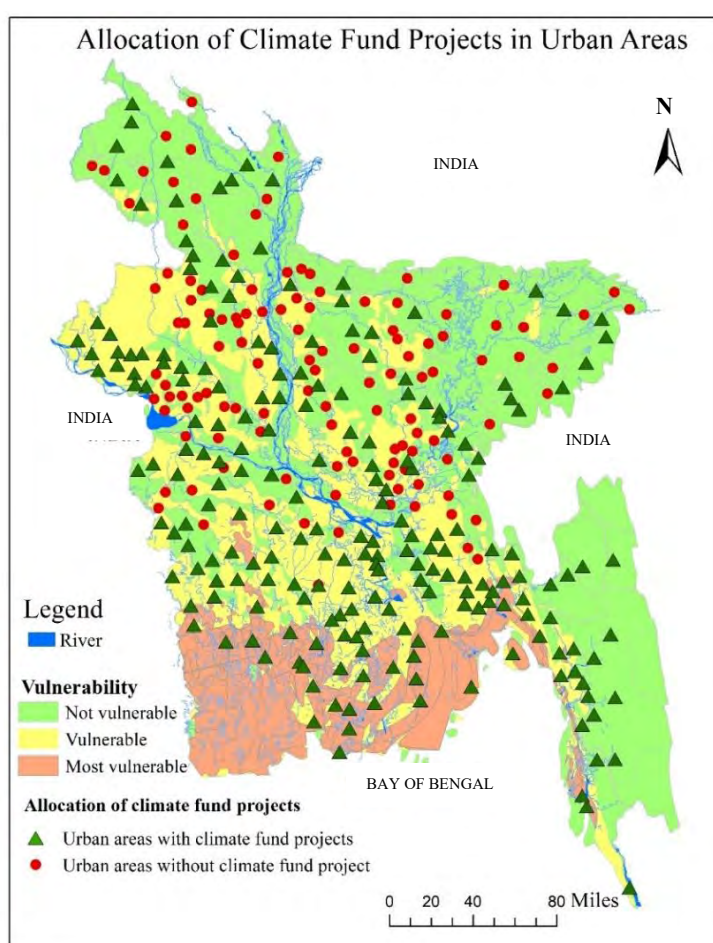
Map 5.5: BCCTF projects in most vulnerable urban areas

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

Map 5.5 shows that, there are ten most vulnerable urban areas without BCCTF urban area projects. These are- Bagerhat, Cox's bazar, Hatiya, Maheshkhali, Narail, Paikgacha, Ramgati, Barguna, Sitakunda and Sandwip. Other studies on these vulnerable areas, for example- a case study on Hatiya and Sanhwip islands, also shows the vulnerability of these islands regarding the adverse impact of increased frequency of cyclones (Paul & Rahman, 2006).

5.2.5 Overall allocation of different climate fund projects in urban areas

This segment explores the total climate fund (including BCCTF, BCCRF, GCF and GEF Trust Fund) project initiated in different urban areas.



Map 5.6: Urban areas with and without climate fund projects

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani and Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

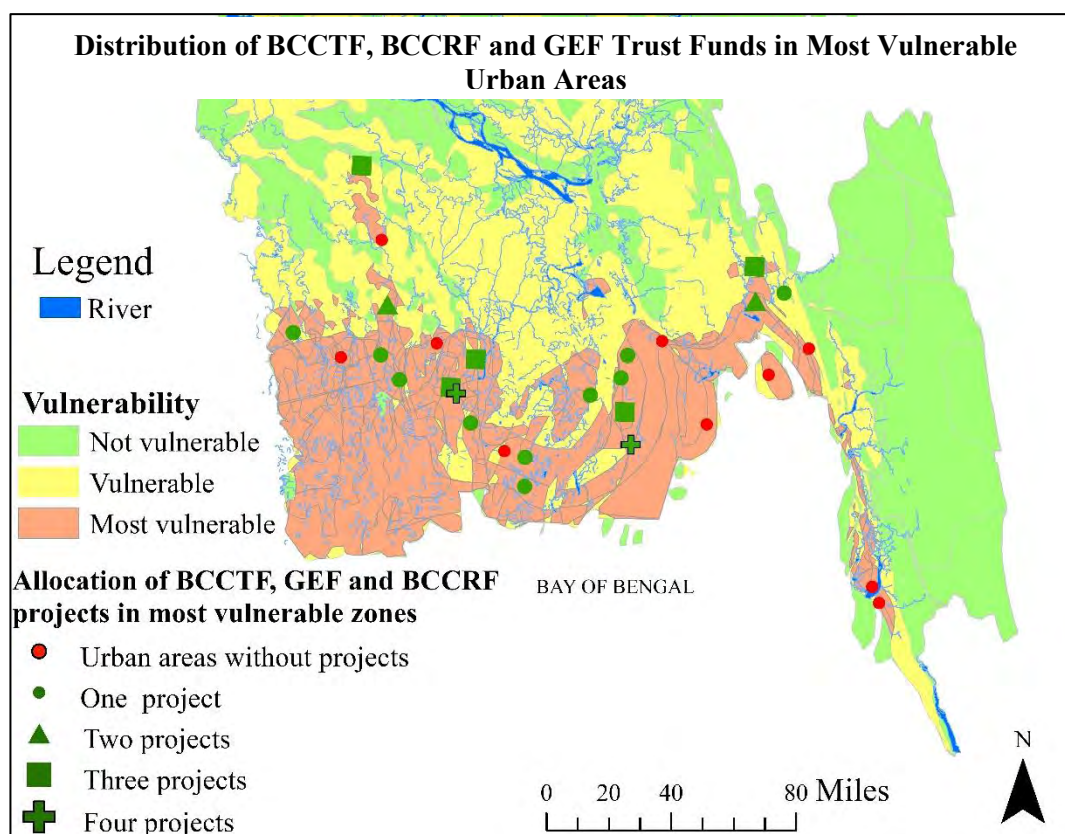
Map 5.6 locates the urban areas with and without climate fund allocation. Most of the urban areas without any climate fund allocation are mainly situated in the north side. Table 5.6 represents that there are 121 urban areas without any climate fund project (44 A class, 44 B class, 32 C class municipality and one city corporation). The table

5.6 also shows that nine projects have been taken in Dhaka (DNCC and DSCC). However, five projects have been initiated under two climate funds in A class municipality (Bhola and Charfasson municipality) and one in city corporation (Chattogram city corporation). Again, all the C class municipalities have less than four projects

Table 5.6: Distribution urban area projects in different types urban areas

Number of projects	Type of urban areas				Total
	A class municipality	B class municipality	C class municipality	City Corporation	
0 project	44	44	32	1	121
1 project	57	37	24	3	121
2 projects	35	16	6	2	59
3 projects	12	5	3	1	21
4 projects	6	2	0	2	10
5 projects	2	0	0	1	3
9 projects	0	0	0	2	2
Total	156	104	65	12	337

(Source: Table compiled from Global Environment Facility, 2020; NDA Secretariat, 2018; Green Climate Fund Independent Evaluation Unit, 2019; The World Bank, 2016; BCCT, 2019)



Map 5.7: Allocation of BCCTF, BCCRF and GEF Trust Fund projects in most vulnerable zone

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

There are around 29 urban centres situated in the most vulnerable climate zone while none of them received BCCRF urban area project and only one received GEF Trust Fund project in Khulna city corporation area. Magura and Bhandaria municipality did not receive any GCF projects. Among these 29 urban centres, 10 centres did not receive any of BCCTF, BCCRF and GEF Trust Fund projects. Only one GCF project for enhancing urban resilience program in coastal areas were undertaken in these study areas. Following table 5.7 shows the demographic profile of the urban areas where the density is highest in Cox's bazar city corporation. Again, around 453,062 people reside in these most vulnerable urban areas without any BCCTF, BCCRF and GEF Trust Fund allocation.

Table 5.7: Demographic profile of the urban areas without any BCCTF, BCCRF and GEF Trust fund projects

Name	Urban area type	Population	Area in sq. km.	Density per sq.km.
Bagerhat	A class municipality	49073	7.53	6517
Barguna	A class municipality	32235	15.57	2070
Cox's bazar	City Corporation	167477	7.94	21093
Hatiya	C class municipality	44802	30.56	1466
Maheshkhali	B class municipality	13252	7.70	1721
Narail	A class municipality	19678	17.74	1109
Paikgacha	A class municipality	16017	5.53	2896
Ramgati	C class municipality	24016	11.81	2034
Sandwip	C class municipality	41365	30.03	1377
Sitakunda	A class municipality	45147	27.97	1614

(Source: Bangladesh Bureau of Statistics, 2014)

From the NCVAR (2018), these areas also show climate vulnerability in terms of people affected, heat stress, water availability and road network (Goosen et al., 2018).

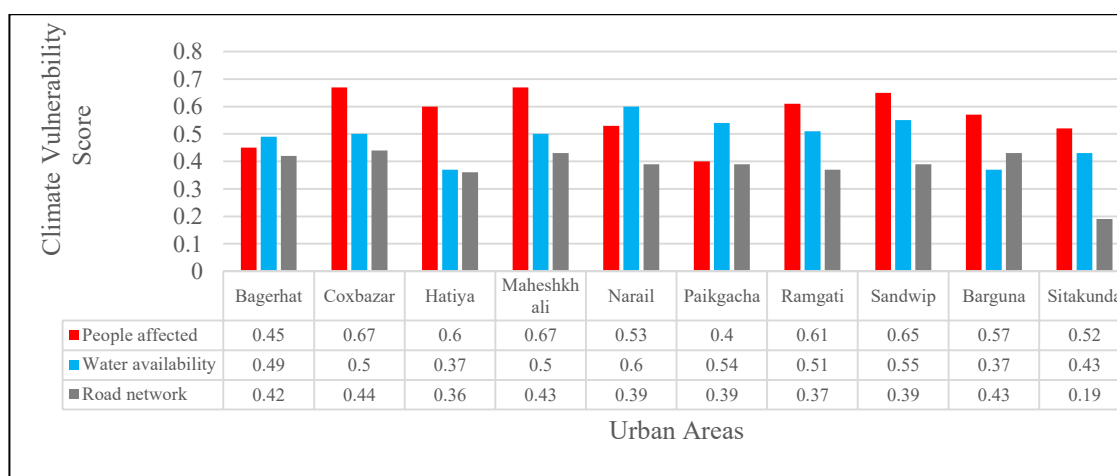


Figure 5.1: Score of areas according to National Climate Vulnerability Assessment Report (NCVAR, 2018) (Source: Goosen et al., 2018).

Figure 5.1 depicts the vulnerability score of these most vulnerable urban areas which are deprived of BCCTF, BCCRF and GEF Trust Fund allocation. Here, scores close to one show higher climate vulnerability. Most of the municipalities are vulnerable (vulnerability score more than 0.6) in terms of people affected by climate change induced hazards and water availability. Based on the vector overlay analysis, the vulnerability score is more than 1.7 for all of these municipalities except for Narail municipality (Appendence Table B1).

5.3 Fund allocation in urban area projects

This segment explores the fund allocation under different climate funds in the urban areas of Bangladesh. Only for BCCTF, the fund source is revenue budget while other funds such as GEF Trust fund, GCF and BCCRF have multilateral sources. Table 5.8 also represents that, urban area projects with total fund of around 5,729 crore BDT has been approved under different climate funds.

Table 5.8: Allocation of climate funds in urban areas

Name of the fund	Sources of fund	Urban area projects	Total Fund (in BDT)
GEF Trust Fund*	Multilateral	2	2759,08,13,850
GCF*	Multilateral	4	2258,96,00,000
Total (International)		6	5018,04,13,850
BCCTF	Revenue budget	237	704,35,20,155
BCCRF*	Multilateral	2	6,88,50,000
Total (National)		239	711,23,70,155
Total		245	5729,27,84,005

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019)

[*Here, 1\$=85 BDT exchange rate has been used]

Table 5.9 describes urban area project wise allocation of climate funds. According to Table 5.9, most fund allocation under GEF Trust fund has been taken for Greater Dhaka Sustainable Urban Transport Corridor Project which is situated in Dhaka (Both DNCC and DSCC) and Gazipur city corporations. Most of the fund under GCF have been allocated for enhancing urban resilience program which are undertaken in 19 coastal districts of Bangladesh (98 urban areas). However, comparatively less fund has been disbursed in BCCRF urban area projects compared to other multilateral climate

funds. There are 327 BCCTF urban area projects under a fund size of 704,35 Lakh BDT till 2019.

Table 5.9: Allocation of multilateral climate fund urban area projects

Fund name	Urban area project name	Climate fund in Lakh BDT	Co-financing in Lakh BDT	Total Fund size in Lakh BDT
GEF Trust fund*	Promoting Low Carbon Urban Development in Bangladesh.	3202.6	55930.0	59132.6
	ASTUD: Greater Dhaka Sustainable Urban Transport Corridor Project.	3935.5	212840.0	216775.5
GCF*	Development of Resilience in selected Hilly Municipal Areas through an Improved Early Warning System, Geo-hazard interventions, and Awareness Raising Campaigns.	8500.0	3400.0	11900.0
	Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area.	37612.5	12537.5	50150.0
	Enhancing Urban Resilience Program.	85000.0	63750.0	148750.0
	Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh.	3196.0	11900.0	15096.0
BCCRF*	Urban Flooding of Greater Dhaka Area in a Changing Climate: Vulnerability, Adaptation and Potential Costs.	----	---	433.5
	Innovations in Flood Risk Mitigation in Dhaka.	----	---	255.0

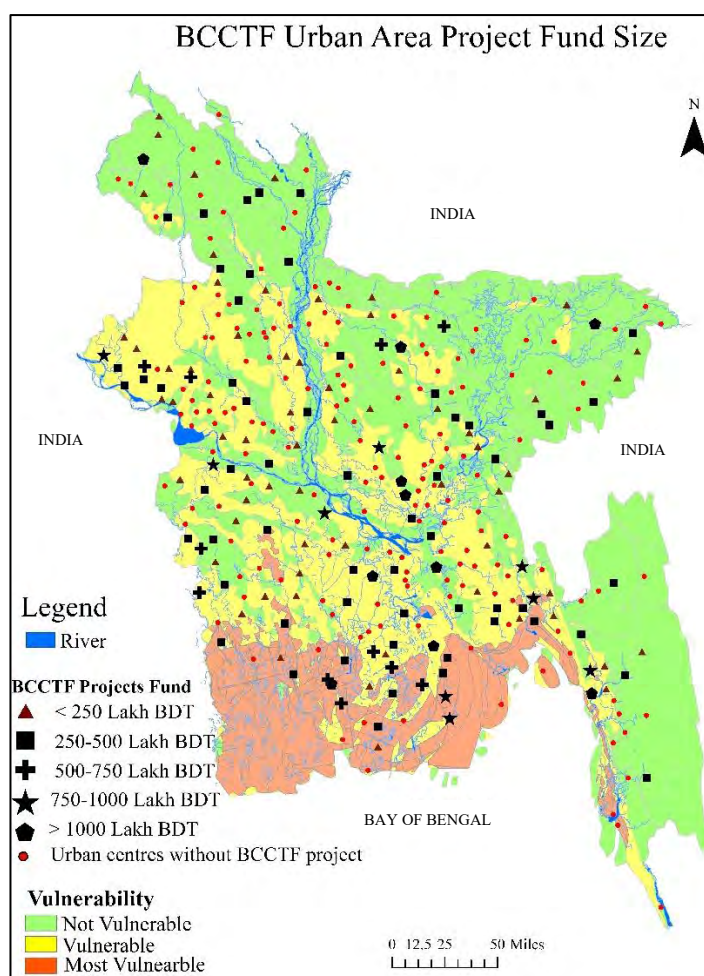
(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016) [*Here, 1\$=85 BDT exchange rate has been used]

Following table 5.10 discusses the allocation of BCCTF urban area projects in 156 urban areas in different vulnerable zones. Here, 36 BCCTF projects with 12,840 Lakh BDT fund size has been initiated in 19 most vulnerable urban centres. Mean allocation of climate fund urban area projects in most vulnerable areas (676 Lakh BDT) are almost double compared to the projects undertaken in vulnerable areas (358 Lakh BDT).

Table 5.10: Allocation of BCCTF fund in urban areas in different vulnerable zone

Vulnerability of urban areas	Urban areas with BCCTF projects	BCCTF fund size in Lakh BDT	Mean BCCTF allocation in Lakh BDT
Less vulnerable	68	31454	463
Vulnerable	69	24689	358
Most vulnerable	19	12840	676

(Source: BCCT, 2019; Rahman et al., 2019)



Map 5.8: BCCTF Urban area project fund allocation

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2019)

Map 5.8 illustrates that; ten urban areas have BCCTF allocation more than 1000 Lakh BDT. However, one project with less than 250 Lakh BDT has been taken in Rajshahi city corporation while projects with fund size 250-500 Lakh BDT have been undertaken in Barishal, Khulna and Rangpur city corporation.

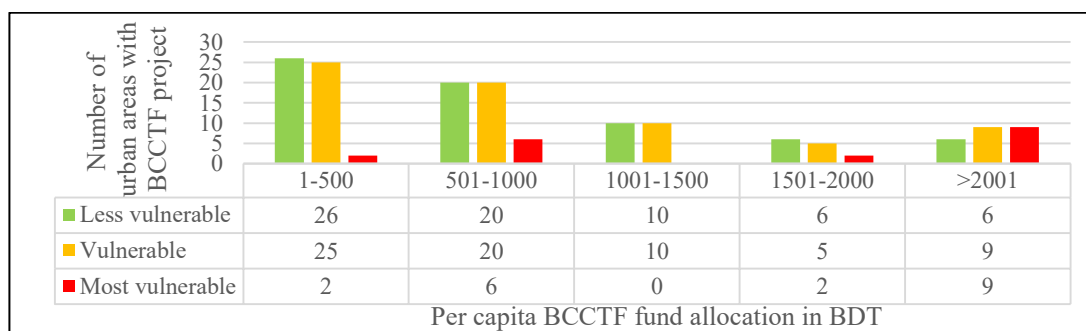


Figure 5.2: Per capita BCCTF project fund allocation in urban areas

(Source BCCT, 2019, Bangladesh Bureau of Statistics, 2014)

Per capita fund allocation of BCCTF in 156 urban areas shows that most of the projects have per capita fund allocation of 1-500 BDT (Figure 5.2). On the other hand, for projects initiated in most vulnerable urban areas, the per capita fund allocation is more than 2001 BDT for nine urban centres. These municipalities are- Sonagazi (2265 BDT), Amtali (2888 BDT), Burhanuddin (3814 BDT), Morrelganj (2990 BDT), Bauphal (6559 BDT), Mathbaria (4354 BDT), Lalmohan (4873 BDT), Bhandaria (8583 BDT) and Charfasson (14289 BDT). However, two most vulnerable urban areas have BCCTF per capita fund allocation less than 500 BDT- Khulna city corporation (60 BDT) and Satkhira municipality (353 BDT). There are around six BCCTF projects with per capita allocation less than 100 BDT in four city corporations (Rajshahi, Chattogram, Dhaka North, Dhaka South) and two municipalities-Bhairab and Jhenaidah.

Mean BCCTF urban area project per capita fund allocation is 1291 BDT. Where the mean value of per capita BCCTF allocation is BDT 3083 for most vulnerable, 1156 BDT for vulnerable and 928 BDT for less vulnerable zone. Therefore, as the population in most vulnerable urban areas is less compared to other urban areas, the per capita BCCTF fund allocation is higher. On the other hand, there are 171 urban areas without any BCCTF climate fund project, where ten of these urban areas are in the most vulnerable coastal zones facing climate change induced sea level rise, salinity intrusion, storm surge, cyclone etc. For example, 167,477 people reside in most vulnerable Cox's bazar city corporation who are deprived of BCCTF fund allocation.

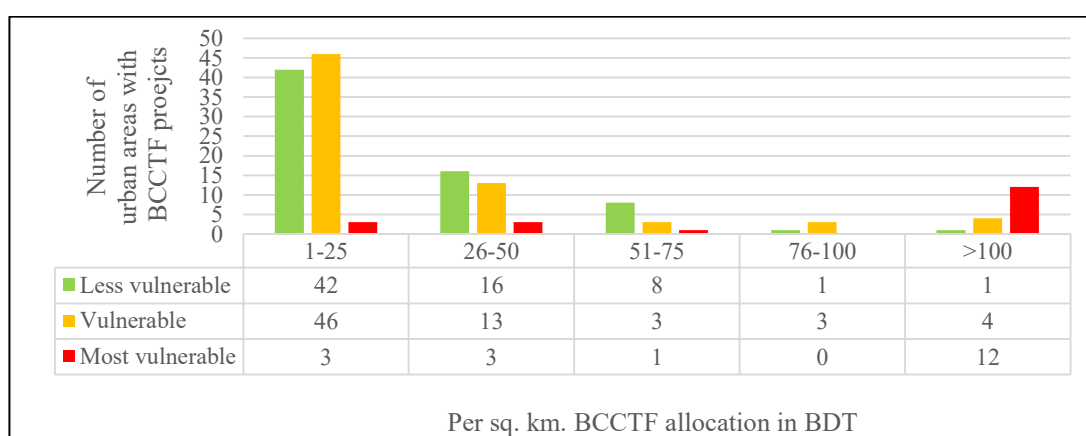


Figure 5.3: Per sq. km. BCCTF project fund allocation in different urban areas
(Source BCCT, 2019, Bangladesh Bureau of Statistics, 2014)

Per sq. km fund allocation of BCCTF projects in the urban areas shows that, 12 projects in the most vulnerable zone have more than 100 BDT fund allocation (Figure 5.3). On the other hand, urban areas situated in less and vulnerable zones have per sq. km. BCCTF allocation less than 50 BDT.

The division wise distribution of climate fund projects in urban areas show that, Chattogram (19%, 48 projects), Dhaka (16%, 41 projects) and Rajshahi (16%, 40 projects) division have highest number of urban area projects (See Appendices Table B2). However, most vulnerable urban areas are situated in Dhaka, Chattogram, Khulna and Barishal division of Bangladesh (Mani et al., 2018; Banks et al., 2011).

Following Table 5.11 depicts division wise climate fund allocation. Around 50% of the total fund is allocated to tackle climate change impact in Dhaka division. On the other hand, Mymensingh, Rangpur and Sylhet division has minimum number of project as well as fund allocation. The multi division fund allocation under GCF has been taken in Dhaka, Chattogram, Khulna and Rajshahi division, while for BCCTF, the projects have been taken in Dhaka and Chattogram division.

Table 5.11: Distribution of climate funds in divisions (in lakh BDT)

Division name	GEF Trust Fund*	GCF*	BCCTF	BCCRF*	Total	% of allocation
Barishal	0	50150	14023	0	64173	11%
Chattogram	0	11900	13185	0	25085	4%
Dhaka	275908	0	9366	689	285963	50%
Khulna	0	0	7281	0	7281	1%
Mymensingh	0	0	4994	0	4994	1%
Rajshahi	0	0	9129	0	9129	2%
Rangpur	0	0	5605	0	5605	1%
Sylhet	0	0	4167	0	4167	1%
Multi division	0	163846	2683	0	166529	29%

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019), [*Here, 1\$=85 BDT exchange rate has been used]

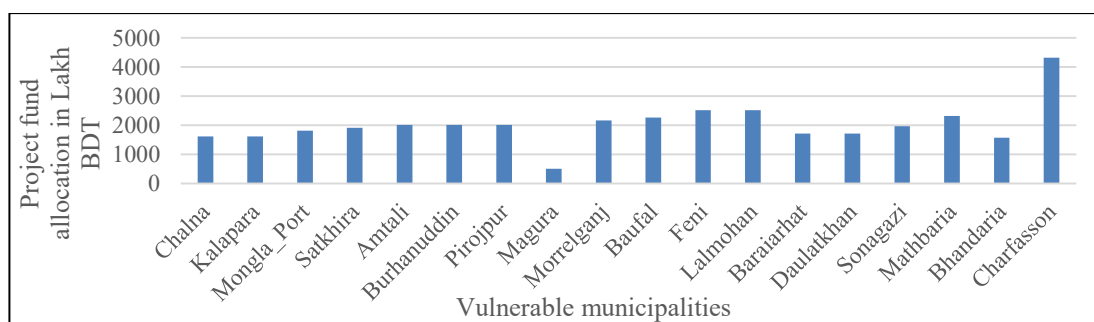


Figure 5.4: Climate fund allocation in most vulnerable urban areas (Source: Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019)

Figure 5.4 depicts that all most vulnerable municipalities have a total climate fund allocation less or equal to approximately 2,500 lakh BDT except for Charfasson municipality. Lowest fund has been allocated in Magura municipal area.

Following table 5.12 discusses the per capita fund allocation in these vulnerable zones. Charfasson municipality has higher per capita total fund allocation compared to others. On the other hand, Magura municipality have BDT 520 per capita fund allocation. However, Khulna city corporation has BDT 2973 per capita fund allocation.

Table 5.12: Per capita total climate fund allocation in the most vulnerable zone

Name	Fund allocation in Lakh BDT	Population	Per capita allocation in BDT
Chalna	1618	14188	11403
Kalapara	1618	17332	9335
Mongla Port	1818	39837	4563
Satkhira	1918	113322	1692
Amtali	2018	17311	11657
Burhanuddin	2018	13110	15392
Pirojpur	2018	60056	3360
Magura	511	98355	520
Morrelganj	2168	21741	9971
Baufal	2268	11435	19833
Feni	2518	156971	1604
Lalmohan	2518	20522	12269
Baraiarhat	1718	11602	14807
Daulatkhan	1718	16728	10269
Sonagazi	1968	19866	9906
Mathbaria	2318	18375	12614
Bhandaria	1579	18396	8583
Charfasson	4318	19595	22036
Khulna	19720	663342	2973

(Source: Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019; Bangladesh Bureau of Statistics, 2014)

Following table 5.13 shows that, three city corporations (Cox's bazar, Gazipur and Narayanganj) do not have any national climate fund (BCCTF and BCCRF) allocation. Most of the city corporations have per capita national climate fund allocation less than 100 BDT while Sylhet city corporation have 389 BDT national climate fund allocation. However, five city corporations have 10 BDT or less than 10 BDT per sq. km. national climate fund allocation where for Sylhet city corporation, the allocation is 70 BDT per sq. km.

Table 5.13: National climate fund allocation in city corporations

Name of the city corporation	Population	Area in sq. km.	BCCTF in Lakh BDT	BCCRF in Lakh BDT	Total national fund in Lakh BDT	Per capita fund in BDT	Per sq. km. fund in BDT
Cox's bazar	167477	7.94	0	0	0	0	0
Khulna	663342	50.61	400	0	400	60	8
Gazipur	179037	47.23	0	0	0	0	0
Narayanganj	286330	12.69	0	0	0	0	0
Rajshahi	448087	97.18	200	0	200	45	2
Barishal	328278	58.05	400	0	400	122	7
Chattogram	2581643	155.4	1092	0	1092	42	7
Comilla	235423	11.47	0	0	0	0	0
Rangpur	300659	50.69	500	0	500	166	10
Sylhet	479837	26.50	1867	0	1867	389	70
Dhaka North	4000000	196.22	2612	344.25	2956.25	74	15
Dhaka South	3800000	109.25	2612	344.25	2956.25	78	27

(Source: The World Bank, 2016; BCCT, 2019; Bangladesh Bureau of Statistics, 2014; Dhaka North City Corporation, 2020; Dhaka South City Corporation, 2020)

5.4 Fiscal year and status of the climate fund projects

This segment explores the fiscal year and status of the climate fund projects. Table 5.14 shows the project timeline and status of multilateral climate funded projects taken in the urban areas of Bangladesh. All of the urban area projects under GCF are ongoing. Only three projects, one under GEF Trust fund and two under BCCRF has been completed. All these three projects have been taken in the Dhaka division.

