City Resilience Strategy

Mongla Port Municipality, Bangladesh

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1. BACKGROUND

1.1 Introduction

It is projected that over 60% of the world's population will be based in cities by the year 2030[1]. Bangladesh is gradually making the shift from 'rural' to 'urban'. Though the level of urbanization is still rather low, only 28.4 percent, it however already had a very large population 42.7 million in 2011, living in nearly 570 urban centres in the country. Projections, keeping in mind the growth rates of population observed during 2001-2011 and based on the UN population projection model, indicate that Bangladesh would achieve 'the tipping point' of 50 per cent urban by 2047. Thus, Bangladesh is expected to be majority 'urban' within the next 35 years. [2] Due to high concentrations of people, infrastructure and resources, the most adverse impacts of climate change will likely be in these areas according to the World Bank[3]. In this context, it is of the utmost urgency that a city is able to increase climate resilience to avoid these impacts.

Climate resilience is defined as the capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve sustainability of the system, leaving it better prepared for future climate change impacts[4]. **Urban Climate Change Resilience (UCCR)** is defined by Rockefeller Foundation as the **capacity** of cities (individuals, communities, institutions, businesses and systems) to **survive**, **adapt**, **thrive** in the face of stress and shocks, and even **transform** when conditions require it[5].

There are a host of benefits for cities associated with building resilience as outlined in Table 1. Investing in resilience reduces losses and damages in the event of a disaster. However, even if the anticipated disaster does not occur for a long time, increased resilience will mean reduction in background risk and unlocking of economic development potential[6].

Table 1: Potential Benefits of Resilience Building

Economic Benefits	Environmental Benefits	Social Benefits
- Avoidance of runaway costs of climate change - Livelihood creation - Higher savings by population, businesses and government	- Biodiversity conservation - Preservation of vital ecosystems and species - Conservation of water resources - Improved practices for	- Improved public health - Decreased mortality - Increased benefits to low-income households - Reduced damage and loss due to natural

[1]United Nations. 2014. World Urbanization Prospects, the 2014 revision. UN Department of Economic and Social Affairs, Population Division.

[2] Islam N. 2015. Urbanization in Bangladesh: Challenges and Opportunities http://www.shiree.org/wp-content/uploads/2015/04/NI-Paper.pdfhttp://www.shiree.org/wp-content/uploads/2015/04/NI-Paper.pdf

[3]World Bank, 2008. Climate Resilient Cities: A primer on reducing vulnerabilities to climate change impacts and strengthening disaster risk management in East Asian cities, Washington D.C.

[4] Folke, C. 2006. "Resilience: The emergence of a perspective for social-ecological systems analyses". Global Environmental Change. **16**: 253–267.

[5]The Rockefeller Foundation. 2015. Insights from the Asian Cities Climate Change Resilience Network: Urban Climate Change Resilience in Action: Lessons from Projects in 10 ACCCRN Cities.

[6] Tanner, T.M. and Rentschler, J. 2015. 'Unlocking the 'Triple Dividend' of Resilience: Why investing in disaster risk management pays off. Interim Policy Note'. Washington D.C.: GFDRR and London: Overseas Development Institute (www.odi.org/tripledividend).

Economic Benefits	Environmental Benefits	Social Benefits
- Reduced risks associated with current climate variability	disaster risk reduction	disaster - Enhanced well-being of all social groups

1.2 Methodology

Mongla's City Resilience Strategy was formulated using the ICLEI ACCCRN Process (IAP). The process helped to identify fragile urban systems, major climate risks to urban systems and vulnerable areas and populations in the city, which were used to formulate resilience interventions.

Pioneered by the Rockefeller Foundation, the Asian Cities Climate Change Resilience Network (ACCCRN) supports practitioners to build inclusive urban climate change resilience in over 50 rapidly urbanising cities. To facilitate this initiative, the IAP toolkit was developed which targets city governments and helps them develop their city resilience strategies with little or no external assistance.

1.2.1 Overview of ICLEI ACCCRN Process

The IAP toolkit consists of a set of sixteen tools which enables local governments to assess the climate risks of various systems in the city in context of urbanization and vulnerability, and plan resilience interventions corresponding to the fragilities identified. The IAP is designed in a step-by-step format, divided into following six phases as shown in Figure 1.

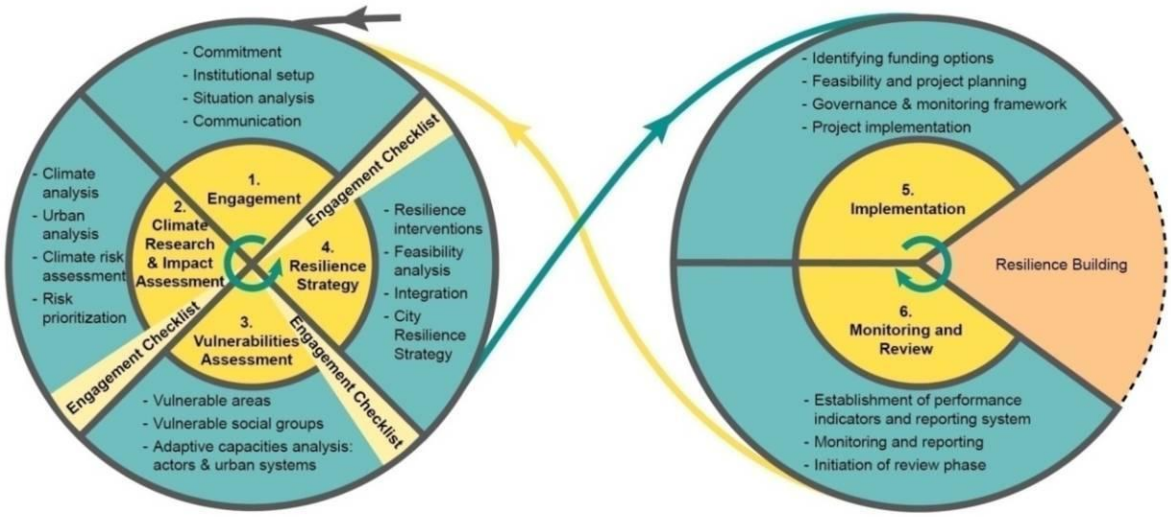

Figure 1: ICLEI ACCCRN Process

Phase 1 – Engagement: This phase begins with gaining political support in the city by formulating a Climate Core Team and a Stakeholder Committee. The climate core team is responsible for the execution of project activities in the city and comprises of key officials from the city government. The Stakeholder Committee is formed with citizen representatives from various relevant institutions and organisations of the city. The climate core team forms a communication plan for the city highlighting key messages to be conveyed to the public and the ways for doing so. This is followed by a scoping exercise which helps in gaining insight about the various city services and the problems faced by the city.

Phase 2 – Climate Research and Impact Assessment: This phase identifies the main impacts of climate change faced by city through Shared Learning Dialogues (SLD) with the Climate Core Team and Stakeholder Committee. An assessment of the past climate trends and future climate projections are conducted through secondary research. These are validated through analysis of city level data as well as local perceptions from city stakeholders. A risk assessment is conducted for fragile urban systems based on the likelihood and consequence of the climate risk statements for those systems.

Phase 3 – Vulnerabilities Assessment: This phase helps in identifying the key vulnerable areas with the fragile urban system and the vulnerable population for each system. This information is gathered in consultation with the Stakeholder Committee through SLD. The adaptive capacities of the urban systems are also assessed in this phase.

Phase 4 – Resilience Strategy: In this phase, the city government uses the information and analysis from the previous phases to identify the relevant resilience interventions. These interventions are prioritised on the basis of their feasibility and applicability to the city. The resilience strategy is then developed and ratified through political support.

Phase 5 & 6 – Implementation and Monitoring & Review: After identifying the resilience interventions for the city, concrete project implementation plans can be prepared. Opportunities for financing and implementing these projects need to be explored. In all cases, monitoring and review remains a mandate of the city government, with active involvement of the Climate Core Team.

1.2.2 ICLEI ACCCRN Process (IAP) in Mongla City

The Mayor of Mongla Port Municipality spearheaded the IAP with support from his staff and ICLEI South Asia. Figure 2 illustrates the process and timeline followed in Mongla. To initiate the IAP, engineers, councillors and other representatives from Mongla Port Municipality, were oriented on the fundamentals of urban development and climate resilience. Simultaneously, members for the Climate Core team (Annexure 3) and the Stakeholder Committee were identified in consultation with the Mayor and Municipal Engineer of the Mongla Port Municipality. The potential climate risks were identified by an assessment of the trends of temperature and precipitation change in the area and desktop studies of secondary literature. These were validated by the Climate Core Team and Stakeholder Committee in an SLD. Through the SLD and other consultations/discussions, a comprehensive Urban Systems Analysis was carried out that identified seven urban systems as fragile, viz. (i) Water Supply, (ii) Transportation, (iii) Health System, (iv) Storm Water Drainage, (v) Solid Waste Management, (vi) Urban/Peri-Urban Agriculture/Animal Husbandry, and (vii) Sanitation.

The seven fragile urban systems identified were critically analyzed considering the direct and indirect impacts of identified climate risks. Through an SLD, Vulnerability Assessment was carried out to critically evaluate the sensitivity, exposure and adaptive capacity of the seven fragile urban systems, identify vulnerable areas for each climate risk and their associated vulnerable actors. Finally, the vulnerability hotspots, reflecting the fragility of a ward, were arrived at by overlaying all the vulnerable wards identified under each fragile urban system.

A list of resilience interventions targeting improved urban resilience and reduced climate risk for all fragile urban systems was developed. These were assessed for their technical, social and financial feasibility and their applicability to Mongla. Interlinkages of these resilience interventions with on-going and planned projects were established and further integration into existing city-level plans was explored.

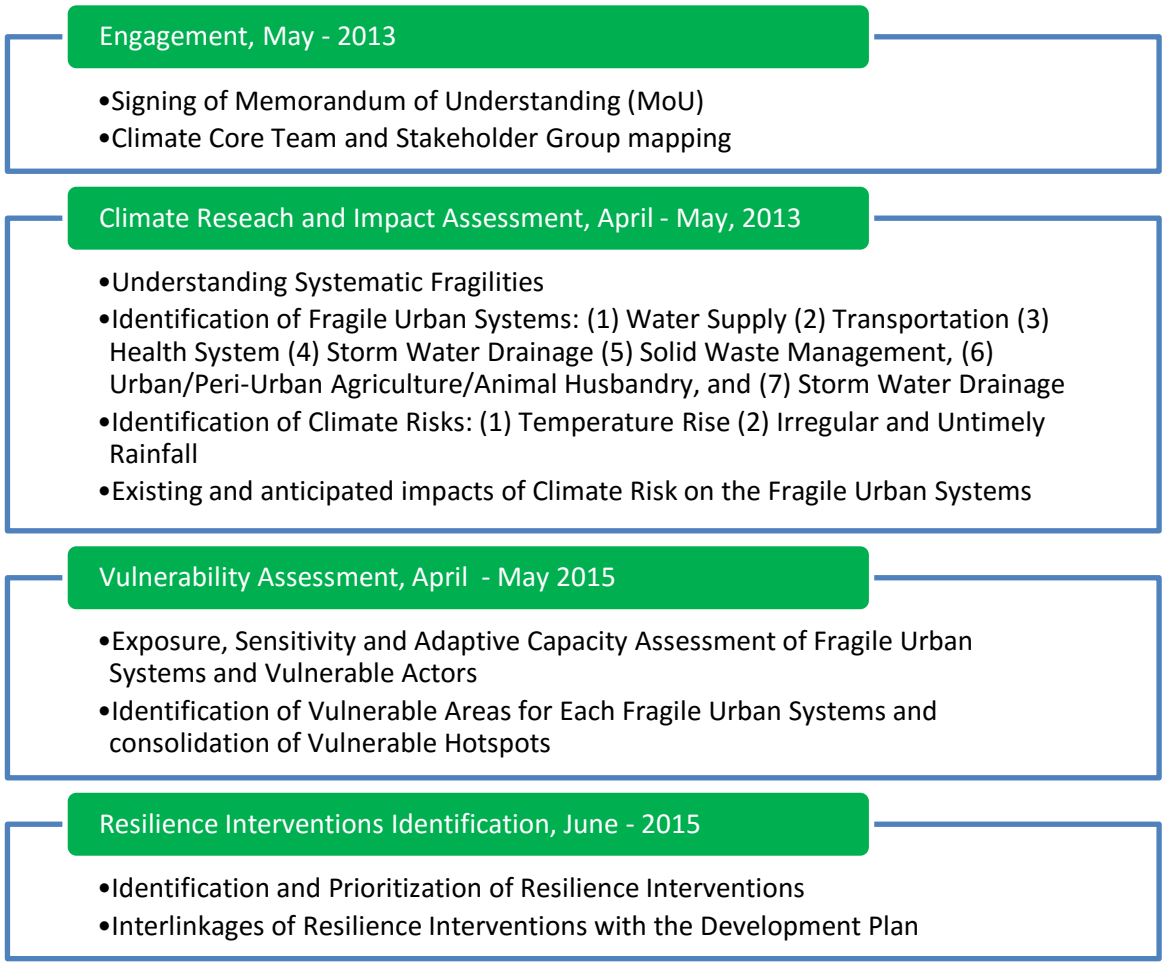

Figure 2: Methodology of IAP in Mongla

2. CITY PROFILE

Mongla is the main sea port in the Bagerhat district of south-western Bangladesh. It is located between 22°29'20"N and 89°35'43"E. The name Mongla originated from Mongla River. Mongla Port Municipality was established in 1990 and is the largest Municipality of Bagerhat district.

2.1 Location

Mongla is located at 22°29'20"N and 89°35'43"E (refer Figure 3) surrounded and well protected by the Sundarban mangrove forest. The port is situated at the confluence of the Pashur River and the Mongla River.

