



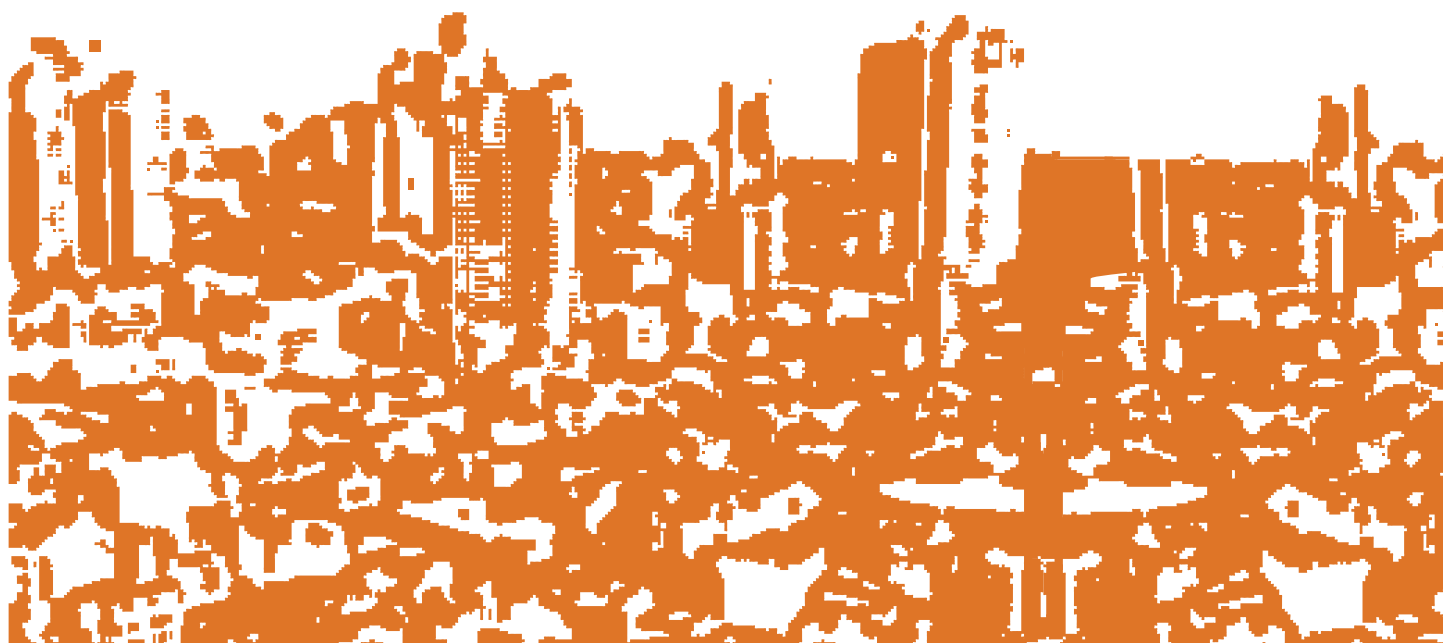
Asian Cities Climate Resilience

WORKING PAPER SERIES 32: 2016

Building Climate Resilience to Noapara Town

A Coastal Urban Centre of Bangladesh

SARDER SHAFIQUL ALAM, A. T. M. JAHANGIR ALAM, M. FEISAL RAHMAN,
SOWMEN RAHMAN & NIAZ RAHMAN



About the authors

Sarder Shafiqul Alam, Principal Investigator, Urban Climate Change Group, International Centre for Climate Change and Development (ICCCAD)

Email: sarder.shafiqul@bcas.net

A. T. M. Jahangir Alam, Researcher, Urban Climate Change Group, International Centre for Climate Change and Development (ICCCAD)

Email: kallal1022@gmail.com

M. Feisal Rahman, Research Officer, Urban Climate Change Group, International Centre for Climate Change and Development (ICCCAD)

Email: feisal1702@gmail.com

Sowmen Rahman, Research Assistant, Urban Climate Change Group, International Centre for Climate Change and Development (ICCCAD)

Email: sowmenurp@gmail.com

Niaz Rahman, Research Assistant, Urban Climate Change Group, International Centre for Climate Change and Development (ICCCAD)

Email: bappy.buet07@gmail.com

Acknowledgements

The authors are grateful to the International Institute for Environment and Development (IIED) for supporting the study by the International Centre for Climate Change and Development (ICCCAD) at the Independent University, Bangladesh (IUB). We are grateful to the Noapara municipality officials, government officials, town planners, non-government organisation representatives, community members, and others who provided support during the collection of data. The authors also wish to thank the reviewers of this working paper from the ICCCAD, especially Dr Saleemul Huq, Director of ICCCAD, and Ms Ina F. Islam, Deputy Director of ICCCAD, and Dr Diane Archer from the IIED for their constructive comments and suggestions. Additional thanks go to Dr Omar Rahman, Vice Chancellor of the IUB.

Contents

About the authors	2
Acknowledgements	2
Abstract	5
Acronyms	6
1 Introduction	7
1.1 Background and rationale	7
1.2 Research objectives	8
1.3 Structure of the report	9
2 Literature Review	10
2.1 Vulnerability of coastal zones to climate change	10
2.2 Vulnerable groups	11
2.3 Climate change and migration	11
2.4 Resilience in coastal urban centres	11
3 Methodology	13
3.1 General introduction	13
3.2 Selection of study sites	13
3.3 Key Informant Interviews (KIIs)	14
3.4 Focus Group Discussions (FGDs)	14
3.5 Consultation workshop	14
3.6 Analysis of data	14
4 Study Area	15
4.1 Reasons for selecting Noapara as a study site	15
4.2 Geography	15
4.3 Demographics	17
4.4 Economic activities	17

5	Climate Change and Water Sanitation	19
5.1	Present status of water in Noapara municipality	19
5.2	Present status of sanitation in Noapara municipality	19
5.3	Vulnerability of Noapara due to climate change	20
5.4	Impact of climatic hazards on water infrastructure and services	21
5.5	Impact of climatic hazards on sanitation infrastructure and other services	22
5.6	Climate change and livelihoods	22
5.7	Climate change and migration	23
6	Building Resilience in Water and Sanitation	24
6.1	Institutional and policy analysis in urban climate resilience in Bangladesh	24
6.2	Integrated approach	25
6.3	Inward migration to Noapara	30
7	Conclusion	31
	References	32

Abstract

This paper attempts to identify ways of making the town of Noapara, a coastal urban centre in the Jessore district in Bangladesh, resilient to the impacts of climate change, with specific focus on the water and sanitation sectors. Climatic events can trigger migration from hazard-prone areas to large cities. But if sufficient livelihood opportunities are available, improved resilience of towns or urban centres close to major cities may play a role in diverting migrants from the large cities. The situation in Noapara was investigated to see what investments would need to be made in the town to make it an attractive option for migrants.

The findings indicate that Noapara lacks access to basic services such as safe water and sanitation, with only one per cent of households being covered by the municipal water supply. The rest are dependent on hand tube wells and other sources. In particular, poor communities lack access to safe water because they do not have their own land, or the economic capacity to afford a tube well. Additionally, the lack of proper drainage systems, adequate sanitation facilities and waste management facilities increases the vulnerability of those communities during hazards. Climate change-induced hazards such as intense rainfall, cyclones, flooding and salinity intrusion are expected to exacerbate this. In order to address these limitations, the appropriate institutional support from the government, and collaboration among stakeholders, including public-private partnerships and community-based organisations, can play a key role. The preparation and implementation of a city resilience plan could eventually attract displaced people to smaller towns such as Noapara.

Acronyms

ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BWDB	Bangladesh Water Development Board
CBO	Community-based organisation
CRI	Climate Risk Index
DoE	Department of Environment
DPHE	Department of Public Health and Engineering
EIA	Environmental Impact Assessment
FGDs	Focus Group Discussions
ICCCAD	International Centre for Climate Change and Development
IIED	International Institute for Environment and Development
IPCC	Inter Governmental Panel on Climate Change
KII	Key Informant Interviews
MoEF	Ministry of Environment and Forest
NAPA	Bangladesh's National Adaptation Programme of Action
NGO	Non-governmental Organisation
UCCR	Urban Climate Change Resilience

1 Introduction

1.1 Background and rationale

Coastal regions in low-lying countries are highly vulnerable to the impacts of climate change such as sea level rise, coastal inundation, erosion, cyclones and saline water intrusion. Bangladesh is situated in one of world's low-lying areas, and the coastal zone of the country is at severe risk of climatic disasters. The global Climate Risk Index (CRI) 2014 identified Bangladesh as being among the top ten most vulnerable countries, and it was ranked fifth in terms of death toll, losses and number of extreme events in the ten years between 1993–2012 (Kreft and Eckstein, 2014). Under the influence of the changing climate, the incidences of extreme weather events are expected to rise and will affect livelihoods in many countries.

These sorts of environmental changes affect patterns of human movement, and developing countries have been the most severely impacted by climate-induced migration (IoM, 2010). According to Walsham (2010), the primary destination for most of Bangladesh's climate-induced migrants is the country's urban slums, particularly in the capital city of Dhaka and other large cities such as Khulna, Chittagong and Rajshahi. This migration has resulted in increased population pressure in the major urban areas. But if people were able to pursue livelihood opportunities and access basic utilities and services in alternative nearby urban centres, they may be less likely to migrate to large cities. If this was the case, it could help reduce pressure on Dhaka's utilities and land resources.

As in other countries, there has been growing concern in Bangladesh about addressing climate change impacts in urban areas. This concern has prompted a number of discussions around urban climate resilience. Kernaghan and da Silva (2014) referred to urban climate change resilience (UCCR) as a process "to catalyse awareness about climate change impacts in urban environments and to initiate processes that enable cities to adapt and become more resilient, thereby reducing risk". Most research on the topic indicates that a holistic, multi-sectoral approach is necessary to make a city resilient to the impacts of climate change. It has been found that "the people who have better access to adequate food, clean water, healthcare and education will inevitably be better prepared to deal with stress including that arising from climate change" (Dodman *et al.*, 2009: 154).

It has been acknowledged that a lack of basic utility services increases the vulnerability of the poor to the impacts of climate change (Baker, 2012; Huq *et al.*, 2007) and more focus is often given to water and sanitation issues in urban settlements. Baker *et al.* (2012: 129) noted, "of all basic services, water, sanitation and drainage have received more attention in the context of climate change adaptation and disasters because of their direct bearing on human health". This is also true in coastal Bangladesh, where the poor suffer from a lack of basic utility services – primarily water and sanitation.

There is little research related to urban climate resilience in Bangladesh and the available studies have primarily focused on Dhaka or on large coastal cities such as Khulna. Existing research on climate change resilience includes a study by the Asian Development Bank (ADB, 2011), which analysed the adaptation options of the water sector infrastructure in response to the likely impacts of climatic events; Roy (2014) explored the sustainability options of sanitation projects in the slums; Kumar *et al.* (2011) assessed the water access and insecurity problems faced by urban dwellers due to

urbanisation and climate change; and Parvin *et al.* (2013) explored the impact of climate change on the urban poor from the perspective of the built environment and suggested ways of enhancing their resilience capacity. In relation to coastal cities, Rejve (2006) documented the changing livelihood patterns of coastal people living in water-logged areas; Islam *et al.* (2014) found that direct discharge of domestic sewage and solid waste into surface drains is one of the major problems faced by the sanitation sector in Khulna city; and Jahan *et al.* (2012) examined how low-income groups developed their climate change adaptive capacity by analysing the impacts of climatic disasters such as cyclones Aila, in 2009, and Sidr, in 2007.