Table 5.14: Fiscal year and status of multilateral fund projects in urban areas

Fund name	Urban area project name	Approved Fiscal year	Status
GCF	Development of resilience in selected hilly municipal areas through an improved early warning system, geo-hazard interventions, and awareness raising campaigns.	2018-2020	Ongoing
	Climate resilient drainage, canal dredging, and flood control for Barishal city corporation area.	2018-2019	Ongoing
	Enhancing urban resilience program.	2018-2019	Ongoing
	Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh.	To be determined	Ongoing
GEF Trust fund	Promoting low carbon urban development in Bangladesh.	2016-2018	Ongoing
	ASTUD: Greater Dhaka sustainable urban transport corridor project	2012-2017	Complete

Fund name	Urban area project name	Approved Fiscal year	Status
BCCRF	Urban flooding of greater Dhaka area in a changing climate: vulnerability, adaptation and potential costs	2010-2016	Complete
	Innovations in flood risk mitigation in Dhaka	2010-2017	Complete

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016)

Table 5.15 shows the fund allocation of the climate fund projects in different time periods. More fund under BCCTF has been allocated between 2014-2015 and the number of projects initiated is also higher at this time period (total 91 urban area projects). Though, most of the urban area projects under BCCTF has been initiated after 2018, the fund size is lower compared to 2014-2015. However, in 2010, not a single urban area project has been taken under BCCTF. Most of the fund under GEF Trust Fund for urban area projects has been allocated in 2012. Again, all the urban area projects under BCCRF have been taken in 2010 while all the urban area projects under GCF have been undertaken after 2018.

Table 5.15: Allocation of climate funds in urban areas along with initiation time

Initiation time of the project	BCCTF		BCCRF		GEF Trust		GCF		Total fund
	Fund size in Lakh BDT	No. of project	Fund size in Lakh BDT	No. of project	Fund size in Lakh BDT	No. of project	Fund size in Lakh BDT	No. of project	
2009	2183	1	0	0	0	0	0	0	2183
2010	0	0	689	2	0	0	0	0	689
2011	6015	10	0	0	0	0	0	0	6015
2012	4040	7	0	0	216776	1	0	0	220816
2013	7140	18	0	0	0	0	0	0	7140
2014	15137	46	0	0	0	0	0	0	15137
2015	12798	45	0	0	0	0	0	0	12798
2016	6000	20	0	0	59133	1	0	0	65133
2017	6589	30	0	0	0	0	0	0	6589
2018 and later	10533	59	0	0	0	0	225896	4	236429

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019)



Figure 5.5: Distribution of BCCTF urban area projects in different time frame

(Source: BCCT, 2019)

Figure 5.5 depicts the fiscal year wise initiation of urban area projects under BCCTF. Though, number of urban area project increased in 2014-2015 and 2015-2016, it decreased in the following two fiscal years and then increased up to 59 projects in 2018-19 fiscal year. For getting project approval from ministry, different agencies and organizations need to apply with project proposal and after a review process those projects get approved by ministry with BCCTF fund. It is assumed that, there might be less application for urban area project approval between 2016-2018. There was only one urban area project taken in DNCC, DSCC and Chattogram city corporations to provide 3R strategies of solid management under BCCTF. But later both the fund size changed and time frame extended to 2019 (BCCT, 2019). Division wise initiation of BCCTF urban area projects in different fiscal year shows that, most of the projects in the Barishal division initiated in 2014-2016 (Appendices Table B3). It might be because of the occurrence of frequent climate change induced hazards in Barishal division. However, most of the projects in Dhaka, Chattogram and Rajshahi division initiated in 2018.

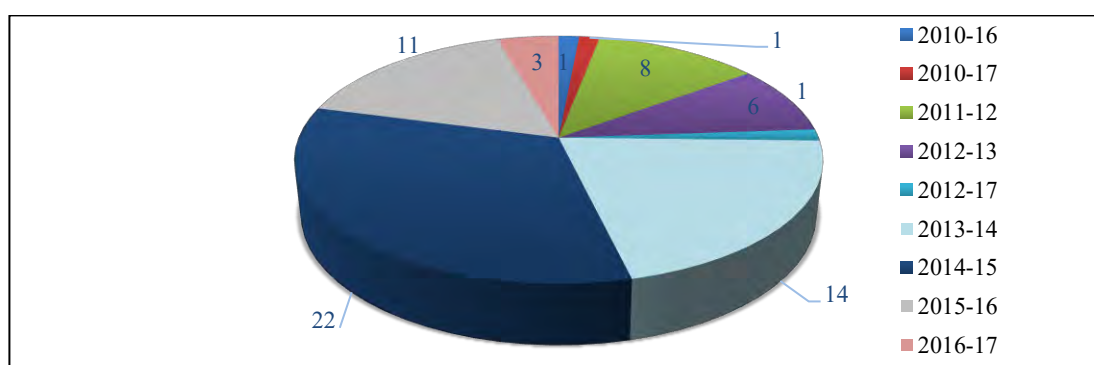


Figure 5.6: Initiation time of completed BCCTF urban area projects

(Source: BCCT, 2019).

Figure 5.6 depicts that till 2019, 22% of the completed BCCTF projects was initiated for the fiscal year 2014-2015 where 14% in 2013-14 and 11% in 2015-16. Only 3% of the BCCTF projects initiated in 2016-17 are completed projects.

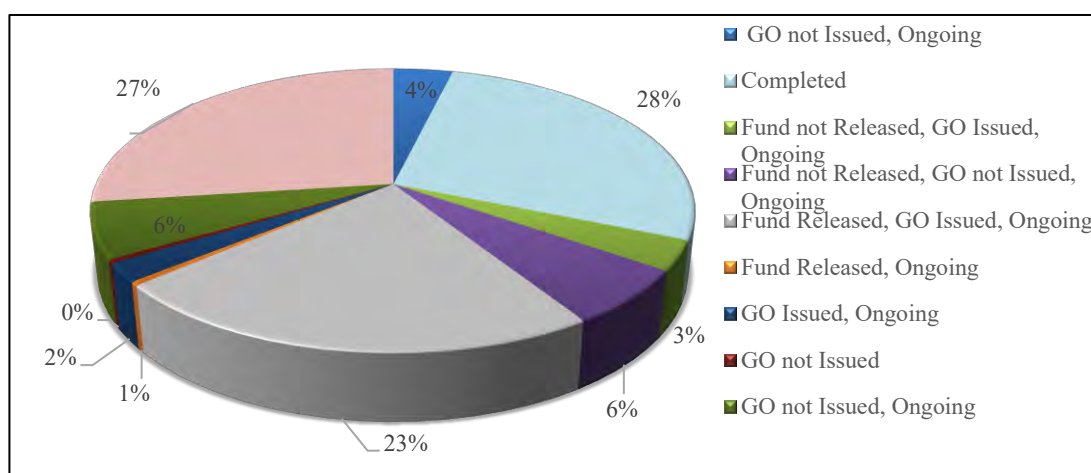


Figure 5.7: Status of the BCCTF urban area projects (Source: BCCT, 2019).

Figure 5.7 depicts the status of the BCCTF urban area projects. 28% projects have been completed while others are ongoing projects till 2019. The figure 5.7 also represents that, there are around ongoing (27%) and fund released GO (Government Order) issued ongoing (23%) projects under BCCTF in urban areas of Bangladesh.

5.5 Implementing agency and ministry of the climate fund projects

Multiple agencies are involved in implementing the climate fund projects. Table 5.16 describes the implementing agency and other executing partners of the urban area climate fund projects in Bangladesh for multilateral climate funds. Table 5.16 shows that projects under BCCRF have been implemented by WBG (The World Bank Group) while UNDP (United Nations Development Programme) was involved in two projects under GCF and one project under GEF Trust Fund. NGO's such as Palli Karma-Sahayak Foundation (PKSF) and Grameen Shakti are involved in climate resilient drainage and flood control project for Barishal City corporation under GCF. Government agencies and ministries such as BMD (Bangladesh Meteorological Department), LGED (Local Government Engineering Department), MoPEMR (Ministry of Power, Energy and Mineral Resources) and RTHD (Road Transport and

Highways Division) are engaged as executing partners of the urban area climate fund projects.

Table 5.16: Implementing agency of multilateral fund projects in urban areas

Fund name	Urban area project name	Agency	Other executing partners
GCF	Development of resilience in selected hilly municipal areas through an improved early warning system, geo-hazard interventions, and awareness raising campaigns	JICA and UNDP	NGI, GSB, District Councils of Project Area and BMD, Government of Bangladesh
	Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area	IDCOL and PKSF	Grameen Shakti
	Enhancing urban resilience program	KfW	Local Government Engineering Department
	Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh	UNDP	IDCOL and MoPEMR, Government of Bangladesh
GEF Trust fund	Promoting low carbon urban development in Bangladesh	UNDP	MoPEMR, Government of Bangladesh
	ASTUD: Greater Dhaka sustainable urban transport corridor project	ADB	RTHD, Government of Bangladesh
BCCRF	Urban flooding of greater Dhaka area in a changing climate: vulnerability, adaptation and potential costs	WBG	DFID
	Innovations in flood risk mitigation in Dhaka	WBG	DFID

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019)

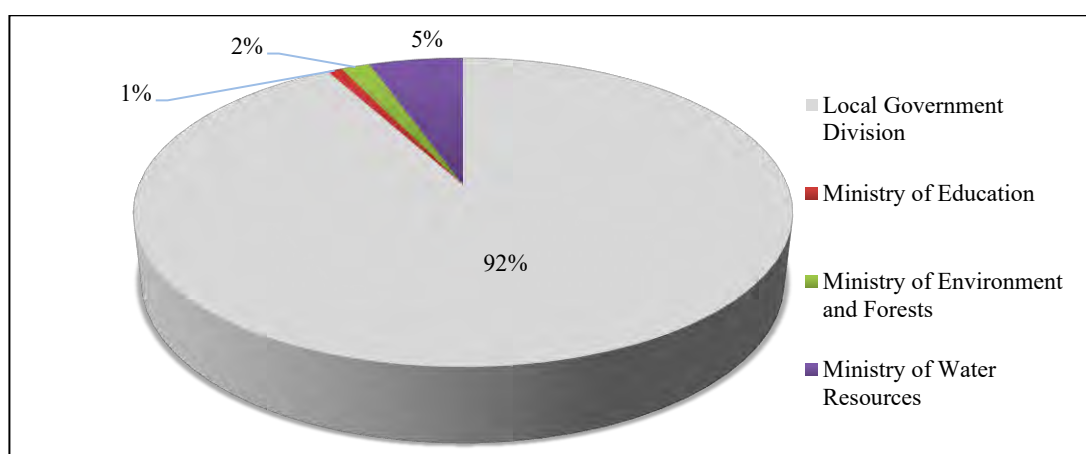
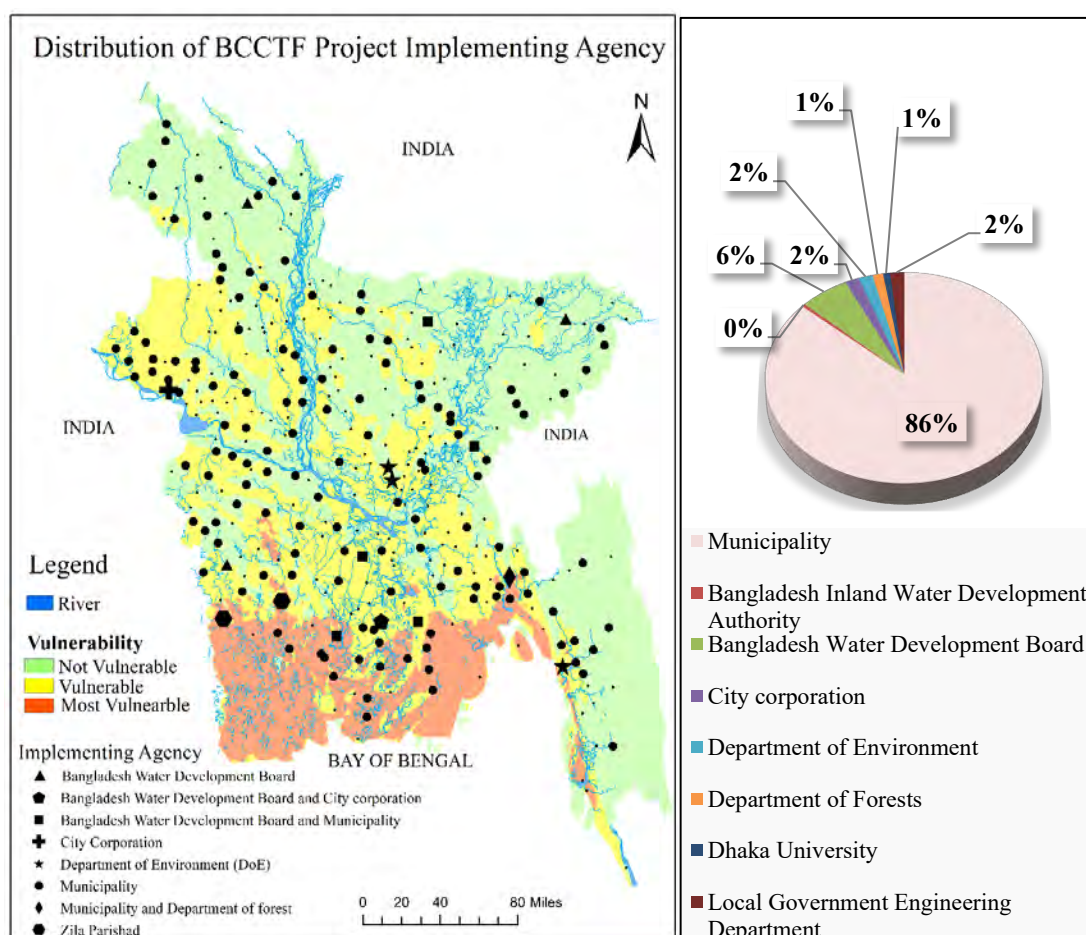


Figure 5.8: Implementing ministry of urban area projects under BCCTF

(Source: BCCT, 2020)

Figure 5.8 shows that around 92% of the BCCTF urban area projects (218 projects) has been implemented by Local Government Division. Only 5% of the projects (13 projects) has been implemented by Ministry of Water Resource while 2% by Ministry of Environment and Forests and 1% by Ministry of Education. The projects implemented by Ministry of Water resource are mainly for construction of embankment, cyclone center and excavation of canal to protect urban areas from climate change induced hazards. However, the projects under Ministry of Environment and Forests are initiated for promoting 3R strategy for solid waste management system, plantation, eco-park development and environmental improvement.



Map 5.9 depicts the spatial distribution of urban area projects taken under different agencies of Bangladesh for BCCTF. Figure 5.9 shows the distribution of project

implementing agencies of BCCTF projects in urban areas. The pie chart shows that around 86% (205 projects) of the urban area projects has been implemented by municipalities. Only 6% of the projects have been implemented by Bangladesh Water Development Board under Ministry of Water Resource.

5.6 Summary

This chapter discusses the climate fund allocation in the urban areas of Bangladesh. Among, 703 climate fund projects until 2019, only 245 projects have been taken in urban areas under BCCTF, BCCRF, GCF and GEF Trust Fund with total fund of around 5,729 crore BDT. Division wise BCCTF urban area project allocation shows that, Dhaka (16%, 41 projects), Chattogram (19%, 48 projects) and Rajshahi (16%, 40 projects) division has highest number of urban area projects while urban areas in Chattogram, Khulna and Barishal division of Bangladesh are more vulnerable considering climate change induced hazards. Around 50% of the total fund is allocated to tackle climate change impact in Dhaka division. Around 29 most vulnerable urban centres did not receive BCCRF urban area project and only one received GEF Trust Fund project in Khulna city corporation area.

Most of the projects under BCCTF have been taken for infrastructural development (25 projects, 11%), solar power street lightening system (18 projects, 8%), to tackle waterlogging and environmental improvement (94 projects, 40%), improvement of drainage (14 projects, 6%) etc. There are 121 urban areas without any climate fund project (44 A class, 44 B class, 32 C class municipality and one city corporation) while 29 of these are situated in most vulnerable zone. There is not any BCCTF, BCCRF and GEF Trust fund undertaken in ten of these most vulnerable urban areas. Future allocation of climate fund project needs to address the climate change induced hazards in these urban areas.

CHAPTER 6: Analysis of Urban Area Climate Fund Projects in the Light of Plan, Policies and Local Context

This chapter discusses the urban area climate fund projects in the light of national and international plans and policies. The discussion focuses on the consistency of allocation of climate funds addressing different pillars, themes, goals, issues, strategies etc. considered in national and international plans and policies. This chapter also presents critical review of plans and policies which has been ignored or not adequately addressed during the initiation of climate change projects in urban areas of Bangladesh.

6.1 National Climate Change Plans and Policies

There are several national plans and policies which address the effects of climate change along with possible adaptation and mitigation measures.

6.1.1 Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009

BCCSAP (2009) aims at increasing the country's resilience to climate change by prioritizing adaptation and disaster risk reduction to promote rapid development (Ministry of Environment and Forests, 2009a). The pillars under BCCSAP (2009) focuses on food security, social protection and health, comprehensive disaster management, infrastructure, research, low carbon development, capacity building as well as institutional strengthening (Appendices Table B4). Comprehensive disaster management focuses on improvement on early warning system, awareness raising and risk management against loss on income and property. Pillar three, infrastructure suggests repair and maintenance of flood embankments, cyclone shelters and coastal polders, improvement of urban drainage etc. Mitigation and low carbon development addresses energy efficiency, renewable energy development, afforestation etc.

Table 6.1 represents the distribution of BCCTF projects under the pillars and themes of BCCSAP (2009) till 2019. Each project under BCCTF needed to address different pillars of BCCSAP (2009) before fund approval. So, the table has been generated from the project's files of each project under BCCTF. Among 237 urban area projects, 194 (49%) projects address infrastructure. Around 181 projects address improvement of urban drainage, 103 projects address planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work. Among 144

(36%) projects which addressed Mitigation and Low Carbon Development, 120 projects addressed renewable energy development while 122 addressed rapid expansion of energy saving device. Not a single urban area BCCTF project addressed Pillar 2, Comprehensive Disaster Management and Pillar 6, Capacity Building and Institutional Strengthening of BCCSAP (2009).

Table 6.1: Distribution of BCCTF Projects according to of Pillars of BCCSAP (2009)

Themes of BCCSAP (2009)	Pillars under themes	Number of BCCTF projects	Total Project	Total cost (in lakh BDT)
Pillar 1: Food Security, Social Protection and Health	P1. Institutional capacity and research towards climate resilient cultivars and their dissemination	2	59	1,099.0
	P6. Adaptation in health sector	1		
	P7. Water and sanitation programme in climate vulnerable areas	47		
	P8. Livelihood protection in ecologically fragile areas	8		
	P9. Livelihood protection of vulnerable socio-economic groups	10		
Pillar 3: Infrastructure	P2. Repair and maintenance of cyclone shelters	3	194	59,066.5
	P3. Repair and maintenance of coastal polders	1		
	P4. Improvement of urban drainage	181		
	P5. Adaptation against floods	44		
	P6. Adaptation against tropical cyclones and storm surges	1		
	P7. Planning and design of river training works	5		
	P8. Planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work	103		
Pillar 4: Research and Knowledge Management	P6. Monitoring of internal and external migration of adversely impacted population and providing support to them through capacity building for their rehabilitation in new environment	1	1	100.0
Pillar 5: Mitigation and Low Carbon Development	P1. Improved energy efficiency in production and consumption of energy	9	144	10,169.7
	P4. Renewable energy development	120		
	P5. Lower emission from agricultural land	2		
	P6. Management of urban waste	8		
	P7. Afforestation and reforestation programme	97		
	P8. Rapid expansion of energy saving device	122		
	P9. Energy and waste efficiency in built environment	2		
	P10. Improvement in energy consumption pattern in transport sector and options for mitigation	4		

(Source: Table adapted from BCCT, 2019; Ministry of Environment and Forests, 2009a)

As most of the projects address multiple themes of BCCSAP (2009), for estimating fund allocation under the themes, the first theme addressed in the projects (according to the project files from BCCT) has been considered. Around, 59,066.5 lakh BDT has been allocated under pillar three for BCCTF urban area projects (Table 6.1).

Table 6.2 describes the distribution of multilateral climate fund urban area projects on the basis of BCCSAP (2009). Both projects under BCCRF address Research and Knowledge Management (pillar 4) while both projects under GEF Trust Fund address Mitigation and Low Carbon Development (pillar 5).

Table 6.2: Distribution of multilateral fund urban area projects on the basis of BCCSAP (2009)

Fund name	Project name	Themes of BCCSAP	Pillars under themes
BCCRF	Urban Flooding of Greater Dhaka Area in a Changing Climate: Vulnerability, Adaptation and Potential Costs	Pillar 4: Research and Knowledge Management	•P2. Climate change modeling at national and subnational level •P4. Monitoring of ecosystem and biodiversity changes and their impacts
	Innovations in Flood Risk Mitigation in Dhaka	Pillar 4: Research and Knowledge Management	•P2. Climate change modeling at national and subnational level •P5. Macroeconomic and sectoral economic impacts of climate change
GEF Trust Fund	Promoting Low Carbon Urban Development in Bangladesh	Pillar 5: Mitigation and Low Carbon Development	•P6. Management of urban waste •P8. Rapid expansion of energy saving device •P9. Energy and waste efficiency in built environment
	ASTUD: Greater Dhaka Sustainable Urban Transport Corridor Project	Pillar 5: Mitigation and Low Carbon Development	•P6. Management of urban waste •P9. Energy and waste efficiency in built environment •P10. Improvement in energy consumption pattern in transport sector and options for mitigation
GCF	Development of Resilience in selected Hilly Municipal Areas through an Improved Early Warning System, Geo-hazard interventions, and Awareness Raising Campaigns	Pillar 2: Comprehensive Disaster Management	•P1. Improvement of flood forecasting and early warning •P3. Awareness raising and public education towards climate resilience
	Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area	Pillar 3: Infrastructure	•P4. Improvement of urban drainage •P5. Adaptation against floods •P8. Planning, design and implementation of resuscitation of river and khals
	Enhancing Urban Resilience Program	Pillar 6: Capacity Building and	•P5. Strengthening institutional capacity for climate change management

Fund name	Project name	Themes of BCCSAP	Pillars under themes
		Institutional Strengthening	
		Pillar 3: Infrastructure	•P4. Improvement of urban drainage
		Pillar 5: Mitigation and Low Carbon Development	•P6. Management of urban waste
	Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh	Pillar 5: Mitigation and Low Carbon Development	•P4. Renewable energy development •P8. Rapid expansion of energy saving device •P9. Energy and waste efficiency in built environment

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; Ministry of Environment and Forests, 2009a)

6.1.2 National Adaptation Programme of Action (NAPA), 2009

The objective to prepare the National Adaptation Programme of Action (NAPA) was to address immediate and urgent needs to tackle climate change along with proposing potential adaptation measures incorporating the findings of researches on climate change impacts, vulnerabilities and adaptation need assessment (Ministry of Environment and Forests, 2009b).

The adaptation strategies of NAPA (2009) were proposed for eight adaptation measures- research and knowledge management, agriculture, fisheries and livestock, health, building climate resilient infrastructure, disaster management, livelihood, biodiversity, policy and institutional capacity building (Appendices Table B5). Adaptation strategies have been proposed under building climate resilient infrastructure measure for repairing, rehabilitating existing infrastructure of urban drainage system as well as planning, designing and constructing urgently needed new ones.

Among the 245 urban area climate fund projects, 79 projects address adaptation strategy while 131 projects address both adaptation and mitigation (Table 6.3). The projects which address adaptation strategies are mainly initiated for structural development such as construction of embankment, disaster resilient housing, drainage system, road network, excavation of khal etc. However, projects with mitigation strategy to tackle climate change were undertaken for carbon mitigation, solid waste management, solar powered street lighting, environmental improvement etc.

Table 6.3: Types of strategy (mitigation/ adaptation) adopted by climate fund in urban area projects.

Name of Fund	Type of strategy			Total
	Adaptation	Mitigation	Both adaptation and mitigation	
BCCRF	2	0	0	2
BCCTF	74	34	129	237
GCF	3	1	0	4
GEF Trust Fund	0	1	1	2
Total	79	36	131	245

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment and Forests, 2009b)

Following Table 6.4 describes the distribution of urban area climate fund projects addressing adaptation measures proposed in NAPA (2009). Climate fund urban area projects only addressed four among eight adaptation strategies proposed in NAPA (2009). According to Table 6.4, around 201 projects has been taken under building climate resilient infrastructure strategy in NAPA (2009) which proposed construction of embankment, drainage system, disaster resilient housing etc. Both projects under BCCRF address research and knowledge management.

Table 6.4: Distribution of urban area climate fund projects on the basis of adaptation measures proposed in NAPA (2009)

Fund name	Adaptation measures in NAPA (2009)				Total
	Building Climate Resilient Infrastructure	Disaster Management	Health	Research and Knowledge Management	
BCCRF	0	0	0	2	2
BCCTF	199	0	3	1	203
GCF	2	1	0	0	3
GEF Trust Fund	0	0	0	0	0
Total	201	1	3	3	208

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment and Forests, 2009b)

Urban flooding of greater Dhaka area in a changing climate project under BCCRF fund developed climate change scenarios for Dhaka by applying climate change models and methodologies at regional levels. Innovations in flood risk mitigation in Dhaka under BCCRF addresses development of climate change scenarios using models, identifies the impact of climate change on ecosystem, biodiversity and macro economy. Only

project addressing disaster management under GCF addresses strengthening community-based adaptation programmes as well as early warning system. All three BCCTF projects addressing adaptation strategies for health is undertaken for providing safe drinking water and sanitation programme.

6.1.3 Bangladesh Climate Change Gender Action Plan (ccGAP), 2013

Bangladesh Climate Change Gender Action Plan (ccGAP) aims at promoting the means to bring equal emphasis for women and men, toward gender equality and enhanced sustainability (Ministry of Environment and Forests, 2013a). Action steps have been proposed in ccGAP (2013) under four key pillars of BCCSAP (2009) (Appendices Table B6). The action steps have put emphasis on ensuring alternative livelihood opportunities for women affected by climate change in urban settings (pillar 1), informing poor women in urban areas on Disaster Risk Reduction (DRR) issues (pillar 2), increasing women's participation in climate change related infrastructure development (pillar 3) as well as in solid waste and drainage management (pillar 5) etc. Two action plans (ensuring alternative livelihood opportunities and informing on DRR issues as well as addressing them in policy framework) under ccGAP (2013) addressed the need of women living in urban settings. Even though several action steps were proposed in ccGAP (2013), not a single climate fund urban area project addressed any of these action steps. Some BCCTF projects considered gender issues in terms of reducing health risk of women; providing benefit to women through ensuring better living environment by reducing waterlogging; providing safe drinking water, waste management, improved transport facilities, job opportunities; ensuring safety of women at night by continuous electricity etc. (BCCT, 2019).

6.1.4 7th Five Year Plan (FYP), 2016-2020

The objectives stated in the 7th FYP for climate change, environment and disaster management are to attain good governance in environmental sustainability, ensure sustainable and more efficient cities, improve environmental health by preserving agricultural land and wetlands and meeting national air and water quality standards as well as reduce potential economic losses due to climate change particularly from floods, drought and salinity etc. (General Economic Division, 2015).

The proposed activities under 7th five-year plan for addressing climate change show that, under adaptation strategy, the plan proposed enhancing Capital Cost Allowance (CCA) financing, managing hazards, infrastructural functioning etc. while under mitigation strategy it proposed enhancing understanding on LCD (Low Carbon Development), capacity of energy saving sectors, ensuring investment in research and innovation etc. (Appendices Table B7).