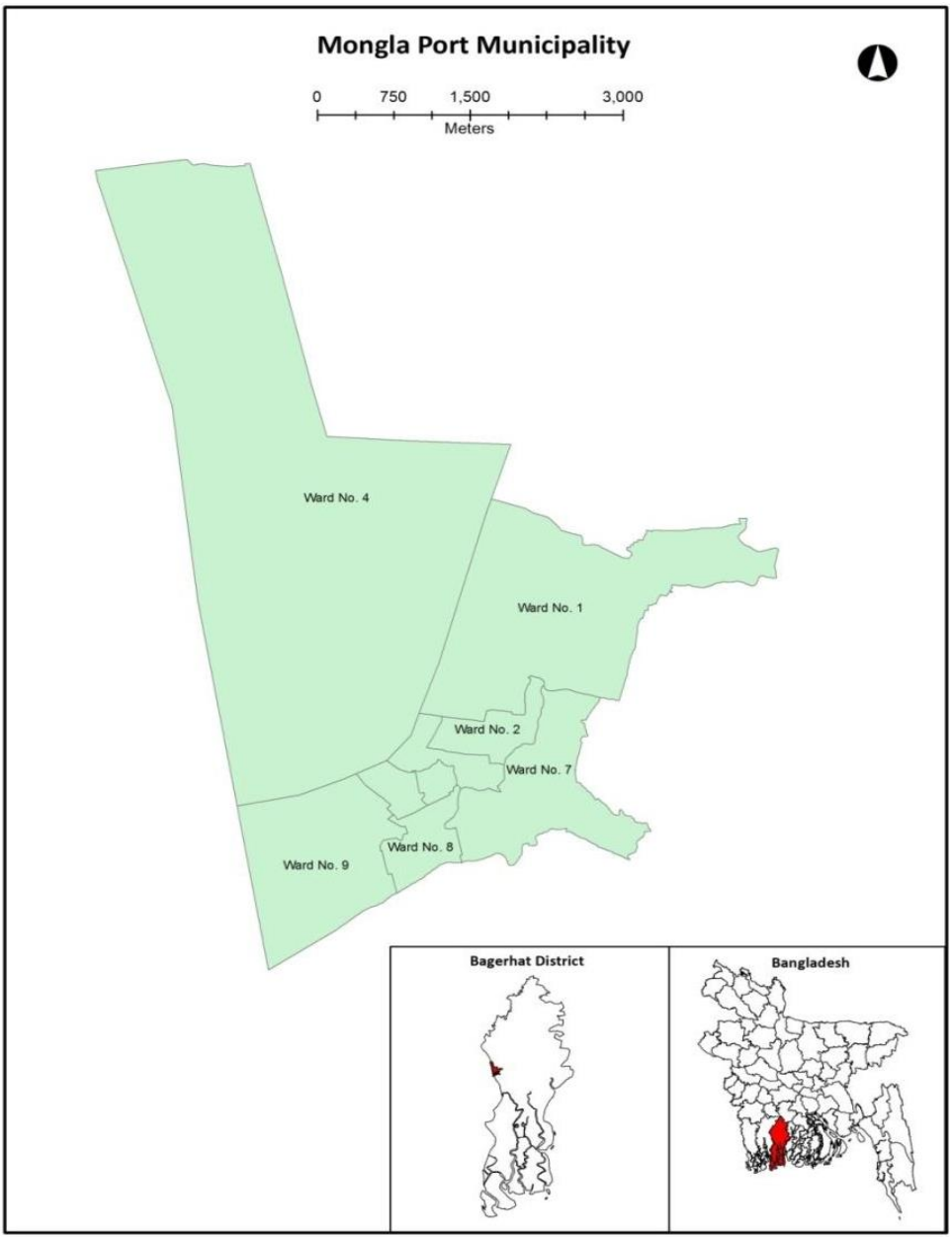

Figure 3: Location of Mongla Port Municipality

2.2 Demography

According to Bangladesh Bureau of Statistics (BBS) population census 2011, the population of Mongla Port Municipality was 39,837 comprising of 21,607 males and 18,230 females. There are 8,927 households. The population density was 2,053.5 persons/sq. km distributed among 9 wards spread over 19.40 sq. km., where, wards 2 and 5 have the highest and least population densities, respectively. The following table represents the ward wise population of Mongla Port Municipality and their population density. The literacy rate in the area under the jurisdiction of the Municipality is 64.1%.

Table 2: Ward-wise Area and Population of Mongla Port Municipality, 2011

Ward No.	Area of Ward (sq. km.)	Total Population	No. of Households	Population Density (Persons/sq. km.)

Ward No.	Area of Ward (sq. km.)	Total Population	No. of Households	Population Density (Persons/sq. km.)
1	1.74	5,661	1,305	3,253.4
2	1.22	4,156	985	3,406.6
3	1.04	3,117	735	2,997.1
4	4.70	6,945	1,285	1,477.7
5	1.92	1,841	451	958.9
6	2.81	2,750	587	978.7
7	3.41	7,032	1,730	2,062.2
8	1.12	3,634	890	3,244.6
9	1.44	4,701	959	3,264.6
Total	**19.4**	**39,837**	**8,927**	**21,643.7**

2.3 Economy and Employment

The Economy of the municipality is largely dependent on agriculture and fisheries. Some industrial and manufacturing activities take place due to the Mongla Port and Mongla Export Processing Zone. These two establishments are a major employment source for the locals. Mongla is also famous for shrimp cultivation and the city earns a lot of foreign exchange from shrimp export. A socio-economic survey[7] revealed that the major income patterns are service 18.76%, house rent 1.96%, business 17.64%, wage earnings 30.93%, agriculture 2.52%, poultry 4.06%, fisheries 2.66%, handicrafts 1.82%, remittance 0.98%, pension 0.56%, land lease 0.70%, shrimp culture 7.28% and others 10.22%.

2.4 Municipal Administration

Mongla Port Municipality regulates most of the civic function and services in the city. At present, the Municipality consists of elected members including a Mayor, nine Councillors, including three female Councillors. The Mayor and Councillors are responsible for all policy decisions. The Chief Executive Officer (CEO) is the head of city administration and is responsible for the functioning of the Municipality including tax collection, estates maintenance, projects, among other things. This is an administrative cadre service post and appointed by the central government. Mongla Port Municipality provides and maintains basic urban services which include water purification and supply, sewage treatment and disposal, garbage disposal and street cleanliness, solid waste management, building and maintenance of roads and streets, street lighting, maintenance of parks and open spaces, cemeteries and crematoriums, registering of births and deaths, conservation of heritage sites, disease control including immunization, and public municipal schools.

Other than the City Municipality, development and planning schemes are implemented by some other government organizations which are as follows:

[7]Khulna Development Authority. 2011. Khulna Metropolitan Development Plan: Preparation of Structure Plan, Master Plan and Detailed Area Plan for the Extension of the Khulna Master Plan Area up to Mongla Town (2012-2032).Government of the People's Republic of Bangladesh, Ministry Of Housing And Public Works

A. **Khulna Development Authority –** responsible for preparing the city master plan, and other development policies.

B. **Local Government Engineering Department –** responsible for construction of local roads, bridges, culverts etc.

C. **Department of Public Health Engineering –** responsible for conducting surveys to determine the water contamination level like arsenic and its pollution in the area.

D. **Public Works Department –**Responsible for implementation of government construction projects. It also undertakes projects for autonomous bodies as deposit works.

E. **Department of Agricultural Extension –** promotes subsidy for betterment of farmers, distributes fertilizer to the poor farmers, and often arranges trainings for farmers on modern techniques of cultivation.

F. **Forest Department –** responsible for forest extension, biodiversity and wildlife conservation etc.

G. **Roads & Highways Department –** responsible for the construction and maintenance of major roads and bridge networks.

H. **Water Development Board –** responsible for flood control, drainage and irrigation activities as well as to enhance water resource management.

I. **Power Development Board –** provides electricity to the residents, commerce and industrial establishment on priority and their capacity basis.

J. **Bangladesh Rural Development Board –** responsible for socio-economic development through implementation of policies and projects for rural development.

3. PAST HAZARDS AND CLIMATIC EVENTS

The city of Mongla is highly vulnerable to cyclones. Table 3 highlights the major hazards witnessed by Mongla in the past. This clearly shows that the city is regularly subject to cyclones, the frequency of which has been increasing over time.

Cyclone Sidr which hit the Khulna-Barisal coast (near Baleshwar river) in 2007 resulted in 3,363 deaths, 871 people missing, 1,928,265 families and 8,545,470 people affected, 1,449,157 houses damaged, and total damage cost of about 450 million USD[8].

Cyclone Rashmi swept across southern Bangladesh on 27 October 2008, killing at least two people and leaving 11 missing. According to the government's Comprehensive Disaster Management Programme (CDMP), the cyclone made landfall early in the morning with wind speeds of up to 80 kmph. Harbour activities in Mongla, were suspended for two days[9].

[8] Islam, M. A. 2009. Country Report: Bangladesh. Monitoring and forecasting of cyclones SIDR and AILA. The 5th International Coordination Group (ICG) Meeting GEOSS Asian Water Cycle Initiative (AWCI) Tokyo, Japan, 15-18, December 2009

[9] http://www.thedailystar.net/news-detail-60557

In 2009 Cyclone Aila made landfall at Bangladesh's south-western coast, killing approximately 120 people and washing away several thousand homes as wind-driven tidal surges inundated vast tracts of land. According to media reports, approximately 500 people went missing who were mostly fishermen. One of the most affected areas was Satkhira district, near Mongla Port[10].

Table 3: List of climatic disasters affecting Mongla and adjacent areas since the 1960s

Year	Event	Common Impacts
1964	Cyclone and Flood due to high precipitation during cyclone events	• Infrastructure loss • Soil Salinization • Agricultural and other horticultural productivity is declining • Depth of the river is decreasing and the city is becoming more vulnerable to flooding • Local Businesses, small and medium level industries such as- fisheries, poultry, animal husbandry are affected significantly • Mal-nutrition, vector borne diseases like – Cholera, Malaria etc. are more common now a days in the city • Transportation system is getting damaged • Educational system is disrupted • Slums face extreme damage • Migratory birds have stopped coming, mangroves affected • Hilsa fish population affected
1970	Flood	
1988	Flood and Cyclone	
2007	Cyclone – Sidr	
2008	Cyclone - Rashmi	
2009	Cyclone - Aila and Flood due to high precipitation during cyclone events	

4. CLIMATE SCENARIO IN THE CITY

The climate is tropical in Mongla. In winter rainfall is much lower than summer rainfall. According to Köppen and Geiger, this climate is classified as Aw. The average annual temperature in Mongla is 26.1 °C with May being the hottest month and January being the coolest. The rainfall averages 1910 mm[11].

4.1 Past Climate Trends

Nishat and Mukherjee (2013)[12] analysed rainfall and temperature data of 40 years (from 1967-2007) across 30 stations of the meteorological department in Bangladesh to find that the temperature and precipitation was increasing across most of the country. The station in Mongla showed an increasing trend in rainfall intensity and more frequent rainfall in a year. The trend analysis showed an increase in mean seasonal rainfall where pre-monsoon rainfall showed an increase of between 8-13 mm/year while monsoonal rainfall showed increases of 21-24 mm/year and post monsoon rainfall increased by 12-24 mm/year.

[10]The International Federation of the Red Cross and Red Crescent Societies. 2009. Bangladesh and India: Cyclone Aila. Information Bulletin number 1. GLIDE n° TC-2009-000105-BGD

[11] http://en.climate-data.org/location/44601/

[12]Nishat, A. and Mukherjee, N. 2013.Climate Change Impacts , Scenario and Vulnerability of Bangladesh. In R. Shaw *et al. (*Eds.) Climate Change Adaptation Actions in Bangladesh, Disaster Risk Reduction.Springer Japan 2013.

Temperature trends also showed an increase of 0.4- 0.65°C in the mean seasonal temperature. The country on the whole was experiencing a warmer winter with minimum temperatures having increased by 0.45°C in winter, by 0.52°C in the monsoons while maximum temperatures increased by a range of 0.03-0.05°C per year during summers.

During the IAP process data was collected from the Bangladesh Meteorological Department (BMD) to analyse the past trends of the rainfall and temperature for Mongla. Rainfall data spanned 23 years (from 1991 to 2014) while temperature data spanned 25 years (1989-2014). The figures 4-8 show rainfall for the city while figures 9-11 show temperature over the last 25 years. Contrary to the data presented in Shaw *et al.* (2013)[12], annual average rainfall seems to be showing a decreasing trend (figure 4). Rainfall during summer, winter and monsoonal seasons is decreasing (figure 5, 6 and 8) and post monsoon rainfall more or less remains the same (figure 7).

