City Resilience Strategy

Dinajpur 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.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

Dinajpur'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 (IAP)

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.

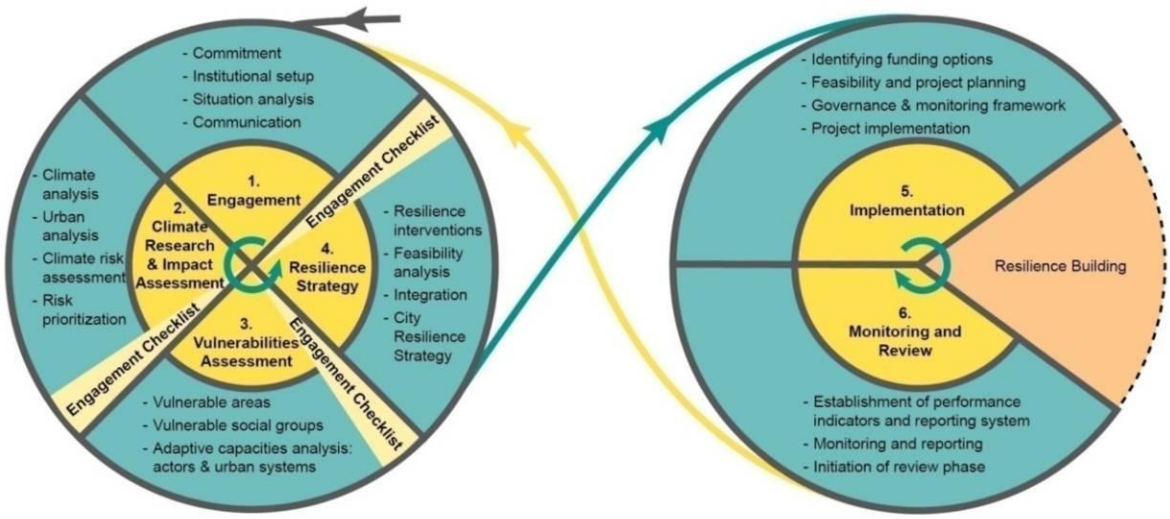

Figure 1: ICLEI ACCCRN Process

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 IAP in Dinajpur City

The Mayor, town planner and engineers of Dinajpur Municipality spearheaded the IAP with support from ICLEI South Asia. Figure 2 illustrates the process and timeline followed in Dinajpur.

To initiate the IAP, municipal town planner, engineers, councillors and other representatives from Dinajpur Municipality, were briefly oriented on the fundamentals of urban development and climate resilience. Simultaneously, members for the Climate Core team and the Stakeholder's Committee were identified in consultation with the Mayor, Town Planner and Municipal Engineer of the Dinajpur 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 five urban systems as fragile, viz. (i) Water Supply, (ii) Biodiversity, (iii) Solid Waste Management, (iv) Economy, and (v) Drainage.

The five fragile urban systems identified were critically analysed considering the direct and indirect impacts of identified climate risks.

Vulnerability Assessment was carried out to critically evaluate the sensitivity, exposure and adaptive capacity of the five 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 Dinajpur. Interlinkages of these resilience interventions with on-going and planned projects are being explored.