Table 6.5 describes that, both BCCRF urban area projects addressed managing hazards and disasters strategy of adaptation while both GEF trust fund projects addressed enhancing capacity of energy saving sectors strategy of mitigation. Two GCF projects (Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area project and Enhancing Urban Resilience Program) addressed infrastructural functioning and maintenance under adaptation. Around 198 BCCTF urban area projects addressed infrastructural functioning and maintenance under adaptation strategy in 7th five-year plan.

Table 6.5: Distribution of urban area climate fund projects on the basis of measures proposed in 7th five-year plan (2016-2020) of Bangladesh.

Type of strategy	Measures proposed in 7 th 5-year plan	Name of the fund				Total
		BCCRF	BCCTF	GCF	GEF Trust Fund	
Adaptation	Food security, social protection and Health	0	3	0	0	3
	Curbing internal migration and displacement	0	1	0	0	1
	Enhance CCA financing	0	0	0	0	0
	Infrastructural functioning and maintenance	0	198	2	0	200
	Managing hazards and disasters	2	0	0	0	2
	Total	2	202	2	0	206
Mitigation	Enhance capacity of energy saving sectors	0	31	0	2	33
	Ensuring investment in research and innovation	0	1	0	0	1
	Other Activities	0	2	0	0	2
	Total	0	34	0	2	36
Total		2	236	2	2	244

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; General Economic Division, 2015)

6.1.5 Bangladesh National Action Plan (NAP) for Reducing SLCPs, 2018

Short Lived Climate Pollutants (SLCPs) refer to four types of pollutants: Black Carbon (BC)(soot); Methane; Tropospheric Ozone (O₃); and some Hydrofluorocarbons (HFCs) which are relatively short-lived in the atmosphere and have significant adverse impacts on health, agriculture and ecosystem productivity, and near-term or regional climate (Ministry of Environment Forests and Climate Change, 2018).

Bangladesh National Action Plan (NAP) for Reducing SLCPs aims at identifying the major emission sources for taking immediate action; the information, capacity and finance gaps needed to be filled to ensure effective long-term planning; and initial options for addressing some of the challenges and problems posed by SLCP mitigation (Ministry of Environment Forests and Climate Change, 2018). The document addressed different sectors such as transport, industry, residential, waste management, agriculture, fossil fuel production etc. (Appendices Table B8).

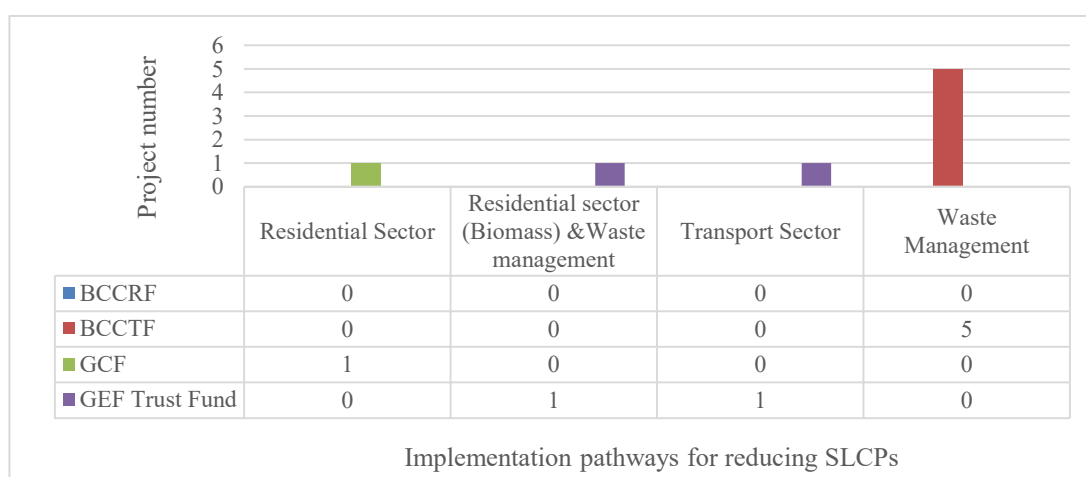


Figure 6.1: Distribution of urban area climate fund projects on the basis of action plans proposed in NAP for Reducing SLCPs (2018) (Source: Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment Forests and Climate Change, 2018)

Figure 6.1 shows that only eight urban area climate fund projects addressed the pathways proposed in NAP for reducing SLCPs. Five urban area projects have been taken under BCCTF fund for solid waste management system improvement by separation and treatment of biodegradable municipal waste through recycling. Promoting low carbon urban development in Bangladesh under GEF Trust Fund addressed both residential sector and waste management sector. ASTUD: Greater Dhaka sustainable urban transport corridor project under GEF Trust Fund addressed

transport sector by encouraging diesel to Compressed Natural Gas (CNG) switch through incentives. Scaling up renewable energy, energy efficiency, waste to energy technologies and businesses to support urban development in Bangladesh project under GCF fund addressed implementation pathway proposed in residential sector.

6.1.6 Bangladesh Delta Plan (BDP), 2100

Bangladesh Delta Plan (BDP), Urban Water Management chapter focuses on the issues of water supply, sanitation, waste management and drainage of the urban hotspots of the Bangladesh Delta (General Economic Division, 2018). Under seven issues related to urban water management, strategies have been proposed in BDP 2100 (Appendices Table B9).

Following Table 6.6 describes that, among 245 urban area climate fund projects, around 155 projects addressed the urban water management strategies proposed in BDP 2100. These projects addressed restoration of existing drainage systems, solid waste management, re-excavation of natural khals etc. Around 15 projects under BCCTF addressed managing river systems and estuaries in newly developed areas by integration of river stabilization/erosion control and land reclamation with urban development. Conserve and preserve urban wetlands and ecosystems and promote their wise-use strategy has been followed in the project taken under BCCTF in Feni municipality for eco-park development.

Table 6.6: Distribution of urban area climate fund projects on the basis of urban water management strategies proposed in BDP (2100).

Proposed strategies	Name of the fund				
	BCCRF	BCCTF	GCF	GEF Trust Fund	Total
Integrated flood risk management	0	0	1	0	1
Develop effective urban institutions and governance	1	0	0	0	1
Conserve and preserve urban wetlands and ecosystems and promote their wise-use	0	1	0	0	1
Integral urban drainage	0	135	1	1	137
Managing river systems and estuaries in newly developed areas	0	15	0	0	15
Total	1	151	2	1	155

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; General Economic Division, 2018)

ASTUD: Greater Dhaka sustainable urban transport corridor project under GEF Trust Fund addressed the strategy of integral urban drainage through restoration of existing drainage systems including the removal of silt, solid waste, and any physical elements that obstruct the discharge or retention capacity. Innovations in flood risk mitigation in Dhaka project under BCCRF addressed developing effective urban institutions and governance strategy by strengthening of the institutional capacity. Enhancing urban resilience program under GCF addressed integral urban drainage by restoration of existing drainage systems and re-excavation of natural khals. Climate resilient drainage, canal dredging, and flood control for Barishal City corporation area project under GCF addressed both integrated flood risk management and integral urban drainage strategies proposed in BDP 2100 for urban water management.

6.1.7 Bangladesh Country Investment Plan for Environment, Forestry and Climate Change (EFCC CIP), 2016-2021

The goal of Bangladesh Country Investment Plan for Environment, Forestry and Climate Change (EFCC CIP) is to increase the contribution of EFCC sectors to national sustainable development through the enhanced provision of ecosystem services, reducing poverty, improving environmental and health benefits, increasing resilience to climate change under four pillars (Ministry of Environment and Forests, 2017). The pillars are- sustainable development and management of natural resources; environmental pollution reduction and control; adaptation and resilience to and mitigation of climate change; environmental governance, gender, and human and institutional capacity development (Appendices Table B10).

Following Table 6.7 shows that around 173 climate fund urban area projects addressed the pillars under EFCC CIP (2016-2021). About 161 BCCTF urban area projects addressed pillar 2 (Environmental pollution reduction and control). These urban area projects were taken mainly for solid waste management, improvement of drainage system, provision of safe drinking water etc. Scaling up renewable energy, energy efficiency, and waste to energy technologies and businesses to support urban development in Bangladesh project under CGF addressed reduced municipal and household pollution under pillar two. Both climate resilient drainage, canal dredging, and flood control for Barishal City corporation area project and enhancing urban

resilience program under GCF addressed sustainable infrastructure development under pillar three. Promoting low carbon urban development in Bangladesh under GEF Trust fund addressed reduced municipal and household pollution under pillar two. ASTUD: Greater Dhaka sustainable urban transport corridor project under GEF Trust Fund addressed both sustainable infrastructure development as well as mitigation and low - carbon development under pillar three. Both urban area projects under BCCRF did not address any pillars proposed in EFCC CIP (2016-2021).

Table 6.7: Distribution of urban area climate fund projects on the basis of pillars proposed in EFCC CIP (2016-2021).

Fund name	EFCC programs		Total
	Pillar 2: Environmental pollution reduction and control	Pillar 3: Adaptation and resilience to, and mitigation of climate change	
BCCRF	0	0	0
BCCTF	161	6	167
GCF	1	3	4
GEF Trust Fund	1	1	2
Total	163	10	173

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment and Forests, 2017)

6.1.8 National Plan for Disasters, 2010-2015

National Plan for Disasters (2010-2015) aims at reducing the vulnerability of the poor to the effects of hazards to a manageable and acceptable humanitarian level by bringing a shift in disaster management from conventional response and relief practice to a more comprehensive risk reduction culture and also by strengthening the capacity of the disaster management system at all levels (Disaster Management Bureau, 2010). The strategic goals (Goal no two and five) proposed in National Plan for Disasters (2010-2015), Bangladesh are related to climate change (Appendices Table B11).

Following Table 6.8 describes that, 198 BCCTF urban area projects addressed development and implement of climate resilient infrastructures strategy under goal two. However, both BCCRF urban area projects addressed expanding risk reduction programming across hazards and sectors. According to table 6.8, GEF Trust fund projects did not address any of the strategic goals proposed in national plan for disasters. Three projects under GCF addressed mainstreaming disaster risk reduction and climate change adaptation.

Table 6.8: Distribution of urban area climate fund projects on the basis of strategic goals proposed in National Plan for Disasters (2010-2015)

Goals in National Plan for Disasters			Fund Name				Total
Strategic Goal	Key targets	Action Agenda	BCCRF	BCCTF	GCF	GEF Trust	
2.0 Mainstreaming Disaster Risk Reduction and Climate Change adaptation.	2.2 Mainstreaming disaster risk reduction and climate change adaptation issues in all the sectoral policies and plans.	2.2.1.7 Develop and implement climate resilient infrastructure	0	198	2	0	200
	2.3 Disaster risk reduction and climate change considerations incorporated in NGO programmes and plans.	2.3.1.2 Advocacy and public awareness for social mobilization.	0	0	1	0	1
5.0 Expanding Risk Reduction Programming across hazards and sectors.	5.1 Update hazard maps and Develop climate change scenarios and accordingly anticipated hazard risks following climate change	5.1.1.1 Conduct Hazard Risk Analysis and produce updated hazard maps 5.1.1.2 Conduct climate change modelling, and produce anticipated hazards maps	2	0	0	0	2
Total			2	198	3	0	203

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Disaster Management Bureau, 2010)

6.1.9 Intended Nationally Determined Contributions (INDC), 2015

INDC (2015) aims to propose mitigation actions that can help to tackle its growing emissions and play its role in global efforts to limit temperature rise to two degrees or preferably 1.5 degrees above pre-industrial levels (Ministry of Environment and Forests, 2015). Improvement of urban resilience through upgrading of drainage system to address urban flooding has been proposed as an adaptation strategy while

management of urban waste has been addressed as a mitigation strategy in INDC (2015) (Appendices Table B 12).

Table 6.9 describes that, 123 urban area projects under BCCTF addressed improvement of urban resilience through improvement of drainage system to address urban flooding while 58 projects addressed climate resilient infrastructure and communication. Around 19 projects also addressed renewable energy development under mitigation strategy. Both BCCRF urban area projects addressed research and knowledge management. ASTUD: Greater Dhaka sustainable urban transport corridor project under GEF Trust fund addressed climate-resilient infrastructure and communication. Development of resilience in selected hilly municipal areas through an improved early warning system, geo-hazard interventions, and awareness raising campaigns under GCF addressed improved early warning system for tropical cyclones, floods, flash floods and droughts. Both climate resilient drainage, canal dredging, and flood control for Barishal city corporation area and enhancing urban resilience program addressed climate-resilient infrastructure and communication in INDC.

Table 6.9: Distribution of urban area climate fund projects on the basis of strategies proposed in INDC (2015)

Adaptation/ mitigation priority sector		Name of fund				Total
		BCCRF	BCCTF	GCF	GEF Trust Fund	
Adaptation	Climate change impacts on health	0	1	0	0	1
	Biodiversity and ecosystem conservation	0	1	0	0	1
	Climate resilient infrastructure and communication	0	58	2	1	61
	Climate-resilient housing	0	2	0	0	2
	Improved early warning system	0	0	1	0	1
	Improvement of Urban resilience through improvement of drainage	0	123	0	0	123
	Inland monsoon flood-proofing and protection	0	9	0	0	9
	Research and knowledge management	2	1	0	0	3
	River training and dredging	0	6	0	0	6
	Climate resilient infrastructure and communication	0	2	0	0	2
	Total	2	203	3	1	209

Adaptation/ mitigation priority sector		Name of fund				Total
		BCCRF	BCCTF	GCF	GEF Trust Fund	
Mitigation	Afforestation and reforestation programme	0	9	0	0	9
	Improved energy efficiency in production and consumption of energy	0	1	0	1	2
	Management of urban waste	0	5	1	0	6
	Renewable energy development	0	19	0	0	19
	Total	0	34	1	1	36

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment and Forests, 2015)

6.1.10 National Environmental Policy (NEP), 2013

The main objective of National Environmental Policy (2013) is to ensure sustainable development by reducing the impact of environmental pollution, natural disasters and climate change induced hazards by using limited natural resources (Ministry of Environment and Forests, 2013b). The policy interventions have been proposed in the NEP (2013) such as preparation of climate change master plan; vulnerability assessment of different sectors affected by climate change; provision of housing program of climate induced displacement/climate migrants at national and international level; formulation and implementation of adaption policies to tackle climate change; reduce Greenhouse gas emission; Clean Development Mechanism (CDM) etc. Table 6.10 describes that, around 34 BCCTF urban area projects has been undertaken addressing the policy of reducing GHG emission. Total five projects (three BCCTF and two GCF) addresses climate resilient development.

Table 6.10: Allocation of climate fund for urban area projects according to National Environmental policy (2013)

Proposed policies	Name of the fund				Total
	BCCRF	BCCTF	GCF	GEF Trust Fund	
Vulnerability assessment of different sectors affected by climate change such as agriculture, water, forest, fisheries, coastal area, infrastructure etc. Strategies of mitigation/adaptation should be followed,	2	0	0	0	2
Reduce Greenhouse gas emission from sectors such as industry,	0	34	1	1	36

Proposed policies	Name of the fund				Total
	BCCRF	BCCTF	GCF	GEF Trust Fund	
production, transport, urbanization, fossil fuel, education, recreation etc.					
Ensure climate resilient agriculture, food, water, industry, housing, transport, fuel, education, health production, use and management.	0	3	2	0	5
Total	2	37	3	1	43

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Ministry of Environment and Forests, 2013b)

6.2 International Climate Change Plan and Policies

Several international plan and policies address the issues of climate change in the urban areas (Table 6.11). These following documents have been prepared by United Nations Development Programme and United Nations Intergovernmental Panel on Climate Change.

Table 6.11: List of international plan and policies addressing the issue of climate change

Name of Plan/ Policy	Time frame	Issues discussed	Ministry/ Agency
1. Sustainable Development Goals (SDG's)	2015-2030	Seventeen goals with targets to ensure sustainable development	United Nations Development Programme
2. IPCC- Fifth Assessment Report (Urban Area)	2014	Adaptation issues and prospects related to 16 key risk factors in urban areas	United Nations Intergovernmental Panel on Climate Change

(Source: Table adapted from Revi et al., 2014; United Nations, 2015)

6.2.1 IPCC- Fifth Assessment Urban Area Report, 2014

IPCC- Fifth Assessment Urban Area Report focuses on the possibilities for governments, enterprises, and population to adapt urban centers to the direct and indirect impacts of climate change (Revi et al., 2014). Adaptation strategies has been proposed under 16 key risk systems in urban areas (Appendices Table B13). IPCC- Fifth Assessment Urban Area Report do not suggest any adaptation strategy of solid waste management, flood mitigation, research on mitigation and migration etc.

Around 131 BCCTF urban area projects initiated for providing improved drainage system and thereby addressed waste water system (Table 6.12). According to table 6.12, both research projects under BCCRF was taken to address the impact of flood in Dhaka which addressed the waste water system. ASTUD: Greater Dhaka Sustainable

Urban Transport Corridor Project under GEF Trust Fund addressed transportation system. Promoting low carbon urban development in Bangladesh under GEF Trust Fund addressed energy system.

Table 6.12: Distribution of urban area climate fund projects on the basis of strategies proposed in IPCC- Fifth Assessment Urban Area Report (2014)

Key risks according to IPCC	Name of the fund				Total
	BCCRF	BCCTF	GCF	GEF Trust Fund	
Coastal zone systems	0	0	1	0	1
Energy systems	0	10	1	1	12
Green built infrastructure	0	4	0	0	4
Human security and emergency response	0	0	1	0	1
Transportation systems	0	7	0	1	8
Urban risks associated with housing	0	2	0	0	2
Waste water system	2	131	1	0	134
Terrestrial ecosystems and ecological infrastructure	0	1	0	0	1
Water supply systems	0	13	1	0	14
Total	2	168	5	2	177

(Source; Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; Revi et al., 2014)

6.2.2 Sustainable Development Goals (SDG's), 2015-2030

In 2015, the Agenda for Sustainable Development was formally adopted by all United Nations Member States as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030 (United Nations, 2015). Among the 17 goals, goal 13 (Climate action) has three targets- Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries, integrate climate change measures into national policies, strategies and planning as well as improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning (Appendices Table B14).

Following Table 6.13 shows the distribution of the urban climate fund projects according to SDGs. The projects addressed only five goals (Goal no 6, 7, 11, 13 and 15). Around 184 BCCTF urban area projects addressed significantly reducing the death and loss caused by disasters, including water related disasters in goal 11 (Table 6.13). Around 40 projects addressed ensuring universal access to affordable, reliable and modern energy services under goal 7.

Table 6.13: Distribution of urban area climate fund projects on the basis of SDGs (2015-2030)

Goals	Targets	BCCRF	BCCTF	GCF	GEF Trust Fund	Total
6. Clean water and sanitation	6.1 Achieve universal and equitable access to safe and affordable drinking water for all	0	9	1	0	10
	6.6 Protect and restore water related ecosystems	0	6	0	0	6
	Total	0	15	1	0	16
7. Affordable and clean energy	7.1 Ensure universal access to affordable, reliable and modern energy services	0	40	1	2	43
11. Sustainable cities and communities	11.1 Ensure access for all to adequate, safe and affordable housing and basic services	0	2	0	0	2
	11.2 Provide access to safe, affordable, accessible and sustainable transport systems	0	8	0	1	9
	11.5 Significantly reduce the death and loss caused by disasters, including water related disasters	2	184	2	0	188
	11.6 Reduce the adverse per capita environmental impact of cities	0	9	1	0	10
	11.7 Provide universal access to safe, inclusive and accessible, green and public spaces	0	3	0	0	3
	Total	2	206	3	1	212
13. Climate action	13.3 Improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	0	0	1	0	1
15. Life on earth	15.1 Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services,	0	1	0	0	1
Total		2	257	6	3	268

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; Dasgupta et al., 2015; The World Bank, 2015; BCCT, 2019; United Nations, 2015)

6.3 Overall scenario of the linkage of urban climate fund projects with plans and policies

In this segment, to understand the overall scenario, composite index has been computed using Quantitative Content Analysis (QCA) method. For the projects addressing the pillars, issues, proposals, themes, goals etc. of the national and international plans and policies (such as BCCSAP (2009), NAPA (2009), 7th FYP (2016-2020), ccGAP (2013), BDP (2100), EFCC CIP (2016-2021), INDC (2015), NEP (2013), SDG's (2015-2030) etc.), score 0-3 has been assigned while score 0 means no linkage with the document. The following table 6.14 shows the composite score of the urban area climate fund projects. According to table 6.14, among 237 BCCTF projects, around 108 projects have the composite score of ten while for both BCCRF projects, the score is six. The mean composite score of the projects is 8.47.

Table 6.14: Composite score of the climate fund projects considering their linkage with national and international plans and policies.

Composite score	Fund name				Total
	BCCRF	BCCTF	GCF	GEF Trust Fund	
4	0	17	0	0	17
5	0	12	1	0	13
6	2	16	1	0	19
7	0	16	1	2	19
8	0	39	0	0	39
9	0	14	1	0	15
10	0	108	0	0	108
11	0	13	0	0	13
12	0	2	0	0	2
Total	2	237	4	2	245

6.4 Summary

This chapter studies the urban area climate fund projects in the light of different national and international plans and policies such as BCCSAP (2009), NAPA (2009), 7th FYP (2016-2020), ccGAP (2013), BDP (2100), EFCC CIP (2016-2021) etc.

Around 194 among 237 urban area BCCTF projects addressed pillar three of BCCSAP (2009) whereas 144 addressed pillar five. Among the 208 urban area climate fund projects which addressed the proposed adaptation measures of NAPA (2009), 201 projects addressed building climate resilient infrastructure measure. Integral urban drainage improvement strategy has been reflected in 137 urban area climate fund projects. 198 urban area projects under BCCTF and two projects under GCF addressed

infrastructural functioning and maintenance adaptation strategy according to 7th FYP (2016-2020). Most projects also addressed waste water system (134 projects) and water supply system (14 projects) according to IPCC- Fifth Assessment Urban Area Report (2014). Goal 11 (Sustainable cities and communities) of SDGs (2015-2030) was mostly reflected in the urban area climate fund projects. Most of the urban area climate fund projects addressed the strategies or proposals of infrastructural development in these plans and policies.

CHAPTER 7: People's Perception Regarding Climate Fund Projects at Local Context

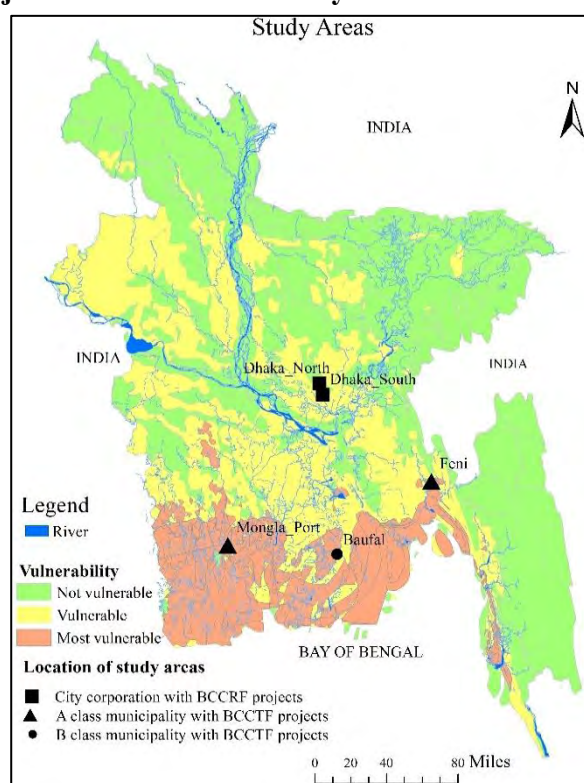
This chapter explores the view of local people regarding the completed climate fund projects taken in the selected urban areas- Feni, Mongla Port and Bauphal municipality of Bangladesh. This chapter also identifies the consistency of these projects with the need of the local people. This chapter investigates whether the completed projects have achieved their proposed goals as well as addressed the impact of climate change induced hazards such as climate change induced flood, salinity intrusion, storm surge, excessive precipitation, temperature change etc. This chapter identifies the challenges faced during project initiation and implementation at the grass-root level as well as suggests strategies for efficient implementation of the projects addressing the need of local people.

7.1 Completed climate fund projects in the selected study areas

Among 245 climate fund urban area projects, six completed projects under BCCTF and BCCRF funds have been selected in five study areas.

Map 7.1 depicts the location of selected study area while table 7.1 displays the general description of the completed climate fund projects taken in those study areas.

The table 7.1 describes that, all the completed projects taken in DNCC and DSCC area are BCCRF funded research projects. Other municipalities have completed construction projects under BCCTF.



Map 7.1: Location of the study areas.

(Source: Base map compiled from General Economic Division, 2018; Savage et al., 2015; Rabbani & Haq, 2016; Alauddin & Mallick, 2010 and Rahman et al., 2018)

Table 7.1: General description of the completed climate fund projects in the selected urban areas

Name of the urban area	Type of urban area	Project fund name	Project name	Project Objective	Implementing agency	Project timeline	Fund in lakh BDT
Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC)	City Corporation	BCCRF	Urban Flooding of Greater Dhaka Area in a Changing Climate: Vulnerability, Adaptation and Potential Costs.	Hydrological modeling and development of adaptation measures; spatial ranking of flood vulnerability; evaluating expected damage from flooding; estimating adaptation costs.	World Bank Group	October 2011-2015	433.5
		BCCRF	Innovations in Flood Risk Mitigation in Dhaka.	Analysis of flood risks facing the city; historical analysis of decision-making about flood risk management, institutional and political economy analysis.	World Bank Group	November 2012-2017	255.0
Feni Paurashavas	A Class Paurashavas	BCCTF	Infrastructural and environmental improvement of Feni Paurashava to prevent climate change induce impacts.	Reduce water logging, convenient transport facilities, immunity to water borne disease.	Feni Paurashava	July 2015-June 2016	200.0
		BCCTF	Resolve the water logging problem, construction of guide wall, forestation and environmental development near Rajajeer Dighi and Bijoy Singh Dighi under Feni Paurashava.	Reduce water logging, convenient transport facilities, immunity to water borne disease.	Department of Forests and Feni Paurashava	January 2017-June 2019	300.0
Mongla Paurashavas	A Class Paurashavas	BCCTF	Construction of required infrastructure project to protect from adverse effect of climate change of the coastal belt, Mongla Port Municipality.	Reduction of water logging; protect Mongla Port municipality from salinity intrusion, flood, cyclone, extreme tide, river bank erosion; improve drainage system; improve transport system; provide health facilities, safe housing, education, food security and employment.	Mongla Port Paurashava, Bagerhat.	April 2014-June 2017	300.0
Bauphal Paurashavas	B Class Paurashavas	BCCTF	Resolve the water logging problem and Environmental improvement of Bauphal Paurashava to prevent climate change induce impacts	Reduction of water logging; provide safe drinking water	Bauphal Paurashava, Patuakhali.	October 2012-December 2017	750.0

(Source: BCCT, 2019; The World Bank, 2016)

Table 7.1 also describes that, the project undertaken in Bauphal municipality has the highest fund size (Around 750 lakh BDT). However, around 500 lakh BDT has been allocated under two BCCTF projects in Feni municipality. While most of the BCCTF construction projects has been undertaken in the municipalities under BCCTF fund, both BCCRf research projects in Dhaka has been undertaken by the World Bank Group (Table 7.1). Both BCCRf research projects address the impact of flooding in Dhaka. On the other hand, BCCTF projects in the municipalities address the improvement of drainage system, provision of safe drinking water, convenient transportation system, protection of municipalities from salinity intrusion, flood, cyclone, extreme tide, river bank erosion etc.