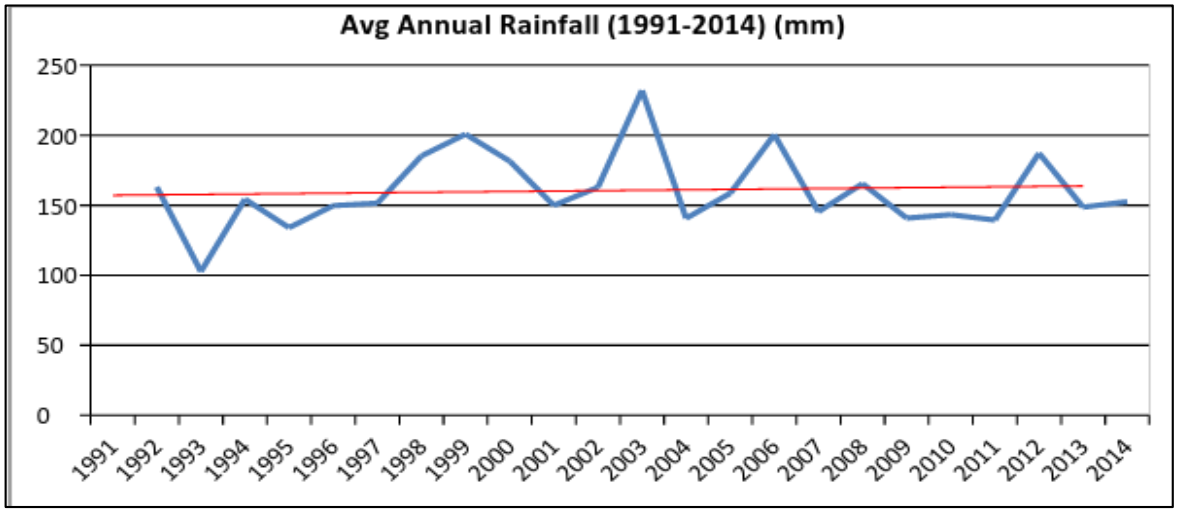

Figure 4: Average Annual Rainfall for Mongla City

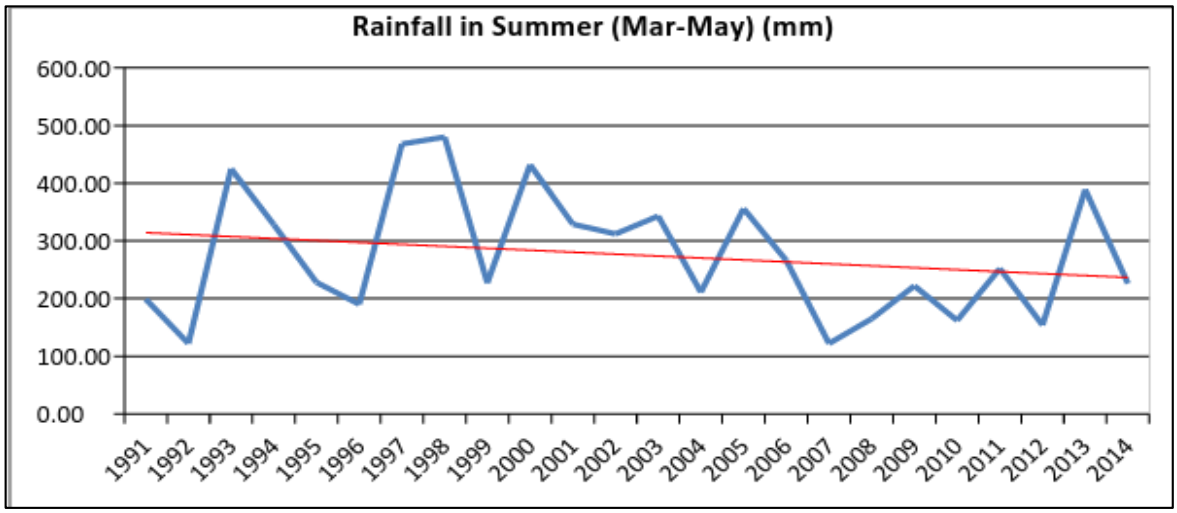

Figure 5: Rainfall in Summer for Mongla City

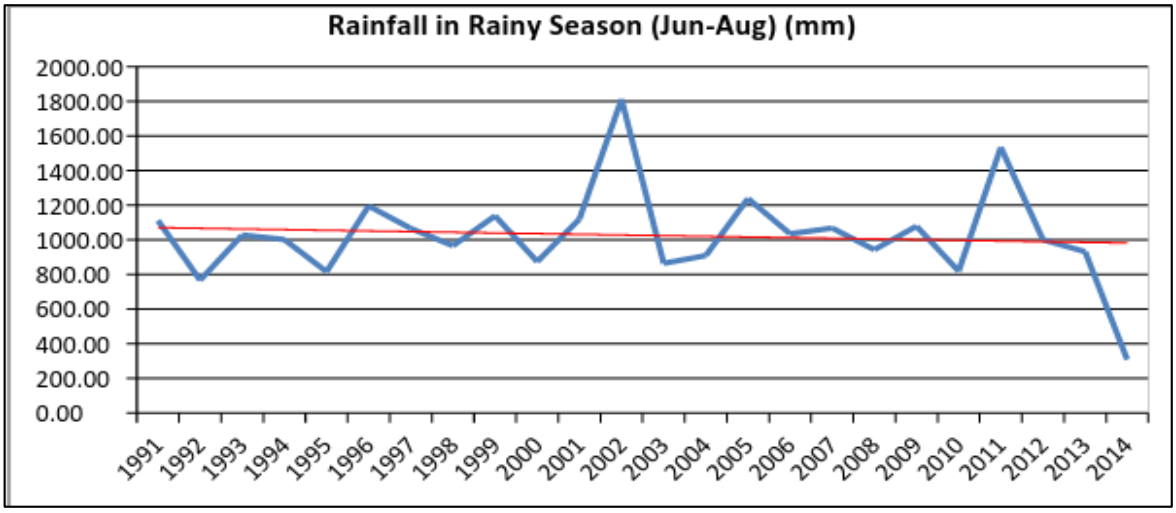

Figure 6: Rainfall in Rainy Season for Mongla City

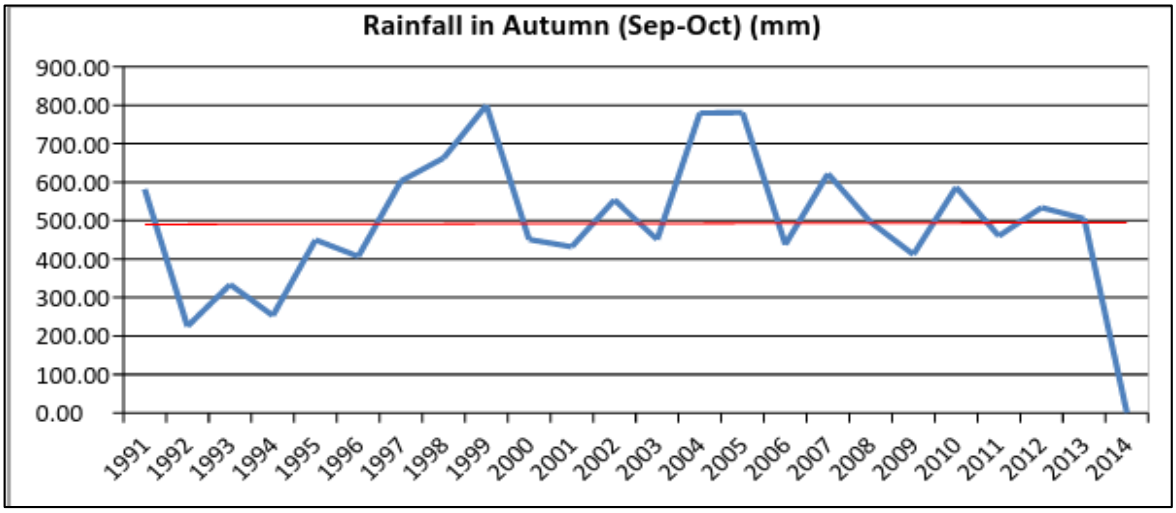

Figure 7: Rainfall in Autumn for Mongla City

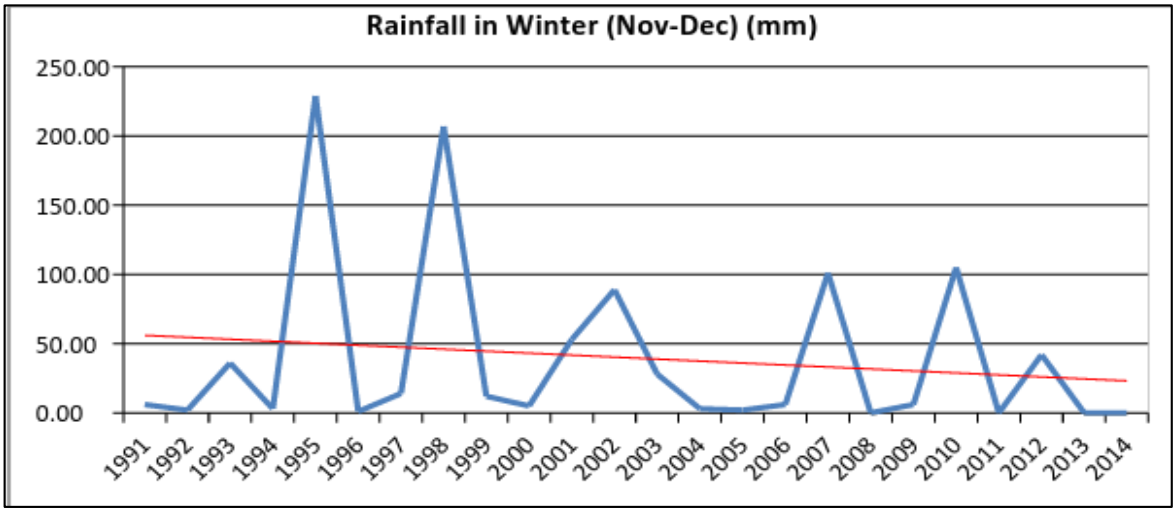

Figure 8: Rainfall in Winter for Mongla City

Annual average temperature is increasing (Figure 9) as is the annual maximum temperature (Figure 10). The annual minimum temperature on the other hand does not agree with the previous study[11] and shows a slight decrease of a minor order (Figure 11). It is important to recognise that this data has been collected specific to Mongla city.

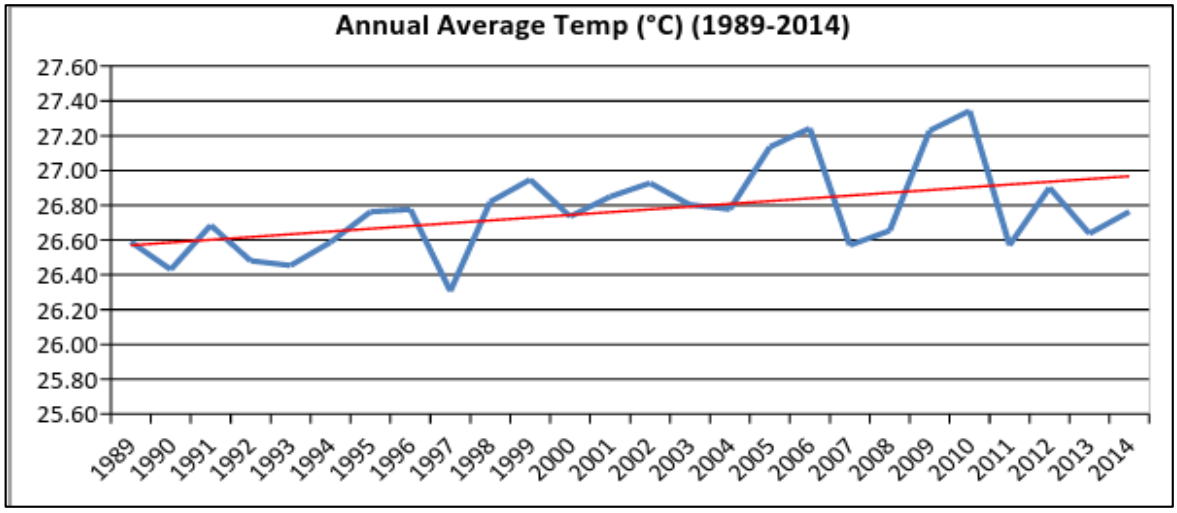

Figure 9: Annual Average Temperature for Mongla City

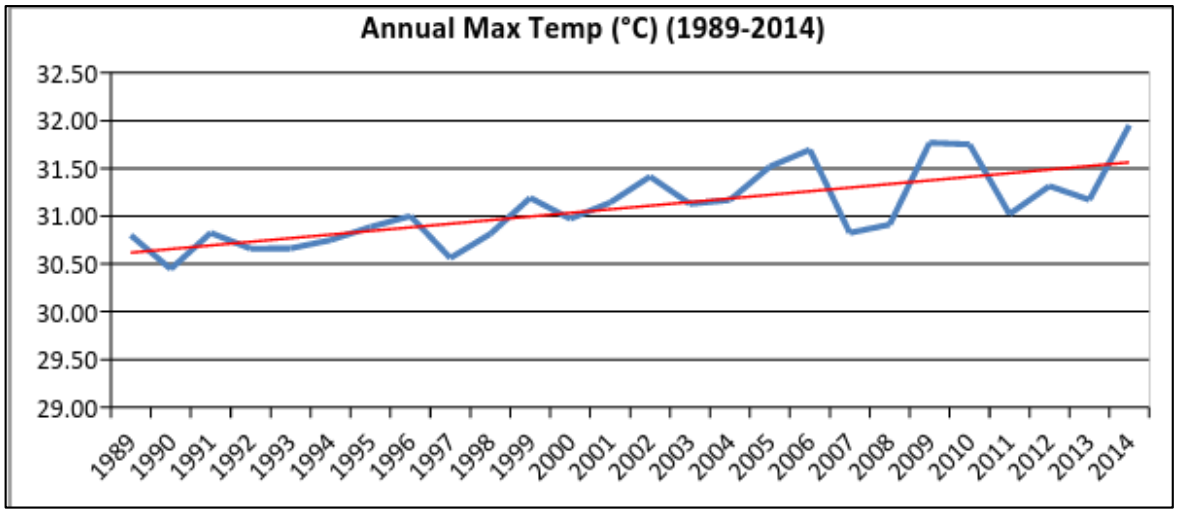

Figure 10: Annual Maximum Temperature for Mongla City

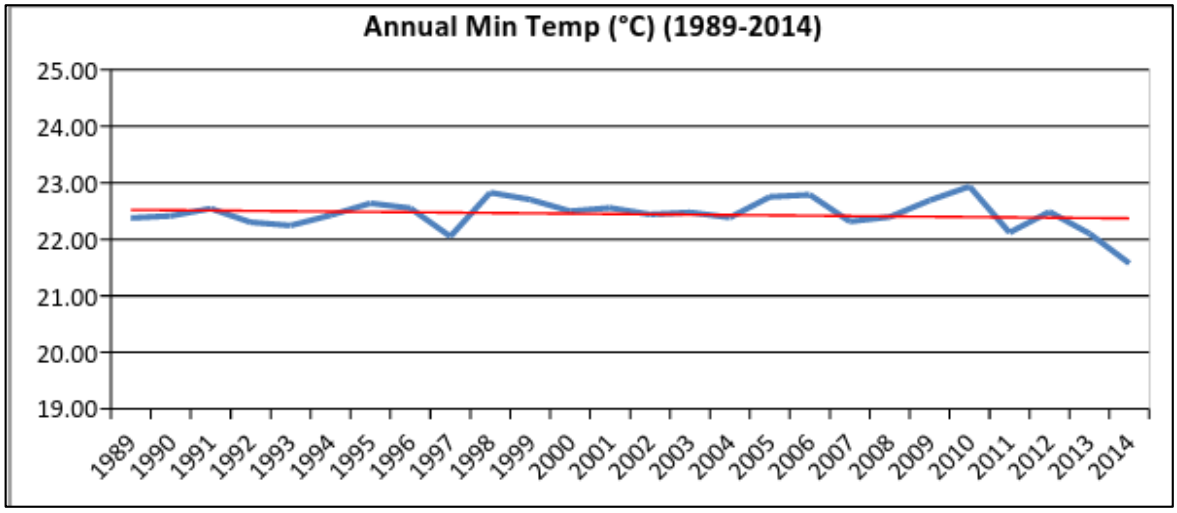

Figure 11: Annual Minimum Temperature for Mongla City

4.2 Climate Change Projections and Climate Scenario Statements

Although there is no dedicated literature available detailing climatic projections for various regions in Bangladesh, the National Plan for Disaster Management (2010-2015)[13] published by the Government of Bangladesh and the Vulnerability, Risk Reduction and Adaptation to Climate Change, Climate Risk and Adaptation Country profile, (2011) published by World Bank[14] is referred to. The National Plan for Disaster Management used a regional climate model PRECIS for Bangladesh.

Table 4: Climate Scenario Statement

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Precipitation change	National Assessment[13]	Pre-monsoon rainfall will decrease while monsoon and post-monsoon rainfall will increase. From 2051 onwards annual average rainfall and monsoon rainfall will follow a higher increasing trend.
	National Assessment[14]	There will be an increase in the amount of run-off, and rainfall intensity.
Temperature change	National Assessment[13]	The monthly average maximum temperature will increase during the monsoon period and will decrease in other periods. The monthly average minimum temperature will increase in all periods and the Annual Maximum and Minimum

[13]Government of Bangladesh. 2010. National Plan for Disaster Management, 2010 – 2015, Disaster Management Bureau Disaster Management & Relief Division, Government of Bangladesh

[14]The World Bank Group. 2011. Vulnerability, Risk Reduction and Adaptation to Climate Change. Climate Risk and Adaptation Country profile, Bangladesh. The World Bank Group, Global Facility for Disaster Reduction and Recovery, Climate Investment Funds.
http://sdwebx.worldbank.org/climateportal/countryprofile/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_BGD.pdf

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
		temperature will follow an increasing trend.
	National Assessment[14]	Mean temperatures across Bangladesh are projected to increase between 1.4°C and 2.4°C by 2050 and 2100, respectively.
Extreme events	National Assessment[13]	The frequency of tropical cyclones in the bay of Bengal may increase and, according to the Intergovernmental Panel on Climate Change's Third Assessment Report, there is "*evidence that the peak intensity may increase by 5% to 10% and precipitation rates may increase by 20% to 30%"* (IPCC 2001). Cyclone-induced storm surges are likely to be exacerbated by a potential rise in sea level of over 27cm by 2050.

Thus the climate risks as agreed upon by stakeholders were:

Climate risk 1: Increased temperature

Climate risk 2: Increase in rainfall intensity

Climate risk 3: Increase in the frequency of cyclones

5. CLIMATE IMPACT ASSESSMENT

Climate impact assessment of urban systems helps to assess their fragilities with respect to the climate impacts identified earlier. These urban systems could include **'core systems'** such as water, sewerage, transport which are essential for running the city and **'secondary systems'** such as health, education, sanitation which rely on the core systems. The urban system analysis in Mongla identified seven fragile urban systems through rigorous discussions in the SLDs:

(i) Water Supply
(ii) Transportation
(iii) Health System
(iv) Storm Water Drainage
(v) Solid Waste Management
(vi) Urban/Peri-Urban Agriculture/Animal Husbandry
(vii) Sanitation

The risks associated with the fragilities of these systems were calculated through a risk assessment exercise conducted by the Stakeholder Committee during the SLD. The fragile urban systems with the highest risks as per the assessment were investigated further.