Most of these (Rejve, 2006; Kumar *et al.*, 2011; Islam *et al.*, 2014) were impact studies. Other studies (ADB, 2011; Parvin *et al.*, 2013) suggested how resilience could be improved in the water and infrastructure sectors in large cities. In Bangladesh, population increases in large cities, which are already overburdened, would lead to failure of the city governments to provide basic services to even higher numbers of inhabitant. Alam *et.al.* (2015) noted that Dhaka city's population increased at a rate of 6.9 per cent which is the highest in the world, growing from 2.2 million in 1975 to 12.3 million in 2000. A significant fraction immense population live without any necessary risk reducing infrastructure, due to unplanned urbanisation and a geographical location that makes the city very susceptible to climatic disasters.

Building the resilience of cities/towns near large cities might reduce the pressure on those larger cities. The literature suggests that potential migrants stop in sub-terminal/intermediate locations before reaching the vulnerable and already overpopulated big cities (Moench and Gyawali, 2008). Such intermediate locations, which are likely to be the nearby towns and municipalities of climate-affected areas, are under-studied in Bangladesh. Climate-related research has so far been conducted either on climate-induced migrants' origins (Black *et al.*, 2013) or on their final destinations (Adri, 2013). This study will address new and intermediate locations along existing migration corridors and will attempt to suggest strategies for establishing resilient utility services in those areas, in order that they may be more attractive to climate-induced migrants.

1.2 Research objectives

The main objective of the research is to identify ways of making coastal urban centres resilient to the impacts of climate change, with specific focus on the water and sanitation sectors. The primary hypothesis is that, given there are available livelihood opportunities, improved resilience of towns or urban centres close to major cities, through appropriate policies and planning, may play a role in diverting migrants from larger cities, and that such improvements will naturally pull people to intermediate cities. This study uses the town of Noapara as a case study of a potential intermediary town, which might attract environmental migrants. The specific objectives are:

- 1) To understand how climate-induced hazards are affecting the sanitation and water supply systems in the town of Noapara in Bangladesh.
- 2) To propose a resilience plan for Noapara to improve provision of utility facilities.

To reach these objectives the report focuses on the following specific research questions:

- a. How is the study area, the town of Noapara, vulnerable to the impacts of climate change?
 - b. How do these vulnerabilities impact the sanitation and water services in the study area?
 - c. How do sanitation and other urban services impact the quality of life and choice of migration of the urban poor?
 - d. How can the quality and provision of utility services be improved?
 - e. What impacts will this improved situation have on the migration choices of the urban poor?
-

1.3 Structure of the report

This working paper is divided into seven chapters. The second chapter of the report reviews the vulnerability of Bangladesh's coastal zone to climate change impacts. It also reviews the ways in which resilience can be brought to a coastal urban centre such as Noapora.

The third chapter describes the methodology used in the data collection and analysis, while the fourth chapter provides an overview of the study area and describes the reasons for selecting Noapara as a study site.

The fifth chapter assesses the climate change vulnerability of the study area as well as the impact of climatic hazards on the water, sanitation and livelihoods of the local community. The role of climate change on migration is also discussed in this chapter.

Chapter six identifies the key organisations and policies that are important in terms of climate resilience planning in the study area, in particular, and Bangladesh, in general. The chapter also suggests a few key recommendations, which are important for climate resilience.

The final chapter includes the findings and conclusions.

2 Literature Review

2.1 Vulnerability of coastal zones to climate change

Bangladesh is vulnerable to climate change in part because it is a deltaic coastal country. In recent years, the magnitude and recurrence of climate-induced disasters such as floods, cyclones, droughts, river erosion, salt-water intrusion and its biological effects have increased significantly (Roy, 2011; Minar *et al.*, 2013).

The southwest coastal region of Bangladesh is highly vulnerable because of the combined effects of climate change, sea level rise, subsidence and changes in upstream river discharge. As a result, cyclones, water logging and salinity intrusion are likely to worsen (MoEF, 2005; MoEF, 2009; Minar *et al.*, 2013; IPCC, 2014). The Asian Development Bank (ADB, 2008) identified several problems in coastal urban centres, including water logging due to lack of drainage capacity, lack of safe drinking water, lack of fresh water due to saline water intrusion, flooding as a result of intense rainfall, and inappropriate disposal of waste and sewage into nearby water bodies. Scientists also anticipate that the present problems will worsen as a result of climate change and sea level rise (Dodman and Satterthwaite, 2008). Table 1 describes the vulnerabilities in different areas of Bangladesh.

Table 1. Climate vulnerabilities in different areas of Bangladesh

Vulnerabilities	Vulnerable areas	Present Status	Risk of Aggravation
Cyclones and storm surges	Islands and exposed <i>upazilas</i> *	Devastating but seasonal	Increasing
Land erosion	Meghna and other estuaries, islands and other coastal areas	Serious, localised, seasonal	Increasing
Floods	Exposed <i>upazilas</i>	Serious, seasonal	Increasing
Drainage congestion	Khulna, Jessore, Noakhali	Localised and year round	Increasing
Salinity intrusion	Western exposed <i>upazilas</i>	Localised, seasonal	Increasing
Drought	Satkhira	Localised and seasonal	Increasing
Shortage of drinking water and arsenic contamination	All over	Serious and year round	Increasing
Ecosystem degradation	Marine, Sundarban	Serious and year round	Increasing
Pollution	Chittagong, Khulna, Dhaka	Serious and year round, cumulative	Increasing
Climate change	All over	Serious and year round, cumulative	Increasing

* Sub district. Source: Islam and Ahmed, 2004

2.2 Vulnerable groups

According to Huq *et al.* (2007), the people most at risk from the impacts of climate change are those who live in hazard-prone areas and who are least able to avoid the direct and indirect impacts of climatic disasters. These people typically lack good-quality homes, sanitation facilities and drainage systems. They cannot afford to move to less risky places, or are unable to change their occupation if a climatic hazard threatens their livelihoods. Low-income groups are most vulnerable to climate change – especially low-income residents who live in urban areas, since they typically have low-quality housing, poor sanitation and drainage facilities (Huq *et al.*, 2007; Baker, 2012).

2.3 Climate change and migration

Reuveny (2007: 657) identified three different coping mechanisms regarding the environmental problems arising from climate change: “Stay in place and do nothing, accepting the costs; stay in place and mitigate changes; or leave affected areas.” Developed countries can reduce the threat of potential hazards by developing new technologies or strengthening infrastructure and capacity development. But in developing countries this may not always be possible due to a lack of appropriate financing mechanisms, technologies and expertise, which eventually can trigger migration from the affected areas (Reuveny, 2007). Generally these people migrate to the urban areas that are economically developed and offer income generation opportunities (Tacoli, 2009). This is also common in Bangladesh. Every year around 200,000–225,000 people migrate from different parts of the country to urban centres due to different kinds of disasters such as erosion, salinity, storm surges and water logging (Ahmed and Neelormi, 2008; Akter, 2011). Most of these people end up in urban slums without appropriate shelter, sanitation and security of tenure (Akter, 2011). As a result, hardship increases for both new and older urban inhabitants because of the limited resources available (Akter, 2011).

2.4 Resilience in coastal urban centres

The coastal areas of the world are frequently affected by extreme events and climatic hazards. The severity of the impact depends on the ability of the system to minimise loss, which, in turn, depends on its resilience (Minar *et al.*, 2013).

Revi *et al.* (2014) defines urban climate resilience as a way to build the systematic capacity of an urban centre so that infrastructural development and land use management reduce the impact of particular hazards. Dickson *et al.* (2012: 18) define resilience as “the ability of a system to withstand or accommodate stresses and shocks such as climate impacts, while still maintaining its function”.

In recent years, a considerable amount of literature has emerged addressing resilience to climate change for urban centres and the factors that contribute to resilience (Muller, 2007; Leichenko, 2011; Moench *et al.*, 2011; Pelling, 2011; Brown *et al.*, 2012; da Silva *et al.*, 2012). According to these studies, several systematic characteristics contribute to a city’s resilience. These are: “flexibility, redundancy, responsiveness, capacity to learn and safe failure” (Tyler *et al.*, 2010; Moench *et al.*, 2011, Brown *et al.*, 2012; da Silva *et al.*, 2012 and Revi *et al.*, 2014: 548). A climate-resilient city not only has the ability to recover from the impacts of climate change, but also the ability to avoid, and the capacity to withstand, unexpected or unpredicted changes. Resilient cities also require coordinated actions by institutions working in the same area or, alternatively, government action at high levels to reduce the risk of flooding by managing the watershed upstream (Brown *et al.*, 2012; Revi *et al.*, 2014).

Considerable work has been devoted to developing frameworks for resilient cities (Brown *et al.*, 2012; ADB, 2014; Kernaghan and da Silva, 2014; Arup, 2014; Tyler and Moench, 2012). Most of these papers suggest that it is a complex process to make a city resilient and that several critical factors should be considered while making a resilience plan. Kernaghan and da Silva (2014) analysed the resilience status of 11 cities in four different countries and proposed 12 building blocks for sustainable urban climate change resilience. These include: knowledge; engaged government leaders, academics, the private sector and civil society; the existence of enabling and supportive national policy and plans; adequate city/municipal budgets; accessible donor finance; and private sector participation. Given the complexity of city resilience, an integrated approach is necessary along with participation at all levels to prepare and effectively implement a resilience plan for a specific city.

3 Methodology

3.1 General introduction

The methodology of this study involved collecting and overlaying five layers of information in two steps. In the first step, secondary data was collected from books, journal articles and reports from government and non-government organisations in order to conceptualise terms such as climate resilience and to develop the tools for primary data collection. The second step involved gathering qualitative data through a mixture of research techniques including Key Informant Interviews (KII) and Focus Group discussions (FGDs). The initial findings were presented to the stakeholders in a workshop for validation.

3.2 Selection of study sites

An exploratory study was carried out in the Noapara municipality to accomplish the following:

- To get an overall picture of Noapara municipality
- To understand the infrastructure, housing and land use pattern in Noapara
- To determine the location of the lowest income groups
- To identify the areas that are most prone to climatic hazards
- To identify the areas where water supply, drainage and sanitation facilities are scarce

The reasons for selecting Noapara as the study site are discussed in section 4.1. There are nine wards (the lowest administrative unit of a municipality) in Noapara. After a two-day field observation and the cross-checking of observations through consultation with key informants and a local NGO called Nobo Diganto, the study team chose ward number six for further data collection through key informants from the community. The ward selection criteria were:

1. High density of low-income residents
2. Poor water and sanitation conditions
3. Prone to climatic hazards

Ward six is the central business area of Noapara town and has a population of nearly 20,000 people. It is also the main administrative area of the town and contains the local *Upazilaparishad* (council) and the municipality buildings. The ward has access to rail, road and water transportation systems. Most of the town's informal settlements and slums are in this ward and by the rail tracks, and are ever-increasing in size. Due to opportunities for economic activities many new migrants are attracted this ward.

3.3 Key Informant Interviews (KIIs)

KIIs are qualitative, in-depth interviews with individuals, including community leaders, professionals, government and non-government organisation representatives or residents, who have first-hand knowledge about the issues related to the research topic. The selected key informants have knowledge about the community, its residents, climate change, water and sanitation. To identify individuals with this knowledge, a list of potential key informants was prepared, and a diverse set of representatives with different backgrounds and from different groups were listed. To carry out the KIIs two different checklists were used, one was for the local residents and another one for government officials, representatives of local NGOs, representatives of local governments and so on. A total of 30 key informants were selected from the community, which included representatives from climatically and economically vulnerable groups, with 17 male and 13 female participants respectively. In addition to the participants from the community, another nine key informants were selected from city corporations, town planners, government officials and non-government organisations; seven of these were male and two were female.