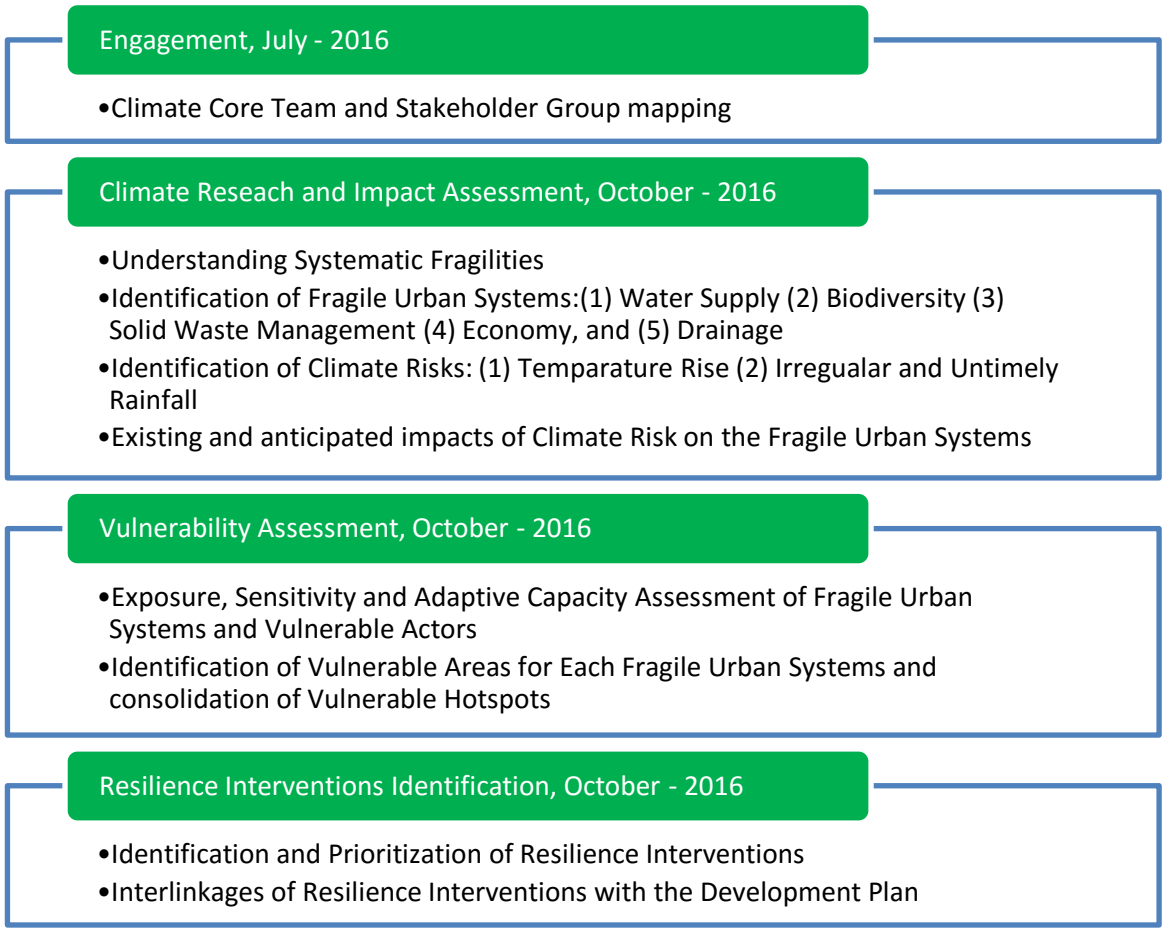

Figure 2: Methodology of IAP in Dinajpur

2. CITY PROFILE

Dinajpur city is the largest city of Dinajpur district which is one of the oldest districts of Bangladesh. Dinajpur city consists of Dinajpur Paurashava (Municipality) and its adjoining 3 mauzas as other urban areas. The city occupies a total area of 22.39 sq. km where 21.06 Sq.km is under the Paurashava which consists of 12 wards and 80 mahallas. The city is believed to be named after one of its rulers King Donuj. There are many historical and culturally significant sites like Dinajpur Rajbari and Ramsagar Dighi.

2.1 Location

Dinajpur municipality is located between 25°28′and 25°48′N latitudes and between 88°34′ and 88°46′E longitudes (refer Figure 3). It is bounded by Kaharole and Khansama upazilas on the

north, West Bengal state of India on the south, Chirirbandar upazila on the east and Biral upazila on the west.