5.1 Urban Systems Analysis

5.1.1 Water Supply

Situation Analysis

Salinity of drinking water is the biggest problem in Mongla. Ground-water is not potable at all. The municipality has set up a Water Treatment Plant which uses harvested rain water but supply coverage is only 50%. There is only one source of water supply, with no backup system. Rainwater harvesting is practised in 25% of households in the city. Municipality is taking up initiatives for rain water harvesting in on a large scale to close the gap in the potable water demand.

At present, however, there is a lack of control on use of water by citizens and there are several areas in the city that have no access to municipal supply of water. This results in health hazards due to use of non-potable or unsafe water by citizens.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Water Supply in Mongla, the urban fragility statement for this system is 'Water supply system is fragile because there is no source of water apart from rain water. The system is dependent on harvested rain water that is treated and supplied by municipality but cannot cover entire population.'

The climate fragility statements for this system are:

"Climate Risk 1: Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues."

"Climate Risk 2: As the system is dependent on rainfall, it will be impacted by shortage of rain."

"Climate Risk 3: System failures can occur due to flooding caused by cyclones and salinization of water reservoirs."

5.1.2 Transportation

Situation Analysis

The Roads and Highway department, Municipality, and LGED together share the responsibility of maintenance of roads in Mongla. There are 65 bridges in Mongla upazila which are made of iron, concrete and wood. Sluice gates are absent. 173 culverts which help the flow of canal water under the roads are present. There are 151 earthen, pucca and semi-pucca roads in the upazila. The length of these roads is about 551.60 km[15].

Road infrastructure, the temporary bridges or culverts get affected every year due to rapid flooding. Destruction of pitch roads occurs regularly due to excessive rain. Water transport in the river is affected by siltation and tides. Due to road infrastructure damage, there are serious impacts on local economy, access to hospitals, and access to schools.

[15]Area Development Organisation. 2014. Conduction and Developing Disaster Management Plan at Upazila Level. MonglaUpazila, Bagerhat. Implemented by Upazila Disaster Management Committee.Overall assisted by Comprehensive Disaster Management Program (CDMP), Ministry of Disaster Management and Relief.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Transportation in Mongla, the urban fragility statement for this system is 'Roads are easily destroyed due to excessive water logging or rainfall. Water transport is impacted by siltation. This impacts access to major service institutions (hospitals, schools) and also impacts economy.'

The climate fragility statement for this system is:

"Climate Risk 1: Destruction of roads will occur due to excess rainfall or cyclones. Furthermore food import that is dependent on water transport will be disrupted. This can create stress on economy and health."

5.1.3 Health System

Situation Analysis

The city's health systems are in a very poor condition in Mongla. There are no diagnostic facilities, no specialised care facilities and no primary health care facility in the city. There is one government near the city which caters to the citizens of Mongla. Because of the lack of facilities, specialist doctors are not available in Mongla. The frequency of vector borne diseases is increasing in the city and needs to be tackled.

The Municipality, the health department, and DPHE share responsibility of management of the health systems in the city.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Health in Mongla, the urban fragility statement for this system is 'Health system is fragile because there are no major hospitals or health care facilities, limiting access to safe health care.'

The climate fragility statements for this system are:

"Climate Risk 1: Increased temperature will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly.

"Climate Risk 2: Water logging can cause water borne diseases, skin diseases, increasing stress on facilities."

"Climate Risk 3: Malnutrition can occur due to effect of cyclones on import of food."

5.1.4 Storm Water Drainage

Situation Analysis

Mongla Port Municipality is responsible for the management of storm water drainage. Mongla city has no planned storm water drainage system. Existing drains are all uncovered and because of dumping of solid waste, they get clogged and create water logging issues. There are no secondary drains in the colonies. Few drains which exist are at levels lower than their outfall canals, which often lead to back flow of water, causing stagnation, odour, and health hazards. Vector borne diseases have become common in the city due to poor drainage conditions.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Storm Water Drainage in Mongla, the urban fragility statement for this system is ‘‘There is lack of planned drainage system and existing open drains are blocked due to solid waste and result in overflow and water logging, leading to health impacts.’

The climate fragility statements for this system are:

“Climate Risk 1: Odour pollution and health issues will increase due to higher temperatures.”

“Climate Risk 2: Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water pollution.”

5.1.5 Solid Waste Management

Situation Analysis

Mongla Port Municipality has no formal solid waste management system. As no door to door collection occurs, open dumping of solid waste is practised, where waste is dumped in low lying areas or in canals. The waste is collected from the secondary collection points and is dumped in an open dumping site on the bank of river. The collection is also not being operated in a systematic manner. The municipality lacks a treatment and disposal facility as well.

Lack of solid waste management results in pollution of the surrounding environment, enables the spread of vector borne diseases thus impacting health. It also impacts drainage and traffic since waste is dumped on roadsides or drains by citizens.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Solid Waste Management in Mongla, the urban fragility statement for this system is ‘There is no solid waste collection or treatment system. Open dumping causes problems in drainage systems, traffic congestion, and health issues.’

The climate fragility statement for this system is:

“Climate Risk 1: Water logging due to excess rain can spread solid waste on streets and cause health issues.”

5.1.6 Urban/Peri-Urban Agriculture/Animal Husbandry

Situation Analysis

Mongla city is rural in nature and a large part of the population is dependent on agriculture and fishery as a means of employment. These occupations are highly dependent on good climate conditions, and so are severely impacted in case of variation in rainfall. Agricultural activities are common in wards 1, 4, 9 and partly in 7.

Due to flooding during the cyclone event – Aila, the soil has become saline. Consequently, agricultural and other horticultural productivity have come down. Salinity of land and resultant agricultural loss has resulted in inflation and impacted the local economy. Although there is a

divisional office of the Agriculture Department of the Central Government present in the city, there is not much initiative taken so far in this sector.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Urban/Peri-Urban Agriculture/Animal Husbandry in Mongla, the urban fragility statement for this system is 'Economy that is based on ecosystems – agriculture, fishery, animal husbandry – are impacted by salinity of soil and variations in rainfall, harming local economy.'

The climate fragility statements for this system are:

"Climate Risk 1: Crops can get reduced due to lack of water because of greater demand on water due to high temperatures."

"Climate Risk 2: Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry."

5.1.7 Sanitation

Situation Analysis

There is no sewerage system in the city. There are no septic tanks in the city, and toilets are either closed with no outlets (pit latrines) or open in drains. Disposal of sewerage into drains leads to pollution of water bodies, and results in health hazards for the citizens.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Sanitation in Mongla, the urban fragility statement for this system is 'There are no proper toilets in majority of the wards in the municipality and no treatment facility. Toilets either open in drains/canals or are pit latrines with no outlets. This causes severe water pollution and health impacts.'

The climate fragility statements for this system are:

"Climate Risk 1: Excess rainfall or flooding can cause health impacts leading to loss of life and productivity."

"Climate Risk 2: Odour caused by higher temperatures due to lack of proper disposal of sewage."

The urban fragility statements and climate fragility statements are explained in Annexure 1.

5.2 Risk Assessment

The climate fragility statements are prioritized through a participatory assessment, during the SLD, based on the degree of risk that each expected climate impact poses for the identified fragile systems. The risk score for each climate fragility statement is defined as a combination of the likelihood of an event to occur and the consequences faced if the event occurred.

The risk scoring is detailed in Annexure 2. Table 5 shows the risk status of the climate fragility statements.

Table 5: Risk Assessment of Climate Fragility Statements

Urban System	Impacts of Climate Change	Risk Status
Water Supply	Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues.	Extreme
	As the system is dependent on rainfall, it will be impacted by shortage of rain.	Extreme
	System failures can occur due to flooding caused by cyclones and salinization of water reservoirs.	High
Transportation	Destruction of roads will occur due to excess rainfall or cyclones. Furthermore food import that is dependent on water transport will be disrupted. This can create stress on economy and health.	Medium
Health System	Increased temperatures will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly.	High
	Water logging can cause water borne diseases, skin diseases, increasing stress on facilities.	High
	Malnutrition can occur due to effect of cyclones on import of food.	High
Storm Water Drainage	Odour pollution and health issues will increase due to higher temperatures.	High
	Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water pollution.	High
Solid Waste Management	Water logging due to excess rain can spread solid waste on streets and cause health issues.	Extreme
Urban/Peri-Urban Agriculture/Animal Husbandry	Crops can get reduced due to lack of water because of greater demand on water due to high temperatures.	High
	Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.	Extreme
Sanitation	Excess rainfall or flooding can cause health impacts leading to loss of life and productivity.	Extreme
	Odour caused by higher temperatures due to lack of proper disposal of sewage.	High

Based on this risk assessment, almost all the fragile urban systems show extreme risks to high risks and must be prioritised immediately. The fragility statements which show medium risks (transportation) can be put on a lower priority.

6. VULNERABILITY ASSESSMENT

6.1 Overview

In order to build resilience there is a need to understand the extent of vulnerability of the city to climate change. This vulnerability depends upon the geographical location, demography,

infrastructure, socio economic condition, ecological condition of the city. The Intergovernmental Panel on Climate Change (IPCC, 2007)[16] defines vulnerability as a function of three parameters of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

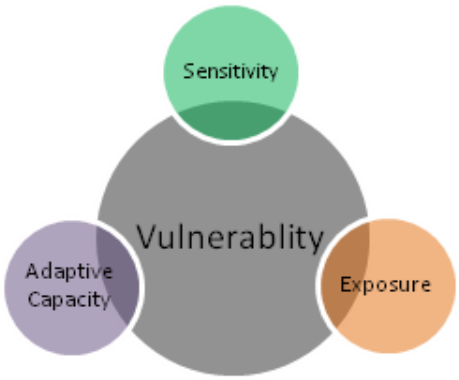

Figure 12: Vulnerability Constituents[16]

Vulnerability assessment through the IAP consists of identification of areas vulnerable to the identified climate risks and actors for all the prioritized climate fragility statements of the fragile urban systems and analysis of the adaptive capacities of the actors and the urban systems. Vulnerability assessment of Mongla city was carried out in consideration of the following elements:

1. **Identification of Vulnerable Places**: Areas that are highly vulnerable to the identified fragile urban systems of the city were identified and mapped to arrive at vulnerability hotspots affected by maximum number of fragile urban systems.

2. **Identification of Vulnerable actors and their adaptive capacity:** In each of the vulnerable areas, the actors that play a critical role towards building urban resilience were identified and assessed in terms of their capacity to organize and respond to threat or disruption, access to resources necessary for response (manpower, technology, funds) and access to information necessary to develop effective plans and actions and to improve responses to disruptions. These determine the adaptive capacity/resilience of the identified actors for a particular fragile system.

3. **Assessment of Adaptive Capacities of Urban Systems**: Adaptive capacity of urban systems is its capacity to absorb and respond to shocks that determines their resilience. The adaptive capacity was determined in the context of economy, technology/infrastructure, governance, social systems and ecosystems.

The sections below identify the vulnerable areas, vulnerable actors and adaptive capacity of the fragile urban systems using the Climate Fragility Statements developed in consultation with the Stakeholder Committee.

[16]IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Annex I., M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

6.2 Identification of vulnerable areas of Fragile Urban Systems

6.2.1 Water Supply: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues.	All wards (Figure 13)
As the system is dependent on rainfall, it will be impacted by shortage of rain.	
System failures can occur due to flooding caused by cyclones and salinization of water reservoirs.	

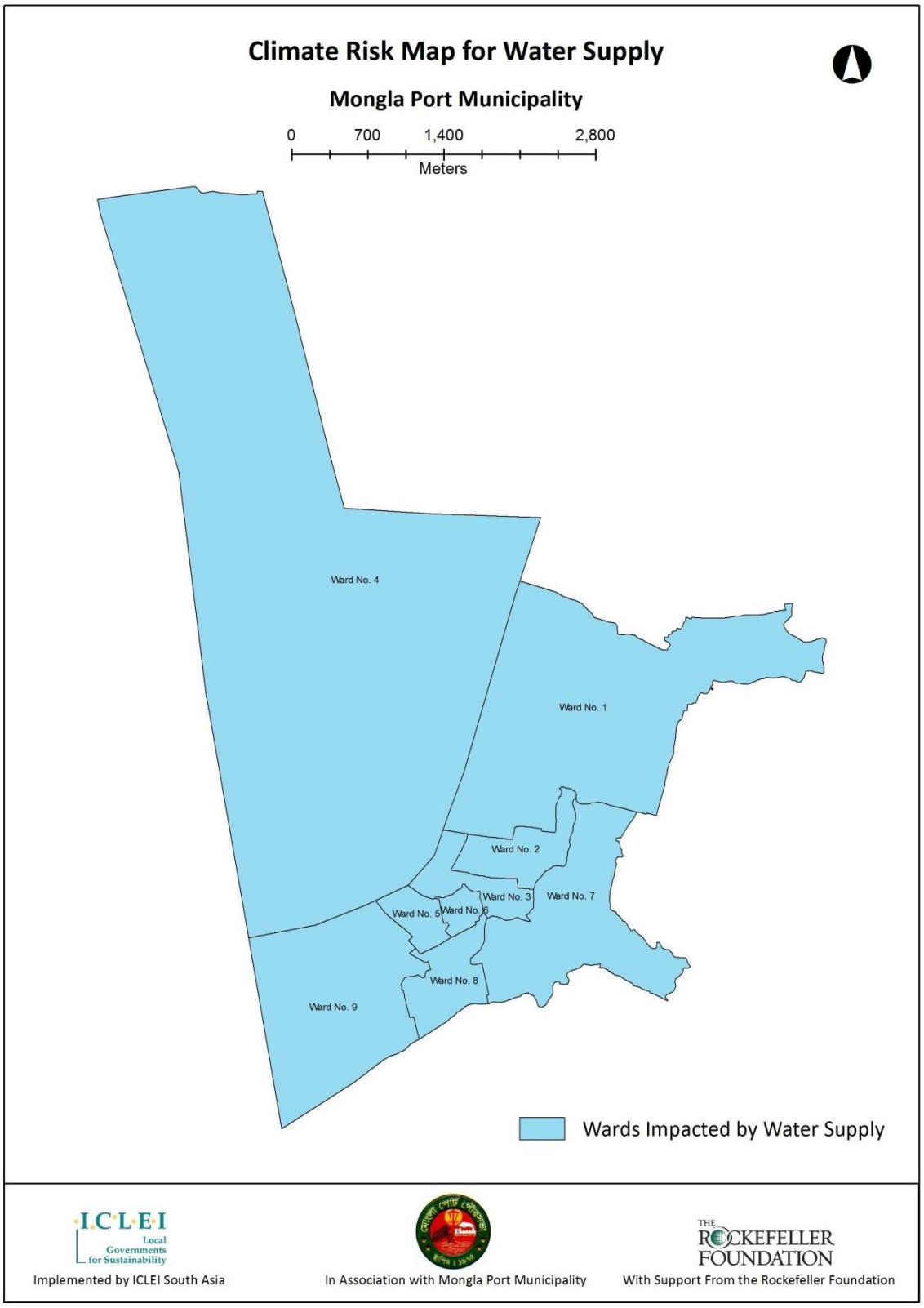

Figure 13: Wards most vulnerable to climate risks in the context of Water Supply, Mongla

6.2.2 Transportation: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Destruction of roads will occur due to excess rainfall or cyclones. Furthermore food import that is dependent on	All wards (Figure 14)

Climate Fragility Statements	Area/ward most vulnerable
water transport will be disrupted. This can create stress on economy and health.	