7.2 Description of the selected projects under BCCTF

Four completed construction projects have been undertaken in three municipalities (Bauphal, Feni and Mongla Port) under BCCTF fund. Table 7.2 describes the project goals, Objectively Verifiable Indicators (OVI) and project works of the selected completed projects under BCCTF climate fund. The projects are mainly construction projects for provision of drainage facilities (Bauphal, Feni and Mongla Port municipality), construction of embankment with installment of solar panel for street lighting (Mongla Port municipality), improvement of waterbodies (Feni municipality) and installment of tube wells (Bauphal municipality) etc.

According to table 7.2, OVI for these projects show that the construction of embankment in Mongla Port municipality would protect the municipality from flood, extreme tide as well as river bank erosion. The construction of Reinforced Cement Concrete (RCC) drains in the municipalities have been undertaken for controlling waterlogging, reducing waterborne diseases, providing better transport facilities as well as reducing the impact of insect borne disease. The improvement of the waterbodies in Feni municipality would reduce waterlogging as a source of water reservoir as well as provide recreational facility.

Table 7.2: Project goals and project works under the completed BCCTF projects undertaken in selected municipalities

Study area	Project ID and Name	Goal	Objectively Verifiable Indicator (OVI)	Project works
Mongla Port municipality	Project ID: 174 Project Name: Construction of required infrastructure project to protect from adverse effect of climate change of the coastal belt, Mongla Port Municipality.	1) Construction of flood protection embankment for protection of river due to high tide. 2) Construction of RCC drain for removing the waterlogging 3) Initialization of solar panel street light for reduce of carbon di oxide.	1) It will be helpful for controlling flood, extreme tide. It would protect the municipality from river bank erosion. 2) The effect of insect, flyers and mosquitoes will be reduced as well as water borne disease. Health and socio- economic condition would be improved. 3) The lighting of embankment with less usage of electricity and reduction of carbon-di oxide for the better climate and environment.	1) Earth filling of Marine Driving road from Kumarkhali Khal to end of Kainmari bridge (5.5km). 2) Construction of RCC Drain from Thankrun bari khal to end of Navy's residence (700m). 3) 73 Nos solar panel would be installed beside the embankment.
Bauphal municipality	Project ID: 101 Project Name: Resolve the water logging problem and environmental improvement of Bauphal Paurashava to prevent climate change induce impacts.	1) Construction of RCC drain to resolve the water logging problem in Paurashava and adjacent areas. 2) Installment of Deep tube well to provide safe drinking water.	1) Development of drain for affected people, water logging control. 2) There will be no water logging in the town area.	1) Md Sultan Fokir Mazer Southy via Leehu pola Bauphal kagogir pool khal in ward no 3 (300 m). 2) A Sattaer holader Bari to Bauphal canal via Balla Mia house in ward 1 (110 m). 3) Master Monir house to South side of Bauphal Khal in ward 8 (110 m). 4) Sabanando Asram to west side of Bauphal Kagogirpool khal in ward 2 (100m). 5) Md Nazrul Islam Sarvear to Bauphal Kagogir pool in ward 2 (90m). 6) Sarder bari Sadhu howlader bari to Sher e Bangla culvert in ward 9 (300m). 7) Ward no 7-end side to Forkaniha Madrasa west side Khal via Baytul Islam Mosque line in wad 6 (280m). 8) Girls school of Poratn Samajkallan office via Bauphal Khal in ward 4 (200 m).

Study area	Project ID and Name	Goal	Objectively Verifiable Indicator (OVI)	Project works
				9) Md Waydut Mia Bari to Bauphal Khal in ward no 5 (200 m). 10) Daruet Sunnat East side to Bauphal Khal in ward 07 (200 m). 11) Nitay Pall Bari to North side of Bauphal Khal in ward no 1 (40 m). 12) Total 164 tube well.
Feni municipality	Project ID: 304 Project Name: Infrastructural and environmental improvement of Feni Paurashava to prevent climate change induce impacts.	Construction of RCC drain to resolve the water logging problem in Paurashava and adjacent areas.	1) It will be helpful for flood control. 2) The effect of insect, flyers and mosquitoes will be reduced as well as water borne disease will stop. 3) There will be no water logging in the town area.	1) Construction of RCC Drain work at Hazi Moksudur Rahman Road (Start from Mohipal Chowdhury Bari road to Connecting Patthan Bari road side) at ward 11 (0-935m). 2) Construction of RCC Drain at west side of Feni Bilonia rail line (Damdama Khal to Biraj Mozumder bari road) at ward 7 (0 to 800 km).
	Project ID: 321 Project Name: Resolve the water logging problem, construction of guide wall, forestation and environmental development near Rajajeer Dighi and Bijoy Singh Dighi under Feni Paurashava.	Construction of boundary wall, RCC retaining wall, RCC walkway, beautification and plantation near waterbodies to reduce waterlogging.	1. It will be helpful for the removal of waterlogging, rest and recreation. 3) The effect of insect, flyers and mosquitoes will be reduced as well as insect water borne disease will be controlled.	1) Construction of Boundary wall, RCC retaining wall, RCC walkway, beautification and plantation at North and West side of Feni Rajajeer Dighi under Feni Paurashava. 2) Construction of a) RCC retaining wall, b) CC road, c) RCC stair gateway, d) Toilet, e) Entry main gate, f) Boundary wall, g) Protection wall, h) Parking tiles in Feni Bijoy Singh Dighi at Word No 13 under Feni Paurashava.

(Source: Table adapted from the project files of BCCT, 2019)

7.3 Description of the selected research projects under BCCRF

Two completed BCCRF projects among five Analytical and Advisory Activities (AAA) projects were initiated in the study areas. The table 7.3 shows that both completed BCCRF AAA projects undertaken in Dhaka addresses the impact of urban flooding. In the “Urban Flooding of Greater Dhaka Area in a Changing Climate project”- three step hydrological modeling was performed and then identification of spatial ranking of flood vulnerability, evaluation of expected damage as well as estimation of adaptation costs has been done. However, assessment of flood risk as well as institutional capacity for flood risk management along with historical review of flood risk management in greater Dhaka has been performed in “Innovations in Flood Risk Mitigation in Dhaka” project under BCCRF.

Table 7.3: Project objective and outcome under the completed BCCRF projects undertaken in the study area.

Name	Objectives	Outcome
Urban Flooding of Greater Dhaka Area in a Changing Climate: Vulnerability, Adaptation and Potential Costs	Hydrological modeling and development of adaptation measures.	- Local engineers were consulted to understand the functioning of each existing drainage system. - A three-step approach (step 1: simulation of basin-level flows from the Brahmaputra River in the GBM system, step 2: effects of climate change on the regional river and step 3: detailed modeling of the drainage system) of hydrological modeling was adopted to account the effects of river flows on flooding. - Structural measures beyond current planned improvements were developed based on the hydrological modeling simulations.
	Spatial ranking of flood vulnerability.	As, the inundation of flood (even the same depth and duration) can have significantly different impacts on the population, this study developed a flood vulnerability index (FVI) that ranked the population and infrastructure of the city’s major areas and wards, according to their relative exposure, susceptibility and resilience.
	Evaluation of expected damage from flooding.	- Based on estimated multiple alternative future scenarios, the study evaluated the direct and indirect economic damage to the local population. - Results of the hydrological modeling exercise were used to quantify the economic damage such as effects on the urban-built environment and infrastructure, human health, and family assets.
	Estimation of adaptation costs.	- Adaptation costs of the proposed structural measures were estimated for each modeled zone by consulting numerous practitioners. - These cost estimates were divided into two components: (a) additional investments required to meet the current

Name	Objectives	Outcome
		adaptation deficit without climate change and (b) further measures required to meet the 2050 climate change deficit.
Innovations in Flood Risk Mitigation in Dhaka.	Assessment of flood risk.	• Analysis of flood risks facing Dhaka city with assessment of spatial changes in urbanization and urban ecosystems is undertaken using publicly accessible satellite imagery, GIS-based mapping tools, and available satellite-based analysis.
	Historical review of flood risk management in greater Dhaka.	• The historical analysis shows how the planning for flood management and drivers of decision making evolved historically; the importance and limitations of both infrastructural and non-infrastructural measures undertaken, and how decisions regarding flood vulnerability have informed spatial planning and zoning.
	Assessment of Institutional Capacity for Flood Risk Management.	• For assessment of institutional capacity and their roles, analysis of relevant plans and policies and capacity of key organizations in shaping flood resilience has been performed. • Study provides recommendations for institutional and organizational reforms as well as structural and nonstructural measures that could be undertaken.

(Source: Table adapted from Dasgupta et al, 2015; The World Bank, 2015; The World Bank, 2016)

7.4 People's perception regarding the climate change induced hazards in the study areas with BCCTF projects

7.4.1 Type of climate change induced hazards in the municipalities

In this study, pair wise ranking has been used to identify different climate change induced hazards faced in the municipalities. According to table 7.4 (a), local people of Mongla Port municipality identified tidal surge, salinity intrusion, cyclone, sea level rise, heavy rainfall as major climate change induced hazards they are facing in the municipality. Both Feni and Bauphal municipality faces cyclone, heavy rainfall, flood and extreme heat. Local people of Feni municipality identified heavy rainfall and extreme heat as major climate change induced hazards affecting Feni Municipality (table 7.4. (b)). Though the direct effect of cyclone and flood is less in the Feni municipality, there is migration of people from adjacent areas facing climate change induced flood, cyclone, sea level rise etc. According to table 7.4 (c), heavy rainfall and flood are the major climate change induced hazards faced in the Bauphal municipality. Though the project taken under climate fund in Mongla Port municipality addressed tidal surge and cyclone, local people still faced the problem of salinity intrusion.

Table 7.4: Pairwise ranking of the climate change induced hazards**a) Mongla Port municipality**

Climate change induced hazards		Tidal surge	Salinity intrusion	Cyclone	Extreme heat	Heavy rainfall	Sea level rise	Priority frequency	Rank
		TS	S	C	EH	HR	SLR		
Tidal surge	T S	X	TS	C	TS	TS	TS	4	1
Salinity intrusion	S	TS	X	S	S	S	S	4	2
Cyclone	C	C	S	X	C	C	SLR	3	3
Extreme heat	E H	TS	S	C	X	EH	EH	2	4
Heavy rainfall	H R	TS	S	C	EH	X	SLR	0	6
Sea level rise	S L R	TS	S	SLR	EH	SLR	X	2	5

*(Source: Field survey, 2019)***b) Feni municipality**

Climate change induced hazards		Cyclone	Extreme heat	Heavy rainfall	Flood	Priority frequency	Rank
		C	H	R	F		
Cyclone	C	X	H	R	C	1	3
Extreme heat	H	H	X	R	H	2	2
Heavy rainfall	R	R	R	X	R	3	1
Flood	F	C	H	R	X	0	4

*(Source: Field survey, 2019)***c) Bauphal municipality**

Climate change induced hazards		Cyclone	Extreme heat	Heavy rainfall	Flood	Priority frequency	Rank
		C	H	R	F		
Cyclone	C	X	C	R	F	1	3
Extreme heat	H	C	X	R	F	0	4
Heavy rainfall	R	R	R	X	R	3	1
Flood	F	F	F	R	X	2	2

*(Source: Field survey, 2019)***7.4.2 Perceived impacts of the climate change induced hazards**

The local people identified that water supply system, waste water supply system and human health are mostly affected by the climate change induced tidal surge, salinity intrusion and cyclone even after the implementation of the BCCTF project in Mongla Port municipality (table 7.5 (a)). According to table 7.5 (b), the local people of Feni municipality identified that transport system, human health and livelihood are mostly affected by the climate change induced hazards even after the implementation of the

project. Migration from other areas is putting pressure on the existing facilities of Feni Municipality. Due to heavy rainfall and flood, waterlogging occurs in Bauphal Municipality and causes impacts on transportation system.

Table 7.5: Pairwise ranking of the impacts of climate change induced hazards

a) Mongla Port municipality

Effects of Climate change induced hazards		Water supply system	Water logging	Energy systems	Food security	Transport system	Housing	Human health	Livelihood	Priority frequency	Rank
		W	WL	E	F	T	H	HH	L		
Water supply system	W	X	W	W	W	W	W	W	W	7	1
Water logging	WL	W	X	WL	WL	T	WL	WL	WL	5	2
Energy systems	E	W	WL	X	F	T	H	HH	L	0	8
Food security	F	W	WL	F	X	T	H	HH	L	1	7
Transport system	T	W	T	T	T	X	T	HH	L	4	4
Housing	H	W	WL	H	H	T	X	HH	H	3	5
Human health	HH	W	WL	HH	HH	HH	HH	X	HH	5	3
Livelihood	L	W	WL	L	L	L	H	HH	X	3	6

(Source: Field survey, 2019)

b) Feni municipality

Effects of Climate change induced hazards		Water supply system	Waterlogging	Transport system	Human health	Livelihood	Priority frequency	Rank
		W	WL	T	HH	L		
Water supply system	W	X	WL	T	HH	L	0	5
Waterlogging	WL	WL	X	WL	WL	WL	4	1
Transport system	T	T	WL	X	HH	T	2	3
Human health	HH	HH	WL	HH	X	HH	3	2
Livelihood	L	L	WL	T	HH	X	1	4

(Source: Field survey, 2019)

c) Bauphal municipality

Effects of Climate change induced hazards		Water supply system	Waterlogging	Transport system	Human health	Priority frequency	Rank
		W	WL	T	HH		
Water supply system	W	X	WL	T	HH	0	4
Waterlogging	WL	WL	X	WL	WL	3	1
Transport system	T	T	WL	X	T	2	2
Human health	HH	HH	WL	T	X	1	3

(Source: Field survey, 2019)

7.4.3 Severity of the problems faced by the local people in different seasons

The seasonal diagrams depict the seasonal variation of the problems faced such as season variation of water scarcity, health hazard, incidence of cyclone, inconvenience to daily activities, economic loss, insect infestation etc. due to climate change induced hazards in the municipalities.

Season	Spring 		Summer 		Monsoon 		Autumn 		Late Autumn 		Winter 	
Month	February	March	April	May	June	July	August	September	October	November	December	January
Criteria												
Scarcity of safe drinking water	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●
Health hazards	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●
Water logging				●●	●●	●●	●●	●●	●	●		
Incidence of cyclone			●●	●●	●●		●●	●●	●●	●●	●●	
Inconvenience to daily activities	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●

Figure 7.1: Severity of the problems faced by the local people of Mongla port municipality in different seasons (Source: Field survey, 2019)

Figure 7.1 shows that, most of the local people face acute scarcity of safe drinking water in the dry season (summer) in Mongla Port municipality. The vulnerability score for water supply is also higher (0.45) according to NCVAR, 2018 (Goosen et al., 2018). Local people (specially the women) have to travel 1-2 km to collect water. Sometimes there is huge queue at the water collection point and they cannot get access to the water. The authority sells water (1 taka per liter) in the dry season sometimes. Some of the local people cannot afford to buy safe drinking water. Some of the NGOs are providing RWH system, but only few can afford this. Due to lack of safe drinking water, they face water borne disease such as diarrhea and typhoid. Therefore, they have to pay medical fees. Water logging also occurs in some low-lying areas due to excessive rainfall. At that time, residents of this municipality suffer to commute to their workplace.

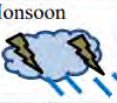
Season	Spring 		Summer 		Monsoon 		Autumn 		Late Autumn 		Winter 	
Month	February	March	April	May	June	July	August	September	October	November	December	January
Criteria												
Water logging			••	•••	•••	•••	•••	•••	•••	•••	•••	•••
Health hazards	••	••	•••	•••	•••	•••	•••	••	••	•••	•••	•••
Economic loss				••	•••	•••	•••	••	•	•		
Migration			••	•••	•••	••	•••	••	•••	•••	•	
Road accident					••	•	•	•	•	••		

Figure 7.2: Severity of the problems faced by the local people of Feni municipality in different seasons (Source: Field survey, 2019)

The seasonal diagram of Feni municipality shows that, economic loss and waterlogging occurs in monsoon and autumn even if BCCTF projects for construction of RCC drains has been undertaken in this area (Figure 7.2). Health hazards also occur due to mosquito infestation. Feni municipality faces migration, mainly in dry season as people from adjacent areas migrate to Feni in search of job.

Season	Spring 		Summer 		Monsoon 		Autumn 		Late Autumn 		Winter 	
Month	February	March	April	May	June	July	August	September	October	November	December	January
Criteria												
Scarcity of safe drinking water	•	•	••	•••	••	•			••	•••	•••	•••
Insect infestation	•••	•••	•••	•••	•••	•••	•••	••	••	•••	•••	•••
Water logging				••	•••	•••	•••	••	•	•		
Odor pollution	••	••	••	•••	•••		••	••	•••	•••	••	••

Figure 7.3: Severity of the problems faced by the local people of Bauphal municipality in different seasons (Source: Field survey, 2019).

According to figure 7.3, odor pollution and insect infestation are the major problems faced even after the implementation of BCCTF project of constructing RCC drains in Bauphal municipal area. The problem of scarcity of drinking water still exists in dry season in this municipality.

7.4.4 Perceived causes and effects of the impacts of climate change induced hazards

This segment discusses the cause effect diagram of the major problem faced in the municipalities. In Mongla Port municipality, scarcity of potable water is perceived as the major problem faced by local people while waterlogging is for both Feni and Bauphal municipality. Even though total 3.231km drainage system has been constructed under BCCTF project, lack of waste management system is considered as one of the major problems for inefficiency of the drainage system in Bauphal municipality.

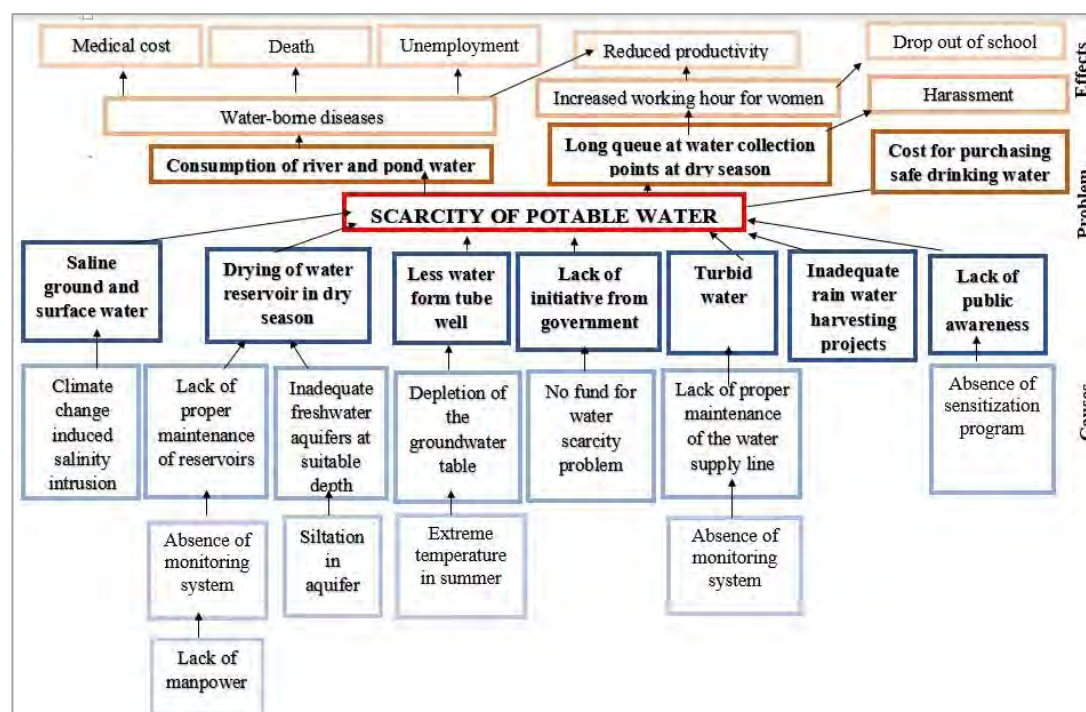
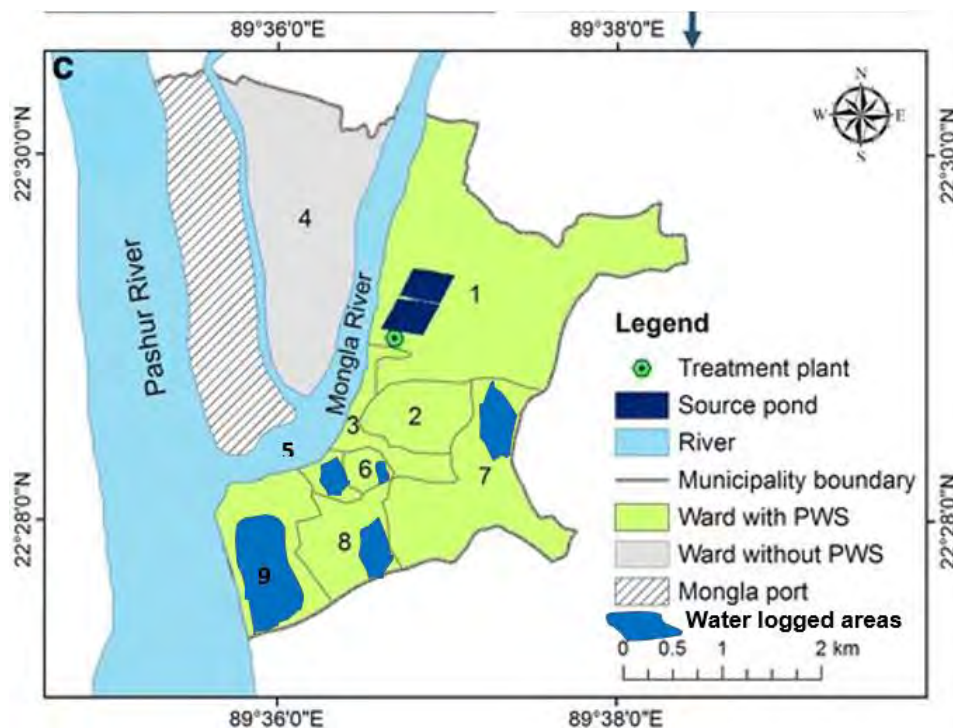


Figure 7.4: Cause effect diagram of potable water scarcity in Mongla Port Municipality (Source: Field survey, 2019).

Figure 7.4 shows the cause effect diagram of Mongla Port municipality while map 7.2 shows the water supply system in the municipality. In Mongla Port municipality, the water supply system consists of one impounding reservoir, two Intec station (30HP-2Nos & 20HP-2Nos), one water treatment plant (200 cubic meter) with an overhead tank of capacity 500 cubic meter, total 25 km water supply line and 22.15 km distribution line with 32 drinking water tape (Ahsan, Akber, Islam, Kabir, & Hoque,

2017). Appendices Image C6 and C7 show water retention pond and a water collection point provided by Mongla Port municipal authority respectively.



Map 7.2: Hazard map showing location of water sources and waterlogged areas in Mongla Port municipality (Base map source: Ahsan et al., 2017)

The cause effect diagram of scarcity of potable drinking water problem in Mongla Port municipality shows that the main causes are saline intrusion, drying of water reservoirs in dry season due to lack of proper management of existing water reservoirs, drying off of tube wells and inadequate Rain Water Harvesting (RWH) projects.

Even if there is one water reservoir to store water in monsoon in Mongla Port municipality, it is not enough to fulfill the need of the local people over the whole year. Due to lack of proper maintenance, siltation occurs. There is provision of piped water supply system of Mongla Port municipality, but it faces both disinfection and distribution failure. Because of improper management and monitoring of the water supply system, siltation in the pipes as well as leakages occur in the water supply lines and result in supply of turbid and muddy water (Ahsan et al., 2017).

Moreover, there is less water from deep tube wells due to salinity, arsenic and reduced ground water level in dry season. Local people are relying on rainwater, but there is lack of financial and technical assistance from government for RWH projects in this

municipality. Even though, some NGOs are providing assistance for RWH system, the poor and vulnerable ones cannot afford it (See Venn diagram of Mongla Port municipality in Figure 4.2 (a)).

The scarcity of safe potable water crisis causes consumption of water from Pashur and Mongla river as well as unsafe surface water which causes water borne diseases like diarrhea, cholera, dysentery etc. As a result, the local people have to bear high medical bills as well as unemployment as a consequence. The local people also need to purchase potable water in dry season from water traders for 20 BDT per water pot (price also very with water scarcity).

Again, as the collection of water is defined as a role for women in this locality, the problem of water scarcity causes increased working hour for women. Sometimes, women have to travel long distance carrying heavy pots filled with water which is very tiresome for them. They also need to wait in queues to collect water from water supply points. Drop out of young girls, reduced productivity and income, death of children etc. are the consequences of potable water crisis in Mongla Port municipality.

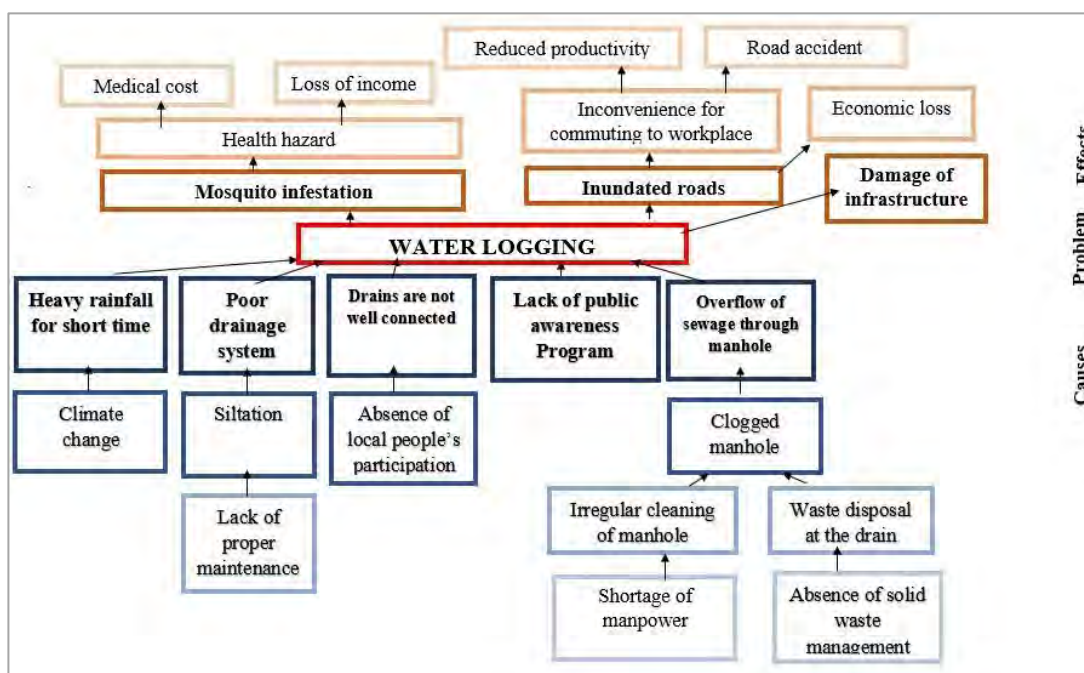


Figure 7.5: Cause effect diagram of waterlogging problem in Feni Municipality
(Source: Field survey, 2019).

Both for Feni and Bauphal municipality, waterlogging occurs due to heavy rainfall for short period of time, poor drainage system, reduced capacity of drains due to irregular

cleaning, absence of solid waste management system and absence of local people's participation during selection of the site for construction of drains (Figure 7.5 and 7.6).