3.4 Focus Group Discussions (FGDs)

Different aspects of climate change-induced vulnerability and impacts of these climatic extreme events on livelihoods were discussed during the FGDs. Efforts were made to have FGD sessions with climatically and economically vulnerable groups as well as with the low-income women of the study area. A total of 12 FGDs were conducted in the Noapara municipality. Male and female FGDs were conducted separately, and the locations were based on study site specifications. The number of participants in each of the FGDs ranged from eight to 15. A FGD session was also conducted that included representatives of NGOs working in the Noapara municipality.

Both the FGDs and KIIs were conducted to answer the following research questions: 1) What is the study area's vulnerability to climate change? 2) What are the impacts of climate change on sanitation and other urban services? 3) What are the impacts of climate-affected services on quality of life? 4) What are the migration choices of the urban poor? 5) How can the situation caused by climate impacts be improved in Noapara municipality?

To ensure participation and appropriate understanding of the climate change context, the discussion was framed in terms of climate variability, frequency and intensity of extreme events.

3.5 Consultation workshop

A stakeholder consultation workshop was also organised in the meeting room of Noapara *pourashava* (municipality) with the presence of the chairman of the *upazila* (sub-district) *parishad* (elected body) and the administrative head of the *upazila*. In the stakeholder consultation meeting, representatives from local NGOs, elected representatives of the local government, community people and government officials were present. The ICCCAD team presented the key findings of the KII and FGDs in the workshop and presented some questions to the audience to validate these findings.

3.6 Analysis of data

The qualitative data generated by the FGDs, KIIs and stakeholder consultations was analysed using the “reflexive iteration” method (Srivastava, and Hopwood, 2009) whereby the data was continuously revisited to identify and refine the emerging themes. While recommending the actions to build resilience of the city, the study drew on the guidelines that were developed for two cities in India, Surat and Gorakpur, which were involved in the Asian Cities Climate Change Resilience Network (ACCCRN) initiative to support the climate resilience of secondary Asian cities.

4 Study Area

Noapara *pourashava*, a municipality of Abhaynagar *upazila* in the Jessore district under the Khulna division, is recognised for its river port, industries and commercial establishments. The municipality is by the Bhairab river. The Noapara *pourashava* is a Class “A” *pourashava*, which has a total of nine wards. Wards 4, 5 and 6 are situated in the town. The other wards are primarily rural. This municipality is attractive to many migrant communities in coastal regions because of its employment opportunities.

4.1 Reasons for selecting Noapara as a study site

The southwest coastal region of Bangladesh was chosen for the study because it is highly vulnerable to water logging, salinity intrusion, cyclones and storm surges, all of which are likely to be exacerbated by the impacts of climate change in the future (IPCC, 2014). There were several compelling reasons to select Noapara municipality as the study area.

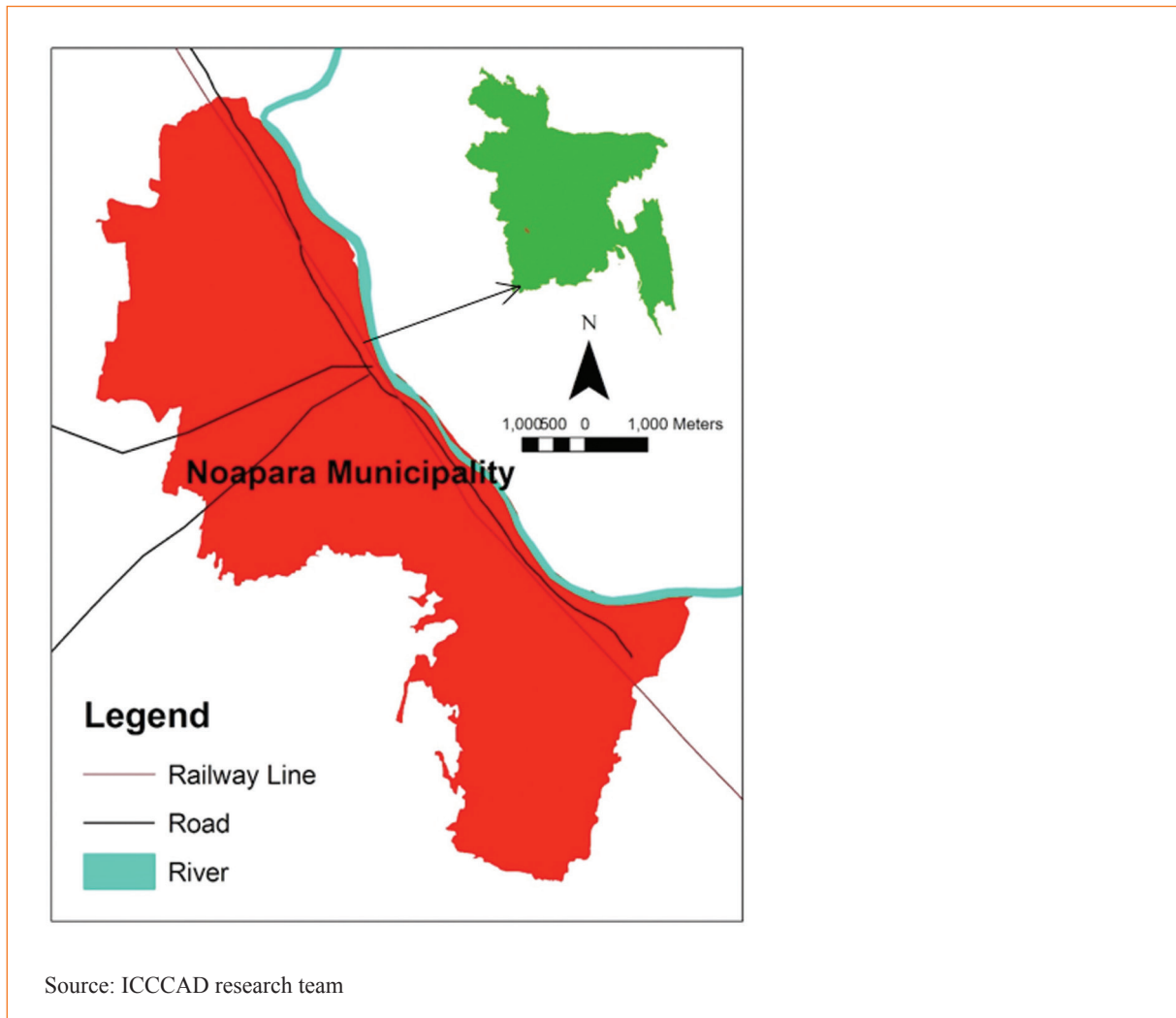
The Noapara municipality is located in the interior coastal zone of the country, which has a lower vulnerability than the exposed coastal zone. There is evidence that potential migrants go to several intermediate locations before reaching the vulnerable and already overpopulated big cities (Moench and Gyawali, 2008) such as Dhaka. Noapara *pourashava* is one such intermediate location, which is linked to other urban areas of the country by road, rail and river transportation systems. In the Noapara area, intense commercial activities exist alongside agricultural activities. Moreover, there are an adequate number of jobs for day labourers, which is the type of work often sought by rural migrants. As a newly growing industrial hub, there are an increasing number of industries, which enhance job opportunities. In addition, long-term planning for urban management is necessary, as few interventions have taken place. But there is still insufficient financial, technical and human resource capacity, so government initiatives are needed to implement the city development plans.

Climate-related research has so far been mainly conducted either in the origins (Black *et al.*, 2013) or in final destinations (Adri, 2013) of climate change induced migrants. Therefore, this particular study will attempt to address such new and intermediate locations of the migration corridor and to suggest approaches to develop resilient utility services in those areas.

4.2 Geography

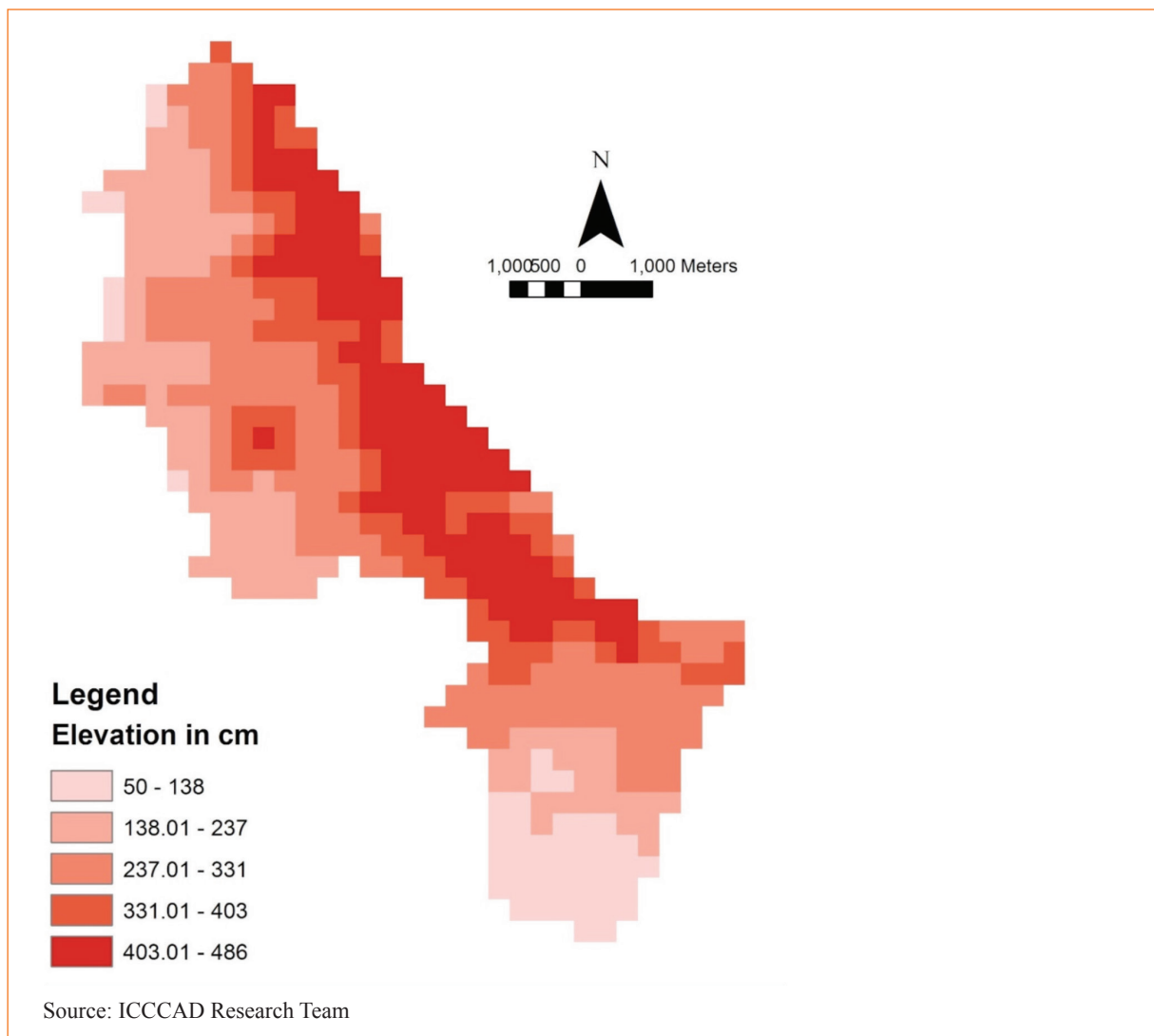
Noapara is located on the western side of Bhairab river (Figure 1) and measures about 25.12km². The municipality is connected with all parts of Bangladesh by rail, waterways and roads. It is about 30 km from the district headquarter, the nearest large city Jessore *Zila Sadar*. It takes about 30 minutes to reach Noapara from Jessore Airport.