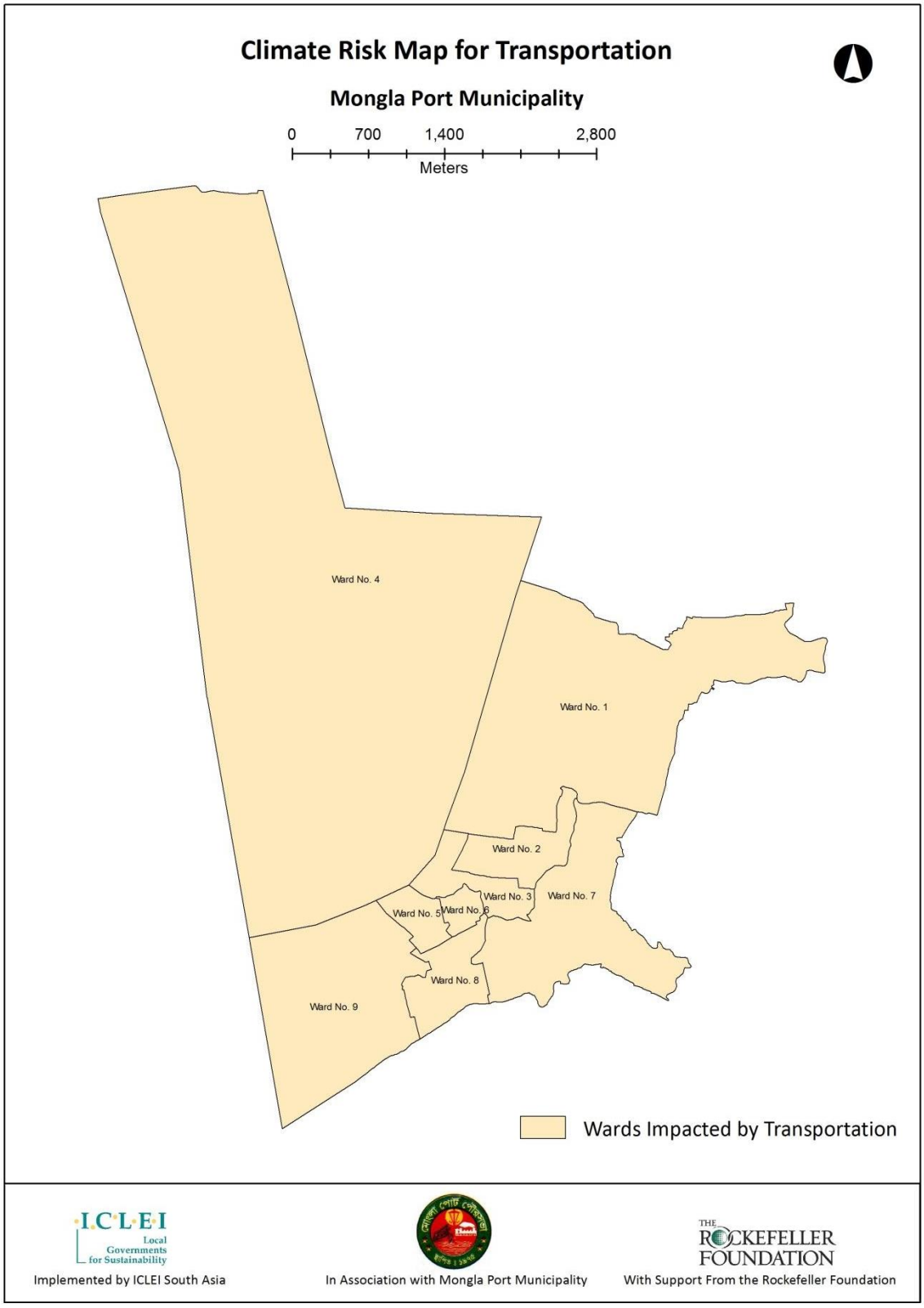

Figure 14: Wards most vulnerable to climate risks in the context of Transportation, Mongla

6.2.3 Health System: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperatures will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly.	Ward 1 and 2 border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala (Figure 15).
Water logging can cause water borne diseases, skin diseases, increasing stress on facilities.	
Malnutrition can occur due to effect of cyclones on import of food.	

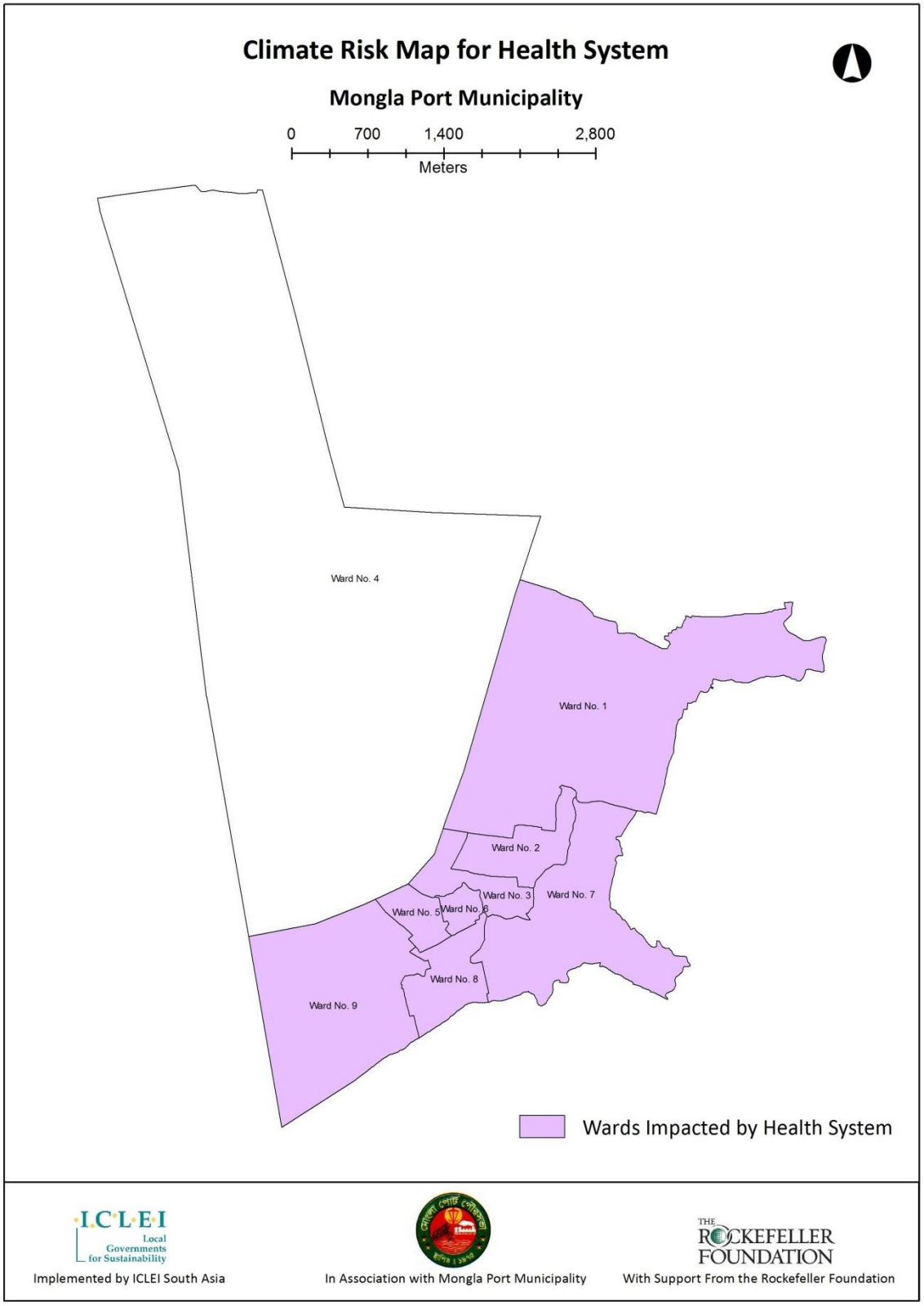

Figure 15: Wards most vulnerable to climate risks in the context of Health System, Mongla

6.2.4 Storm Water Drainage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Odour pollution and health issues will increase due to	Ward 1 and 2 Border - Miapara,

Climate Fragility Statements	Area/ward most vulnerable
higher temperatures.	Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Boajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala (Figure 16).
Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water pollution.	

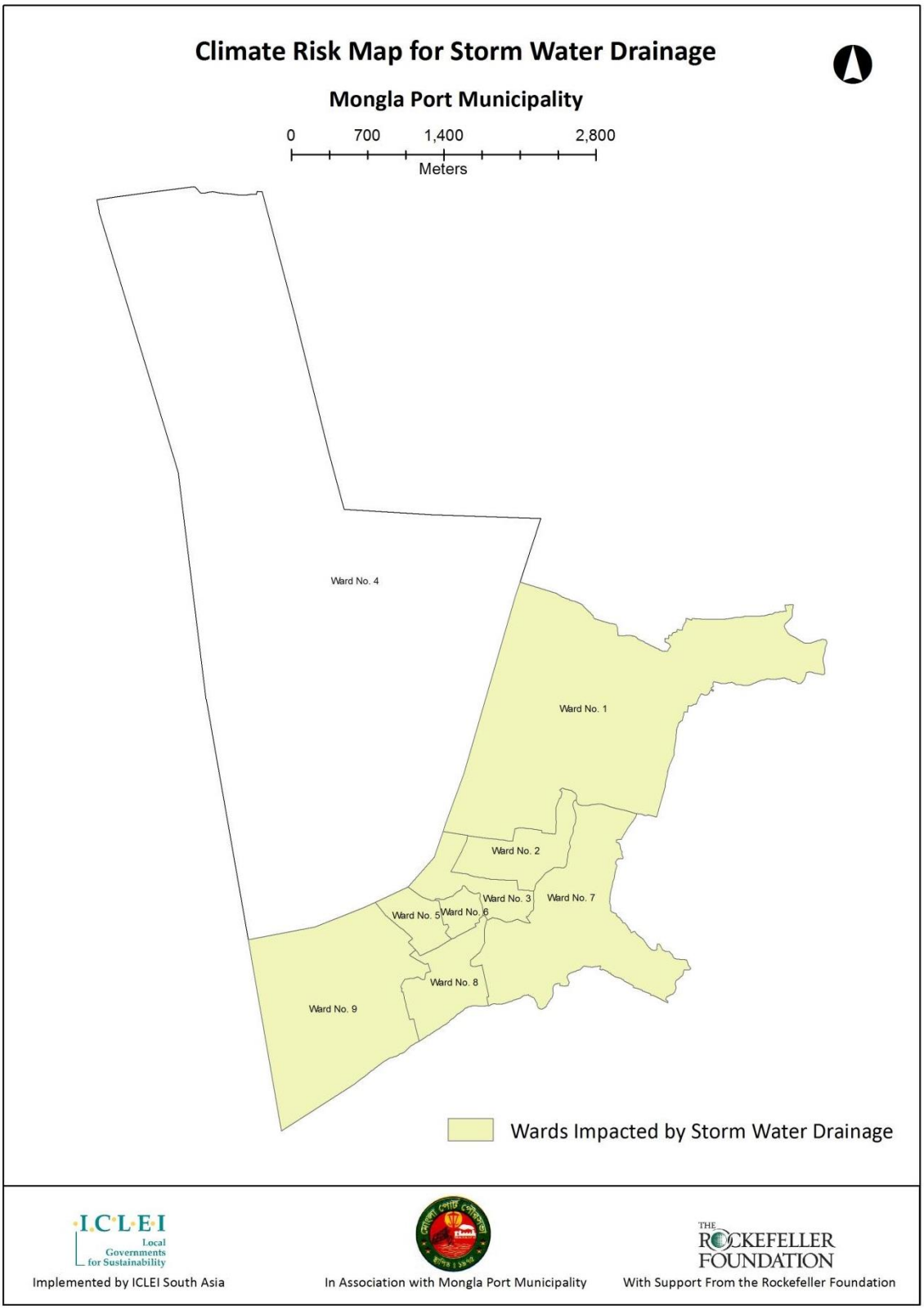

Figure 16: Wards most vulnerable to climate risks in the context of Storm Water Drainage, Mongla

6.2.5 Solid Waste Management: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Water logging due to excess rain can spread solid waste on	Ward – 3 (partly), 5, 6, 9 (Figure

Climate Fragility Statements	Area/ward most vulnerable
streets and cause health issues.	17).

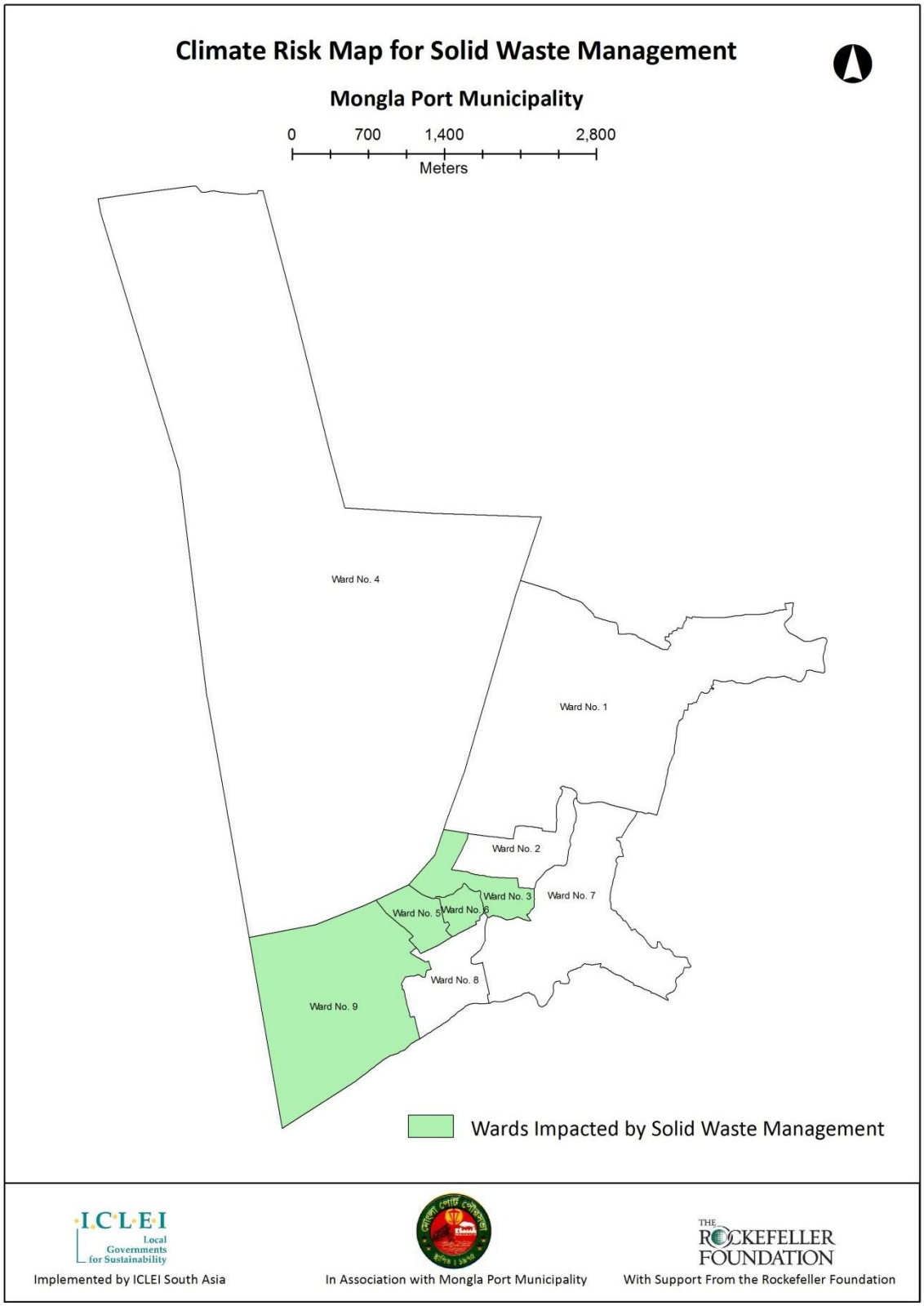

Figure 17: Wards most vulnerable to climate risks in the context of Solid Waste Management, Mongla

6.2.6 Urban/Peri-Urban Agriculture/Animal Husbandry: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Crops can get reduced due to lack of water because of greater demand on water due to high temperatures.	Ward – 1, 4, 7 (partly), 8, 9 (Figure 18)
Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.	