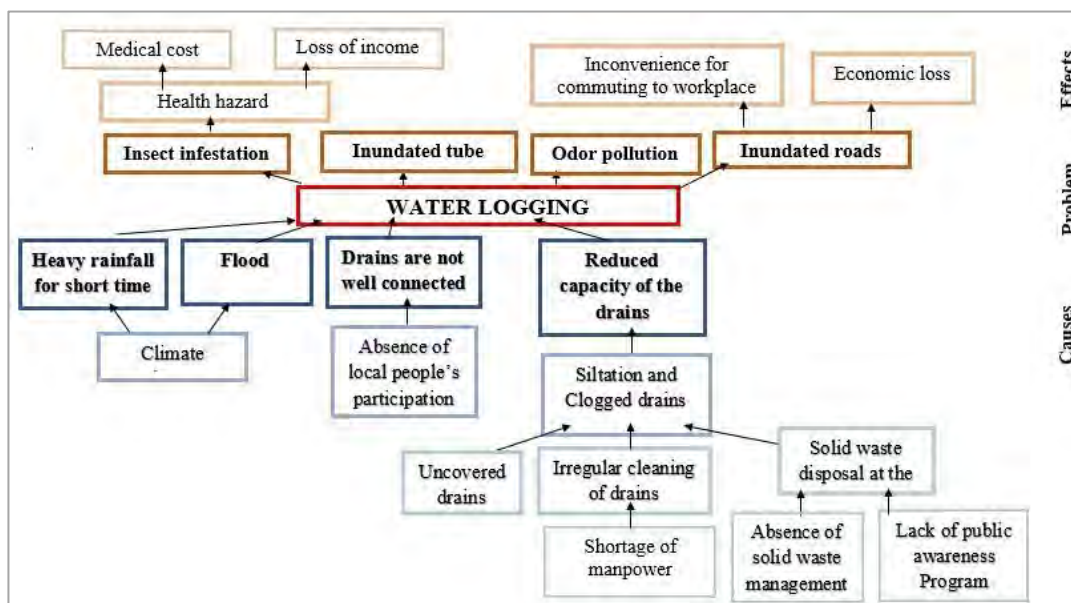
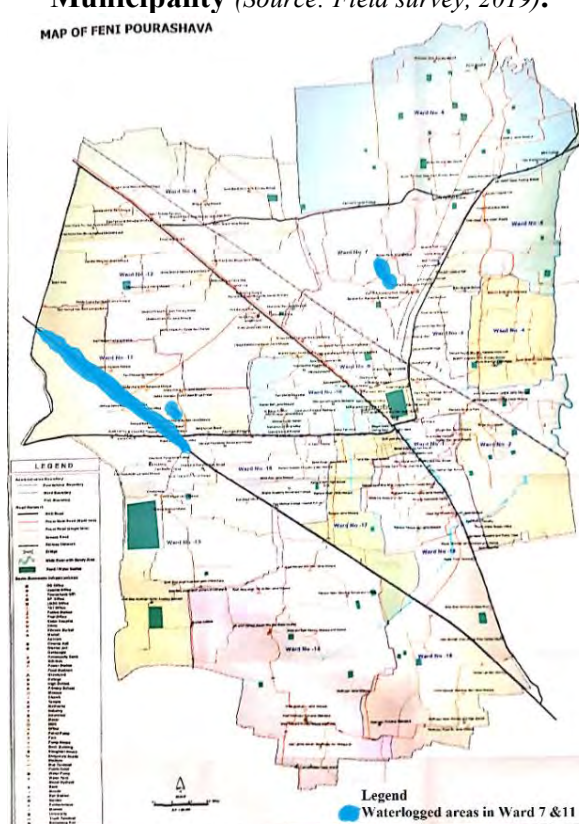


Figure 7.6: Cause effect diagram of waterlogging problem in Bauphal Municipality (Source: Field survey, 2019).



Map 7.3: Hazard map showing waterlogged areas in Feni municipality (Base map source: Feni municipality, 2019)

According to figure 7.5 and 7.6, the consequences of waterlogging in these municipalities are health hazard due to insect such as mosquito and fly infestation, odor pollution, inundated roads, economic loss of property, reduced productivity etc. Since, there is not any provision of solid waste collection system in the municipalities, local people dump wastes in the roadsides and drains, which also causes clogging of drains as well as act as the breeding ground for insects. Siltation in the drains also reduces the capacity of the drains. In some areas, the drains are not well connected and uncovered. These uncovered drains also cause accidents. Map 7.3 depicts the hazard map of Feni municipality, where in Ward 11, waterlogging occurs at Mohipal road (one of the major roads) and causes economic loss to adjacent shops and business activities (See Appendices Image C 31).

7.5 People's perception regarding the BCCTF project

This segment discusses the people's perception regarding the climate fund projects under BCCTF fund. According to this table 7.6, local people are satisfied with the construction of embankment at Mongla Port municipality. The embankment protects the municipality from cyclones, tidal surge, river erosion etc. as well as provides easy transportation network. Among the municipalities, only in Mongla Port municipal authority ensured local people's participation before implementation of the embankment construction project. There is strong relationship among municipality office and local people in Mongla Port municipality (Venn diagram in Figure 4.2 (a)) For the construction of RCC drain projects in all municipalities, waterlogging still occurs in some cases and local people are not satisfied with the project outcome. According to the local people, the existing drains cause odor pollution and insect infestation due to solid waste dumping on the drains and irregular cleaning of the drains. In Feni and Bauphal municipalities, the drains are not well connected. Local people suggested regular cleaning of drains, well management and maintenance of the drains, provide cover to uncovered section, ensure well connected drainage system, provide solid waste management system, increase the width and depth of the drains in low-lying areas and regular spraying of mosquitocides and insecticides. Proper maintenance of solar lights and tube wells are needed. Local people suggested maintenance of the dighi as well as ensure equal access and safety for all.

Table 7.6: People's perception regarding the outcome of BCCTF projects in the municipalities

Project Id and Name	Activity	Outcome	Local people's perception regarding the outcome
Project ID: 174 Project Name: Construction of required infrastructure project to protect from adverse effect of climate change of the coastal belt, Mongla Port Municipality.	1) Earth filling of Marine Driving road from Kumarkhali Khal to end of Kainmari bridge.	Protection from flood and storm surge.	The embankment protects the city from flood, tide and storm surge (Appendices Image C2 and C3). Local people suggested more height of the embankment.
		Protection from river bank erosion and sea level rise	The embankment protects the city from riverbank erosion and sea level rise
		Improved transport system	The road beside the embankment provides easy transport and so local people can move easily from one place to another. But there is problem of road accidents as the local van drivers are not well trained. Use of search lights by drivers are causing nuisance.
	2) Construction of RCC Drain from Thankrun bari khal to end of Nevy's residence.	Control water logging	The problem of waterlogging still stays in some areas (Appendices Image C8). The site of the development of the RCC drain was selected by the authority and influential people. There is mismanagement in the control of sluice gate. Again, due to the lack of proper solid waste management system, people dump solid waste in the drain which causes overflow of the drain.
		Reduce insect, flyer and mosquito infestation	Due to waterlogging and overflow of drain, there is problem of insect infestation
		Improve public health	People are affected by waterborne disease. In 2019, 25 local people had been affected by dengue fever according to local people.
		Improvement in agricultural sector and employment	Due to the use of sluice gate, aquafarming is affected (Appendices Image C5).
		Control saltwater intrusion	The problem of salt water intrusion still stays on the city.
	3) Installment of solar panel beside the embankment.	Reduce carbon di oxide	Though the use of solar panel is beneficiary for the local people, some of the solar lights are not working. Proper maintenance of the solar light is needed (Appendices B Image C2).
		Lightening in the embankment	It provides lighting facilities in the embankment.
		Recreational facilities	The embankment is used for recreational activities in afternoon and evening.
		City beautification	The riverbank landscaping increased the beauty of the city.
		Reduce the use of electricity	It reduced the use of electricity.

Project Id and Name	Activity	Outcome	Local people's perception regarding the outcome
Project ID: 101 Project Name: Resolve the water logging problem and environmental improvement of Bauphal Pourashava to prevent climate change induce impacts	1) Md Sultan Fokir Mazer Southy via Leehu pola Bauphal kagogir pool khal in ward no 3 (300 m).	Control water logging	The problem of waterlogging reduced. The drain is also used as access road to the houses (Appendices B Image C43-C44). As the exit point of the drain is not covered, local people dump solid waste there which causes odor pollution and mosquito infestation in the area.
	2) A Sattaer holader Bari to Bauphal canal via Balla Mia house in ward 1 (110 m).	Control water logging	The problem of waterlogging reduced due to the construction of RCC drains. But some parts of the drain are broken and needs repairing. The drain is covered in most of the parts and used as access road to the houses. The exit point of the drain is not clean and therefore acts as a breeding ground of mosquitoes (Appendices Image C35-37). There is also odor pollution.
	3) Master Monir house to South side of Bauphal Khal in ward 8 (110 m).	Control water logging	The problem of waterlogging has reduced. But the length and width of the drain is not adequate. Local people suggested to increase the width of the drain (Appendices Image C60).
	4) Sabanando Asram to west side of Bauphal Kagogirpool khal in ward 2.	Control water logging	The problem of water logging still exists in the area. There should be provision of regular cleaning of the drains (Appendices Image C47-48). There is siltation in the drain even though it is covered with RCC slab.
	5) Md Nazrul Islam Sarvear to Bauphal Kagogir pool in ward 2.	Control water logging	The problem of waterlogging has reduced (Appendices Image C45-46). There should be proper cleaning of the khal connecting the RCC drain. There is problem of mosquito infestation.
	6) Sarder bari Sadhu Howlader bari to Sher e Bangla culvert in ward 9 (300m).	Control water logging	The drain is not well connected and some parts of the drain are not covered which causes accidents. There is presence of odor pollution in the area. There is stagnant water in the drain which acts as a breeding ground for mosquito and other insects. The authority should extend the drain and connect it properly (Appendices Image C58-C59). There should be provision of drain cover as well as monthly cleaning of the drain, spraying of mosquitocides and insecticides.
	7) Ward no 7end side to Forkaniha Madrasa west side Khal via Baytul Islam Mosque line in wad 6 (280m).	Control water logging	There is no waterlogging in the area (Appendices Image C55). There is need of cover on the drain. There is problem of mosquito infestation in the area.

Project Id and Name	Activity	Outcome	Local people's perception regarding the outcome
	8) Girls school of poratn Samajkallan office via Bauphal Khal in ward 4 (200 m).	Control water logging	There is problem of waterlogging. Presence of a solid waste dumping site near the drains causes clogging and overflow of waste water. The local people suggested proper solid waste management system along with relocation of the landfill site. There is presence of stagnant water in the drain which is a breeding ground for mosquito, fly and other insects. There is presence of odor pollution in the area (Appendices Image C49-C52).
	9) Md Waydut Mia Bari to Bauphal Khal in ward no 5 (200 m).	Control water logging	The problem of waterlogging reduced (Appendices Image C53-54).
	10) Daruet Sunnat East side to Bauphal Khal in ward 07 (200 m).	Control water logging	The problem of waterlogging has reduced (Appendices Image C57). People are satisfied with the project.
	11) Nitay Pall Bari to North side of Bauphal Khal in ward no 1 (40 m).	Control water logging	The problem of waterlogging has reduced. But part of the drain is not covered and there is presence of solid waste dumping in the area. Again, the project only serves one household. The local people feel that such project should be taken for many households rather than a single household (Appendices Image C40-C41).
	12) Installment of 164 tube well.	Provide safe drinking water	The people who had access to the tube wells are satisfied with the project (Appendices Image C38, C39, C42). Some local people complained that they were promised to get tube-well under the project as they provided land for drain construction for but did not receive one (Appendices Image C53). The allocation of the tube well was contradictory.
Project ID: 304 Project Name: Infrastructural and Environmental improvement of Feni Pourashava to prevent climate change induce impacts.	1) Construction of RCC drain work at Hazi Moksudur Rahman Road (Start from Mohipal Chowdhury Bari road to Connecting Patthan Bari road side) at ward 11 (0-935m)	Control water logging	The local people are not satisfied with the RCC drain. According to them, water logging still occurs. Again, some part of the RCC drain is already broken (Appendices Image C21-C22). There is also solid waste dumping in the drain. People suggested to provide cover to the drain and also repair the broken parts of the drain. They suggested proper cleaning of the drain along with spraying of insecticides. Local people also believe that the municipality should consult the local people before construction of any drain to understand the suitable location of the drain.
		Reduce insect, flyer and mosquito infestation	Due to absence of proper maintenance, the drains are clogged and works as breeding ground for insects.
		Improve public health	People are affected by insect borne disease.
	2) Construction of RCC drain at west side of Feni Bilonia rail line (Damdama Khal to	Control water logging	The water drains out in front of the school (Sishu Kishore Academy) during excessive rainfall. There is solid waste dumping which clogs the drain and creates overflow of waste water. People near Biraj Majuder bari said they did not have waterlogging problem due to the presence of waterbody near the road. But because of the presence of drain, they are facing

Project Id and Name	Activity	Outcome	Local people's perception regarding the outcome
	Biraj Mozumder bari road) at ward 7 (0 to 800 km)		problems such as reduction of crop production, mosquito infestation, odor pollution etc. Again, the site selection of the development of the RCC drain was also selected by the authority without any consultation with the local people (Appendices Image C27-C29).
		Reduce insect, flyer and mosquito infestation	Due to absence of proper maintenance, the drains are clogged and work as breeding ground for insects.
		Improve public health	People are affected by insect borne disease.
Project ID: 321 Project Name: Resolve the water logging problem, construction of guide wall, forestation and environmental development near Rajajeer Dighi and Bijoy Singh Dighi under Feni Paurashava	1) Construction of Boundary wall, RCC retaining wall, RCC walkway, beautification and plantation at North and West side of Feni Rajajeer Dighi under Feni Paurashava	Control water logging	Rajajeer Dighi works as a water retention pond.
		Reduce insect, flyer and mosquito infestation	Due to the cleaning of the waterbody and beautification, there is reduction of insect, flyer and mosquito infestation.
		Place for rest and recreation for local people	The sellers of Jhilpar market were affected due to relocation of their shops (Appendices Image C 14-C17). Though, some people use the Dighi for bathing and washing and aged people use the area for exercise and walking in the morning, the Dighi area is mainly used by young male people. As the side of the Dighi is enclosed by walls, female inhabitants of the area do not visit the Dighi for safety concern. The place has become a hiding place for young school going teenagers as they bunk their classes. Local people suggested proper monitoring of the area along with development of walkway in all four sides of the Dighi.
		Improve public health	The project improved public health. Some local people suggested that there should be a monitoring body who prevents solid waste dumping on the Dighi and spray mosquitocides.
	2) Construction of a) RCC retaining wall, b) CC road, c) RCC stair gateway, d) Toilet, e) Entry main gate, f) Boundary wall, g) Protection wall, h) Parking tiles in Feni Bijoy Singh Dighi at Word No 13 under Feni Paurashava	Control water logging	Bijoy Singh Dighi works as a water retention pond. As there was lack of recreational place in the Feni Municipality, the users of the Bijoy Singh Dighi are satisfied with the project. Though, there is reduction of insect infestation, the local people suggested monthly proper maintenance of the area along with proper spraying of mosquitocide.
		Reduce insect, flyer and mosquito infestation	Due to the cleaning of the waterbody and beautification, there is reduced of insect, flyer and mosquito infestation.
		Place for rest and recreation for local people	The area is a place for rest and recreation for local people. Before the project was taken, women did not feel safe to visit the area. But now at the afternoon, the place works as a place for rest and recreation for the local people. There are also temporary food shops for the local visitors (Appendices Image C 23-C126).
		Improve public health	The project improved public health.

(Source: Table adapted from BCCT, 2019 and Field survey, 2019)

According to table 7.6, local people are satisfied with the construction of embankment, installment of solar light and tube-well projects. For every drainage improvement project, local people are not satisfied with the projects as the project failed to achieve the goals and new problems emerged such as health hazard, odor pollution, insect infestation etc. Therefore, for construction of embankment and waterbody beautification projects, the existing condition improved while for every drainage construction project, the existing condition deteriorated in the municipalities.

Following table 7.7 describes perception of local people regarding the project goal, initiation time, cost, utilization of fund, expectation towards project, satisfaction level, consistency between project goals and outcome as well as climate change induced hazards. Local people are satisfied with the goals of the projects as well as the initiation time of the projects. The local people of all municipalities were not informed about the project cost. Only the local people of Mongla Port municipality are satisfied with the utilization of the fund. The problem of waterlogging is perceived as a major problem for Feni and Bauphal municipality. On the other hand, the people of Mongla Port municipality said that the problem of potable water crisis due to climate change induced saline intrusion was not addressed in the project initiated under BCCTF fund.

Table 7.7: Perception of local people regarding the projects

Issue considered	Local people's view regarding the completed BCCTF construction project			
	Construction of required infrastructure in Mongla Port Municipality	Resolve the water logging problem and environmental improvement of Bauphal Municipality	Infrastructural and environmental improvement of Feni Municipality	Resolve the water logging problem and environmental development near Rajajeer Dighi and Bijoy Singh Dighi under Feni Municipality
Goal of the project	Satisfied	Satisfied	Satisfied	Satisfied
Initiation time of the project	Satisfied	Satisfied	Satisfied	Satisfied
Project cost	Not informed about the project cost.	Not informed about the project cost.	Not informed about the project cost.	Not informed about the project cost.
Utilization of fund	Well utilized	Not well utilized	Not well utilized	Not well utilized
Expectation toward the project	Local people expected that the project would solve the problem of flood, tidal	Local people expected that the project would solve the problem of waterlogging.	Local people expected that the project would solve the	Local people expected that the project would solve the problem of waterlogging and create a place for rest

Issue considered	Local people's view regarding the completed BCCTF construction project			
	Construction of required infrastructure in Mongla Port Municipality	Resolve the water logging problem and environmental improvement of Bauphal Municipality	Infrastructural and environmental improvement of Feni Municipality	Resolve the water logging problem and environmental development near Rajajeer Dighi and Bijoy Singh Dighi under Feni Municipality
	surge, storm surge etc. and therefore protect their houses and livelihood.		problem of waterlogging.	and recreation for the local people.
Consistency between the project goal and outcome	Local people feel that there is consistency between project goal and outcome except for the issue of waterlogging in the city.	There is still problem of waterlogging in some adjacent areas. The drain is uncovered in some areas. The capacity of the drain also reduced due to siltation and solid waste dumping.	Local people feel that there is problem of waterlogging in some adjacent areas. The length and site of the drain is not enough.	There is consistency between project goal and outcome. But the Rajajeer Dighi is not accessible to all specially to women.
Satisfaction level	Satisfied	Not satisfied	Not satisfied	Not satisfied
Consistency between the climate induced hazards and project goal	Though the project could address flood, storm surge, riverbank erosion, water level rise etc., the project failed to address the issue of scarcity of safe water due to extreme heat and salinity intrusion.	There is consistency between the climate change induced hazards and project goal. Still the projects could not address the climate change induced flood.	There is consistency between the climate change induced hazards and project goal.	There is consistency between the climate change induced hazards and project goal.

(Source: Field survey, 2019)

7.6 Summary

This chapter describes the selected projects taken in the study areas under BCCTF and BCCRF fund as well as the project goals, outcomes and their linkage with the climate change induced hazards faced. Both BCCRF research projects address the issue of urban flooding. Similarly, projects have been taken in all three municipalities to address climate change induced waterlogging. But, waterlogging still occurs in the municipalities due to lack of proper maintenance of the drains, irregular cleaning, uncovered drains, solid waste dumping, lack of well-connected drains etc. Even if the

problem of waterlogging is less severe in Bauphal municipal area after the construction of RCC drains, there is problem of odor pollution and insect such as fly and mosquito infestation because of solid waste dumping and lack of proper maintenance of the drains in the area. Among the study areas, in Mongla Port municipality, the problem of potable water crisis is severe due to climate change induced salinity intrusion and the project initiated under BCCTF failed to address this issue. Local people from all municipalities suggested consultation with them before selection of project objective and site.

CHAPTER 8: Major Findings, Conclusion and Future Scope of Work

This chapter provides a brief description of the major findings, recommendation and conclusion of this research. Based on the research findings, recommendations have been proposed for promoting climate resilient and sustainable urban areas of Bangladesh.

8.1 Major findings

The following table 8.1 describes the major findings with respect to every objective of this research. Among 703 projects, only 245 climate fund projects have been undertaken in urban areas of Bangladesh. Even though, coastal areas of Bangladesh face the adverse impact of climate change induced salinity intrusion, cyclone, storm surge etc., around half of the total fund is allocated in Dhaka division. Moreover, 121 urban areas do not have any climate fund project undertaken to tackle climate change. The issue of climate change induced hazards in urban areas along with necessary plans, policies or strategies to tackle climate change, has been ignored in the national plan and policy documents. For example, none of the eight adaptation measures of NAPA (2009) addressed the issue of climate change in urban areas. Even though ccGAP (2013) addressed this issue for urban area, not a single urban area climate fund project was initiated following any of the four key pillars of ccGAP (2013). Most of the projects addressed infrastructural development to tackle waterlogging in the urban areas. In depth analysis of the selected climate fund projects shows that, the problem of waterlogging still exists in the study areas along with other problems of odor pollution, insect infestation, solid waste dumping etc.

Table 8.1: Major findings of this research

Objectives	Issues	Major findings
Spatial Distribution of Climate Fund Projects in Urban Areas of Bangladesh.	Climate fund projects taken in urban areas.	• Among, 703 climate funded projects until 2019, only 245 projects have been initiated in urban areas under BCCTF, BCCRF, GCF and GEF Trust Fund • There are 121 urban areas without any climate fund project • 29 urban centres situated in the most vulnerable climate zone did not receive any BCCTF or BCCRF urban area project.
	Fund source.	Only for BCCTF, the fund source is revenue budget while other funds such as GEF Trust fund, GCF and BCCRF have multilateral sources.
	Division wise allocation.	• Chattogram (19%, 48 projects), Dhaka (16%, 41 projects) and Rajshahi (16%, 40 projects) division has highest number

Objectives	Issues	Major findings
		of BCCTF urban area projects while urban areas in Chattogram, Khulna and Barishal division of Bangladesh are more vulnerable. • Around 50% of the total fund is allocated to tackle climate change impact in Dhaka division. Per capita allocation of national funds in city corporation areas show that, the city corporations are deprived ones.
	Initiation year.	Number of BCCTF urban area project increased in 2014-2015 and 2015-2016, but decreased in the following two fiscal years and then increased up to 59 projects in 2018-19 fiscal year.
	Sectors of the urban area addressed.	• Most of the projects under BCCTF have been taken for infrastructural development (25 projects, 11%), solar power street lightening system (18 projects, 8%), to tackle waterlogging and environmental improvement (94 projects, 40%), improvement of drainage (14 projects, 6%) etc. • Most fund allocation under GEF Trust fund has been taken for Greater Dhaka Sustainable Urban Transport Corridor Project. • For GCF, enhancing urban resilience program are situated in 98 coastal urban areas of Bangladesh.
Analysis of Climate Fund Projects in Urban Areas of Bangladesh in the Light of Plan, Policies and Local Context	Policy and planning documents addressing climate change.	• Among the six pillars of BCCSAP (2009), pillar 4 (Mitigation and Low Carbon Development) suggested only the management of urban waste for tackling the impact of climate change induced hazards in the urban areas of Bangladesh. • None of the eight adaptation measures of NAPA (2009) addressed the issue of climate change in urban areas. • Though, ccGAP (2013) addressed this issue of climate change for urban area, not a single urban area climate fund project was initiated following any of the four key pillars of ccGAP (2013).
	Allocation of urban area climate fund projects and their linkage with national plan and policies.	• Around 194 among 237 urban area BCCTF projects addressed pillar 3 (Infrastructure) of BCCSAP (2009) whereas 144 addressed pillar 5 (Mitigation and Low Carbon Development). • Among the 208 urban area climate fund projects which addressed the proposed adaptation measures of NAPA (2009), 201 projects addressed building climate resilient infrastructure measure. • Only eight urban area climate fund projects addressed any of the action plan proposed in NAP for Reducing SLCPs (2018). • Integral urban drainage improvement strategy has been reflected in 137 urban area climate fund projects. • 198 urban area projects under BCCTF and two projects under GCF addressed infrastructural functioning and maintenance strategy according to 7th FYP (2016-2020). • Around 33 projects (31 BCCTF and 2 GEF Trust fund) also addressed enhancing capacity of energy saving sectors mitigation strategy of 7th FYP (2016-2020).
	Urban area climate fund projects and their linkage with international plans and policies.	• Most projects also addressed waste water system (134 projects) and water supply system (14 projects) according to IPCC- Fifth Assessment Urban Area Report (2014). • Goal 11 (Sustainable cities and communities) of SDGs (2015-2030) was mostly reflected in the urban area climate fund projects.

Objectives	Issues	Major findings
People's Perception Regarding Climate Fund Projects at Local Context.	Climate change induced hazards	• Both BCCRF projects are research projects undertaken in DNCC and DSCC area and address the issue of urban flooding. • Similarly, projects have been taken in all three municipalities to address climate change induced waterlogging.
	Project outcome	• Waterlogging still occurs in the municipalities due to lack of proper maintenance of the drains, irregular cleaning, uncovered drains, solid waste dumping, lack of well-connected drains etc. • Even if the problem of waterlogging is less severe in Bauphal municipal area after the construction of RCC drains, there is problem of odor pollution and insect such as fly and mosquito infestation. • Local people are satisfied with construction of embankment and installation of solar light in Mongla Port municipal area. • For the installment of tube wells in Bauphal municipality, the local people who have access to the tube wells are satisfied with the project. • In Mongla Port municipality, the problem of potable water crisis is severe due to climate change induced salinity intrusion and the projects initiated under BCCTF failed to address this issue. • Most of the infrastructural development projects have been taken to address waterlogging failed to improve health sector and new public health issue has emerged.
	Suggestions of local people	• Consultation with local people before selection of project site as well as width and depth of the RCC drains. • More height of the embankment as well as regular maintenance of the solar lights in the embankment of Mongla Port municipality. • Allocation of tube wells should have been done after consulting with local people.

8.2 Conclusion, recommendation and future scope of work

The urban areas of Bangladesh face the adverse impact of climate change induced hazards such as sea level rise, cyclone, flood, salinity intrusion, storm surge, change in temperature and rainfall which causes waterlogging, water scarcity, damage of infrastructure etc. Even though national and international plan and policy documents such as BCCSAP (2009), NAPA (2009), 7th FYP (2016-2020), ccGAP (2013), BDP (2100), EFCC CIP (2016-2021), INDC (2015), NEP (2013), SDG's (2015-2030) etc. addressed the issue of climate change in Bangladesh, the issue of the impacts of climate change induced hazards in the urban areas is still neglected in these policy documents. To tackle the impact of climate change induced hazards, 703 climate funded projects have been initiated under BCCTF, BCCRF, ASAP, GEF, GCF, LDCF,

PPCR etc. funds until 2019, where only 245 projects have been initiated in urban areas under BCCTF, BCCRF, GCF and GEF Trust Fund. Even though, coastal areas of Bangladesh face the adverse impact of climate change induced salinity intrusion, cyclone, storm surge etc., around half of the total fund is allocated in Dhaka division. Moreover, 121 urban areas do not have any climate fund allocation to tackle climate change. Most of these urban area climate fund projects addressed infrastructural development to tackle waterlogging in the urban areas. The analysis of the perception of local people regarding the selected climate fund urban area projects shows that, in all study areas the problem of waterlogging still exists along with other problems of odor pollution, insect infestation, solid waste dumping, overflow of drain etc. due to lack of proper management and maintenance of the project areas after the implementation of projects. In Mongla Port municipality, the allocation of climate fund did not consider the issue of scarcity of safe drinking water due to climate induced salinity intrusion. Only in the Mongla Port municipality, the local people are satisfied with the outcome of climate fund project.

Based on literature review and major findings of this research, the following recommendations has been proposed in the table 8.2. Fund should be allocated to address the climate change induced hazards in the most vulnerable urban areas without any climate fund project. The objective and project works should consider the impacts of climate change at local context as well as the view of local people at grass-root level.