Figure 1. Location Map of Noapara Municipality



The municipality is between 0.5m and 4m higher than the mean sea level, and the elevation of the area decreases from east to west (Figure 2).

Figure 2. Elevation Map of Noapara Municipality



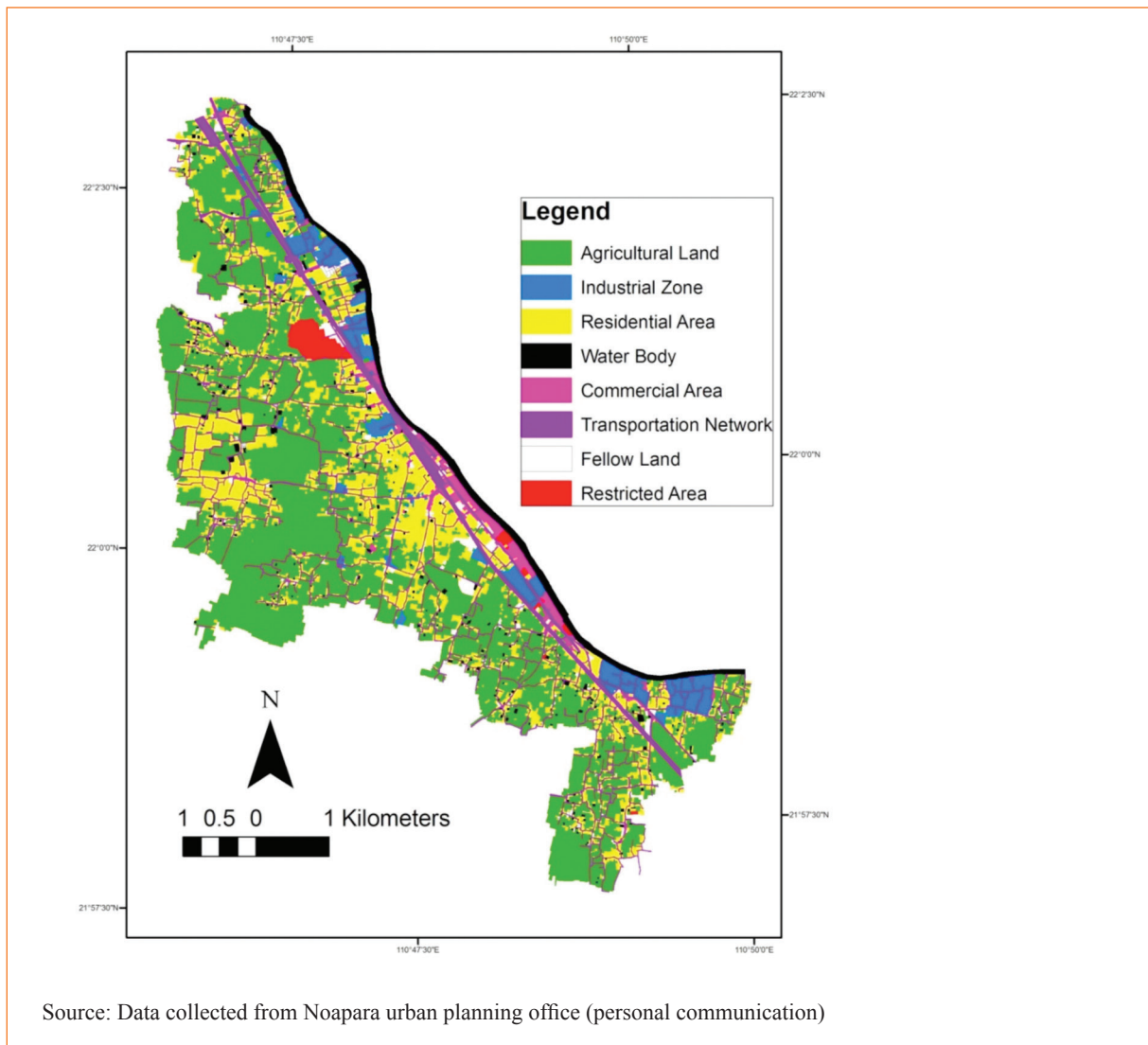
4.3 Demographics

According to the *Bangladesh Population and Housing Census 2011*, the total population of Noapara is 85,856 (BBS, 2012). About 50.56 per cent is male and 49.44 per cent is female, compared with the national population, which is 50.66 per cent male and 49.94 per cent female (BBS, 2012). The population density of Noapara is 3,314 people per km².

4.4 Economic activities

Because of its locational advantages and spatial characteristics, Noapara has the potential to develop as a trade and industrial hub. There is an efficient communication system, and its interconnected water, road and rail transportation systems make it a unique business hub.

Figure 3. Land Use Map of Noapara Municipality



Most of the area is used for agriculture, but alongside the Bahirab river there are jute mills, textile mills, rice mills, paper mills, leather factories and cement factories (Figure 3). There are 38 industries — 26 are large, five medium and seven small (Abhaynagar Upazila. (n.d.)) — which provide employment for around 8,000 workers coming from different parts of the country, mostly from water-logged areas. To address the growing demand for labour in the industrial sector, some industry owners bring labourers to the city on lorries or buses.

5 Climate Change and Water Sanitation

5.1 Present status of water in Noapara municipality

The main source of water in the town is ground water or surface water, which is supplied to the community either through pipelines or tube wells, and sometimes through dip tube wells. The poor people living in the villages collect their required water from the hand pump tube wells, rivers or ponds directly. The existing water line is only 15km long and is run through only two water pumps. According to the participants of the stakeholder FGD, only one per cent of the people living in the municipality get their water supply through pipelines.

There is an acute shortage of safe and fresh water in the municipality, especially in the low-income settlements. Locals explained that they usually do not get safe drinking water from tube wells due to high concentrations of naturally occurring arsenic. The water level of the river Bhairab is decreasing due to siltation and the drainage system of the area is poor. Only a few areas near the Bazaar and Noapara towns have drainage facilities. The existing drains are seldom cleaned. Additionally, some low-income houses are constructed over the drain because there is a lack of space. This interrupts the draining of rainwater, causing or aggravating inundation. People living along the railway line suffer the most due to water logging, but a drainage line recently constructed on the eastern side of the railway line has reduced water logging to a limited extent. Since there are no solid waste collection services, people often throw waste in the streets and drains, which blocks the drainage of water. Stagnant water causes environmental hazards such as the breeding of mosquito and other insects.

5.2 Present status of sanitation in Noapara municipality

High- and middle-income residents of the town have safe sanitation through the provision of *pucca* latrines (made of bricks with concrete structured ceiling and floor) with septic tanks. Semi-*pucca* latrines (made of bricks, tin, iron nails etc with a tin shed) feature a plinth of concrete with fences and tin or bamboo sheds, and *pucca* latrines feature a plinth, walls and concrete sheds. But access to safe sanitation in the informal settlements along the rail line is lacking. The slum residents mostly use *kutchra* latrines (made of straw, bamboo, wood), or hanging latrines (defecation platform over a pond, lake, river or other water source), for the purpose of defecation. The excreta of the *kutchra* latrine is stored in holes made in the ground. When one hole becomes full, then another one is dug beside it. In slum areas, open defecation occurs.

Another type of latrine is made with rings of concrete slabs for the storage of excreta; these need to be cleaned regularly every three to four months and slum dwellers pay for the associated expenses. Sacks of cloth or sheets of tin are used as the fence for those latrines.

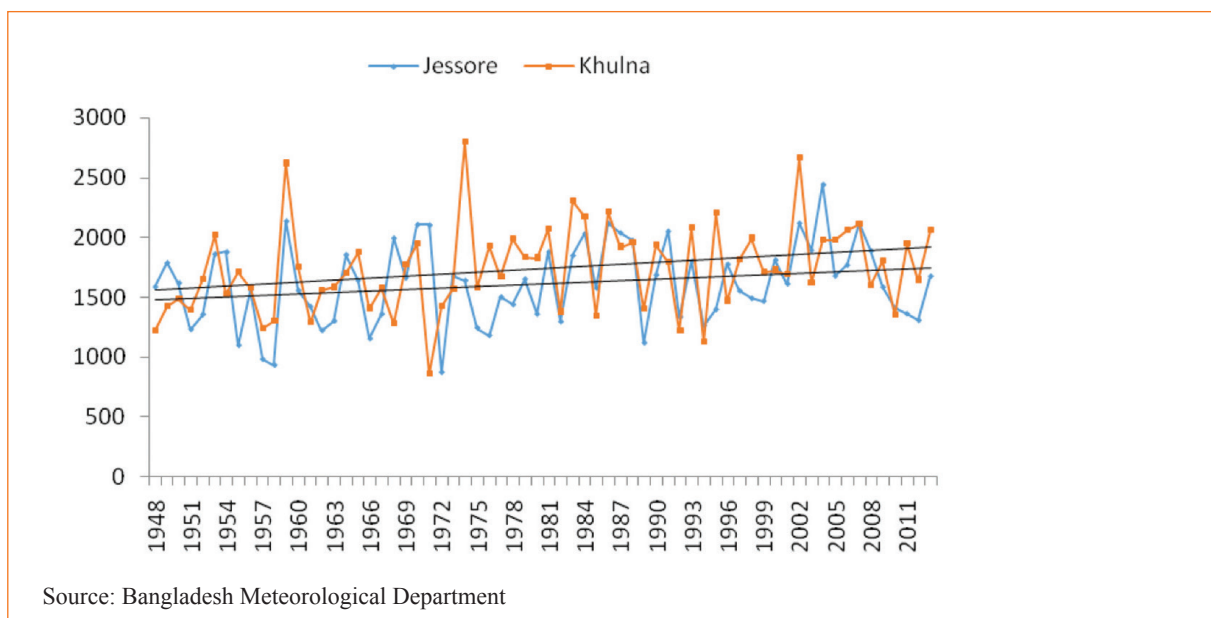
The sanitation conditions are particularly unhygienic in the low-income settlements due to the absence of a sanitation management system. Hanging latrines and open defecation cause serious environmental pollution problems in the Bastuhara slum area. The slum dwellers report that waste from the high-income areas is being piled up indiscriminately near the slum. This causes foul odour and severe pollution, which contaminates water during periods of water logging. Neither government bodies nor NGOs are currently monitoring the sanitation of the slums.

5.3 Vulnerability of Noapara due to climate change

According to the community, the severe climatic hazards that frequently occur in this area are torrential rainfall, water logging and storms. The area also experiences the hazards caused by floods, heat waves, cold waves and drought. These climatic hazards more or less hamper their lives and livelihoods. Some people, mostly those who are active in NGOs and community-based organisations (CBOs), are directly aware of climate change. However, to improve understanding of climate change, the focus group discussions were framed in terms of climate variability, frequency and intensity of extreme events. The community members noted that they have generally been aware of changes in weather and the onset of the seasons. All of the community residents interviewed responded that the area is vulnerable to climate change impacts.