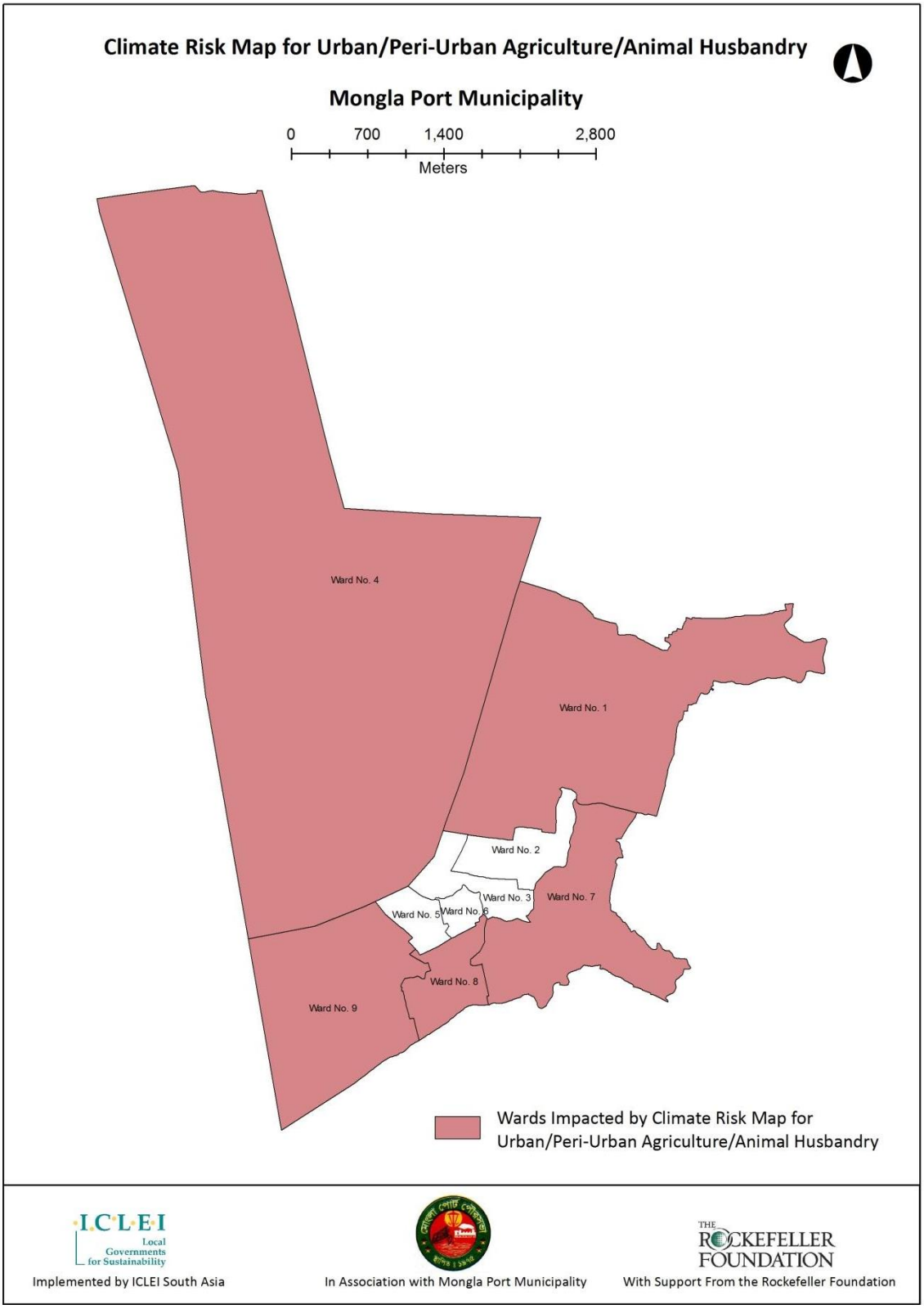

Figure 18: Wards most vulnerable to climate risks in the context of Urban/Peri-Urban Agriculture/Animal Husbandry, Mongla

6.2.7 Sanitation: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable

Excess rainfall or flooding can cause health impacts leading to loss of life and productivity.	Ward – 1 (partly), 2 (partly), 3 (partly), 5, 6, 9 (Figure 19)
Odour caused by higher temperatures due to lack of proper disposal of sewage.	

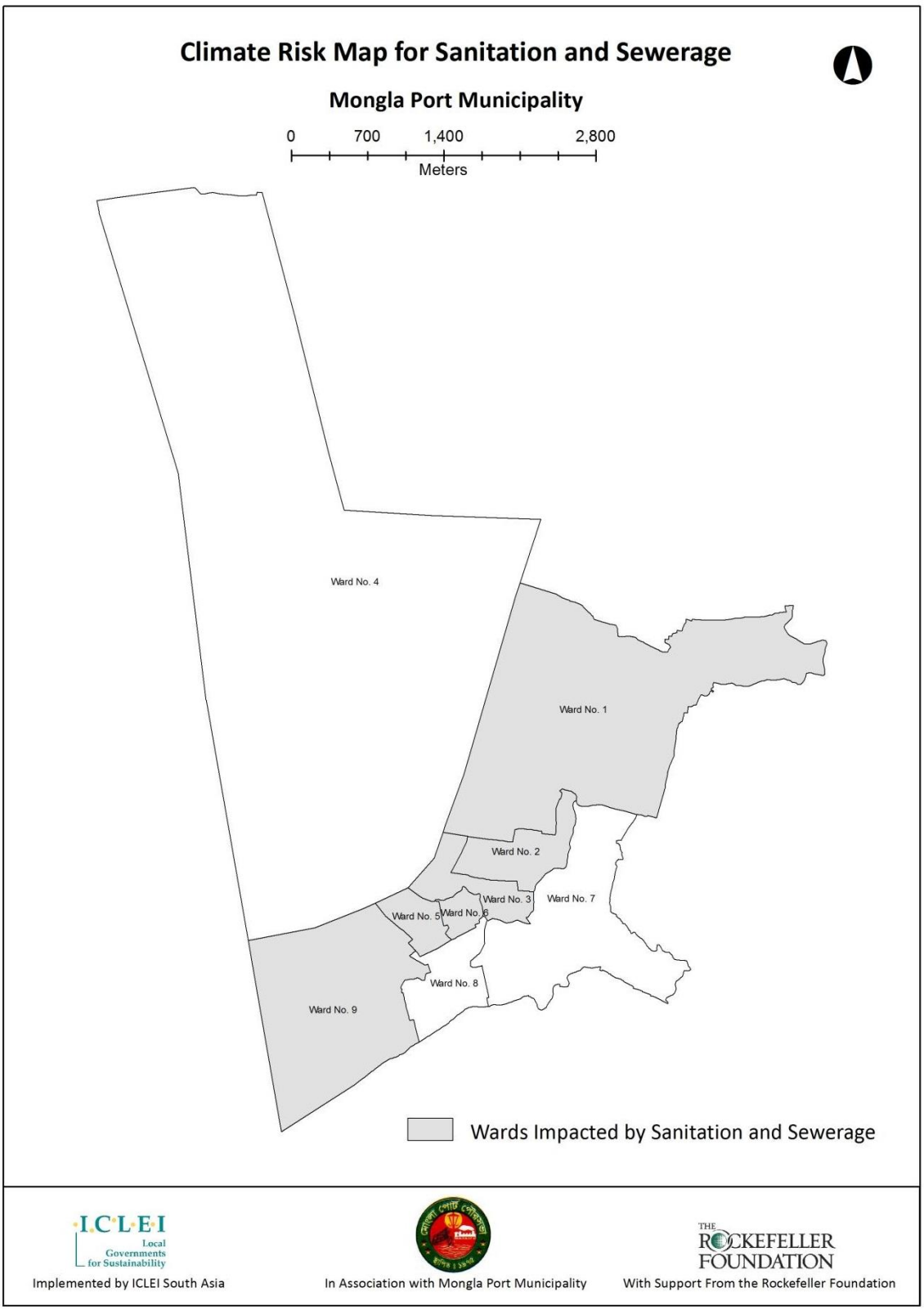

Figure 19: Wards most vulnerable to climate risks in the context of Sanitation and Sewerage, Mongla

Through these assessments, the area that was found to be most vulnerable is ward 9 which is vulnerable to all seven fragile urban systems, while ward 1, 3, 5 and 6 are vulnerable to six fragile urban systems. It is important to note that ward 9 is vulnerable to tidal influences and is downstream of two rivers therefore it is often flooded or water logged. Other wards 2, 7 and 8, are impacted by five fragile urban systems.

The Vulnerability hotspot map (Figure 20) helps to identify the wards which must be focused on for future interventions to build resilience that are identified in later chapters.

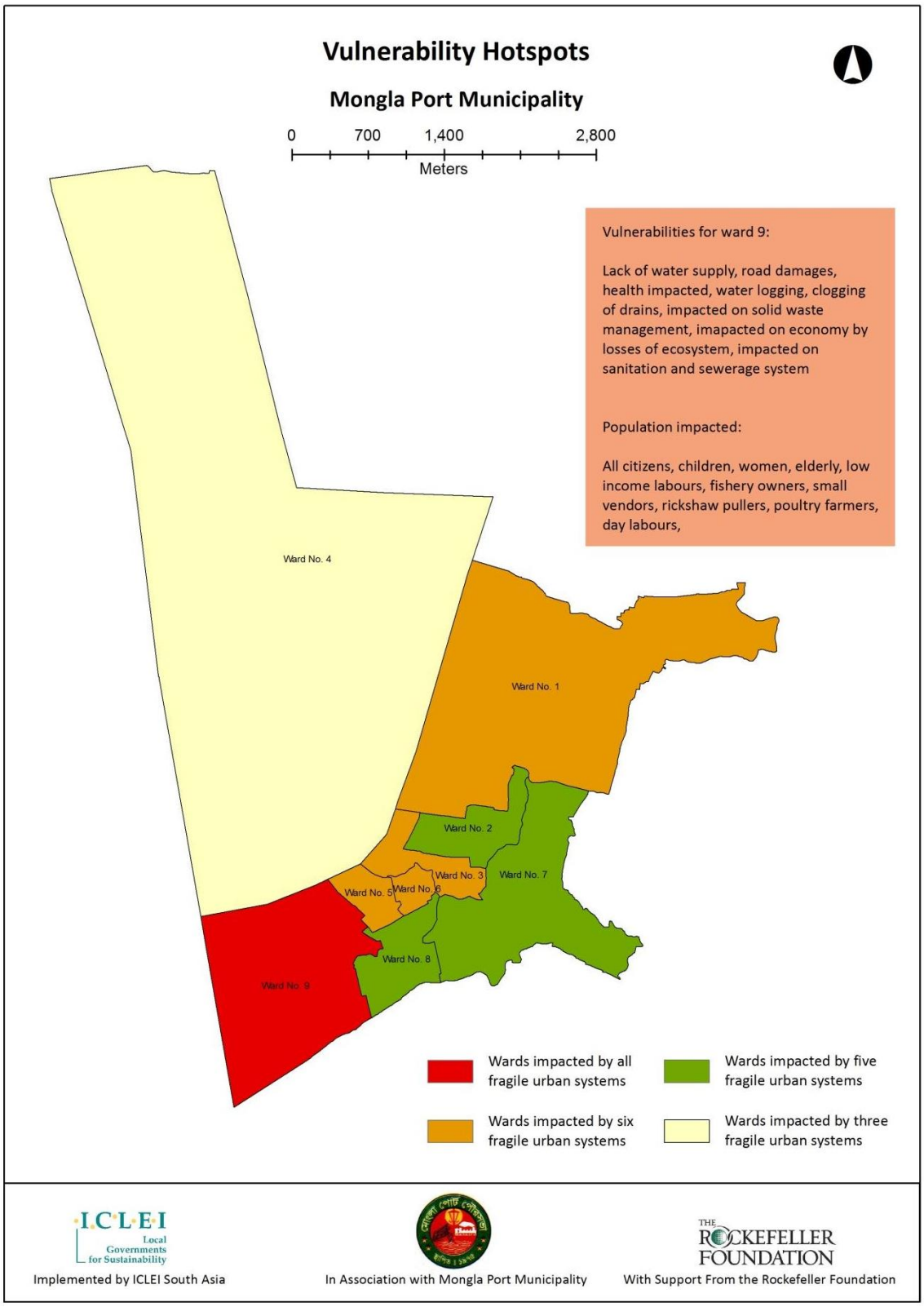

Figure 20: Consolidated Vulnerable Hotspots for Mongla city

6.3 Actor Analysis

Identification of actors and their level of adaptive capacities were carried out in a discussion among the Core Team in Mongla. The common citizens in Mongla seem to have low adaptive capacity, since they generally have low access to financial and technical resources for adaptation

although they may have access to information regarding impending disasters for which they would need to take action. Since cyclones and floods are common in the city, typically people are aware of what they need to do. However, they have serious financial constraints to take appropriate action to mitigate impacts of these disasters. This group includes farmers, fishermen, poultry farmers, small businessmen, daily wage labourers, etc. However, the farmers and fishermen who own land and businesses have sufficient financial resources to tide over disasters. The municipality has medium to high adaptive capacity, with good access to information regarding disasters but limited access to technical and financial resources, which limits their ability to respond to disasters appropriately. In the case of other federal government departments, there may be technical and financial resources available, but they may not necessarily be able to allocate such resources to appropriate locations when needed.

Table 6 gives the details of the adaptive capacity of the actors for each system.