Table 8.2: Proposals to promote climate resilient urban areas in Bangladesh

Issues	Proposal
Climate fund projects allocation	• Need to increase the allocation of the climate funds to tackle impact of climate change in urban areas. • During the allocation, the urban areas are located in the most vulnerable zones should be prioritized. • Climate fund project objective or project outcome should consider the need of the local people as well as the likely impact of climate change induced hazards affecting the urban area. • More urban area projects should be initiated to address other pillars, themes or strategies rather than only infrastructural development in urban areas. • As, NGOs and CBOs of the municipalities are already involved in projects to tackle climate change, government need to put more emphasis on the expectations and needs of the local people.

Issues	Proposal
Plan and policy documents	• The upgradation and formulation of national plans and policies should put more focus on the impact of climate change induced hazards in the urban areas of Bangladesh. • Detail guidelines should be provided to ensure climate resilient urban areas. • Along with the guidelines, the activities and responsibilities of different agencies and institutions should be mentioned. • The documents should consider the need of most vulnerable group. • Only one project has been initiated under BCCTF to address the issue of climate migration. Feni municipality faces climate migration from adjacent vulnerable areas. More fund should be allocated to address climate migration.
Efficient implementation of the projects	• The view of local people along with other stakeholders should be considered before selecting the objective, project site and project works. • Local people can be involved for efficient implementation of the urban area climate fund projects. • There should be proper and regular monitoring after the implementation of the projects.

This research showed allocation of climate fund projects in the urban areas and their linkages with the national and international plans and policies and at last local people's view regarding the impact of climate change induced hazards in some selected urban areas of Bangladesh. Farther in detail research can be done on all types of climate fund projects taken in all types of areas of Bangladesh. This research would help policy makers, planners, structural engineers and other stakeholders to identify the most vulnerable urban areas facing climate change induced hazards along with the climate fund allocation in those areas and thereby take necessary steps to ensure climate resilient urban development.

References

- Agrawala, S., Ota, T., Ahmed, A. U., Smith, J., & Van Aalst, M. (2003). *Development and climate change in Bangladesh: focus on coastal flooding and the Sundarbans*: OECD Paris.
- Ahammad, R. (2011). Constraints of pro-poor climate change adaptation in Chittagong city. *Environment and Urbanization*, 23(2), 503-515.
- Ahmed, A. U., Alam, M., & Rahman, A. A. (1999). Adaptation to climate change in Bangladesh: future outlook *Vulnerability and adaptation to climate change for Bangladesh* (pp. 125-143): Springer.
- Ahmed, F. R. S. (2012). Climate Change Issues in Bangladesh & Need for Adaptation to Climate Change.
- Ahmed, S. (2015). Climate risks in megacities of the global south: Focus on Dhaka, Bangladesh. *The "State of DRR at the Local Level" A 2015 Report on the Patterns of Disaster Risk Reduction Actions at Local Level*, 1-11.
- Ahmed, S. S., & Ahmed, M. Urbanization and Economic Development of Bangladesh: The Primacy of Dhaka and Competitiveness.
- Ahsan, M. S., Akber, M. A., Islam, M. A., Kabir, M. P., & Hoque, M. I. (2017). Monitoring bacterial contamination of piped water supply in rural coastal Bangladesh. *Environmental monitoring and assessment*, 189(11), 1-13.
- Alam, K., Shamsuddoha, M., Tanner, T., Sultana, M., Huq, M. J., & Kabir, S. S. (2011). The political economy of climate resilient development planning in Bangladesh. *IDS Bulletin*, 42(3), 52-61.
- Alam, M., & Rabbani, M. G. (2007). Vulnerabilities and responses to climate change for Dhaka. *Environment and Urbanization*, 19(1), 81-97.
- Alam, S. S., Alam, A., Rehman, M. F., & Rahman, S. (2016). Building climate resilience to Noapara town: a coastal urban centre of Bangladesh.
- Alauddin, S., & Mallick, D. (2010). *Case study: Local Capacity Building for Advancing Adaptation to Climate Change in Floodplains and Coastal Areas of Bangladesh*. Paper presented at the South Asian Regional Workshop on Climate Smart Disaster Risk Managemnt, Delhi.

- Ali, A. (1999). Climate change impacts and adaptation assessment in Bangladesh. *Climate Research*, 12(2/3), 109-116.
- Archer, D., Almansi, F., DiGregorio, M., Roberts, D., Sharma, D., & Syam, D. (2014). Moving towards inclusive urban adaptation: approaches to integrating community-based adaptation to climate change at city and national scale. *Climate and Development*, 6(4), 345-356.
- Asian Development Bank. *Climate Change in South Asia: Strong Response for Building a Sustainable Future*. Retrieved from <https://www.adb.org/sites/default/files/publication/27475/climate-change-sa.pdf>
- Ayers, J. M., Huq, S., Faisal, A. M., & Hussain, S. T. (2014). Mainstreaming climate change adaptation into development: a case study of Bangladesh. *Wiley Interdisciplinary Reviews: Climate Change*, 5(1), 37-51.
- Bangladesh Bureau of Statistics. (2011). *Statistical Year Book of Bangladesh 2011*. Dhaka: Ministry of Planning, Government of Bangladesh.
- Bangladesh Bureau of Statistics. (2014). *Bangladesh Population and Housing Census 2011, National Report Volume- 3, Urban Area Report*. Ministry of Planning, Government of the People's Republic of Bangladesh.
- Bangladesh Climate Change Trust (BCCT). (2019). BCCTF Govt. Projects List.
- Banks, N., Roy, M., & Hulme, D. (2011). Neglecting the urban poor in Bangladesh: research, policy and action in the context of climate change. *Environment and Urbanization*, 23(2), 487-502.
- Baten, M. A., Seal, L., & Lisa, K. S. (2015). Salinity intrusion in interior coast of Bangladesh: challenges to agriculture in south-central coastal zone. *American Journal of Climate Change*, 4(03), 248.
- Bauphal Upazila. (2020). Bangladesh National Portal. Retrieved from <http://bauphal.patuakhali.gov.bd/site/page/ab5633d9-17a2-11e7-9461-286ed488c766/%E0%A6%8F%E0%A6%95%20%E0%A6%A8%E0%A6%9C%E0%A6%B0%E0%A7%87%20%E0%A6%AA%E0%A7%8C%E0%A6%B0%E0%A6%B8%E0%A6%AD%E0%A6%BE>

- Beermann, J., Damodaran, A., Jörgensen, K., & Schreurs, M. A. (2016). Climate action in Indian cities: an emerging new research area. *Journal of Integrative Environmental Sciences*, 13(1), 55-66.
- Bellinson, R., & Chu, E. (2019). Learning pathways and the governance of innovations in urban climate change resilience and adaptation. *Journal of environmental policy & planning*, 21(1), 76-89.
- Boswell, M. R., & Mason, S. G. (2018). Regional climate planning and local outcomes in California *Climate change in cities* (pp. 59-76): Springer.
- Bourgeois, E., & Hughes, S. (2018). Metropolitan Governance of Waste for Climate Change Mitigation: Examining the Case of Montreal *Climate Change in Cities* (pp. 77-93): Springer.
- Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative research journal*, 9 (2), 27.
- Brown, S., Nicholls, R. J., Wadey, M., Shareef, A., Khaleel, Z., Lincke, D., . . . S, M. (2015). *Effects of 2°C Warming: IMPACT2C modelling results for a 2°C climate for key global vulnerable regions* Climate Service Center Germany.
- Bulkeley, H., & Betsill, M. M. (2013). Revisiting the urban politics of climate change. *Environmental politics*, 22(1), 136-154.
- Bulkeley, H., Carmin, J., Broto, V. C., Edwards, G. A., & Fuller, S. (2013). Climate justice and global cities: Mapping the emerging discourses. *Global Environmental Change*, 23(5), 914-925.
- Bulkeley, H., & Tuts, R. (2013). Understanding urban vulnerability, adaptation and resilience in the context of climate change. *Local Environment*, 18(6), 646-662.
- Castán Broto, V., Oballa, B., & Junior, P. (2013). Governing climate change for a just city: challenges and lessons from Maputo, Mozambique. *Local Environment*, 18(6), 678-704.
- Chambers, R. (1992). Actual or potential uses of RRA/PRA methods in health and nutrition.
- Choudhury, A. M., Neelormi, S., Quadir, D., Mallick, S., & Ahmed, A. U. (2005). Socio-economic and physical perspectives of water related vulnerability to

climate change: results of field study in Bangladesh. *Science and Culture*, 71(7/8), 225.

Das, A., & Hossain, N. (2017). *Appraising climate change impact mitigation standards to ground realities: the lessons from Bangladesh climate change Trust funded projects*. Paper presented at the International Conference on Disaster Risk Mitigation.

Das, P. K. (2010). *Climate Change and Education, Bangladesh*: UKaid.

Dasgupta, S., Kamal, F. A., Khan, Z. H., Choudhury, S., & Nishat, A. (2014). River salinity and climate change: evidence from coastal Bangladesh *World Scientific Reference on Asia and the World Economy* (pp. 205-242): World Scientific.

Dasgupta, S., Zaman, A., Roy, S., Huq, M., Jahan, S., & Nishat, A. (2015). *Urban Flooding of Greater Dhaka in a Changing Climate: Building local resilience to disaster risk*: World Bank Publications.

Dhaka North City Corporation. (2020). Retrieved from Bangladesh National Portal: <http://www.dncc.gov.bd/site/page/b3f35dad-996d-44e1-b61d-86bce8f9ae2a/->

Dhaka South City Corporation. (2020). Retrieved from Bangladesh National Portal: <http://www.dscc.gov.bd/site/page/c918f990-1f75-46cb-95ad-c08d10197af5/->

Disaster Management Bureau. (2010). *National Plan for Disaster Management 2010-2015*. Disaster Management & Relief Division.

Engberg, L. A. (2018). Climate adaptation and citizens' participation in Denmark: experiences from Copenhagen *Climate Change in Cities* (pp. 139-161): Springer.

Fariza, A., Abhimata, N. P., & Hasim, J. A. N. (2016). *Earthquake disaster risk map in east Java, Indonesia, using analytical hierarchy process—Natural break classification*. Paper presented at the 2016 International Conference on Knowledge Creation and Intelligent Computing (KCIC).

Fatemi, M., Okyere, S. A., Diko, S. K., & Kita, M. (2020). Multi-level climate governance in Bangladesh via climate change mainstreaming: lessons for local climate action in Dhaka city. *Urban Science*, 4(2), 24.

- Feni Sadar Upazila. (2020). Retrieved from Bangladesh National Portal:
<http://sadar.feni.gov.bd/site/page/4f003922-2144-11e7-8f57-286ed488c766/%E0%A6%8F%E0%A6%95%20%E0%A6%A8%E0%A6%9C%E0%A6%B0%E0%A7%87%20%E0%A6%AA%E0%A7%8C%E0%A6%B0%E0%A6%B8%E0%A6%AD%E0%A6%BE>
- Field, C. B., & Barros, V. R. (2014). *Climate change 2014–Impacts, adaptation and vulnerability: Regional aspects*: Cambridge University Press.
- Fotheringham, A. S., & Rogerson, P. A. (2008). *The SAGE handbook of spatial analysis*: Sage.
- General Economic Division. (2012). *Perspective Plan of Bangladesh 2010-2021*. Dhaka: Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.
- General Economic Division. (2015). *Seventh Five Year Plan, FY 2016- FY 2020*. Dhaka: Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.
- General Economic Division. (2018). *Bangladesh Delta Plan 2100*. Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.
- General Economic Division. (2020). *8th Five Year Plan, July 2020- June 2025*. Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.
- General Economic Division. (2012). *Bangladesh Climate Public Expenditure and Institutional review*. Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.
- Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. *Built environment*, 33(1), 115-133.
- Global Environment Facility. (2020). Projects. Retrieved from Global Environment Facility. Retrieved from Investing in our Planet: <https://www.thegef.org/projects-faceted?f>
- Global Environment Facility. (2021). Retrieved from Investing in our Planet: <https://www.thegef.org/about-us>

- Goosen, H., Hasan, T., Saha, S., Rezwana, N., Rahman, R., Assaduzzaman, M., . . . van Scheltinga, C. (2018). *Nationwide Climate Vulnerability Assessment in Bangladesh, Final Draft*. Retrieved from https://www.academia.edu/40175392/Nationwide_Climate_Vulnerability_Assessment_in_Bangladesh
- Green Climate Fund. About GCF. Retrieved from <https://www.greenclimate.fund/about>
- Green Climate Fund Independent Evaluation Unit. (2019). *Forward Looking Performance Review of the Green Climate Fund Countries Report: Incheon*. Retrieved from <https://www.greenclimate.fund/sites/default/files/document/gcf-b23-20.pdf>
- Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. *science*, 319(5864), 756-760.
- Hassan, M. M. (2017). Monitoring land use/land cover change, urban growth dynamics and landscape pattern analysis in five fastest urbanized cities in Bangladesh. Remote Sensing Applications. *Society and Environment*, 7, 69-83.
- Hassan, M. M., & Nazem, M. N. I. (2016). Examination of land use/land cover changes, urban growth dynamics, and environmental sustainability in Chittagong city, Bangladesh. *Environment, Development and Sustainability*, 18(3), 697-716. doi:10.1007/s10668-015-9672-8
- Homsy, G. C. (2018). Size, sustainability, and urban climate planning in a multilevel governance framework *Climate change in cities* (pp. 19-38): Springer.
- Huq, S. (2001). Climate change and Bangladesh. *Science*, 294(5547), 1617-1618.
- Huq, S., & Rabbani, G. (2011). Climate change and Bangladesh: policy and institutional development to reduce vulnerability. *Journal of Bangladesh Studies*, 13(1), 1-10.
- Hussain, F. A., & Ahmad, M. M. (2019). Effects of Climate Finance on Risk Appraisal: A Study in the Southwestern Coast of Bangladesh. *Advances in Meteorology*, 2019.

- Iftikhar, M. N., Ali, S., & Sarzynski, A. (2018). Community–government partnership for metered clean drinking water: A case study of Bhalwal, Pakistan *Climate Change in Cities* (pp. 163-179): Springer.
- Independent Commission for Aid Impact. (2011). *The Department for International Development's Climate Change Programme in Bangladesh*. Retrieved from <https://www.oecd.org/countries/bangladesh/49092047.pdf>
- International Fund for Agricultural Development. (2012). *Bangladesh: Climate adaptation and Livelihood Protection (CaLIP) – Scaling up best practice and testing new adaptation Interventions in the Haor Infrastructure and Livelihood Improvement Project (HILIP)*. Retrieved from <https://www.ifad.org/documents/38714170/39150184/ASAP+Bangladesh+factsheet.pdf/789ef4a1-f084-41ba-892e-17881ec6f166>
- International Organization for Migration. (2020). *Assessing the Evidence: Environment, Climate Change and Migration in Bangladesh*. Retrieved from <https://iom.org.bd/wp-content/uploads/2017/06/Environment-ClimateChange-and-Migration-in-Bangladesh-1.pdf>
- Jabareen, Y. (2013). Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. *Cities*, 31, 220-229.
- Jenks, G. F. (1967). The data model concept in statistical mapping. *International yearbook of cartography*, 7, 186-190.
- Kabir, M. H., Sato, M., Habbiba, U., & Yousuf, T. B. (2018). Assessment of urban disaster resilience in Dhaka North City Corporation (DNCC), Bangladesh. *Procedia engineering*, 212, 1107-1114.
- Kabir, S. E. (2014). *Effective utilization of climate change trust fund in adaptation programs in Bangladesh: a focus on stakeholder participation*. BRAC University.
- Kemmerzell, J. (2018). Innovations in European climate governance and their impact on local climate policy: An analysis of German major cities *Climate Change in Cities* (pp. 39-57): Springer.
- Khisty, C. J. (1994). Evaluation of pedestrian facilities: beyond the level-of-service concept. *Transportation Research Record*, 1438.

- Khulna Water Supply and Sewerage Authority. (2018). *Khulna Water Supply Project*. Retrieved from https://www.adb.org/sites/default/files/project-documents/42171/42171-013-emr-en_1.pdf
- Kreft, S., Eckstein, D., Dorsch, L., Fischer, L., & Germanwatch, E. (2015). *Briefing Paper, Global Climate Risk Index 2016. Who Suffers Most From Extreme Weather Events*.
- Kumar, K. (1989). *Conducting key informant interviews in developing countries*: Agency for International Development Washington DC.
- Kumar, S. (2002). Methods for community participation: a complete guide for practitioners. *Methods for community participation: a complete guide for practitioners*.
- Leal Filho, W., Balogun, A.-L., Olayide, O. E., Azeiteiro, U. M., Ayal, D. Y., Muñoz, P. D. C., . . . Toamukum, N. Y. (2019). Assessing the impacts of climate change in cities and their adaptive capacity: Towards transformative approaches to climate change adaptation and poverty reduction in urban areas in a set of developing countries. *Science of the Total Environment*, 692, 1175-1190.
- Local Government Engineering Department. (2017). Retrieved from Urban Management Unit: [http://www.Local Government Engineering Department.gov.bd/UnitAbout.aspx?UnitID=10](http://www.LocalGovernmentEngineeringDepartment.gov.bd/UnitAbout.aspx?UnitID=10)
- Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., & Mosier, T. (2018). *South Asia's hotspots: The impact of temperature and precipitation changes on living standards*: The World Bank.
- Marshall, M. N. (1996). The key informant technique. *Family practice*, 13, 92-97.
- Martin, M., Kang, Y. H., Billah, M., Siddiqui, T., Black, R., & Kniveton, D. (2013). *Policy analysis: Climate change and migration Bangladesh*. Retrieved from <http://admin.indiaenvironmentportal.org.in/files/file/climate%20change%20and%20migration%20bangladesh.pdf>
- Ministry of Environment and Forests. (2005). *National Adaptation Programme of Action (NAPA) Final Report*. Government of the People's Republic of Bangladesh.

- Ministry of Environment and Forests. (2009a). *Bangladesh Climate Change Strategy and Action Plan*. Government of the People's Republic of Bangladesh.
- Ministry of Environment and Forests. (2009b). *National Adaptation Programme of Action (NAPA)*. Government of the People's Republic of Bangladesh.
- Ministry of Environment and Forests. (2012). *National Report on Sustainable Development*. Peoples' Republic of Bangladesh.
- Ministry of Environment and Forests. (2013a). *Bangladesh Climate Change Gender Action Plan (ccGAP: Bangladesh)*. Government of the People's Republic of Bangladesh.
- Ministry of Environment and Forests. (2013b). *National Environmental Policy*. Government of the People's Republic of Bangladesh.
- Ministry of Environment and Forests. (2015). *Intended Nationally Determined Contributions (INDC)*. Government of the People's Republic of Bangladesh.
- Ministry of Environment and Forests. (2017). *Bangladesh Country Investment Plan for Environment, Forestry and Climate Change (2016 – 2021)*. Government of the People's Republic of Bangladesh.
- Ministry of Environment Forests and Climate Change. (2018). *Bangladesh National Action Plan (NAP) for Reducing Short Lived Climate Pollutants (SLCPs)*. Government of the People's Republic of Bangladesh.
- Mishra, L. (2016). Focus group discussion in qualitative research. *Techno Learn: An International Journal of Educational Technology*, 6(1), 1-5.
- Mongla Port Municipality Office. (2020). Retrieved from <http://www.monglaportmunicipality.gov.bd/about>.
- NDA Secretariat. (2018). *Journey with Green Climate Fund: Bangladesh's Country Programme for Green Climate Fund*. Ministry of Finance, Economic Relations Division. Government of the Peoples' Republic of Bangladesh.
- Papa, F., Frappart, F., Malbeteau, Y., Shamsudduha, M., Vuruputur, V., Sekhar, M., . . . Pandey, R. K. (2015). Satellite-derived surface and sub-surface water storage in the Ganges–Brahmaputra River Basin. *Journal of Hydrology: Regional Studies*, 4, 15-35.

- Parvin, G. A., Ahsan, S. R., & Shaw, R. (2013). Urban risk reduction approaches in Bangladesh *Disaster risk reduction approaches in Bangladesh* (pp. 235-257): Springer.
- Paul, A., & Rahman, M. (2006). Cyclone mitigation perspectives in the Islands of Bangladesh: a case of Sandwip and Hatia Islands. *Coastal Management*, 34(2), 199-215.
- Quang Ngai Province. (2007). *Socio-Economic Planning Process. Participatory Rural Appraisal Manual*. Retrieved from Quang Ngai Province, Vietnam: https://himachal.nic.in/WriteReadData/1892s/15_1892s/1499233748.pdf
- Rabbani, G., & Haq, S. (2016). *The effects of changes in flooding, sea level rise and changes in salinity on multidimensional inequality*. Retrieved from <http://gobeshona.net/publication/effects-changes-flooding-sea-level-rise-changes-salinity-mulidimensional-inequality/#sthash.WJWswHke.dpbs>
- Rahman, A., & Alam, M. (2003). Mainstreaming adaptation to climate change in Least Developed Countries (LDCs). *Bangladesh Country Case Study*.
- Rahman, M. S., Mohiuddin, H., Kafy, A.-A., Sheel, P. K., & Di, L. (2019). Classification of cities in Bangladesh based on remote sensing derived spatial characteristics. *Journal of Urban Management*, 8(2), 206-224.
- Rahman, M. T. *Strategy for Urban Sector Development in Bangladesh*. <https://www.theigc.org/wp-content/uploads/2015/05/1SouthAsiaRahman.pdf>
- Rahman, S. M., & Ahmad, M. M. (2016). Perception of local experts about accessibility to international climate funds: Case of Bangladesh. *The Journal of Developing Areas*, 53-68.
- Rahman, S. M., Ahmad, M. M., & Alam, M. S. (2016). From strategy to execution: the case of local climate fund in Bangladesh. *International Journal of Environmental Policy and Decision Making*, 2(1), 1-18.
- Rai, N., & Smith, B. (2015). Climate Investment Funds Pilot Programme for Climate Resilience (PPCR) in Bangladesh A Status Review: iied.
- Rajasekar, U., Chakraborty, S., & Bhat, G. (2018). Climate resilient smart cities: opportunities for innovative solutions in India *Climate change in cities* (pp. 203-227): Springer.

- Revi, A., Satterthwaite, D., Aragón-Durand, F., Corfee-Morlot, J., Kiunsi, R. B., Pelling, M., . . . Sverdluk, A. (2014). Towards transformative adaptation in cities: the IPCC's Fifth Assessment. *Environment and Urbanization*, 26(1), 11-28.
- Rosenzweig, C., Solecki, W. D., Hammer, S. A., & Mehrotra, S. (2011). *Climate change and cities: First assessment report of the urban climate change research network*: Cambridge University Press.
- Rourke, L., & Anderson, T. (2004). Validity in quantitative content analysis. *Educational technology research and development*, 52(1), 5.
- Sari, A. D., & Prayoga, N. (2018). Enhancing citizen engagement in the face of climate change risks: A case study of the flood early warning system and health information system in Semarang City, Indonesia *Climate Change in Cities* (pp. 121-137): Springer.
- Sarzynski, A. (2018). Multi-level governance, civic capacity, and overcoming the climate change “adaptation deficit” in Baltimore, Maryland *Climate change in cities* (pp. 97-120): Springer.
- Satterthwaite, D., Huq, S., Pelling, M., Reid, H., & Lankao, P. R. (2007). Adapting to climate change in urban areas. *London: IIED*.
- Savage, M., Mujica, A., Chiappe, F., & Ross, I. (2015). Climate finance and water security: Oxford: Oxford Policy Management.
- Shahid, S., Wang, X.-J., Harun, S. B., Shamsudin, S. B., Ismail, T., & Minhans, A. (2016). Climate variability and changes in the major cities of Bangladesh: observations, possible impacts and adaptation. *Regional Environmental Change*, 16(2), 459-471.
- Shamsuddoha, M., & Chowdhury, R. K. (2007). Climate change impact and disaster vulnerabilities in the coastal areas of Bangladesh. *COAST Trust, Dhaka*, 40-48.
- The World Bank. (2015). *Flood Risk Management in Dhaka: A Case for Eco-Engineering Approaches and Institutional Reform*. People's Republic of Bangladesh.

- The World Bank. (2016). *BCCRF annual report 2016*. Dhaka: Government of People's Republic of Bangladesh.
- Transparency International Bangladesh. (2013). *An Assessment of Climate Finance Governance in Bangladesh*. Retrieved from https://www.transparency.org/files/content/activity/2013_AssessmentOfClimateFinance_Bangladesh_EN.pdf
- Transparency International Bangladesh. (2017). Climate Finance and Local Government Institutions: Governance in Project Implementation.
- Tremblay, M. A. (1957). The key informant technique: A nonethnographic application. *American Anthropologist*, 59(4), 688-701.
- UCLA Center for Health Policy Research. *Section 4: Key Informant Interviews. UCLA Center for Health Policy Research-Health DATA Program – Data, Advocacy and Technical Assistance*. Retrieved from https://healthpolicy.ucla.edu/programs/healthdata/trainings/Documents/tw_cba23.pdf
- Uddin, M. N., & Anjuman, N. (2013). Participatory rural appraisal approaches: an overview and an exemplary application of focus group discussion in climate change adaptation and mitigation strategies. *International Journal of Agricultural Research, Innovation and Technology*, 3(2), 72-78.
- United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. Retrieved from https://www.un.org/pga/wp-content/uploads/sites/3/2015/08/120815_outcome-document-of-Summit-for-adoption-of-the-post-2015-development-agenda.pdf
- United Nations Population Division. (2019). Bangladesh Population. Retrieved from Worldometers: <http://www.worldometers.info/world-population/bangladesh-population/>
- University of Illinois Extension—Program Planning and Assessment. Needs Assessment Techniques: Using Key Informant Interviews. Urbana, IL: University of Illinois. Retrieved from <http://www.aces.uiuc.edu/~PPA/NeedsAsmnt.htm>

- Unwin, D. J. (1996). GIS, spatial analysis and spatial statistics. *Progress in Human Geography*, 20(4), 540-551.
- Van Aalst, M. K., Cannon, T., & Burton, I. (2008). Community level adaptation to climate change: the potential role of participatory community risk assessment. *Global Environmental Change*, 18(1), 165-179.
- Vij, S., Biesbroek, R., Groot, A., & Termeer, K. (2018). Changing climate policy paradigms in Bangladesh and Nepal. *Environmental science & policy*, 81, 77-85.
- Wong, K. Y., Casey, R. G., & Wahl, F. M. (1982). Document analysis system. *IBM journal of research and development*, 26(6), 647-656.
- Zafri, N. M., Sameen, I., Jahangir, A., Tabassum, N., & Hasan, M. M. U. (2020). A multi-criteria decision-making approach for quantification of accessibility to market facilities in rural areas: an application in Bangladesh. *GeoJournal*, 1-17.
- Zhao, K., Jin, B., Fan, H., Song, W., Zhou, S., & Jiang, Y. (2019). High-performance overlay analysis of massive geographic polygons that considers shape complexity in a cloud environment. *ISPRS International Journal of Geo-Information*, 8(7), 290.