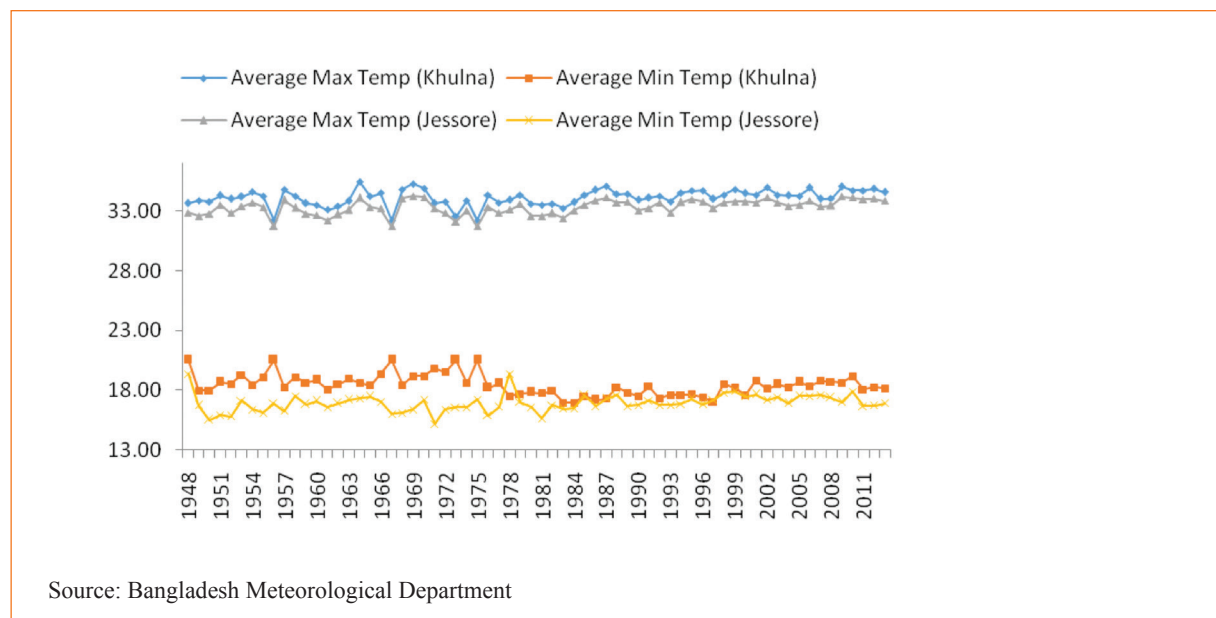
The respondents of the KIIs stated that they have recently been observing more frequent climatic hazards, such as increasing intensity of torrential rainfall and decreases in the number of rainy days. Around 23 per cent of the KII respondents stated that water logging is the result of this increasing rainfall within a short span of time. Sometimes excessive rainfall creates flooding. This trend of increasing rainfall patterns was also shown by analysing historical rainfall data from two nearby meteorological stations at Khulna and Jessore (Figure 4). This increasing pattern of rainfall may create more severe flooding in the future. According to the report of World Bank (2000), a five per cent increase in rainfall could lead to an increase of up to 20 per cent in the area being inundated.

Figure 4. Trends of Annual Rainfall in Jessore and Khulna Monitoring stations, which are about 30km from Noapara



According to local people, they are experiencing changes in weather patterns: the summers are becoming hotter and the winters are cooler. Around 37 per cent of the community respondents said that they had experienced heat waves in 2014, and 20 per cent said that cold waves blew over their area that same year. The high temperatures ultimately affect water scarcity by causing drought. Around 34 per cent of the community respondents mentioned that the area was affected by drought in the past year. The analysis of temperature data from Khulna and Jessore meteorological stations showed that maximum temperatures are increasing and minimum temperatures are decreasing (Figure 5). The literature also described similar scenarios. According to the World Bank (2000), during a period of 40 years (1968–2008) the temperature of the coastal region has increased by 0.5°C and it is predicted to increase by 1°C by 2020 (Hossain and Hossain, 2012).

Figure 5. Trend of average maximum and minimum temperature in Jessore and Khulna monitoring stations



Cyclones and tidal surges are other disasters that frequently affect the area. According to the FGDs and KIIs, in a period of eight years (2007–2015) the area has been affected by cyclones seven times. The most devastating cyclones occurred in 2007; 20 per cent of the respondents said that they had observed cyclones in that year. According to the World Bank (2000), the number of cyclones and tidal surges will increase in the future, though the rate is not confirmed.

5.4 Impact of climatic hazards on water infrastructure and services

According to community respondents, flooding and water logging, which are mainly caused by heavy rainfall, affect water supply and collection of water. The tube wells are generally inundated during a flooding event. Local people reported that drain water mixes with tube well water after heavy rainfall or flooding. Contaminated floodwater and waste materials make the water of tube wells impure. Depletion of the groundwater table during the hot summers because of rising temperatures has ultimately led to drought. During droughts, the rivers and ponds dry up and water is not regularly available in the hand tube wells because the groundwater table is low, requiring more effort to extract water. Another major effect of climate change in the area is intrusion of saline water. Respondents stated that during the summer season the water becomes saline and they lack safe drinking water. This intrusion of salinity also affects collection of water through hand pumps. During the dry seasons people totally depend on deep tube wells for collection of fresh water.

According to the chairman of Abhoynagar *upazila*: “I am now 75 years old; during my childhood I have not seen salinity in the river Bahirab. However, nowadays 75 per cent of the river water becomes saline in a specific time of the year. Moreover, we used to get water at 100–150ft depth for year after year, but now to get water we have to dig up to 800–900ft below the ground”

The findings are also in line with the literature: according to Allison *et al.* (2003), during the dry season, the encroachment of salt water from the Bay of Bengal penetrates 100km or more inland through the tributary channels.

5.5 Impact of climatic hazards on sanitation infrastructure and other services

In the absence of sewerage systems, climatic hazards such as storm water congestion and flooding cause severe impacts on sanitation infrastructure and systems, particularly in the low-income settlements of Noapara municipality. People in these areas experience difficulty in accessing basic sanitation facilities during floods or after heavy rainfall. Latrines and septic tanks are generally inundated and excreta overflow from them. Waste and germs spread in water-logged areas during heavy rainfall and foul odours emanate from the overflowing toilets and waterlogged areas. Water stagnation during floods also causes mosquito and insect problems. The slum dwellers experience structural damage to the toilets during storms or cyclones. The open latrines and hanging latrines are generally destroyed in storms and cyclones, while the tins of latrines are blown away in strong winds, creating access problems to sanitation facilities in the low-income settlements.

Sometimes people connect the septic tank to the drainage line, which causes severe water pollution in the river because most of the drainage line is directly linked to the river. Moreover, at times excreta from septic tanks create blockages in the drainage system which leads to overflows in drains. During periods of storm water congestion and flooding, defecation in open spaces beside the railway track also causes severe environmental and health problems to the inhabitants of nearby areas.

5.6 Climate change and livelihoods

Climate change impacts cause varying degrees of disruption in the lives and livelihoods of the low-income people of the Noapara municipality. According to community members, floods affected the area in the years 1999 and 2014 and torrential rainfall five times in a period of eight years between 2001 and 2008. Subsequently, these torrential rainfall events created water logging. During these kinds of events, roads, houses and other infrastructure are generally inundated by water, causing misery to respondents. Some recalled that during the last flood event people had to take out loans to reconstruct their houses, which caused an economic crisis. Daily necessities became scarce and prices increased. Floods also hampered agricultural production and fishery activities. The women could not do household chores. The earthen stoves were inundated and cooking became difficult. The hawkers were financially affected because they could not sell products in the street during prolonged heavy downpours. Hailstorms damaged the roofs of the houses by creating holes in them. Cowsheds were flooded, so it became too difficult to provide shelter and feed the cattle. Snakes and insects posed a danger after rainfall. Home craft activities such as handicraft, stitching *katha* (handmade quilt made out of old sarees or old clothing) and design work were hampered, resulting in shrinking incomes, thereby causing short-term poverty. Consequently, people moved away from agricultural activities in favour of non-agricultural activities.

The research found that skin diseases and water-borne diseases increased in the low-income communities where there are poor drainage and sanitation systems.

Respondents said they experienced an increase in daytime temperature and frequency of heat waves during the summer every year. They experienced extreme rises in temperature between 2013 and 2014. Some impacts mentioned included diarrhoea, vomiting, allergy, prickly heat, rashes, fever and other diseases caused by extreme heat. Children are more

prone to these diseases than other groups. In extreme heat people are less efficient at work. The excessive heat also results in increased water pollution.

Respondents also suffered due to increase in intensity of cold waves during the winter season, especially in 2013 and 2014. They also stated that they felt cold at night throughout the year. The children and elderly suffered from colds, coughs and pneumonia because of these cold waves.

These responses indicate that communities experience excessive heat during the day and excessive cold at night; people sometimes find it difficult to adjust to the changing weather and this can cause illnesses.

5.7 Climate change and migration

There are mainly two types of migrant observed in the Noapara municipality – seasonal migrants and permanent migrants. There are also other classes of daily migrants who come to the town every day from the nearby areas, mainly from Monirampur and Keshobpur to work in the factories in Noapara.

Fourteen out of 30 KII families identified themselves as local residents and the remaining 16 had migrated to the city. Of the migrants, seven indicated that their migration was associated with climatic disasters (river erosion, cyclones and surges, and salinity intrusion) and that they had migrated to the area within the last 6–25 years. The other nine migrant families moved to the city specifically in search of jobs and had migrated within the past 15–48 years. Seasonal migration is common in the city because there are economic opportunities for wage labourers. Also, several thousand daily migrants who live in flood- and water-logging affected areas come to the city for industrial work.

Analysis of the origin of the migrants showed that most of them came from climatically vulnerable areas. For example, riverbank erosion is becoming a severe problem in the Faridpur district. Due to these events many people migrate from this area to nearby cities or towns (Shamsuddoha *et al.*, 2012). A report by an NGO, Displacement Solutions (2012) noted that displacement is primarily caused by increases in tidal height in coastal areas and riverbank erosion in mainland areas, followed closely by tropical cyclones and storm surges.

6 Building Resilience in Water and Sanitation

Building resilience of the water and sanitation sectors of a town is important to ensure the proper functioning of a city – and the results of the previous chapter demonstrate that the residents of Naopara’s informal settlements are already suffering the consequences of inadequate water and sanitation provision. Resilient cities should be capable of addressing hazards so as to ensure that poor and vulnerable groups are able to cope with the added pressures imposed by climate change. Naopara’s water and sanitation infrastructure is currently unable to meet the basic needs of its citizens. Future climate change-related hazards are likely to aggravate its water and sanitation scenario. Therefore, it is necessary for the city to address its infrastructure gaps to contribute to the city’s resilience to climatic hazards. In order to develop and implement a sustainable and resilient city development plan, it is necessary to assess hazard risks and vulnerabilities of the town and local communities, and undertake a political and institutional analysis. Successful implementation of the plan then requires an integrated approach.

6.1 Institutional and policy analysis in urban climate resilience in Bangladesh

Analysis of institutional weakness is vital to cope with climate change impacts because climatic hazards are linked to structural vulnerability (Revi, 2008; Karanth and Archer, 2014). In Bangladesh, there are several organisations and policies responsible for climate change adaptation at the national and city levels. The key institutions and the policies are presented in Table 2.