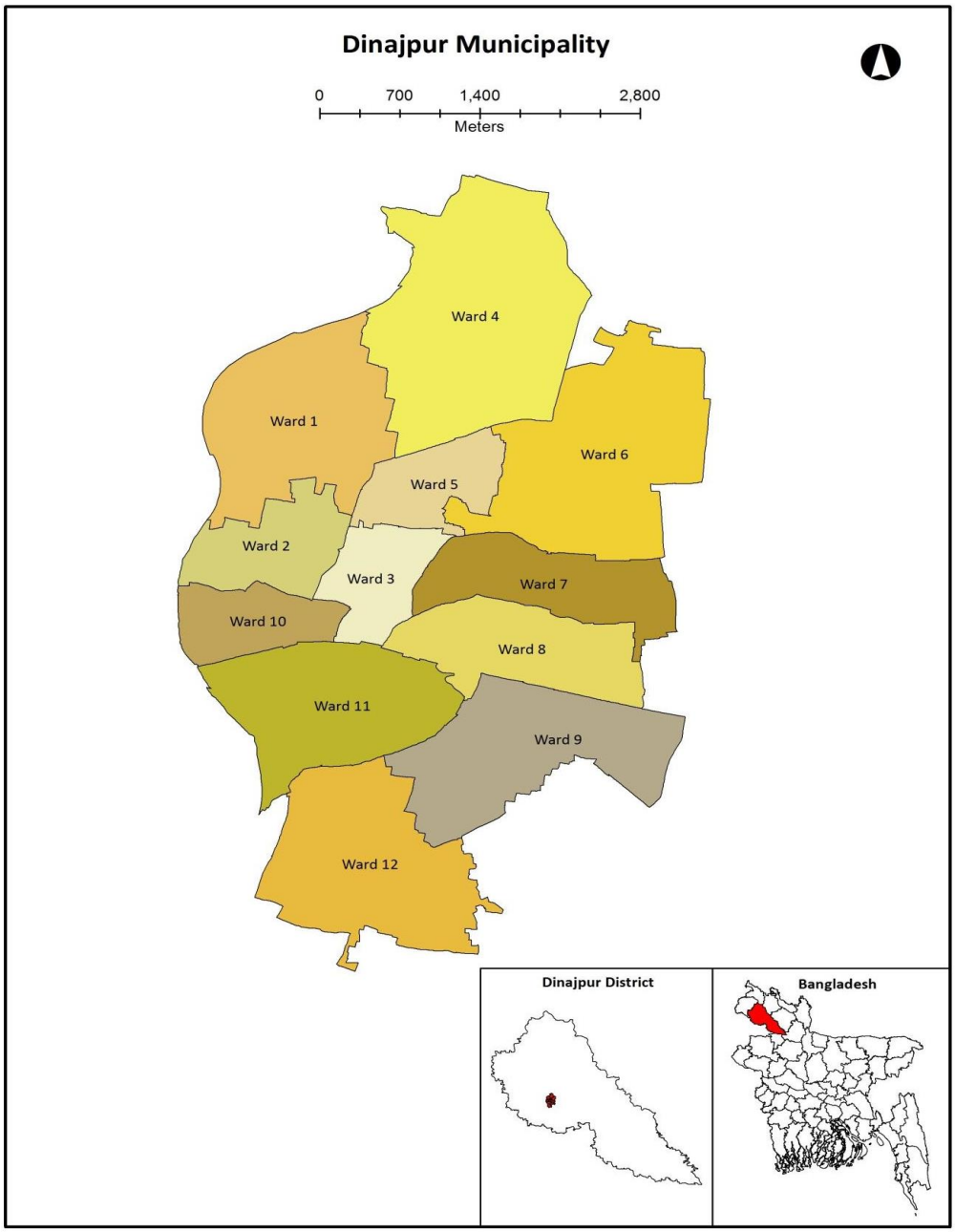

Figure 3: Location of Dinajpur Municipality

2.2 Demography

According to Bangladesh Bureau of Statistics (BBS) population census 2011[7], the population of Dinajpur Municipality was 186,727 comprising of 96,139 males and 90,588 females. There are 40,929 households. The population density was 9,945.47 persons/Sq.km distributed among 12 wards spread over 21.06 Sq.km. municipal area, where, ward 10 and 12 are the most and least congested wards, respectively. Table 2 represents the ward-wise population of Dinajpur

[7]Bangladesh Bureau of Statistics (BBS). 2011. Population and Housing Census 2011. Community Report: Dinajpur. Bangladesh Bureau of Statistics, Statistics and Information Planning, Government of Bangladesh.

Municipality and their population density. The literacy rate in the area under the jurisdiction of the Municipality is 75.4%.