Appendices A

Table A1: Coordination schema

Objectives	List of variables	Level of data	Type of data/ Data Source	Method of Data collection
1. To study the spatial distribution of projects under climate change funds in urban areas of Bangladesh	Name of fund	Nominal	Secondary	Document Analysis
	Project location	Nominal	Secondary	Document Analysis
	Type of urban area	Ordinal	Secondary	Document Analysis
	Time frame of the project	Interval	Secondary	Document Analysis
	Budget of the project	Ratio	Secondary	Document Analysis
	Project status	Nominal	Secondary	Document Analysis
	Project implementing agency	Nominal	Secondary	Document Analysis
	Population of the urban area	Ratio	Secondary	Document Analysis
	Area of the urban area	Ratio	Secondary	Document Analysis
2. To study the projects under climate change funds in the urban areas in the light of national plans, policies and local context	Objective of the project	Nominal	Secondary	Document Analysis
	Activities under the project	Nominal	Secondary	Document Analysis
	Type of strategy (Mitigation, adaptation)	Nominal	Secondary	Document Analysis
	Six pillars of BCCSAP, 2009.	Nominal	Secondary	Document Analysis
	Eight adaptation measures of NAPA, 2009	Nominal	Secondary	Document Analysis
	Ten adaptation issues and six mitigation issues of 7 th 5-year plan (2016-2020)	Nominal	Secondary	Document Analysis
	Action steps of ccGAP: Bangladesh, 2013	Nominal	Secondary	Document Analysis
	Six sectors in NAP, 2018	Nominal	Secondary	Document Analysis
	Strategies under seven issues for urban areas in BDP, 2100	Nominal	Secondary	Document Analysis
	Four pillars of priority investment in EFCC CIP, 2016-2021	Nominal	Secondary	Document Analysis
	Four strategies of Coastal Zone policy, 2005	Nominal	Secondary	Document Analysis

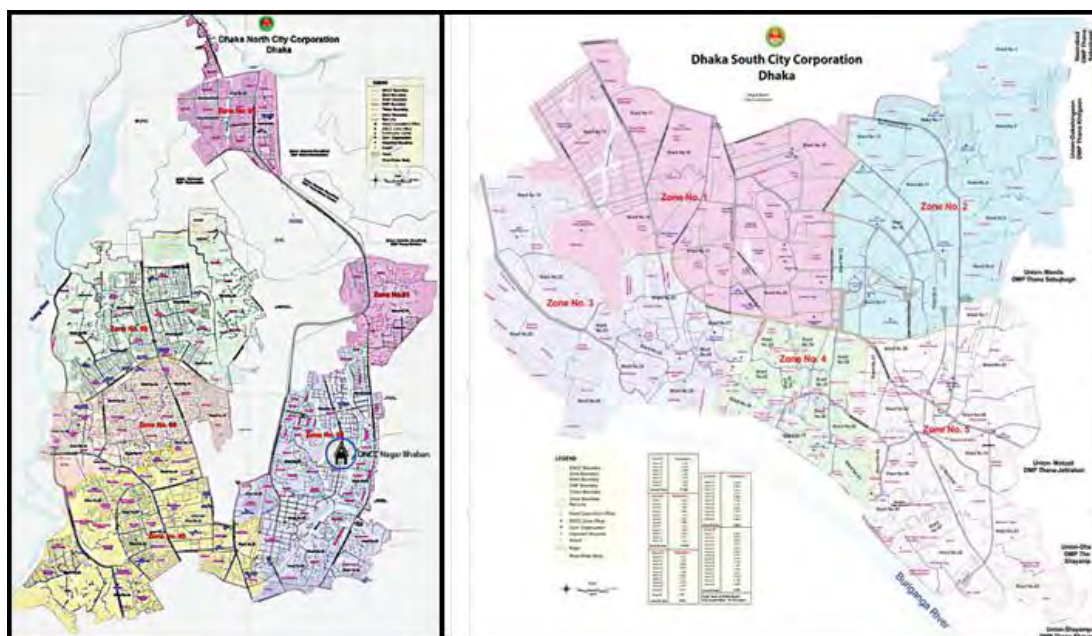
Objectives	List of variables	Level of data	Type of data/ Data Source	Method of Data collection
	strategies for both adaptation and mitigation measures in INDC, 2015	Nominal	Secondary	Document Analysis
	Action agenda in National Plan for Disasters, 2010-2015	Nominal	Secondary	Document Analysis
	Eleven proposals in NEP, 2013	Nominal	Secondary	Document Analysis
	Seventeen goals of SDGs (2015-2030)	Nominal	Secondary	Document Analysis
	16 key risk factors in urban areas according to IPCC urban area report, 2014	Nominal	Secondary	Document Analysis
3. To understand the view of local people regarding the climate change induced hazards and their linkage with projects under climate change funds in the selected urban areas of Bangladesh	Climate change induced hazard type	Nominal	Primary / PRA Survey	KII/ FGD
	Spatial dimension of the climate change induced hazard	Nominal	Primary / PRA Survey	KII/ FGD
	Temporal dimension of the climate change induced hazard	Interval	Primary / PRA Survey	KII/ FGD
	Likely impact of the climate change induced hazards	Nominal	Primary / PRA Survey	KII/ FGD
	Inclusion of local people in the projects	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding the goal of the project	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding the initiation time of the project	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding the project cost	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding the utilization of fund	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's expectation towards the project	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding consistency between the project goal and outcome	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding consistency between the climate induced hazards and project goal	Nominal	Primary / PRA Survey	KII/ FGD
	Local people's view regarding benefit of project	Nominal	Primary / PRA Survey	KII/ FGD
	Satisfaction level of the local people regarding the project	Ordinal	Primary / PRA Survey	KII/ FGD

Table A2: List of the interviewee for KII

Designation of the interviewee	Organization
Secretary	Ministry of Environment, Forest & Climate Change
Senior Fellow	Climate Change Group at the International Institute for Environment
Fellow	Bangladesh Centre For Advanced Studies (BCAS)
Senior Specialist	Center for Environmental and Geographic Information Services (CEGIS)
Research Associate	International Centre for Climate Change & Development (ICCAD)
Senior Research Officer	International Centre for Climate Change & Development (ICCAD)
Research Officer	International Centre for Climate Change & Development (ICCAD)
Assistant Director	Bangladesh Climate Change Trust (BCCT)
Mayor	Municipality
Engineer	Municipality
Faculty member	BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS)
Faculty member	Department of Civil Engineering (CE), Bangladesh University of Engineering & Technology (BUET)
Faculty member	Department of Water Resources Engineering (WRE), Bangladesh University of Engineering & Technology (BUET)
Faculty member	Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET)
Faculty member	Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering & Technology (BUET)
Faculty member	Department of Urban and Regional Planning (URP), Bangladesh University of Engineering & Technology (BUET)
Research Assistant	Department of Urban and Regional Planning (URP), Bangladesh University of Engineering & Technology (BUET)

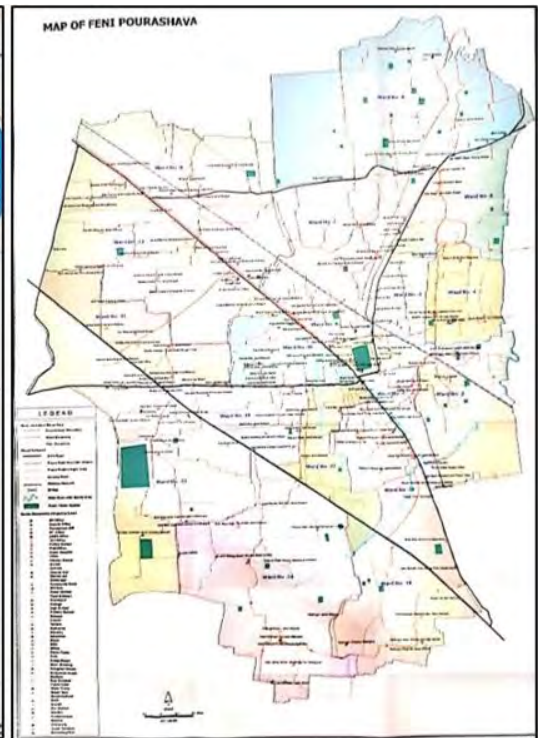
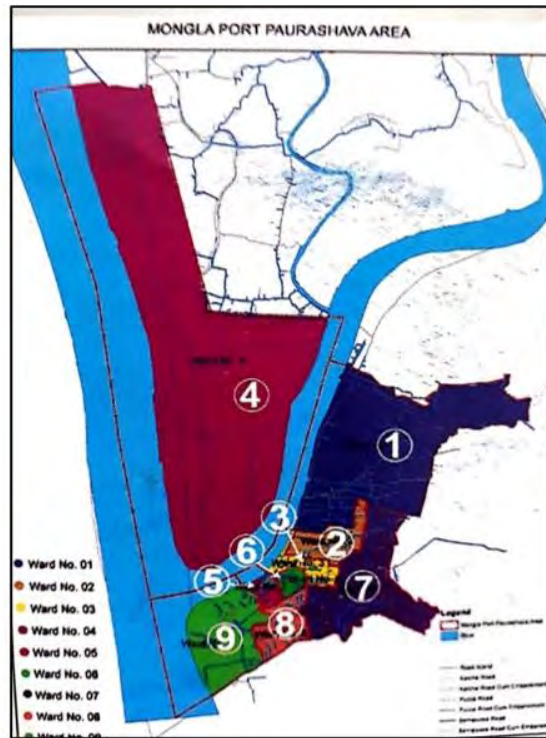
Table A3: Survey form showing the matrix for ranking the following climate change induced hazards according to the severity of impact in urban areas of Bangladesh

Respondents Name					
Respondents Designation					
Climate change induced hazards	1.Climate change induced flood (F)	2. Climate change induced salinity intrusion (S)	3. Climate change induced storm surge (SS)	4. Change in rainfall (R)	5. Change in temperature (T)
1.Climate change induced flood (F)	X				
2.Climate change induced salinity intrusion (S)	X	X			
3.Climate change induced storm surge (SS)	X	X	X		
4.Change in rainfall (R)	X	X	X	X	
5.Change in temperature (T)	X	X	X	X	X



Map A1: Map of the DNCC
(Source: Dhaka North City Corporation, 2020)

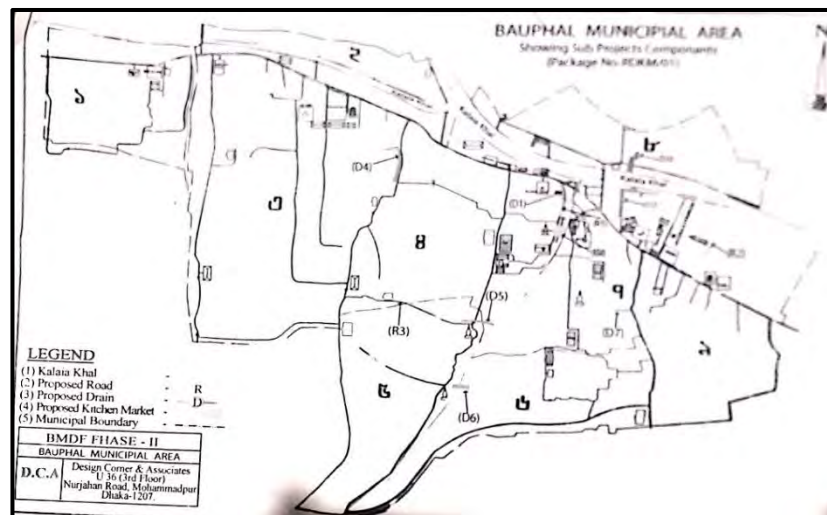
Map A2: Map of the DSCC (Source: Dhaka South City Corporation, 2020)



Map A3: Mongla Port municipality
(Source: Mongla Port municipality 2020)

Map A4: Feni municipality (Source: Feni municipality 2020)

Maps of the Mongla Port



Map A5: Bauphal municipality (Source: Bauphal municipality 2020)

Appendices B

Table B1 Vulnerability Score of areas according to National Climate Vulnerability Assessment Report (2018)

Most vulnerable urban areas	Name	Vulnerability score according to NCVAR (2018)					Vulnerability index from vector overlay analysis
		People affected	Heat stress	Ground water quality	Water availability	Road network	
Urban areas without BCCTF, BCCRF and GEF trust fund projects	Bagerhat	0.45	0.35	0.46	0.49	0.42	1.78
	Coxbazar	0.67	0.37	0.55	0.5	0.44	1.72
	Hatiya	0.6	0.23	0.39	0.37	0.36	1.78
	Maheshkhali	0.67	0.45	0.55	0.5	0.43	1.72
	Narail	0.53	0.42	0.64	0.6	0.39	1.56
	Paikgacha	0.4	0.23	0.49	0.54	0.39	1.82
	Ramgati	0.61	0.3	0.44	0.51	0.37	1.73
	Sandwip	0.65	0.46	0.51	0.55	0.39	1.92
	Barguna	0.57	0.24	0.00	0.37	0.43	1.62
	Sitakunda	0.52	0.41	0.41	0.43	0.19	1.92
Selected municipalities for exploring local people's perception	Mongla Port	0.63	0.35	0.45	0.35	0.36	1.68
	Baufal	0.72	0.37	0.4	0.49	0.44	1.77
	Feni	0.62	0.29	0.58	0.56	0.42	1.66

(Source: Goosen et al, 2018 and outcome from overlay analysis)

Table B2 Distribution of urban climate fund projects in divisions

Division Name	Name of fund				Total urban area project
	GEF Trust fund	GCF	BCCTF	BCCRF	
Barishal	0	2	36	0	38
Chattogram	1	3	44	0	48
Dhaka	2	2	35	2	41
Khulna	1	2	34	0	37
Mymensingh	0	0	13	0	13
Rajshahi	0	1	39	0	40
Rangpur	0	0	21	0	21
Sylhet	0	0	15	0	15
Total	4	10	237	2	238

(Source: Table adapted from Global Environment Facility, 2020; NDA Secretariat, 2018; The World Bank, 2016; BCCT, 2019)

Table B3 Division wise BCCTF projects taken in different divisions

Year	Divisions of Bangladesh							
	Barishal	Chattogram	Dhaka	Khulna	Mymensingh	Rajshahi	Rangpur	Sylhet
2009-10	0	1	1	0	0	0	0	0
2011-12	1	4	1	2	1	0	1	0
2012-13	1	1	1	1	0	2	1	0
2013-14	5	4	2	4	1	0	1	1
2014-15	11	6	6	6	3	4	4	6
2015-16	10	9	4	6	2	9	3	2
2016-17	1	3	3	4	3	4	1	1
2017-18	4	4	6	4	0	6	4	2
2018-19	3	12	11	7	3	14	6	3
Total	36	44	35	34	13	39	21	15

(Source: BCCT 2019)

Table B4: Themes and pillars under BCCSAP (2009)

Themes of BCCSAP (2009)	Pillars under themes
Pillar 1: Food Security, Social Protection and Health	P1. Institutional capacity and research towards climate resilient cultivars and their dissemination
	P2. Development of climate resilient cropping systems
	P3. Adaptation against drought
	P4. Adaptation in fisheries sector
	P5. Adaptation in livestock sector
	P6. Adaptation in health sector
	P7. Water and sanitation programme in climate vulnerable areas
	P8. Livelihood protection in ecologically fragile areas
	P9. Livelihood protection of vulnerable socio-economic groups
Pillar 2: Comprehensive Disaster Management	P1. Improvement of flood forecasting and early warning
	P2. Improvement of cyclone and storm surge warning
	P3. Awareness raising and public education towards climate resilience
	P4. Risk management against loss on income and property
Pillar 3: Infrastructure	P1. Repair and maintenance of existing flood embankments
	P2. Repair and maintenance of cyclone shelters
	P3. Repair and maintenance of coastal polders
	P4. Improvement of urban drainage
	P5. Adaptation against floods
	P6. Adaptation against tropical cyclones and storm surges
	P7. Planning and design of river training works
	P8. Planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work
Pillar 4: Research and Knowledge Management	P1. Establishment of a centre for knowledge management and training on climate change
	P2. Climate change modeling at national and subnational level
	P3. Preparatory studies for adaptation against sea level rise
	P4. Monitoring of ecosystem and biodiversity changes and their impacts
	P5. Macroeconomic and sectoral economic impacts of climate change

Themes of BCCSAP (2009)	Pillars under themes
	P6. Monitoring of internal and external migration of adversely impacted population and providing support to them through capacity building for their rehabilitation in new environment
	P7. Monitoring the impacts of various issues related to management of tourism in Bangladesh and implementation in priority action plan
Pillar 5: Mitigation and Low Carbon Development	P1. Improved energy efficiency in production and consumption of energy
	P2. Gas exploration and reservoir management
	P3. Development of coal mines and coal fired power stations
	P4. Renewable energy development
	P5. Lower emission from agricultural land
	P6. Management of urban waste
	P7. Afforestation and reforestation programme
	P8. Rapid expansion of energy saving device
	P9. Energy and waste efficiency in built environment
	P10. Improvement in energy consumption pattern in transport sector and options for mitigation
Pillar 6: Capacity Building and Institutional Strengthening	P1. Revision of sectoral policies for climate resilience
	P2. Main-streaming climate change in national, sectoral and spatial development programmes
	P3. Strengthening human source capacity
	P4. Strengthening gender consideration in climate change management
	P5. Strengthening institutional capacity for climate change management
	P6. Main-streaming climate change in Media

(Source: Ministry of Environment and Forests, 2009a)

Table B5: Adaptation strategies proposed in NAPA (2009)

Adaptation measures	Strategies
A. Research and Knowledge Management	Develop climate change scenarios for Bangladesh by applying global climate change models and methodologies at regional and national levels
	Design and develop models for likely hydrological impacts of climate change on the Ganges-Brahmaputra-Meghna system and to assess likely future system discharges and river levels in order to derive design criteria for flood protection embankments
	Monitor and research the impacts of climate change on ecosystems and biodiversity
	Research the likely impacts of climate change on the macro-economy of Bangladesh (a Bangladesh 'Stern Report') and key sectors (e.g., livelihoods and food security) and contribute to developing a climate proof national development plan
	Research the linkages between (a) climate change and poverty; and (b) climate change, poverty and health in order to identify possible interventions to increase the resilience of poor and vulnerable households to climate change
	Filling the Climate Change Knowledge Gap for Water Resources Planning, designing and implementation of project
	Establish a Centre for Research and Knowledge Management on Climate Change to ensure Bangladesh has access to the latest ideas and technologies from around the world, and ensure that data is widely and freely available to researchers
B. Agriculture,	Develop climate change resilient cropping systems fisheries and livestock systems to ensure local and national food security

Adaptation measures	Strategies
Fisheries and Livestock	Introduce and scale up existing innovative technologies to deal with flood, drought and salinity such as maize production under wet bed notillage method, no-tillage potato cultivation under water hyacinth mulch in wet sown condition, vegetable cultivation on floating bed, sorjan systems of cropping in tidally flooded agro-ecosystem etc.
	Development and protection of dry season fish refuges for sustainable management of fisheries through community husbandry in the northwestern part of Bangladesh
	Adaptation of fish culture techniques to increased flood levels and diversification of aquaculture techniques in the flood- prone northcentral region of Bangladesh
	Adaptation to flood on freshwater wetlands fisheries with special emphasis to recruitment of small indigenous fish species
	Adaptive measures for the fisheries resources with the impacts of climatic changes in the coastal ecosystem of Bangladesh
	Adaptive measures to reduce stresses in ruminants and poultry due to temperature extremes through housing and management systems
	Improvement in the supply of feeds and forages through community-based production and conservation for feeding livestock and poultry in case of flood, drought, salinity and tidal surges
C. Health	Implement surveillance systems for existing and new disease risks and ensure health systems are geared up to meet future demands
	Development of Strategy for Alternative Sources of Safe Drinking Water and Sanitation Programme in areas at risk from climate change
	Awareness and Behavioral Change and Communication for Climate Change related Health Problems
D. Building Climate Resilient Infrastructure	Repair and rehabilitate existing infrastructure (e.g., coastal embankments, river embankments and drainage systems, urban drainage systems) and ensure effective operation and maintenance systems
	Plan, design and construct urgently needed new infrastructure (e.g., cyclone shelters, coastal and river embankments and water management systems; urban drainage systems, river erosion control works, flood shelters) to meet the changing conditions expected with climate change
	Undertake strategic planning of future infrastructure needs, taking into account the likely (a) future patterns of urbanization and socio-economic development; and (b) the changing hydrology of the country, because of climate change
	Particular Specification in National Building Code for building industry and infrastructure in potentially vulnerable areas
E. Disaster Management	Strengthen the government's capacity and that of civil society partners and communities to manage natural disasters, and ensure that appropriate policies, laws and regulations are in place
	Strengthen community-based adaptation programmes and establish them in each of the disaster-prone parts of the country
	Strengthen our cyclone, storm surge and flood early warning systems to enable more accurate short, medium and long-term forecasts
	Incorporation of Climate Change Considerations in Standing Order for Disaster (SOD) Preparedness in Bangladesh
	Coastal afforestation Programme in the Coastal Region to protect natural and human system from cyclone and storm surges
F. Livelihood	Increase the resilience of vulnerable groups, including women and children, through development of community level adaptation, livelihood diversification, better access to basic services and social protection and scaling up

Adaptation measures	Strategies
G. Biodiversity	Undertake Community Participated Afforestation Programme in all the regions of the country to improve natural environment and to enhance livelihood of common people.
	The Sundarbans receive special attention to preserve and to enhance its biodiversity on sustainable basis
	Changes of land use system and crop diversity with resilient varieties of rice and other crops
H. Policy and Institutional Capacity Building	Review and revise, where appropriate, all government policies to ensure that they take full account of climate change and its impacts
	Mainstream climate change in national, sectoral and spatial development planning and ensure that impacts on vulnerable groups and women are prioritized in plans
	Build the capacity of key government ministries and agencies to take forward climate change adaptation
	Build the capacity of the government to undertake international and regional negotiations on climate change. Regional and international cooperation is essential in order to build necessary capacity and resilience
	Capacity Development for Water Sector Managers for Designing Structural Adaptation
	Development of Negotiating Instruments for Sustainable Drainage Systems
	Formulation of Land and Water Zonation for Climate Change Adaptation in Bangladesh

(Source: Ministry of Environment and Forests, 2009b)

Table B6: Action steps proposed in ccGAP (2013)

Themes of BCCSAP (2009)	Objectives/ Action steps in Bangladesh Climate Gender Action Plan
Pillar 1: Food Security, Social Protection and Health	Recognize women's contribution in agriculture to GDP
	Ensure women's access to land tenure ship/ leasing for cultivation.
	Enhance women knowledge and access to financial instruments.
	Introduce innovative (and as far as possible organic) agriculture and aquaculture technologies for female farmers and entrepreneurs.
	Promote indigenous knowledge/ products on agriculture.
	Integrate CC and gender in national health policy and programs.
	Ensure alternative livelihood opportunities for women affected by climate change in urban settings.
	Ensure women's involvement in efficient water management.
	Improve social security/ protection of women, adolescents, and children pre, during and post-disaster and emergency situations.
Pillar 2: Comprehensive Disaster Management	Develop gender responsive policy based on disaster management, climate change and sustainable development
	To allocate adequate financial resources to address gender and DRR issues.
	Ensure participation of women in community risk assessment (CRA) vulnerability and capacity assessment activities.
	Develop adequate communication facilities to ensure movement of women to reach safe places (cyclone shelters, flood shelters, killahs, & others).
	Equip women and men in providing first aid and primary health care as first responders.
	Equip women and community with DRR, CCA and SD nexus in building the framework for 'resilience
	Develop context specific IEC/ ICT materials focusing DRR incorporating gender issues

		To inform poor women in urban areas on DRR issues and address their issues in policy framework.
Pillar 3: Infrastructure		Transform the infrastructure sectors in Bangladesh to be more gender inclusive and equitable.
		Increase women's participation in climate change related infrastructure development (planning, designing, construction and maintenance)
		Enhance technical capacity for gender responsive infrastructure development.
		Increase women's role as whistle blowers for monitoring and maintenance of infrastructure (early warning, embankment breach, river erosion, infrastructure breakage).
		Ensure protection of infrastructure from damages during calamities.
		Ensure secure and uninterrupted mobility of women in transport sector.
Pillar 5: Mitigation and Low Carbon Development		Ensure that gender considerations are address in the process of reviewing energy and technology policies.
		Develop gender responsive programs to reduce GHG emission at household (HH) while ensuring women's access to energy and power technologies
		Improve women's knowledge on climate change mitigation issues.
		Develop women's entrepreneurship related to waste management.
		Increase women's participation in solid waste and drainage management.
		Mainstream gender considerations in coastal and social forestry programs or initiatives.

(Source: Ministry of Environment and Forests, 2013a)

Table B7: Activities under the 7th FYP (2016-2020) for Climate Change Mitigation and Adaptation

Type of strategies	Activities under the 7th Five Year Plan for Climate Change Mitigation /Adaptation
Adaptation	Issue 1: Promote a whole-of government approach for climate change readiness
	Issue 2: Enhance understanding, knowledge, capacity and coordination
	Issue 3: Prioritize programmes and projects
	Issue 4: Improved Implementation, Monitoring and Shared learning
	Issue 5: Enhance CCA financing
	Issue 6: Integrate Gender Sensitivity in project design
	Issue 7: Food security, social protection and Health
	Issue 8: Managing hazards and disasters
	Issue 9: Infrastructural functioning and maintenance
	Issue 10: Curbing internal migration and displacement
Mitigation	Issue 1: Enhance understanding on LCD
	Issue 2: Improve capacity in analyzing available opportunities
	Issue 3: Enhance capacity of energy saving sectors
	Issue 4: Improvement in Coordination and Communication among Institutions
	Issue 5: Ensuring investment in research and innovation
	Issue 6: Other Activities

(Source: General Economic Division, 2015)

Table B8: Activities suggested in National Action Plan (NAP) for Reducing SLCPs (2018)

Implementation pathways	Action Plan for Reducing SLCPs
Transport Sector	Standards for the reduction of pollutants from vehicles (including diesel particle filters), equivalent to those included in Euro6/VI standards, for road and off-road vehicles
	Elimination of high-emitting vehicles in road and off-road transport
	Encourage Diesel to CNG switch through incentives (particularly commercial vehicles in large cities)
	Promoting cleaner diesel
	Emission standards for diesel generators; Inspection and maintenance of diesel generators
	Emission reduction from diesel/oil-based quick rental power plants
Residential Sector	Replacing lump coal by coal briquettes in cooking and heating stoves
	Pellet stoves and boilers, using fuel made from recycled wood waste and sawdust, to replace current wood burning technologies in the residential sector in industrialized countries
	Introduction of clean-burning (fan-assisted) biomass stoves for cooking and heating in developing countries
	Substitution of traditional biomass cookstoves with stoves using clean-burning fuels (liquefied petroleum gas (LPG) or biogas)
	Reduction of black carbon emission from kerosene used for residential lighting
Industry	Replacing traditional brick kilns with vertical shaft brick kilns
	Replacing traditional coke ovens with modern recovery ovens
	Emission-based license fee for brick kilns
	Promoting alternative construction materials
	Introduction of improved rice parboiling technology
Fossil Fuel Production and Transport	Extended pre-mine degasification and recovery and oxidation of methane from ventilation air from coal mines
	Extended recovery and utilization, rather than venting, of associated gas and improved control of unintended fugitive emissions from the production of oil and natural gas
	Reduce gas leakage from long-distance transmission pipelines
Waste Management	Upgrading primary wastewater treatment to secondary/ tertiary treatment with gas recovery and overflow control
	Septic tank sludge and fecal sludge collection and treatment
	Separation and treatment of biodegradable municipal waste through recycling, composting and anaerobic digestion as well as landfill gas collection with combustion/ utilization
Agriculture and Livestock	Ban on open burning of agricultural waste.
	Controlling open burning of solid and other wastes
	Control of methane emissions from livestock, mainly through farm-scale anaerobic digestion of manure from cattle and pigs
	Intermittent aeration of continuously flooded rice paddies

(Source: Ministry of Environment Forests and Climate Change, 2018)

Table B9: Strategies proposed in BDP (2100)

Issues	Strategies proposed
1. Integral urban drainage	Restoration of existing drainage systems including the removal of silt, solid waste, and any physical elements that obstruct the discharge or retention capacity.