The Ministry of the Environment and Forest (MoEF) and the Directorate of the Environment (DOE) published the national policy document on the National Adaptation Programme of Action (NAPA) of Bangladesh in 2005. The NAPA does not directly highlight urban climate change resilience issues, but under capacity building it mentions projects for enhancing climate resilience of urban infrastructure and industries. The national policy for safe drinking water and sanitation strategy issued in 1998, the national sanitation strategy issued in 2005 and the pro-poor strategy for water sanitation sector issued in 2005 do not include any consideration of climate change. But the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), published by MoEF in 2009, includes provision for improved urban drainage under the infrastructure theme. National action policies and strategic plans play an important role in the planning of any development activities at the city level. Moreover, it is necessary to build capacity at the city level so that climate change impacts can be understood and the required multi-stakeholder agencies can be engaged to take proper initiatives (Karanth and Archer, 2014).

Table 2. Stakeholders and entry points for climate resilience planning

National Level	City Level
<ul style="list-style-type: none"> ■ Ministry of Environment and Forest (MoEF) <ul style="list-style-type: none"> – Department of Environment (DoE) <p>Published policy documents on National Adaptation Program of Action (NAPA) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP)</p>	Municipal Government
<ul style="list-style-type: none"> ■ Ministry of Disaster Management and Relief 	Municipal Disaster Management Committee
<ul style="list-style-type: none"> ■ Ministry of Housing and Public works <ul style="list-style-type: none"> – Urban Development Directorate 	
<ul style="list-style-type: none"> ■ Ministry of Local Government and Rural Development ■ Local Government Engineering Department 	Local Government Engineering Department (LGRD)
<ul style="list-style-type: none"> ■ Ministry of Health <ul style="list-style-type: none"> – Department of Public Health and Engineering published a policy document on National Sanitation Strategy 	Department of Public Health and Engineering (DPHE)
<ul style="list-style-type: none"> ■ Ministry of Water Resources <ul style="list-style-type: none"> – Published policy document on National Water Policy 	

Source: ICCCAD field survey 2015

6.2 Integrated approach

Increasingly, the urban climate resilience literature suggests that the presence of multi-stakeholder and multi-level collaboration is essential (Corfee-Morlot *et al.*, 2011; Brown *et al.*, 2012; Leck and Simon, 2013; Karanth and Archer, 2014). In a multi-level collaboration, representation from all groups of people from policymakers to community members is sought, to expedite the process of achieving resilience through planning and decision making (Revi *et al.*, 2014). Moreover, bottom-up community-based development or adaptation activities (for example, community sanitation facilities) have to be supported through multi-level governance and extended opportunities and linked into wider city level adaptation initiatives. At the same time, appropriate institutional coordination mechanisms and capacity support are required for planning climate adaptation activities locally (Brown *et al.*, 2012; Karanth and Archer, 2014).

These policies and strategic action plans need to be modified to take into consideration climate change resilience. Stakeholder KII findings and consultation workshop participants pointed out that in Noapara city there is lack of cooperation and collaboration among relevant national government agencies and among the local government agencies and other stakeholders. Furthermore, only four organisations were found to work alongside the community people (see Table 2). Apart from this, several NGOs work in the municipality.

The findings also revealed that climate change risk reduction and adaptation and mitigation related strategies and actions are yet to be undertaken in the city. Therefore, dialogues for Noapara city should identify balanced and resilient actions of major business actors contributing to the city's growth. The city should also consider the safety and protection of its vulnerable populations from climatic risks and hazards. A capable body or actor should take the lead in bridging the risks and set investment priorities to clearly direct all stakeholders engaged in the city's urban and economic development (Karanth and Archer, 2014).

A multi-stakeholder platform including representatives from all these stakeholder organisations could work together to build resilience in Noapara municipality. Noapara town can take lessons from Mymensingh city, in central Bangladesh, which has recently developed a resilient city action plan to reduce disaster risks and vulnerability. The plans were developed through a multi-stakeholder approach including national government, local government, academics, NGOs, CBOs and local communities. Academics conducted surveys to understand risks and vulnerabilities to disasters. The results were used by academics and urban planners to develop a land use plan and a disaster risks reduction action plan to provide necessary infrastructure and services for the local community. Field findings were validated through stakeholder consultation and a participatory exercise at city levels (personal communication with the city mayor).

In undertaking an integrated approach, Noapara faces the following challenges:

- Noapara is a relatively new town and a significant area of the township is still used for agricultural purposes
- The population is increasing rapidly because there are economic opportunities in the town and there is a lack of institutional arrangements for new migrants to the city
- Being a new municipality, Noapara lacks sufficient resources (such as human resources, funds and public land) to undertake development projects
- Several unplanned developments have already been built by local private entities, and local industries were predominantly built without any environmental impact assessment (EIA)
- There is a lack of coordination and exchange of information among government agencies and private entities
- The municipality, as well as local NGOs, do not have programmes and plans focusing on climate change-induced hazards

Local NGOs and private organisations are involved in awareness-building activities on water and sanitation and microcredit-related programmes, but most do not have any long-term strategies. They are not involved in local infrastructure development work and lack coordination with government and private institutions and organisations.

Noapara municipality is vulnerable to several climatic impacts, all of which have some impact on the water and sanitation sector of the area. Therefore, it is necessary to have an integrated approach, which will focus on every aspect of climatic disasters relevant to the area. Disaster-specific plans and coordination among those plans will help make the city resilient. It should be noted here that city governments typically do not have the technical capacity, funds and necessary policy framework for undertaking an integrated approach to address climatic disasters. This means Noapara also requires assistance from the national government or other sources in the form of technical and financial support as well as policy and regulatory assistance. In this regard, Mongla municipality in the Bagerhat district can serve as an example for Noapara's local policymakers. Mongla municipality received technical and financial support from international development agencies through the national government. Local leaders, especially the Mongla municipality mayor, used networking with the national government and policymakers to secure such assistance and in implementing the disaster risk reduction related action plan in the city (personal communication with the Mongla city mayor).

Comprehensive analyses of vulnerability and risks are the key points for making any urban plan. A detailed vulnerability and risk analysis is beyond the scope of this current research. However, the in-depth interviews with community people and stakeholders led to the findings outlined above regarding the impacts of climatic hazards on their lives in informal settlements. Moreover, the research team also went through the resilience plan of other cities of developing countries, which have built their resilience under the ACCCRN initiatives. In recommending a resilience plan for Naopora, the guidelines followed were from the ACCCRN climate resilient cities. According to the recommendation of the research team, the Noapara municipal government should play the lead role in building resilience. It is their responsibility to group all the stakeholders under the same umbrella. After modification of the above-mentioned policies, they can begin to undertake project-based activities by considering long-, medium- and short-term goals. Often the funds provided by the national government are inadequate for the development and implementation of a resilient city plan, so funds from donors and the private sector, through national government, will be needed.

The prime actions recommended for building resilience, particularly for the residents of Naopora's informal settlements, are described below and a summary of the required actions will follow the discussion.

Management of water logging and flooding

First, the hotspots where stagnant water gathers should be identified, and the necessary steps to drain the water from those areas should then be taken.

The existing land use map from Noapara municipality should be considered when taking any development activities or strategic action plans. The master plan of the town, which was recently developed, should be strictly enforced, but there is currently a lack of necessary central government funding support as well as a lack of human resource to enforce and implement the master plan.

According to a study which looked at mainstreaming resilience in Gorakhpur City in India, marking low-lying areas as no development zones with green land use ensures the drainage of storm water: “Mapping and demarcation of water bodies and open areas in the city is important to regulate reclamation and unauthorised change of land use” (TERI, 2012). A similar approach could be taken in Noapara by protecting certain areas from development activities so that torrential rainwater can easily be drained out through these low-lying channels to prevent flooding and water logging. To identify these areas, a comprehensive mapping study needs to be done, either by the municipality or an expert consultant, to identify these areas and possible strategies to ensure water drainage. Likely impacts of climate change are also important while considering strategies to reduce flooding or water logging. Data available from the Bangladesh Meteorological Department may be useful in predicting future rainfall patterns.

Master plans and development activities or actions should consider the environmental risk reduction concerns by integrated planning. There is a need to translate the urban risk reduction plan at the community level for education and effective enforcement.

Ensure adequate supply of water

The BWDB should assist the town government, Local Government Engineering Department (LGED) and Department of Public Health Engineering (DPHE) in assessing the locations where water can be extracted in order to supply water to every citizen. This will also provide essential information on ground water recharge locations of water pumps. But it is not enough to simply ensure the supply of water; it is also necessary to ensure the quality of the water. The DPHE can play a key role here by regularly monitoring water quality and also keeping the public informed of the water quality, as it is currently doing in Bera and Singra municipalities.

Usually Noapara’s storm water discharges directly into the river Bhirab. The participants of the stakeholder consultations explained that such direct discharge is not only creating environmental problems but also posing health hazards to those who use the river water. LGED and DPHE need to coordinate efforts to prevent the discharge of the town’s waste water into the river by treating it prior to disposal.

Local people also lack safe drinking water due to encroachment of arsenic and intrusion of salinity in the hand tube wells. To overcome this problem, there should be an investment in sufficient deep tube wells. Respondents suggested that there should be a tube well installed every kilometre so that people can access safe drinking water easily.

Ensure adequate drainage and sewerage facilities

According to the discussion of stakeholder consultation meetings, there are no sewerage systems in the Noapara town area, and drainage facilities are confined to the Bazar area. Moreover, sometimes people connect their sewerage line to the drainage network, resulting in untreated waste being directly discharged into the river. In addition, sometimes people construct their housing over the drainage line, especially in the slum areas. These activities hamper the proper and timely cleaning of the drain. To improve drainage and sewerage facilities, Mongla municipal town in the Bagerhat district recently employed several development measures to alleviate the town’s water logging and drainage overflow problems. The municipal corporation has introduced solid waste dumping bins. The township has also constructed

large ponds to harvest and conserve rainwater to alleviate the town's drinking water problem. Mongla town also has a protection embankment along the Pasur and Mongla rivers to prevent tidal flood and surge inundation. To carry out these improvements the city corporation received funding support from international development partners through national government. This has increased the town's resilience, and is an example that Noapara could seek to follow (personal communication with the mayor of Mongla).

To overcome relevant challenges in Noapara the following steps could be taken.

First, the city needs separate sewerage and drainage systems along with sewage treatment plans to ensure the safe disposal of waste in some specific sites. A detailed feasibility study is required to plan the drainage and sewerage system, and then the necessary finance sources will need to be identified. LGED, DPHE and the municipal authority in collaboration with town planners should establish separate sewerage and drainage infrastructure.

Second, there is scope to further create awareness among the local community about safe drinking water and sewerage facilities as well as the importance of not connecting the sewerage line to the drainage network. DPHE and the city government can implement programs to raise drinking water safety awareness for community people. Besides the municipal corporation, NGOs, CBOs and local educational institutions may also play a role in raising community awareness.

Third, the frequency of cleaning the open drains should be increased, especially before and during monsoon to ensure the easy flow of water, by municipal authority cleaners. Also the LGED in association with the municipal authority should monitor regular wastewater or rainwater drainage status, and take necessary action to ensure functional water drainage facilities. Waste dumping facilities with good accessibility and regular collection should be built. Furthermore, awareness-building programs by municipalities, CBOs and community leaders should be undertaken to raise community awareness regarding problems created by dumping in open drains.

Fourth, the ban on polythene plastic bags, which constrain the proper flow of water through drainage lines, should be strictly enforced. There is already a national law against the production and use of polythene bags in Bangladesh, but it is not actively enforced and plastic bags continue to be used. Provisions for alternative resources, such as jute bags, should also be made easily available.

Fifth, a committee should be set up that includes representatives from all the key stakeholders in Noapara such as the DPHE, LGED, municipal government, NGOs and community people (as proposed by Alam *et al.*, (2015)). This committee would coordinate activities and take necessary decisions. Suggestions from community members and NGOs working in this area should be considered, to ensure city resilience, but it requires the participation of all stakeholder groups.