Table 6: Analysis of the adaptive capacities of local actors identified

Fragile Urban System	**Climate Fragility Statements**	**Area/ward most vulnerable**	**Actors**	**Level of Adaptive Capacity**
Water Supply	Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues. As the system is dependent on rainfall, it will be impacted by shortage of rain. System failures can occur due to flooding caused by cyclones and salinization of water reservoirs.	All wards	Low income group	Low
			Middle income group	Low
			NGOs	Low
			Mongla Port Municipality	Medium
			Mongla Port Authority	Low
			Children	Low
			Farmer	Low
			Fishermen	Low
			Poultry farmers	Low
Transportation	Destruction of roads will occur due to excess rainfall or cyclones. Furthermore food import that is dependent on water transport will be disrupted. This can create stress on economy and health.	All wards	Low income group	Low
			Middle income group	Low
			Mongla Port Municipality	High
			Transport Department	Medium
			Mongla Port Authority	Medium
			Children	Low
			Farmer	Low
			Fishermen	Low
			Poultry farmers	Low

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
			Elderly	Low
			Small businessmen	Low
			Daily wage labour class	Low
			Small vendors	Low
			Residents	Low
Health	Increased temperatures will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly. Water logging can cause water borne diseases, skin diseases, increasing stress on facilities. Malnutrition can occur due to effect of cyclones on import of food.	Ward 1 and 2 border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower	Low income group	Low
			Middle income group	Low
			Children	Low
			Elderly	Low
			Municipality	Medium
			Health department	High
			Port authority hospital	Medium
			St. Pauls hospital	Low
			Private clinics	Low
			Paribarik Shastha Clinic	Low

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
		Kewratala		
Storm Water Drainage	Odour pollution and health issues will increase due to higher temperatures. Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water pollution.	Ward 1 And 2 Border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala	Residents	Low
			Municipality	High
			Small vendors	Low
			Small businessmen	Low
			Daily wage labour class	Low
Solid waste management	Water logging due to excess rain can spread solid waste on streets and cause health issues.	Ward – 3 (partly), 5, 6, 9	Low income group	Low
			Middle income group	Low
			Municipality	Medium

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
			Children	Low
			Elderly	Low
Urban/Peri-Urban Agriculture/ Animal Husbandry	Crops can get reduced due to lack of water because of greater demand on water due to high temperatures. Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.	Ward – 1, 4, 7 (partly), 8, 9	Farmer	Low
			Fishermen	Medium
			Poultry farmer	Medium
			Agriculture department	Medium
			Fishery department	Medium
			Irrigation department	Low
			Daily wage labourer	Low
			Municipality	Medium
Sanitation	Excess rainfall or flooding can cause health impacts leading to loss of life and productivity. Odour caused by higher temperatures due to lack of proper disposal of sewage.	Ward – 1 (partly), 2 (partly), 3 (partly), 5, 6, 9	Low income group	Low
			Middle income group	Low
			Children	Low
			Elderly	Low
			Sanitation department of Municipality	High

6.4 Adaptive Capacity of Fragile Urban Systems

The adaptive capacities of the seven fragile urban systems were assessed during the SLD against the five parameters of economy, technology, governance, societal and ecosystem services (Table 7). The municipality has access to some funds for taking up work on the various urban systems, has the support of citizens and robust ecosystem services to adapt to the impacts. There is political stability and policies are in place for most of the urban systems and adaptive capacity varies between medium to high in this regard except in the case of the urban peri-urban agriculture and sanitation where there is no leadership shown. However, there is need to build technological and infrastructural support for the sanitation system including that of solid waste management to increase their adaptive capacity.

Table 7: Consolidated vulnerability analysis of Fragile Urban Systems identified for Mongla

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
Water Supply	Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues. As the system is dependent on rainfall, it will be impacted by shortage of rain. System failures can occur due to flooding caused by cyclones and salinization of water reservoirs.	All Wards	- Low income group - Middle income group - NGOs - Mongla Port Authority - Children - Farmer - Fishermen - Poultry farmers	- Mongla Port Municipality		- Economic - Technology/Infrastructure - Governance	- Societal - Ecosystem Services
Transportation	Destruction of roads will occur due to	All Wards	- Middle income	- Mongla Port Municipality		- Economic - Governance	- Technology /Infrastruct

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	excess rainfall or cyclones. Furthermore food import that is dependent on water transport will be disrupted. This can create stress on economy and health.		group - Low income group - Children - Farmer - Fishermen - Poultry farmers - Elderly - Small businessmen - Daily wage labour class - Small vendors - Residents	- Mongla Port Authority - Transport Department		- Ecosystem Services	ure - Societal
Health	Increased temperatures will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly. Water logging can cause water borne diseases, skin diseases,	Ward 1 And 2 Border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony,	- Low income group - Middle income group - Children - Elderly - St. Pauls hospital - Private clinics - ParibarikShastha Clinic	- Municipality - health department - Port authority hospital		- Economic - Ecosystem Services	- Governance - Technology /Infrastructure - Societal

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	increasing stress on facilities. Malnutrition can occur due to effect of cyclones on import of food.	Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala					
Storm Water Drainage	Odour pollution and health issues will increase due to higher temperatures. Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water	Ward 1 And 2 Border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony,	- Residents - Small vendors - Small businessmen - Daily wage labour class	- Municipality		- Economic - Ecosystem Services - Governance - Technology/Infrastructure	- Societal

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	pollution.	Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala					
Solid waste management	Water logging due to excess rain can spread solid waste on streets and cause health issues.	Ward – 3 (partly), 5, 6, 9	- Low income group - Middle income group - Children - Elderly	- Municipality	- Technology/Infrastructure - Governance	- Economic	- Societal - Ecosystem Services
Urban/Peri-Urban Agriculture/Animal Husbandry	Crops can get reduced due to lack of water because of greater demand on water due to high temperatures.	Ward – 1, 4, 7 (partly), 8, 9	- Farmer - Irrigation department - Daily wage labourer	- Fishermen - Poultry farmer - Agriculture department		- Economic - Governance	- Technology /Infrastructure - Ecosystem Services

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.			- Fishery department - Municipality			- Societal
Sanitation	Excess rainfall or flooding can cause health impacts leading to loss of life and productivity. Odour caused by higher temperatures due to lack of proper disposal of sewage.	Ward – 1 (partly), 2 (partly), 3 (partly), 5, 6, 9	- Low income group - Middle income group - Children - Elderly	- Sanitation department of Municipality	- Technology/Infrastructure - Governance	- Economic	- Ecosystem Services - Societal

7. RESILIENCE INTERVENTIONS

Possible adaptation interventions were identified for the seven fragile urban systems in Mongla on the basis of their climate risks and vulnerabilities, the vulnerable areas and the vulnerable actors to adapt to the possible impacts of climate change on these systems. Once the interventions were determined, their resilience score was calculated as high, medium, average and low on the basis of their resilience potential assessed in terms of their redundancy, flexibility, responsiveness and ability to increase access to information. If the interventions improved only one indicator mentioned above, their score was low, if they addressed two, their score was average, if they addressed three, their score was medium and if they addressed all four, their score was high. The climate resilience interventions were also assessed qualitatively for their technical, financial and political feasibility. The overall feasibility was calculated as an average of the qualitative feasibility for all three indicators. Finally their impact on the overall resilience of the city (short, medium or long term) was considered to assess the average time taken for the impacts to be felt on the resilience of the city.

These interventions were linked to existing city plans and schemes so as to determine whether the required interventions can be integrated with little or no additional resources into existing departmental programs or projects.

A total of 25 resilience interventions have been identified in the process as listed in **Table 8.** The interventions are grouped by fragile urban system and as infrastructural or non-infrastructural measures. The overall resilience score, overall feasibility and impact on the resilience of the city is given in the table. The table also gives an indicative duration for implementing the intervention as short (0-3 years needed), medium (3-5 years needed) or long term (more than 5 years needed) and an indicative cost requirement for the intervention as high (requiring substantial financial support), medium (requiring partial financial support) or low (can be covered by city budget). Each intervention's possible co-benefits are also outlined in the table.

Table 8: Prioritised Resilience Interventions against Resilience Indicators

Prioritised Interventions	Overall Resilience Score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Water Supply						
Policy/ Non-Infrastructural Measures						
Awareness building activities on accessing and using safe water during floods.	High	High	Long term	Short	Low	Can be used for other systems together
Infrastructural Measures						
Rain Water Harvesting - Implementation of a rainwater harvesting program for the storage of rainwater in surface (public) ponds/tanks and recharging ground water where appropriate. The Municipality can also encourage citizens to apply this rainwater harvesting program in their building rooftops for both potable and non-potable usage.	Medium	High	Long term	Short	Low	Improve soil conditioning, green area development
Establishment of a surface (river) water treatment plant. The plant should be situated in a location where it will remain safe during cyclones or any disaster.	High	Medium	Short term	Short	High	Improve health
Transportation						
Infrastructural Measures						
During construction of drains, appropriate height of drains need to be maintained so that they are at a lower level from the roads to prevent water logging of roads	Average	High	Short term	Short	Low	Improved drainage

Prioritised Interventions	Overall Resilience Score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Durable construction materials to be used in road laying protecting against salinity and sea erosion.	Average	Medium	Short term	Short	High	Better roads is linked to better economy in the long run
Health						
Policy/ Non-Infrastructural Measures						
Awareness building programs for residents, community groups and health practitioners through workshops, seminars, and school programs, ward level visit and campaigns wherein health risks due to climate change and adaptation responses could be discussed. IEC materials such as publications, leaflets, posters, could be created. These programs would be implemented by NGOs and health institutions with initiatives and leads taken by the ULBs like the Municipality, Medical Institutions, and DPHE etc.	High	High	Long term	Short	Low	Can be used for other systems together
Preparation of a health emergency response plan jointly by the municipality and City Hospitals to respond to climate and disaster emergency events. This may include – regular drill/practice sessions with local emergency response organizations, staff specific emergency situation guidelines, containment of risks,	High	Medium	Long term	Short	Medium	

Prioritised Interventions	Overall Resilience Score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
check lists for post emergency situation and treatment etc.						
Infrastructural Measures						
Provision of resilient health care infrastructure – building hospitals at elevated locations, with facilities to meet challenges of water related and heat related diseases and stresses	High	Medium	Short term	Short	High	
Storm water drainage						
Policy/ Non-Infrastructural Measures						
Build awareness among the citizens aimed at bringing about a behavioural change and ensure that dumping waste in the open and in drains is not carried out. Education programs can be undertaken which must be aimed at encouraging children to share the learning with families.	High	High	Long term	Short	Low	Can be used for other systems together
Infrastructural Measures						
Regular maintenance of drains	Average	High-medium	Short term	Short	High	Improved health
Augmentation of drainage network	Medium	Medium-low	Long term	Medium	High	Improved health
Conservation of Water Reservoirs	Medium	Medium-low	Medium term	Medium	High	Improved health, better soil conditions, green area

Prioritised Interventions	Overall Resilience Score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
						development
Solid Waste Management						
Policy/ Non-Infrastructural Measures						
Awareness building programs should be undertaken with the help of local partners and NGOs. These programs would be consisting of spreading information and awareness regarding Hygiene, the 3Rs, and so on. This can be integrated into school curriculum across the city.	High	High	Long term	Short	Low	Can be used for other systems together
Training for municipal staff on safety and waste handling procedures, and proper use and maintenance of equipment.	High	High	Short term	Short	Medium	
Development of an Integrated Solid Waste Management Plan for the city.	High	High	Long term	Short	High	
Infrastructural Measures						
Setting up of a monitoring and complaint centre	Medium	Medium	Short term	Short	High	Improved governance
Urban/Peri-Urban Agriculture/Animal Husbandry						
Policy/ Non-Infrastructural Measures						
Coordination with the fisheries/agriculture sector departments to develop climate resilient varieties.	Medium	High	Long term	Medium	High	Improve livelihood for farmers and fishermen
Infrastructural Measures						
Construction of flood protection	Average	Low	Short term	Medium	High	

Prioritised Interventions	Overall Resilience Score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
embankments on river banks. Tree plantations on the embankments would also reduce the risk from cyclones						
Sanitation						
Policy/ Non-Infrastructural Measures						
Increase monitoring and supervision for usage of safe and well designed sanitary latrines by all and encourage people not to connect their latrine outlets with open drains or any ponds and canals. Mongla Port Municipality could publish a regulatory notice mentioning a penalty or fine if any open linkage is found. DPHE can be engaged for joint monitoring.	Average	High	Medium term	Short	Medium	Cleaner rivers can lead to better fish production, improved health; penalties can generate municipal revenue
Awareness building and Education programmes on sanitary latrines and the harmful effects of linking septic tank outlets with open drains.	High	High	Long term	Short	Low	Can be used for other systems together
Guidelines on septic tank construction	High	High	Long term	Short	Low	
Infrastructural Measures						
Decoupling septic tank outlets from storm water drains	Average	Low	Short term	Short	Low	Penalties can generate municipal revenue

7.1 Integration into city plans

The government of Bangladesh has proposed a project to set up two Indian economic zones at Mongla and Bheramara in Kushtia at an estimated cost of $ 88 million, aiming to boost FDI inflow. Bangladesh Economic Zone Authority (BEZA) under the Prime Minister's Office will implement the proposed project by June 2017[17].

A summary of the issues, climate impacts, vulnerable areas and resilience actions sector-wise is given below.

Water Supply

Issues:	● No source of water apart from rainwater ● The system is dependent on harvested rainwater that is treated and supplied by municipality but cannot cover the entire population	
Potential Climate Impacts:	● Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues. ● As the system is dependent on rainfall, it will be impacted by shortage of rain. ● System failures can occur due to flooding caused by cyclones and salinization of water reservoirs.	
Potentially Impacted Areas:	All wards	
Risk Status:	Extreme	
Actors:	Vulnerable - Low income group - Middle income group - NGOs - Mongla Port Authority - Children - Farmer - Fishermen - Poultry farmers	Supporting - Mongla Port Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Policy and Institutional Measures		
Awareness building activities on accessing and using safe water during floods.	Cost of IEC materials, publication costs, trainings, meetings, logistics	USD 3000 per drive
Infrastructural Measures		
Rain Water Harvesting - Implementation of a rainwater harvesting program for the storage of rainwater in surface (public) ponds/tanks and	Civil and construction costs, labour, equipments, materials, staff costs, training, meetings	USD 10000 per unit

[17] http://en.prothom-alo.com/economy/news/82859/2-Indian-economic-zones-to-be-set-up-in-Kushtia

Type of Measures	Cost per unit and description	Cost estimate
recharging ground water where appropriate. The Municipality can also encourage citizens to apply this rainwater harvesting program in their building rooftops for both potable and non-potable usage.		

Transportation

Issues:	● Roads are easily destroyed due to excessive water logging or rainfall ● Water transport is impacted by siltation	
Potential Climate Impacts:	● Destruction of roads will occur due to excess rainfall or cyclones. Furthermore food import that is dependent on water transport will be disrupted. This can create stress on economy and health.	
Potentially Impacted Areas:	All wards	
Risk Status:	Medium	
Actors:	**Vulnerable** - Middle income group - Low income group - Children - Farmer - Fishermen - Poultry farmers - Elderly - Small businessmen - Daily wage labour class - Small vendors - Residents	**Supporting** - Mongla Port Municipality - Mongla Port Authority - Transport Department

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Infrastructural Measures		
During construction of drains, appropriate height of drains need to be maintained so that they are at a lower level from the roads to prevent water logging of roads	Planning costs, material, equipments, labour, staff costs, training, meetings	A detailed project report needs to be prepared to estimate costs of construction.