Issues	Strategies proposed
	• Re-excavation of natural khals. • Khals and retention areas have to be protected from encroachment through land use regulations. • Public space can also be redeveloped to enlarge the retention capacity of the drainage system. • Solid waste management projects to improve the quality of open water.
2. Integrated flood risk management	• Embankments in high density urban areas can be kept free of development by spatial reservations and building restrictions for securing space for future reinforcements. • Protection of existing and future urban centers and economic zones. • Buildings and settlements outside the dike ring should be flood proof by elevating the settlements. • Maintain sufficient space for the river to discharge and thereby prevent unwanted encroachment of embankments, floodplains and waterfronts in urban area
3. Enhancing urban water security and water use efficiency	• Limit leakage and pursue full metering to reduce the percentage of non-revenue water use. • Development of piped water systems to allow more conformable water consumption, • Central water treatment. • Increased use of surface water for drinking purpose through installation of water treatment plants. • Reallocation of small and medium heavy polluting industries from residential or commercial areas. • Improvement of sewerage system linked with improvements in urban drainage to prevent sewerage overflows. • Education programmes on water pollution, environmental degradation.
4. Managing river systems and estuaries in newly developed areas	• Preservation of the unique character of river landscape through integrated urban and landscape design for land reclamation. • Integration of river stabilization/erosion control and land reclamation with urban development.
5. Conserve and preserve urban wetlands and ecosystems and promote their wise-use	• Ecological targets for the wetlands. • Make a regional spatial plan or strategy in which green and blue ecological and recreational spaces and networks are defined. • Create an urban strategy for green blue and recreational networks of different scales. • Deploy land use zoning to keep existing green and blue spaces open. • Include spaces for plants in the interior and exterior spaces of new buildings.
6. Develop effective urban institutions and governance	• Strengthening of the institutional capacity. • Decentralization focused on subsidiarity in infrastructure development • Improved implementation of urban plans. • Capacity development for integral urban design and spatial planning by advancements in the educational program.
7. Integrated and sustainable use of urban land and water resources	• Introduction of integral spatial planning in spatial policy making. • Advancements in local urban planning and land use regulations. • Establish a national spatial strategy and plan with the prioritization in the development of economic zones. • Establish a vision including guidelines for sustainable urban development.

(Source: General Economic Division, 2018)

Table B10: Pillars proposed in EFCC CIP (2016-2021).

Pillar	Programmes	Sub-Programmes
Pillar 1: Sustainable development and management of natural resources	1.1 Sustainable forest management, and enhanced socioeconomic benefits from forests	1.1.1. Social forestry, reforestation, afforestation, coastal greenbelt development, landscape restoration, and agroforestry 1.1.2. Improve forest monitoring (to include both biophysical and socioeconomic aspects) – geographic information systems (GIS) and remote sensing-based forest management 1.1.3. Develop small and medium-sized forest enterprises and value chains for socioeconomic benefits, food security and employment creation 1.1.4. Improve security of land tenure, stakeholder awareness and capacity
	1.2. Biodiversity conservation	1.2.1. Develop and enhance the conservation of protected areas through government–community co-management 1.2.2. Improve biodiversity monitoring (including by strengthening the monitoring capacity of institutions) 1.2.3. Endangered species conservation and management 1.2.4. Support integrated resource management in the Sundarbans
	1.3. Sustainable management of wetlands, rivers and marine ecosystems	1.3.1. Support the implementation and scaling up of the Master Plan for the Haor and Flood-prone Areas 1.3.2. Sustainable fisheries and fishing habitat management in inland and marine ecosystems 1.3.3. River water improvement
	1.4. Soil and groundwater management	1.4.1. Improve soil fertility and groundwater management, with particular focus on north and northwest Bangladesh 1.4.2. Manage soil erosion in hilly areas 1.4.3. Manage coastal land and prevent and cope with waterlogging and salinity
Pillar 2: Environmental pollution reduction and control	2.1. Reduced industrial pollution	2.1.1. Support adoption of cleaner production and end-of-pipe technologies in industrial processes like brick kilns, textiles and leather 2.1.2. Prevent, reduce and mitigate damage to natural ecosystems due to oil spills, ship-breaking and drilling
	2.2. Reduced municipal and household pollution	2.2.1. Improve the collection, management and treatment of solid waste (including household and medical waste) at the municipal and cross-municipal levels 2.2.2. Improve the supply of safe drinking water to semi-urban and rural communities 2.2.3. Increase the collection and treatment of sewerage and drainage water 2.2.4. Improve sanitation at the community level
	2.3 Reduced pollution from agriculture and other sources	2.3.1. Minimize pollution from fertilizers and pesticides 2.3.2. Reduce pollution from chemical use
Pillar 3: Adaptation and resilience to, and mitigation of climate change	3.1. Disaster risk reduction	3.1.1. Strengthen early-warning systems 3.1.2. Strengthen climate-change-resilient buildings, roads and storage facilities 3.1.3. Manage the risk of losses of income and property
	3.2: Sustainable	3.2.1. Strengthen coastal and inland embankments and improve drainage capacity

Pillar	Programmes	Sub-Programmes
	infrastructure development	3.2.2. Support the operation and maintenance of water management systems 3.2.3. Support the development of irrigation schemes (drought-prone areas)
	3.3: Mitigation and low - carbon development	3.3.1. Support climate-smart technologies for industry and power generation 3.3.2. Promote low-cost public transport models and low-emission vehicles
	3.4. Increased resilience at the community level	3.4.1. Develop community adaptation through community-based and ecosystem-based adaptation 3.4.2. Scale up local innovations on adaptation
Pillar 4: Environmental governance, gender, and human and institutional capacity development	4.1. Improved legislative, regulatory and policy framework	4.1.1. Strengthen the regulatory framework for the EFCC sectors (including pollution prevention and control) 4.1.2. Improve the application and enforcement of the regulatory framework 4.1.3. Support rational arbitration among users of ecosystem services 4.1.4. Improve the knowledge base for the formulation, coordination and implementation of EFCC policies
	4.2. Improved stakeholder participation and gender equity	4.2.1. Develop and strengthen mechanisms for stakeholder participation in EFCC policy development and implementation 4.2.2. Encourage gender equity and empowerment and increase the inclusion of minorities in the EFCC sectors 4.2.3. Support producer organizations and other rural groups
	4.3. Improved organizational capacity and processes for evidence-based decision-making	4.3.1. Support the development of systems for data collection, use and dissemination as an aid for improving budget planning, implementation, monitoring and evaluation 4.3.2. Support training and extension in the EFCC sectors 4.3.3. Establish a centre for knowledge management and training on EFCC 4.3.4. Support knowledge systems, including the implementation of the Research Master Plan and strengthening research organizations, and extension and educational NGOs

(Source: Ministry of Environment and Forests, 2017)

Table B11: Disaster management action matrix (2010-2015) addressing climate change

Strategic Goal	Key targets	Action Agenda for 2010-2015
2. Mainstreaming Disaster Risk Reduction and Climate Change adaptation	2.1 Risk reduction and climate change adaptation principles and practices are mainstreamed within all development programmes and policies	2.1.1.1 Identify relevant development policy and planning frameworks, develop and establish mechanisms to ensure risk reduction and climate change adaptation. 2.1.1.2 Develop Disaster Impact and Risk Assessment (DIRA) tool for all hazards 2.1.1.3 Develop CC Risk and Impact Assessment (CCRIA) tool 2.2.1.4 Develop and implement an advocacy strategy facilitating incorporation of disaster risk reduction 2.1.1.5 Design and implement capacity building training to strengthen relevant planning capability at national and local levels.

Strategic Goal	Key targets	Action Agenda for 2010-2015
		2.1.1.5 Incorporate disaster risk reduction approaches in all ongoing and future development plans, programs, and policies. 2.1.1.6 Inclusion of disaster risk management within the development project validation process through Disaster Impact and Risk Assessment (DIRA) in addition to EIA
	2.2 Mainstreaming disaster risk reduction and climate change adaptation issues in all the sectoral policies and plans	2.2.1.1 Establish Focal points within relevant ministries and departments 2.2.1.2 Identify relevant sectoral policy and planning frameworks and documents 2.2.1.3 Review and revise the policy and planning documents incorporating disaster risk reduction and climate change adaptation issues 2.2.1.4 Capacity building of the professionals and practitioners and Institutional strengthening 2.2.1.5 Research to generate options for livelihood adaptation and disaster risk reduction 2.2.1.6 Knowledge management 2.2.1.6 Develop and implement an advocacy strategy facilitating incorporation of disaster risk reduction and climate change adaptation issues 2.2.1.7 Develop and implement climate resilient infrastructures 2.2.1.7 Prepare a monitoring and evaluation Guideline
	2.3 Disaster risk reduction and climate change considerations incorporated in NGO programmes and plans	2.3.1.1 Inclusion of Disaster Risk Reduction Mechanism into FD-6 Form (for NGO programmes) 2.3.1.2 Advocacy and public awareness for social mobilization 2.3.1.3 Prepare a monitoring and evaluation Guideline
5.0 Expanding Risk Reduction Programming across hazards and sectors	5.1 Update hazard maps. Develop climate change scenarios and accordingly anticipated hazard risks following climate change	5.1.1.1 Conduct Hazard Risk Analysis and produce updated hazard maps 5.1.1.2 Conduct climate change modelling, cyclone & Storm surge modelling, flood and drought modelling and produce anticipated hazards maps
	5.2 Establish an Integrated Approach to disaster management including Climate Change and climate variability impacts	5.2.1.1 Capacitate the Climate Change Cell (CCC) within DoE 5.2.1.2 Develop scenario and prediction models to determine climate change and climate variability impacts. 5.2.1.3 Conduct research to determine climate change and climate variability impacts for Bangladesh 5.2.1.4 Strengthen existing knowledge and information accessibility on impact prediction and adaptation to climate change 5.2.1.5 Identify adaptation options through action research 5.2.1.6 Establish a climate change information library, database and Knowledge information network 5.2.1.7 Incorporate climate change and climate variability impact information in the disaster Risk reduction programmes design

Strategic Goal	Key targets	Action Agenda for 2010-2015
		5.2.1.8 Design and implement capacity building programme to improve understanding on climate change

(Source: Disaster Management Bureau, 2010)

Table B12: Adaptation and Mitigation Priorities proposed in INDC (2015) for Bangladesh

Type of strategies	Adaptation/ Mitigation Priorities for Bangladesh
Adaptation strategies	- i.Improved Early warning system for tropical cyclone, flood, flash flood and drought - i.Disaster preparedness and construction of flood and cyclone shelters - i.Tropical cyclones and storm surge protection - v.Inland monsoon flood-proofing and protection - v.Climate resilient infrastructure and communication - i.Climate resilient housing - i.Improvement of Urban resilience through improvement of drainage system to address urban flooding - i.River training and dredging (including excavation of water bodies, canals and drains) - x.Stress tolerant (salinity, drought and flood) variety improvement and cultivation (including livestock and fisheries) - x.Research and knowledge management - i.Adaptation on local-level perspectives etc. - i.Adaptation to climate change impacts on health - i.Biodiversity and ecosystem conservation - v.Capacity Building at Individual and institutional level to plan and implement adaptation programmes and projects in the country
Mitigation strategies	- i.Improved energy efficiency in production and consumption of energy - i.Gas exploration and reservoir management - i.Development of coal mines and coalfired power station(s) - v.Renewable energy development - v.Lower emissions from agricultural land - i.Management of urban waste - i.Afforestation and reforestation programme

(Source: Adapted from Ministry of Environment and Forests, 2015)

Table B13: Adaptation issues proposed in IPCC- Fifth Assessment Urban Area Report (2014)

Key Risk	Adaptation issues
1. Coastal zone systems	Coastal cities with extensive port facilities and large-scale industries are vulnerable to increased flood exposure. High-growth cities located on low-lying coastal areas are also at greater risk. There is a possibility of nonlinear increase in coastal vulnerability over the next two decades.
2. Terrestrial ecosystems and ecological infrastructure	Ecosystem services will be impacted by altered ecosystem functions such as temperature and precipitation regimes, evaporation, humidity, and soil moisture levels, indicating close links with sustainable water management. Knowledge gaps exist with respect to thresholds to adaptation of various ecosystems.
3. Water supply systems	Adaptation response requires changes to network infrastructure as well as demand side management, to ensure sufficient water supplies, increased capacities to manage reduced freshwater availability, flood risk reduction, and water quality.
4. Waste water system	Managing waste water flows improves water supply and ecosystem services. Reducing vulnerability of infrastructure may be easier in new areas, well-funded local bodies, or as part of scheduled interventions.

Key Risk	Adaptation issues
5. Green built infrastructure	Green infrastructure not utilized sufficiently in most cities. Climate change impacts can bring attention to the dual benefits of green infrastructure for climate change mitigation and impact management.
6. Energy systems	Most urban centers are energy intensive, with energy-related climate policies focused only on mitigation measures. A few cities have adaptation initiatives underway for critical energy systems. There is great potential for non-adapted, centralized energy systems to magnify and cascade impacts to national or transboundary consequences from localized extreme events.
7. Integrated and sustainable use of urban land and water resources	Introduction of integral spatial planning in spatial policy making. Advancements in local urban planning and land use regulations. Establish a national spatial strategy and plan with the prioritization in the development of economic zones. Establish a vision including guidelines for sustainable urban development.
8. Food system and security	Urban food sources are dependent on local, regional, and often global supplies. Climatic drivers can exacerbate food insecurity, especially of the urban poor. Enhanced social safety nets can support adaptation measures. Urban and peri-urban agriculture, local markets, and green roofs hold good prospects as adaptive measures, but are under-utilized in rapidly growing cities.
9. Transportation systems	A difficult sector to adapt due to large existing stock, especially in developed country cities, leading to potentially large secondary economic impacts with regional and potentially global consequences for trade and business. Emergency response requires well-functioning transport infrastructure.
10. Communication systems	Resilient communication systems are a critical component of emergency response, and therefore adaptation. The rise of decentralized and networked mobile communications offers great potential for real-time and easily accessed information dissemination and communication systems. Information quality control is a key element in realizing the potential of communications systems for early warning and adaptation.
11. Urban risks associated with housing	Poor quality, inappropriately located housing is often most vulnerable to extreme events. Adaptation options include enforcement of building regulations and upgrading. Some city studies show the potential to adapt housing and promote mitigation, adaptation, and development goals simultaneously. Rapidly growing cities, or those rebuilding after a disaster, especially have opportunities to increase resilience, but this is rarely realized. Without adaptation, risks of economic losses from extreme events are substantial in cities with high-value infrastructure and housing assets, with broader economic effects possible.
12. Human health	Health is a higher order risk impacted by key developmental issues including water supply, water and air quality, waste management, housing quality, sanitation, food security, and provision of health care services and insurance. Certain groups of people are particularly vulnerable, such as the elderly, the chronically ill, the poor, and the very young, and require targeted social care interventions. Longer term developmental improvements need considerable financial resources and coherent intergovernmental action, limiting prospects for near-term adaptation.
13. Human security and emergency response	Security is linked to key developmental issues such as income, housing, health care, education, and food security. Moderate prospects as city governments can enhance emergency response services, to significantly reduce vulnerability for those who are most at risk. Where security and emergency forces have limited public trust, and especially with regard to

Key Risk	Adaptation issues
	gender issues, scope for supporting adaptation and risk management is considerably constrained
14. Key economic sectors and services	Large diversity across cities in terms of key economic sectors and adaptive capacity to disruptions in city services. Cities reliant on climate-sensitive tourism or agriculture may require economic diversification. Good prospects for advancing co-benefits through “green “and “waste “economy.
15. Livelihoods	Informal economy is more vulnerable, and often less adaptive in the short term. Social protection measures, in the specific context of urban livelihoods, are required.
16. Poverty and access to basic services	Reducing basic service deficit could reduce hazard exposure, especially of the poor and vulnerable, alongside upgrading of informal settlements, improved housing conditions and enabling the agency of low-income communities. Significant prospects where adaptation is already being implemented as part of human development or social protection.

(Source: Revi et al., 2014)

Table B14: Sustainable development goals (2030) with targets

Goals	Targets
1.No poverty	1.1 Eradicate extreme poverty for all people everywhere 1.2 Reduce people living in poverty in all its dimensions according to national definitions 1.3 Implement nationally appropriate social protection systems and measures for all 1.4 Ensure everyone have equal rights to economic resources 1.5 Build the resilience of the poor and reduce their exposure and vulnerability to climate related extreme events
2. Zero hunger	2.1 End hunger and ensure access by all people 2.2 End all forms of malnutrition 2.3 Double the agricultural productivity and incomes of small-scale food producers 2.4 Ensure sustainable food production systems 2.5 Maintain the genetic diversity of seeds, plants and animals.
3. Good health and wellbeing	3.1 Reduce the global maternal mortality 3.2 End preventable deaths of newborns and children under 5 years of age 3.3 End the epidemics of AIDS, tuberculosis, malaria, neglected tropical diseases etc. 3.4 Reduce by one third premature mortality from noncommunicable diseases. 3.5 Strengthen the prevention and treatment of substance abuse 3.6 Halve the number of global deaths and injuries from road traffic accidents 3.7 Ensure universal access to sexual and reproductive healthcare services 3.8 Achieve universal health coverage 3.9 Reduce the number of deaths and illnesses from pollution and contamination.
4. Quality education	4.1 Ensure that all girls and boys complete free, equitable and quality education 4.2 Ensure that all girls and boys have access to quality early childhood development 4.3 Ensure equal access to affordable and quality technical, vocational and education 4.4 Increase the number of youth and adults who have relevant skills 4.5 Eliminate gender disparities in education 4.6 Ensure that all achieve literacy and numeracy 4.7 Ensure that all acquire the skills needed to promote sustainable development
5. Gender Equality	5.1 End all forms of discrimination against all women and girls everywhere 5.2 Eliminate all forms of violence against all women in the public and private spheres 5.3 Eliminate child and forced marriage and female genital mutilation 5.4 Recognize and value unpaid care and domestic work and the promotion of shared responsibility within the household and the family as nationally appropriate 5.5 Ensure women’s full and effective participation and equal opportunities 5.6 Ensure universal access to sexual and reproductive health and reproductive rights

Goals	Targets
6. Clean water and sanitation	6.1 Achieve universal and equitable access to safe and affordable drinking water for all 6.2 Achieve access to adequate and equitable sanitation and hygiene for all 6.3 Improve water quality 6.4 Substantially increase water use efficiency across all sectors 6.5 Implement integrated water resources management at all levels 6.6 Protect and restore water related ecosystems
7. Affordable and clean energy	7.1 Ensure universal access to affordable, reliable and modern energy services 7.2 Increase substantially the share of renewable energy in the global energy mix 7.3 Double the global rate of improvement in energy efficiency
8. Decent work and economic growth	8.1 Sustain per capita economic growth in accordance with national circumstances 8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation 8.3 Promote development-oriented policies that support productive activities 8.4 Improve progressively, global resource efficiency in consumption and production 8.5 Achieve full and productive employment and decent work for all 8.6 Substantially reduce the proportion of youth not in employment, education or training 8.7 Take immediate and effective measures to eradicate forced labour 8.8 Protect labour rights and promote safe and secure working environments for all 8.9 Devise and implement policies to promote sustainable tourism 8.10 Strengthen the capacity of domestic financial institutions
9. Industry, innovation and infrastructure	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human wellbeing, 9.2 Promote inclusive and sustainable industrialization 9.3 Increase the access of small scale industrial and other enterprises 9.4 Upgrade infrastructure and retrofit industries to make them sustainable 9.5 Enhance research, upgrade the technological capabilities of industrial sectors.
10. Reduce inequalities	10.1 Progressively achieve and sustain income growth 10.2 Empower and promote the social, economic and political inclusion of all, 10.3 Ensure equal opportunity and reduce inequalities of outcome 10.4 Adopt policies, especially fiscal, wage and social protection policies 10.5 Improve the regulation and monitoring of global financial markets and institutions 10.6 Ensure enhanced representation and voice for developing countries 10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people
11. Sustainable cities and communities	11.1 Ensure access for all to adequate, safe and affordable housing and basic services 11.2 Provide access to safe, affordable, accessible and sustainable transport systems 11.3 Enhance inclusive and sustainable urbanization 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage 11.5 Significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water related disasters, with a focus on protecting the poor and people in vulnerable situations 11.6 Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management 11.7 Provide universal access to safe, inclusive and accessible, green and public spaces
12. Responsible consumption and production	12.1 Implement the 10 Year Framework of Programmes on Sustainable Consumption and Production Patterns 12.2 Achieve the sustainable management and efficient use of natural resources 12.3 Halve per capita global food waste at the retail and consumer levels 12.4 Achieve the environmentally sound management of chemicals and all wastes 12.5 Reduce waste generation through prevention, reduction, recycling and reuse 12.6 Encourage companies to adopt sustainable practices 12.7 Promote sustainable public procurement practices 12.8 Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature
13. Climate action	13.1 Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries 13.2 Integrate climate change measures into national policies, strategies and planning 13.3 Improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14. Life below water	14.1 Prevent and significantly reduce marine pollution of all kinds 14.2 Sustainably manage and protect marine and coastal ecosystems

Goals	Targets
	14.3 Minimize and address the impacts of ocean acidification 14.4 Effectively regulate harvesting and end overfishing 14.5 Conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information 14.6 Prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing 14.7 Increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources.
15. Life on earth	15.1 Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, 15.2 Promote the implementation of sustainable management of all types of forests 15.3 Combat desertification, restore degraded land and soil 15.4 Ensure the conservation of mountain ecosystems, including their biodiversity 15.5 Take urgent and significant action to reduce the degradation of natural habitats 15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources 15.7 Take action to end poaching and trafficking of protected species of flora and fauna 15.8 Introduce measures to prevent the introduction and invasive alien species on land and water ecosystems and control or eradicate the priority species 15.9 Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts
16. Peace, Justice and strong institutions	16.1 Significantly reduce all forms of violence and related death rates everywhere 16.2 End abuse, exploitation, trafficking and all forms of violence against children 16.3 Promote the rule of law and ensure equal access to justice for all 16.4 Significantly reduce illicit financial and arms flows, 16.5 Substantially reduce corruption and bribery in all their forms 16.6 Develop effective, accountable and transparent institutions at all levels 16.7 Ensure responsive, inclusive, participatory and representative decision making 16.8 Broaden and strengthen the participation of developing countries in the institutions of global governance 16.9 Provide legal identity for all, including birth registration 16.10 Ensure public access to information and protect fundamental freedoms
17. Partnerships for the goals	17.1 Strengthen domestic resource mobilization 17.2 Developed countries to implement their official development assistance commitments, 17.3 Mobilize additional financial resources for developing countries from multiple sources 17.4 Assist developing countries in attaining long term debt sustainability 17.5 Adopt and implement investment promotion regimes for least developed countries 17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries 17.8 Fully operationalize the technology bank and science, technology and innovation capacity building mechanism for least developed countries 17.9 Enhance international support for implementing effective and targeted capacity building in developing 17.10 Promote a universal, rules based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, 17.11 Significantly increase the exports of developing countries, 17.12 Realize timely implementation of duty free and quota free market access 17.13 Enhance global macroeconomic stability 17.14 Enhance policy coherence for sustainable development 17.15 Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development 17.16 Enhance the Global Partnership for Sustainable Development, 17.17 Encourage and promote effective public, public private and civil society partnerships, building on the experience and resourcing strategies of partnerships 17.18 Enhance capacity building support to developing countries 17.19 Build on existing initiatives to develop measurements of progress on sustainable development

(Source: United Nations, 2015)

Appendices C



Image C1: Mongla Port Pourashava



Image C2: Embankment near Pashur river in Mongla Port



Image C3: Solar panel near the embankment in Mongla Port municipality



Image C4: FGD with the local people near embankment in Mongla Port municipality



Image C5: Sluice gate near the embankment in Mongla Port municipality



Image C6: Water retention pond in Mongla Port municipality



Image CC7: Water collection point during dry season in Mongla Port municipality



Image C8: Balurmath area, a low-lying area facing waterlogging in Mongla Port municipality



Image C9: RCC drain in Mongla Port municipality



Image C10: Solid waste disposal in the drain in Mongla Port municipality



Image C11: Sluice gate near Thakurain Khal in Mongla Port municipality



Image C12: Feni municipality office



Image C13: KII with municipality engineer



Image C14: Rajajer Dighi in Feni municipality



Image C15: Rajajer Dighi in Feni municipality



Image C16: FGD at Rajajer Dighi in Feni municipality



Image C17: Market place beside Rajajer Dighi in Feni municipality



Image C18: RCC drain at Pathanbari road in Feni municipality



Image C19: RCC drain at Pathanbari road in Feni municipality



Image C20: FGD at Pathanbari road in Feni municipality



Image C21: Uncovered drain at Pathanbari road in Feni municipality



Image C22: Poor drainage system at Pathanbari road in Feni municipality



Image C23: Boundary wall at Bijoy Singh Dighi in Feni municipality



Image C24: Walkway at Bijoy Singh Dighi in Feni municipality



Image C25: Walkway at Bijoy Singh Dighi in Feni municipality



Image C26: Entrance gate of Bijoy Singh Dighi in Feni municipality



Image C27: RCC drain near Biraj Majumder Bari in Feni municipality



Image C28: RCC drain near Biraj Majumder Bari in Feni municipality



Image C29: Solid waste dumping at RCC drain near Biraj Majumder Bari in Feni municipality



Image C30: RCC drain near Bilonia railline in Feni municipality



Image C31: Mohipal road in Feni municipality



Image C32: Solid waste dumping at RCC drain near Mohipal in Feni municipality



Image C33: Bauphal municipality



Image C34: RCC drain near Satterholader bari (ward 1) Bauphal municipality



Image C35: RCC drain near Satterholader bari (ward 1) Bauphal



Image C36: RCC drain near Satterholader bari (ward 1) Bauphal municipality



Image C37: Discharge point of the RCC drain near Satterholader bari (ward 1) in Bauphal municipality



Image C38: Tube well near Satterholader bari (ward 1) in Bauphal municipality



Image C39: Tube well near Satterholader bari (ward 1) in Bauphal municipality



Image C40: RCC drain near Nitaipalli bari Bauphal municipality



Image C41: Uncovered RCC drain near Nitaipalli bari, Bauphal municipality



Image C42: Tubewell near Nitaipalli bari, Bauphal municipality



Image C43: RCC drain near Sultan Fokir mazer (south), Bauphal municipality



Image C44: Uncovered RCC drain near Sultan fokir mazer (south), Bauphal municipality



Image C45: Covered RCC drain near Md Nazrul islam bari, Bauphal municipality



Image C46: Drain connected with adjacent khal near Md Nazrul islam bari, Bauphal municipality



Image C47: Covered RCC drain near Sabanondo, Bauphal municipality



Image C48: Drain connected with adjacent khal near Sabanondo, Bauphal municipality



Image C49: Covered RCC drain near Poraton Gilrs school, Bauphal municipality



Image C50: Uncovered RCC drain near Poraton Gilrs school, Bauphal municipality



Image C51: Landfill site near uncovered RCC drain at Poraton Gilrs school Bauphal municipality



Image C52: Bushes near uncovered RCC drain at Poraton Gilrs school, Bauphal municipality



Image C53: Uncovered RCC drain near Md Waydul mia bari, Bauphal municipality



Image C54: Covered RCC drain near Md Waydul mia bari, Bauphal municipality



Image C55: RCC drain near Forkania madrasa, Bauphal municipality



Image C56: Hole in covered RCC drain near Daruet sunat, Bauphal municipality



Image C57: Hole in covered RCC drain near Daruet sunat, Bauphal municipality



Image C58: Covered RCC drain near Sarderbari to sadhu howlader bari, Bauphal municipality



Image C59: Uncovered RCC drain near Sarderbari to Sadhu Howlader bari, Bauphal municipality



Image C60: Hole in covered RCC drain near Monir master bari, Bauphal municipality