Siltation is another major problem of the river Bhirab which is having adverse effect on the town's water logging problem and also on the employment sector. The labourers of the Noapara port explain their worries about siltation. In earlier times many big cargo ships used to come to the Noapara port but nowadays due to siltation only small cargos can come to the port now. In addition to this, siltation also creates severe problem in the loading and unloading of the goods. The BWDB should come forward to ensure the proper navigation of the river as siltation is affecting commercial activities and employment opportunities available.

Provide sanitary latrines

The goal of the National Sanitation Strategy (GoB 2005) was to achieve 100 per cent access to sanitation by 2010. The strategy aimed to ensure access to hygienic latrines for every citizen, thus breaking the cycle of transmission of diseases. The goal could have been achieved but the infrastructure that was built was not resilient to climate change and is damaged during flooding and cyclone events. Therefore, the target of no open defecation has not been achieved practically.

To overcome the situation, awareness needs to be raised about the need to construct cyclone-resistant latrine infrastructure. The NGOs can play a vital role in this because they have the capacity to mobilise people in short timeframes. Second, those who do not have the capacity to build *pucca* latrines should be provided with economic support in the form of loans or grants. The provision of community-based latrines for landless people can be effective in this regard.

Improve solid waste management

There is no specific data about the current generation of solid waste from the municipality. But the population of the town is increasing as migrants continue to arrive from different parts of the country, which means that the amount of solid waste is also increasing and will continue to do so in the future. Yet there is no specific solid waste dumping site for the city and uncollected waste contaminates water sources. Sometimes the low-lying areas in the outskirts of the city are used as dumping sites.

Some possible management strategies include the identification of some dumping sites, which would be demarcated and buffered within the land use plan of the town. The planners of the municipality also should consider the potential impact of climate change while designing any dumping sites.

To manage the waste, the option of door-to-door waste collection is necessary. Residents can be encouraged to separate their organic and inorganic waste, so that only non-degradable, non-recyclable waste goes to landfill. This separation of waste also has the potential to help produce energy or fertiliser from the organic waste should a decision be made to do so at a later date.

Awareness should also be raised among the community to prevent the dumping of waste materials in random locations within the city. Awareness-raising activity could include drama, song, billboard messages, and other events for children and adults. Awards by the municipal corporation to the best clean area leader of the municipality could also provide some social recognition for city cleaning activities.

A summary of the actions required in the water and sanitation sectors to building resilience of Noapara town as described above is listed in Table 3 and Table 4, respectively.

Table 3. Actions to bring resilience in the water sector

Resilience Strategy	Required Action	Primary Concern Body	Secondary Concern Body	Support*
Improve drainage system by considering long-term sustainability	(Long-term plan) assess climate change impact and vulnerability	<ul style="list-style-type: none"> ■ Urban planner 	<ul style="list-style-type: none"> ■ Government ■ Climate change expert ■ Modelling 	Technical assistance and finance
Sink (set-up) sufficient no of tube-well (1 in each km ²) Provide supply water in whole municipality	Long-term plan	<ul style="list-style-type: none"> ■ Water and sanitation expert 	<ul style="list-style-type: none"> ■ Government ■ Urban planner ■ Sanitation engineer 	Technical assistance and finance
Awareness raising of the city dwellers (water resource use and maintenance of the infrastructure)	<ul style="list-style-type: none"> ■ Development of tools ■ Training ■ Motivation 	<ul style="list-style-type: none"> ■ NGOs 	<ul style="list-style-type: none"> ■ NGO ■ Government 	Technical support and financial assistance
Formation of water resource management committee	<ul style="list-style-type: none"> ■ Formation of CBOs ■ Training 	<ul style="list-style-type: none"> ■ Municipal Authority 	<ul style="list-style-type: none"> ■ NGO ■ Government 	Technical support and financial assistance
Follow up activity to measure the effectiveness	Participatory monitoring and evaluation	<ul style="list-style-type: none"> ■ Researchers 		Technical support and financial assistance

* Technical support should be provided both by the government and academic experts. Funding support could be provided directly by the national government or international donors through the national government.

Table 4. Actions to bring resilience in the sanitation sector

Resilience Strategy	Required Action	Primary Concern Body	Secondary Concern Body	Support**
Building of cyclone-resistant toilets with high sanitation facilities		<ul style="list-style-type: none"> ■ Department of Public health Engineering 	<ul style="list-style-type: none"> ■ Municipality 	Technical support and financial assistance
Reduce the overflow of toilet waste	Construction of sewerage system	<ul style="list-style-type: none"> ■ Department of Public Health Engineering 	<ul style="list-style-type: none"> ■ Municipality 	Technical support and financial assistance
	Construction of sanitary latrines	<ul style="list-style-type: none"> ■ Municipality ■ Department of Public health Engineering 	<ul style="list-style-type: none"> ■ Community People 	Technical support and financial assistance Awareness raising

***Technical support should be provided both by the government and academic experts. Funding support could be provided directly by the national government or international donors through the national government.*

6.3 Inward migration to Noapara

Noapara already has a large number of different types of migrants including climate change-induced migrants. There are growing economic opportunities, such as jobs in local industries, as well as different transport facilities, so it is likely that rather than migrating long distances to large cities, future migrants from climate disaster-prone areas, particularly along the coast, could target Noapara.

KII respondents, who included city corporation officers, town planners, government officials and NGOs, all highlighted that people come to Noapara from coastal and other climatic-affected regions of the country. Initially, these migrants came on a temporary basis to earn an income, but they then settle permanently with their families. The respondents also indicated that if basic facilities, particularly safe water and sanitation infrastructure and services, are ensured, future migration will likely increase.

Workshop participants recommended strengthening multi-stakeholder collaboration and cooperation among government agencies, city industrialists, urban planners, NGOs and community representatives. Academics could conduct research to feed into sustainable city long-term plans and the city corporation should implement such plans with the involvement of all other stakeholders.

The current study findings show that every day thousands of people come to the Noapara municipality in search of work but permanent inhabitants of Noapara rarely leave. The seasonal migrants who mainly come from different climatic hazard-prone areas primarily migrate in search of better job opportunities. All 30 KII community respondents, nine KII institution respondents and all 12 FGD participants mentioned that more protection from climatic hazard impacts would increase migration to Noapara. But they also explained that water sanitation amenities alone would not be enough to attract migrants; job opportunities will also be necessary. The stakeholder consultation workshop suggested that more private investment will increase employment opportunities in the area and such would attract more potential migrants. In addition to this, because the area is less vulnerable than surrounding areas and has a communication network through road, river and rail, it could become a business hub of the country.

7 Conclusion

The findings of the study underline that the Noapara municipality has a lack of basic services, particularly an adequate, safe water supply and sanitation infrastructure, which are fundamental for making cities climate resilient. Only about one per cent of the town's population is served by the municipality's supply line, and people mainly use hand tube wells for drinking and other purposes. But in some areas hand tube well water contains arsenic, which means some people have to travel long distances to collect safe drinking water. The poor in particular lack access to water because they do not own land nor do they have the economic capacity to buy and install a tube well. At the same time, improper water drainage systems aggravate the situation in those communities.

Low-income groups, especially those living in slum areas, lack safe sanitation facilities. This creates several environmental problems by blocking drainage channels and polluting nearby water bodies, which eventually increases health risks. Climatic hazards, such as intense rainfall and storm events, flooding, drought, cyclones and salinity, in conjunction with the existing water and sanitation situation, is anticipated to aggravate the existing challenges.

Noapara municipality is an important economic hub of the country because it is well connected through rivers, road and railway networks. The city has the potential to grow further with the arrival of new migrants. In order to accommodate new migrants, particularly those from climate-affected areas, the city needs to build its climate resilience. Noapara town requires a comprehensive analysis of risks and vulnerability, and while making a resilience plan, will need policies and institutional support. There are different ministries, departments, policies and strategies guiding the urban climate change resilience. To develop the necessary infrastructure for making a city resilient, especially in the water and sanitation sector, it is essential to consider climate change and resilience in water sanitation policies and strategies. An integrated approach and strategic plan will need to build resilience in the Noapara municipality. Public-private partnerships, including CBOs at all stages and levels, would be required to build the city's climate resilience and to attract more climate-displaced people to become permanent residents. Noapara is yet to become a destination choice for future climate-displaced people and no assessment has been done on how it may attract migrants. Due to lack of funding and a shortage of capable staff at the municipal corporation, the city lacks comprehensive understanding on risk and vulnerability. Accordingly, the city still needs to take action to understand how to become more resilient, and to implement policies to achieve this. It also needs to create better facilities for employment and establish better housing with adequate water and sanitation for climate-displaced migrants.

Noapara municipal authority has to play the key role with regard to increasing the city's resilience, and thereby making the town more attractive to migrants. It should do so incorporating all the stakeholders under the same umbrella. The municipality should take the lead in analysing risks and vulnerability and make proper action plans on the basis of that analysis. Relevant ministries, departments, policies and strategies need to develop and guide the pathway to bring climate change resilience to places such as Noapara. A multi-stakeholder platform will make achieving resilience easier. Finally, the availability of a monitoring and impact evaluation system would ensure the effectiveness of the city resilience action plan.

References

- Abhaynagar Upazila. (n.d.). Noapara Municipality at a Glance (একনজরনেওয়াপাড়াপট্টা রসভা). Available at: <http://abhaynagar.jessore.gov.bd/node/16532-এক-নজর-নেওয়াপাড়া-পট্টা-রসভা> [Accessed 09/06/2015]
- ADB 2008. *People's Republic of Bangladesh: Strengthening the resilience of the water sector in Khulna to climate change*. Technical Assistance Report. Asian Development Bank
- ADB, 2014. *Urban Climate Change Resilience a synopsis*. Asian Development Bank. Available at: <http://www.adb.org/sites/default/files/publication/149164/urban-climate-change-resilience-synopsis.pdf> [Accessed 15/1/2015]
- ADB. 2011. *Adapting to Climate Change - Strengthening the Climate Resilience of the Water Sector Infrastructure in Khulna, Bangladesh*. Asian Development Bank (ADB). Available at: <http://adb.org/sites/default/files/pub/2011/adapting-climate-change-ban.pdf> [Accessed 08/02/2015]
- Adri, N. 2013. *Climate-induced Rural-Urban Migration in Bangladesh: Experience of Migrants in Dhaka City*. Paper presented in Technical University of Munich, November 23, 2013.
- Ahmed, A. U. and S. Neelormi, 2008. *Climate change, loss of livelihoods and forced displacements in Bangladesh: whither facilitated international migration?* Available at: http://www.csrlbd.org/resources/climatechange/%20doc_details/47-climate-change-loss-of-livelihoods-andforced-displacements-in-bangladesh [Accessed 21 April, 2016]
- Akter, T. 2011. *Migration and living conditions in urban slums: implications for food security*. Unnayanonneshan. Available at: <http://unnayan.org/reports/Migration.and.living.conditions.in.urban.slums.pdf> [Accessed 15/2/2015]
- Alam, S.S., Alam, J. AT M. and Rahman, S. (2015) "Urban climate resilience, water and sanitation Improving multi-stakeholder collaboration in Dhaka, Bangladesh" Asian Cities Climate Change Resilience working paper series, published by IIED September 2015.
- M. A. Allison, S. R. Khan, S. L. Goodbred, and S. A. Kuehl, "Stratigraphic Evolution of the Late Holocene Ganges-Brahmaputra Lower Delta Plain," *Sedimentary Geology* 155 (2003): 317–42.
- Arup 2014. *City Resilience Index: City Resilience Framework*. Ove Arup & Partners International Limited, London, United Kingdom
- Baker, J. L. 2012. *Climate Change, Disaster Risk, and the Urban Poor: Cities Building Resilience for a Changing World*. World Bank, Washington, DC. Available at: http://ipcc-wg2.gov/njlite_download2.php?id=9885 [Accessed 08/02/2015]
- BBS. 2012. *Population and Housing Census 2011*. Bangladesh Bureau of Statistics. Available at: <http://www.bbs.gov.bd/PageWebMenuContent.aspx?MenuKey=333> [Accessed 09-02-2015]
- Brown, A., A. Dayal. and C. Rumbaitis. 2012. From practice to theory: emerging lessons from Asia for building urban climate change resilience. *Environment and Urbanization* 24 (2), 531–556.
- Corfee-Morlot, J., I. Cochran, S. Hallegatte, and P. Teasdale. 2011. Multilevel Risk Governance and Urban Adaptation Policy. *Climatic Change* 104 (1): 169–197.
- Da Silva, J., S. Kernaghan. and A. Luque. 2012. A systems approach to meeting the challenges of urban climate change. *International Journal of Urban Sustainable Development* 4(2), 125–145.
- Dickson, E., J. L. Baker, D. Hoornweg and A. Tiwari. 2012. *Urban risk assessment: Understanding disaster and climate risk in cities*, World Bank, Washington, D.C.