Health

Issues:	● Health system is fragile because there are no major hospitals or health care facilities limiting access to safe health care.

Potential Climate Impacts:	● Increased temperatures will cause stress on existing infrastructure to meet heat related health disorders which will disproportionately affect children and the elderly. ● Water logging can cause water borne diseases, skin diseases, increasing stress on facilities. ● Malnutrition can occur due to effect of cyclones on import of food.	
Potentially Impacted Areas:	Ward 1 and 2 border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Bajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala	
Risk Status:	High	
Actors:	Vulnerable - Low income group - Middle income group - Children - Elderly - St. Pauls hospital - Private clinics - Paribarik Shastha Clinic	Supporting - Municipality - health department - Port authority hospital

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Policy and Institutional Measures		
Preparation of a health emergency response plan jointly by Municipality RCC and City Hospitals to respond to climate and disaster emergency events. This may include – regular drill/practice sessions with local emergency response organizations, staff specific emergency situation guidelines, containment of risks, check lists for post emergency situation and treatment etc.	Meetings, training, planning cost, staff costs, logistics	USD 15000 to formulate plan
Infrastructural Measures		
Provision of resilient health care infrastructure – building hospitals at elevated locations, with facilities	Civil and construction costs, equipments, materials, staff costs, trainings	A detailed project report needs to be prepared to estimate

Type of Measures	Cost per unit and description	Cost estimate
to meet challenges of water related and heat related diseases and stresses		costs.

Storm Water Drainage

Issues:	● Lack of planned drainage system ● Existing open drains are blocked due to solid waste ● Overflow and water logging	
Potential Climate Impacts:	● Odour pollution and health issues will increase due to higher temperatures. ● Since there are no secondary drains, excessive rainfall and flooding due to cyclones can cause water logging leading to water borne diseases due to water pollution.	
Potentially Impacted Areas:	Ward 1 And 2 Border - Miapara, Meser Shah Sarak, Shere Bangla Road, Ghiasuddin Sadak; Ward 3 – Halim Sadak, Link Road of Moser Sadak; Ward 6 - Ratarati Colony, Notun Colony, Hotat Colony, Kosai Colony, Silaiwala Colony; Ward 5 - Press Club Road, Mach Bajar Road, Kacha Boajar Road, Somokollan Road, Power House Road, Balur Math; Ward 7- Moser Sadak; Ward 8 - Muslim Colony, Zia Sadak, Rudra Mohammad, Sahidullah Sadak; Ward 9 - Signal Tower Kewratala	
Risk Status:	High	
Actors:	**Vulnerable** - Residents - Small vendors - Small businessmen - Daily wage labour class	Supporting - Municipality

Type of Measures	Cost per unit and description	Cost estimate
Policy and Institutional Measures		
Build awareness among the citizens aimed at bringing about a behavioural change and ensure that dumping waste in the open and in drains is not carried out. Education programs can be undertaken which must be aimed at encouraging children to share the learning with families.	Cost of IEC materials, publication costs, staff costs, training, meetings, logistics	USD 3000 per awareness drive
Infrastructural Measures		
Regular maintenance of drains	Per km costs of staff, materials, repair	USD 2500 per km of drains

Solid Waste Management

Issues:	● There is no solid waste collection or treatment system. ● Open dumping causes problems in drainage systems, traffic congestion, and results in health issues	
Potential Climate Impacts:	● Water logging due to excess rain can spread solid waste on streets and cause health issues.	
Potentially Impacted Areas:	Ward – 3 (partly), 5, 6, 9	
Risk Status:	Extreme	
Actors:	**Vulnerable** - Low income group - Middle income group - Children - Elderly	Supporting - Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Policy and Institutional Measures		
Development of an Integrated Solid Waste Management Plan for the city.	Cost of consultants, trainings, meetings, logistics	USD 15000 for development of plan
Infrastructural Measures		
Setting up of a monitoring and complaint centre	Cost of equipments, materials, staff training, response team trainings, policy development	A detailed project report needs to be prepared to estimate costs

Urban/Peri-Urban Agriculture/Animal Husbandry

Issues:	● Economy that is based on ecosystems – agriculture, fishery, animal husbandry – are impacted by salinity of soil and variations in rainfall, harming local economy	
Potential Climate Impacts:	● Crops can get reduced due to lack of water because of greater demand on water due to high temperatures. ● Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.	
Potentially Impacted Areas:	Ward – 1, 4, 7 (partly), 8, 9	
Risk Status:	Extreme	
Actors:	**Vulnerable** - Farmer - Irrigation department - Daily wage labourer	Supporting - Fishermen - Poultry farmer - Agriculture department - Fishery department - Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Infrastructural Measures		
Construction of flood protection embankments on river banks. Tree plantations on the embankments would also reduce the risk from cyclones	Cost of materials, equipments, labour, planning, meetings, trainings	A detailed project report is needed to estimate costs

Sanitation

Issues:	● There are no proper toilets in majority of the wards in the municipality and no treatment facility. ● Toilets either open in drains/canals or are pit latrines with no outlets. ● Severe water pollution and health impacts.	
Potential Climate Impacts:	● Excess rainfall or flooding can cause health impacts leading to loss of life and productivity. ● Odour caused by higher temperatures due to lack of proper disposal of sewage.	
Potentially Impacted Areas:	Ward – 1 (partly), 2 (partly), 3 (partly), 5, 6, 9	
Risk Status:	Extreme	
Actors:	**Vulnerable** - Low income group - Middle income group - Children - Elderly	Supporting - Sanitation department of Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost estimate
Policy and Institutional Measures		
Increase monitoring and supervision for usage of safe and well designed sanitary latrines by all and encourage people not to connect their latrine outlets with open drains or any ponds and canals. Mongla Port Municipality could publish a regulatory notice mentioning a penalty or fine if any open linkage is found. DPHE can be engaged for joint monitoring	Cost of training, meetings, staff costs, equipments, labour	USD 10000 per drive
Infrastructural Measures		
Decoupling septic tank outlets from	Cost of equipments, labour,	USD 10000 per drive

storm water drains	staff training	

8. CONCLUSION

The implementation of the IAP toolkit in the port city of Mongla revealed that the city is very vulnerable to projected climate change impacts of higher temperatures, increased rainfall intensity and increased frequency of cyclones. The city needs to adapt to possible impacts of the same. The economy is largely based on agriculture and fishery and basic urban services are poor in the city. Therefore the city has a greater need to adapt to climatic changes that may be faced by the already fragile urban systems. Seven urban systems were identified as fragile - water supply, drainage, sewerage, solid waste management, transportation, health and urban and peri urban agriculture - and climate fragility statements were formulated for all of them corresponding to the three climate scenarios.

The vulnerability map of the city shows ward 9 which is subject to tidal influences as the vulnerable hotspot in the city, while ward 1, 3, 5 and 6 are vulnerable to six fragile urban systems.

Mongla Port Municipality scored medium- high on adaptive capacity in all the systems in terms of its capacity to organize and respond to threat or disruption, access to resources necessary for response (manpower, technology, funds) and access to information necessary to develop effective plans and actions and to improve responses to disruptions. Other government departments like the Agricultural and Fisheries Department also rated high and can channelize their efforts and pool their resources along with those of the municipality to build resilience in the city. This is at present lacking.

The list of interventions identified in this CRS includes both hard and soft measures. These measures either directly or indirectly contribute to climate change adaptation while making the city more resilient. The finances required for implementation of the interventions can be obtained through assessment of the existing financial statements, existing projects, other national schemes, and also international programs. Mongla Port Municipality and other implementing agencies can pick projects according to their priority and need within a specific fragile urban system as well as the different climate scenarios agreed upon during initial stages of IAP. Integration of all prioritised interventions into other plans of the town is also important in order to avoid duplicity of efforts and enhance coordination. The way forward for the city to build resilience includes:

- **Inter-departmental coordination:** Building coordination between different government departments for better integration of developmental activities with urban resilience and allocation of resources to aspects that are more vulnerable.
- **Policy improvement:** Several urban systems lack proper policy under which action can be taken for improving the operation and maintenance. For instance, for decoupling of sewage lines from drains, prevention of littering, conservation of water and rainwater harvesting, policies can be developed at the local level to improve the condition of the urban system in the city. This needs to be coupled with awareness generation programmes that can assist residents to adopt newer and up-to-date practices for the betterment of the urban services.

- **Capacity Development:** The staff in the municipality requires training on the management of natural resources to improve urban service delivery and on operation and maintenance of newer and up-to-date systems. This is extremely essential for improvement in urban services and reducing the fragility of urban systems. Research and development in the field of agriculture and fishery that can be applied by the farmers and fishermen is also identified as a major means of improving resilience in this field.

- **Service level improvement:** Basic urban services in the city are poor and needs substantial improvement. Structural and policy measures can be undertaken as outlined in the resilience interventions to improve, water resource management, sanitation and drainage, and solid waste management.

It is essential for the municipality to start collaboration with different agencies to build their technical capacity to undertake resilience building projects in the city. Planning in advance can not only help to avoid future threats but also provide opportunities to better social, economic and environmental development in the city.

Annexure 1

Urban system analysis

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Part of city function (Completely / Shared / No)	Fragility statement
Water Supply	***Flexibility & Diversity:*** Salinity of drinking water is the biggest problem of the area. Ground water is not potable at all. Municipality has set up a Water Treatment Plant which uses harvested rain water and coverage of which is 50% only. ***Redundancy:*** Single source of water supply, no backup system. Rainwater harvesting system in 25% of households. ***Safe failure:***	● No control of water use by citizens ● Sufficient water is not supplied by municipality ● Health impacts by using non-potable or unsafe water because of lack of municipal supply. ● 10-12 areas have no access to water.	Municipality	Water supply system is fragile because there is no source of water apart from rain water. The system is dependent on harvested rain water that is treated and supplied by municipality but cannot cover entire population.
Transportation	***Flexibility & Diversity:*** ***Redundancy:*** *water transport affected by siltation and tides* ***Safe failure:*** Road infrastructure, the temporary bridges or culverts are getting affected every year due to rapid flooding. Destruction of pitch roads due to excessive rain.	● Local economy ● Health – access to hospitals ● Education – access to schools ● Inflation	Roads and Highway Department, Municipality, LGED	Roads are easily destroyed due to excessive water logging or rainfall. Water transport is impacted by siltation. This impacts access to major service institutions (hospitals, schools) and also impacts economy.
Health System	***Flexibility & Diversity:*** Frequencies of vector borne diseases are going up quite fast. No adequate hospitals – no diagnostic facility, primary health care available, but no specialised care. ***Redundancy:*** ***Safe failure:***	● Difficulties in access to hospitals results in increased mortality ● No facility – hence no specialist wants to stay in Mongla.	Municipality, Health Department, DPHE	Health system is fragile because there are no major hospitals or health care facilities, and people cannot access safe health care.
Storm Water Drainage	***Flexibility & Diversity:*** ***Redundancy:*** ***Safe failure:*** Open drains create problems because of dumping of solid waste. No secondary drains.	● Vector borne diseases due to stagnant water ● Odour ● Level of canals where drains open is higher than drain level, so back	Municipality	Open drains are blocked due to solid waste and result in overflow, leading to health impacts.

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Part of city function (Completely / Shared / No)	Fragility statement
		flow		
Solid Waste Management	***Flexibility & Diversity:*** Only open dumping of solid waste in low lying areas or in canals ***Redundancy:*** ***Safe failure:*** There is no proper SWM practice in the city. The waste is collected from the secondary collection point and dumped in an open dumping site on the bank of river. The collection is also not being operated in a systematic manner.	● Health ● Odour and mosquitoes ● Environment ● Drainage ● Improper collection leads to traffic congestion	Municipality	There is no solid waste collection or treatment system. Open dumping causes problems in drainage systems, traffic congestion, and health issues.
Urban/Peri-Urban Agriculture/Pisiculture/Animal Husbandry	***Flexibility & Diversity:*** dependent on rainfall, so severely impacted in case of variation in rainfall ***Redundancy:*** ***Safe failure:*** Agricultural activities in ward number 1, 4, 9 and partly in 7. Due to flood during the cyclone event – Aila, the soil got Salinized. Consequently, Agricultural and other horticultural productivity have come down. Salinity of land creates problem in all.	● Inflation ● Local economy		Economy based on ecosystems – agriculture, fishery, animal husbandry – are impacted by salinity of soil and variations in rainfall, harming local economy.
Sanitation and Sewerage	***Flexibility & Diversity:*** no sewerage system, no septic tanks, toilets are either closed with no outlet or opening in drains. ***Redundancy:*** ***Safe failure:*** no outlet of toilets results in overflow and goes to drains and water bodies.	● Pollution of water bodies ● Health impacts		There is no proper toilet in a majority of areas in the municipality and no treatment facility. Toilets either open in drains/canals or are pit latrines with no outlets. This causes severe water pollution and health impacts.

Annexure 2

Risk Prioritisation

Urban system	Impacts of climate change	Likelihood	Consequence	Risk score	Risk status
Water Supply	Existing supply of water will fall short in case of greater demand due to higher temperatures causing health issues.	5	4	20	**Extreme**
	System dependent on rainfall, so will be impacted by shortage of rain.	5	5	25	**Extreme**
	System failures due to flooding caused by cyclones and salinization of water reservoirs.	3	4	12	**High**
Transportation	Destruction of roads due to excess rainfall or in cyclones. Disruption of import of food by water transport.	3	3	9	**Medium**
Health System	Stress on existing infrastructure to meet heat related health disorders which will be a problem for children and elderly.	4	4	16	**High**
	Water logging can cause water borne diseases, skin diseases, more stress on facilities.	3	4	12	**High**
	Malnutrition due to effect on import of food.	4	3	12	**High**
Storm Water Drainage	Odour pollution and health issues due to higher temperatures.	5	3	15	**High**
	Since there are no secondary drains, excessive rainfall and flooding can cause water logging due to cyclones leading to water borne diseases due to water pollution.	5	3	15	**High**
Solid Waste Management	Water logging due to excess rain can cause spread of solid waste on streets and health issues.	5	4	20	**Extreme**
Urban/ Peri-Urban	Crops reduced due to lack of water because of greater demand on water due	5	3	15	**High**

Urban system	Impacts of climate change	Likelihood	Consequence	Risk score	Risk status
Agriculture/ Pisciculture/ Animal Husbandry	to high temperatures.				
	Excess rainfall or flooding can cause salinity of soil damaging agriculture, fishery, animal husbandry.	5	4	20	**Extreme**
Sanitation and Sewerage	Excess rainfall or flooding can cause health impacts leading to loss of life and productivity.	5	5	25	**Extreme**
	Odour caused by higher temperatures due to lack of proper disposal of sewage.	5	3	15	**High**

Annexure 3

List of the members of the Climate Core Team, their position, and proposed responsibilities

Name	Position	Responsibility
Mr. Eng. Shoriful Islam	Chairperson	Supervise the overall works and management issues of the Core Team
Mr. Amal Krishna Saha	Project Nodal Officer	Ensure the coordination and implementation of the project
Mr. Ratan Kumar Mondal	Member	Coordination and implementation of the project works in specific to the sectors