- Displacement Solutions. 2012. *Climate displacement in Bangladesh, The need for urgent housing, land and property (HLP) Rights Solutions*. Available at: <http://displacementsolutions.org/wp-content/uploads/DS-Climate-Displacement-in-Bangladesh-Report-Low-Res-For-Web.pdf> [Accessed 09/06/2015]
- Dodman, D and D, Satterthwaite. 2008. Institutional capacity, climate change adaptation and the urban poor. *IDS Bulletin* 29(4): 67–74
- Dodman, D, J. Ayers and S. Huq. 2009. “Building resilience” in The Worldwatch Institute (editor), *State of the World 2009: Into a Warming World*. W W Norton & Company, New York, 151–172.
- GoB (2005), National Sanitation Strategies, Ministry of LGRD&C, Government of Bangladesh, Dhaka
- Hossain, M. L. and M. K. Hossain. 2012. *Climate Change, Sea Level Rise and Coastal Vulnerabilities of Bangladesh with Adaptation Options*. Available at: http://www.academia.edu/1224958/climate_change_sea_level_rise_and_coastal_vulnerabilities_of_bangladesh_with_adaptation_options [Accessed 09/06/2015]
- Huq, S., S. Kovats., H. Reid. and D, Satterthwaite. 2007. Editorial: Reducing risks to cities from disasters and climate change. *Environment & Urbanization* 19(1) 3–15.
- International Organization of Migration (IoM). 2010. *Assessing the Evidence: Environment, climate change and migration in Bangladesh*. Available at http://publications.iom.int/bookstore/free/environment_climate_change_bangladesh.pdf [Accessed 8/2/2015]
- IPCC. 2014. *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Working Group II Contribution to the IPCC 5th Assessment Report (WGII AR5).
- Islam, M.R. and M. Ahmed, 2004. *Living in the coast. Problems, opportunities and challenges*. Government of the People’s Republic of Bangladesh. Ministry of Water Resources. Water Resources Planning Organisation (WARPO).
- Islam, S. A., M. Rahman, M. S. Islam and M. A. Razzaque. 2014. *Problems of existing sanitation system in Khulna city of Bangladesh: a case study*. 3rd International Joint Student Seminar on Civil Infrastructure, AIT, Bangkok, Thailand. Available at: https://www.researchgate.net/publication/259029551_PROBLEMS_OF_EXISTING_SANITATION_SYSTEM_IN_KHULNA_CITY_OF_BANGLADESH_A_CASE_STUDY [Accessed 08/02/2015]
- Jahan, F., A. M. Shahan, M. Rashid and S. R. Khan. 2012. *Poverty and Climate Change in Urban Bangladesh (ClimUrb): a case study of Magbara, Khulna*. World Poverty Institute, University of Manchester. Available at: http://www.bwpi.manchester.ac.uk/medialibrary/publications/working_papers/bwpi-climurb-case-study-1-012.pdf [Accessed 7/12/2014]
- Karant, A. and D. Archer. 2014. Institutionalising mechanisms for building urban climate resilience: experiences from India. *Development in Practice*, 24:4, 514–526, DOI: 10.1080/09614524.2014.911246
- Kernaghan, S., and da Silva, J. 2014. Initiating and sustaining action: Experiences building resilience to climate change in Asian cities. *Urban Climate* 7, 47–63.
- Kreft, S. and D. Eckstein. 2014. *Global Climate Risk Index 2014*. Available at: <http://germanwatch.org/en/download/8551.pdf> [Accessed 12/02/2015]
- Kumar, U., M. Alam, R. Rahman, S. Mondal and H. Huq. 2011. *Water Security in Peri-Urban Khulna: Adapting to Climate Change and Urbanization*. Peri Urban Water Security Discussion Paper Series, Paper No. 2, SaciWATERS. India.
- Leck, H. and D. Simon. 2013. Fostering multiscale collaboration and co-operation for effective governance of climate change adaptation. *Urban Studies*, 50 (6): 1221–1238.
- Minar M.H., M. B. Hossain and M. D. Shamsuddin. 2013. Climate change and coastal zone of Bangladesh: vulnerability, resilience and adaptability. *Middle-East Journal of Scientific Research* 13 (1), 114–120
- Ministry of Environment and Forest (MoEF) 2005. *National Adaptation Programme of Action (NAPA)* Available at: <http://unfccc.int/resource/docs/napa/ban01.pdf> [Accessed 14/2/2015]
- Ministry of Environment and Forest (MoEF), 2009. *Bangladesh climate change strategy and action plan 2009*, Ministry of Environment and forest, Government of the People’s Republic of Bangladesh Available at: http://www.moef.gov.bd/climate_change_strategy2009.pdf [Accessed 15/2/2015]
- Moench, M. and D. Gyawali. 2008. Desakota: Reinterpreting the Urban-Rural Continuum, Conceptual foundations for understanding the role ecosystem services play in the livelihoods of the poor in regions undergoing rapid change, Part II A.

- Moench, M., S. Tyler., and J. Lage. 2011. *Catalyzing urban climate resilience: Applying resilience concepts to planning practice in the ACCCRN Program (2009–2011)*. Institute for Social and Environmental Transition, International (ISET-International), Boulder, CO, USA. 292.
- Muller, M. 2007. Adapting to climate change: water management for urban resilience. *Environment and Urbanization* 19(1) 99–113.
- Parvin, A., A. F. M. A. Alam and R. Asad. 2013. *Climate Change Impact and Adaptation in Urban Informal Settlements in Khulna: A Built Environmental Perspective*. Available at: http://www.academia.edu/7641208/Climate_Change_Impact_and_Adaptation_in_Urban_Informal_Settlements_in_Khulna_A_Built_Environmental_Perspective [Accessed 07/12/2014]
- Pelling, M. 2011. *Adaptation to climate change: From resilience to transformation*. Routledge, Abingdon, Oxon, UK and New York, NY, USA.
- Rejve, K. 2006. *Changes in livelihood pattern of inhabitants in waterlogged areas in southwest region in Bangladesh*. Masters dissertation, Postgraduate Programs in Disaster Management, BRAC University, Bangladesh. Available at: <http://dspace.bracu.ac.bd/bitstream/handle/10361/1383/05268018.PDF?sequence=14> [Accessed 08/02/2015]
- Reuveny, R. 2007. *Climate change-induced migration and violent conflict*. *Political Geography* 26, 656–673
- Revi, A. 2008. Climate Change Risk: An Adaptation and Mitigation Agenda for Indian Cities. *Environment and Urbanization* 20 (1): 207–229.
- Revi, A., D. E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R. B. R. Kiunsi, M. Pelling, D.C. Roberts, and W. Solecki, 2014. Urban areas. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M. D., Bilir, T. E., Chatterjee, M., Ebi, K. L., Estrada, Y.O., Genova, R.C., Girma, B., E.S., Levy, A.N., MacCracken, S., Mastrandrea, P. R. and White L.L. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 535–612.
- Roy, D.C. 2011. Vulnerability and Population Displacements due to Climate-induced Disasters in Coastal Bangladesh. In Leighton, M., X. Shen and K. Warner (eds.). *Climate Change and Migration: Rethinking Policies for Adaptation and Disaster Risk Reduction*, Publication Series No. 15/2011, Germany: UNU-EHS, 24–33.
- Roy, T. K. 2014. Sustainability Options of Sanitation Projects in the Slums of Khulna City. *Equality in the City: Making Cities Socially Cohesive*, World Town Planning Day - 2014, Bangladesh Institute of Planners. Available at: http://www.bip.org.bd/SharingFiles/journal_book/20141118150912.pdf [Accessed 08/02/2015]
- Shamsuddoha, Md., Khan, S.M.M.H, Raihan, S., and Hossain, T. (2012) *Displacement and Migration from Climate Hot-spots: Causes and Consequences*, Center for Participatory Research and Development and ActionAid Bangladesh, Dhaka: December, 2012.
- Srivastava, P. and N. Hopwood. 2009. A practical iterative framework for qualitative Data analysis. *International Journal of Qualitative Methods* 8(1), 76–84.
- Tacoli, C. 2009. Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment and Urbanization* 21(2): 513–525.
- TERI. 2012. *Mainstreaming Climate Resilience in Urban Areas: A case of Gorakhpur City*. New Delhi, India.
- Tyler, S., M. Moench, 2012. A framework for urban climate resilience. *Climate and Development* 4(4): 311–326.
- Tyler, S., S. O. Reed., K. Macclune., and S. Chopde. 2010. Planning for urban climate Resilience: Framework and Examples from the Asian Cities Climate Change Resilience Network (ACCCRN). *Climate Resilience in Concept and Practice: ISET Working Paper 3*, Institute for Social and Environmental Transition (ISET), Boulder, CO, USA.
- Walsham, M. 2010. *Assessing the Evidence: Environment, Climate Change and Migration in Bangladesh*. International Organization for Migration (IOM), Regional Office for South Asia: Dhaka.
- World Bank. 2000. *Bangladesh Climate Change and Sustainable Development*, 1–166.
-

Building Climate Resilience to Noapara Town: A Coastal Urban Centre of Bangladesh

Asian Cities Climate Resilience Working Paper Series

This working paper series aims to present research outputs around the common theme of urban climate resilience in Asia. It serves as a forum for dialogue and to encourage strong intellectual debate over concepts relating to urban resilience, results from the ground, and future directions. The series is also intended to encourage the development of local research capacity and to ensure local ownership of outputs.

The series has arisen out of the Asian Cities Climate Change Resilience Network (ACCCRN, www.acccrn.org), an initiative funded by the Rockefeller Foundation.

The series is intended to present research in a preliminary form for feedback and discussion. Readers are encouraged to provide comments to the authors whose contact details are included in each publication.

Published by IIED May, 2016

IIED order no: 10779IIED

<http://pubs.iied.org/10779IIED.html>

ISBN 978-1-78431-346-3

80-86 Gray's Inn Road, London WC1X 8NH, UK

Tel: +44 (0)20 3463 7399

Fax: +44 (0)20 3514 9055

email: humans@iied.org

www.iied.org