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

Ward No.	Area of Ward (sq. km.)	Total Population	No. of Households	Population Density (Persons/sq. km.)
1	1.95	19,346	4,416	9,921
2	1.42	16,694	3,902	11,756.3
3	0.95	12,065	2,198	12,700
4	2.49	19,677	3,714	7,902.4
5	0.93	12,959	2,978	13,934.4
6	3.13	17,824	4,055	5,694.6
7	1.46	11,474	2,615	7,858.9
8	1.53	14,184	3,093	9,270.6
9	2.60	25,729	5,674	9,895.8
10	0.97	14,862	3,429	15,321.6
11	1.14	13,225	3,000	11,600.9
12	2.49	8,688	1,855	3,489.2
Total	**21.06**	**186,727**	**40,929**	**11,9345.7**

2.3 Economy and Employment

The economy of Dinajpur mainly depends upon agriculture based production. Dinajpur is famous for rice and its 'Katharivog' rice is considered the best produced rice in Bangladesh. It also produces wheat, vegetables and fruits like litchis and mangoes (variety-Kosba) which are considered to be one of the best. Therefore a large percentage of people from Dinajpur depend upon agri-based products. The main industry also includes rice processing mills. Dinajpur district is also rich in natural resources like coal and has three of the five coal fields discovered in Bangladesh.

2.4 Municipal Administration

Dinajpur Municipality was established in 1869. It regulates most of the civic function and services in the city. At present, the Municipality consists of elected members including a Mayor, 16 Councillors, including four female Councillors. The Mayor and Councillors are responsible for all the policy decisions. There is a position for Chief Executive Officer (CEO) who is the head of Municipality administration and is responsible for the functioning of the Corporation including tax collection, estates maintenance, projects, among other things. This is an administrative cadre service post and appointed by the central government. Dinajpur Municipality provides and maintains basic urban services which include water supply, sewage 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 Municipality, development and planning schemes are implemented by some other government organizations which are as follows:

a) **Local Government Engineering Department –** responsible for construction of local roads, bridges, culverts etc. and also administering the local governments.
b) **Department of Public Health Engineering –** responsible for conducting surveys to determine the water contamination level like arsenic and its pollution in the area.
c) **Public Works Department –** responsible for implementation of government construction projects. It also undertakes projects for autonomous bodies as deposit works.
d) **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.
e) **Department of Forest –** responsible for forest extension, biodiversity and wildlife conservation etc.
f) **Roads & Highways Department –** responsible for the construction and maintenance of major roads and bridge networks.
g) **Water Development Board –** responsible for flood control, drainage and irrigation activities as well as to enhance water resource management.
h) **Power Development Board –** provides electricity to the residents, commerce and industrial establishment on priority and their capacity basis.

3. PAST HAZARDS AND CLIMATIC EVENTS

Dinajpur district faces risks of variability in monsoon rains, flash floods, cyclones and extended droughts[8].

In 2013[9] flash floods hit the district affecting a total of 35 districts, 5 of which were in the Dinajpur Sardar upazila. 10,000 people were stranded in the incident which was caused due to overflows from the Punarbhaba, Atrai and Kakra rivers following heavy rainfall. Storms[10] in 2015 killed at least four people and affected Dinajpur Sadar, Chirirbandar, Phulbarhi and Nababganj upazilas leading to power outage, and infrastructure loss.

Additionally, a cold wave in early 2013[11] affected more than 20 districts of which Dinajpur was one. More than 50% of the population were affected and 80 people died, many of whom were children.

4. CLIMATE SCENARIO IN THE CITY

Dinajpur experiences a hot, wet and humid tropical climate. The district has a distinct monsoonal season, with an annual average temperature of 25 °C and monthly means varying between 18 °C in January and 29 °C in August. Average annual precipitation is around 1728 mm[12].

4.1 Past Climate Trends

[8]Siddiquee, S.A., Islam, S.M.N. and Chakraborty, T.R. 2013.A Substantial Trend Analysis of Climatic Indicators in the Coast of Bangladesh. Wyno Academic Journal of Educational Research and Essays. Vol. 1(4): 47-58
[9]http://www.crisisforums.org/discussion/1237/bangladesh-flash-flood-hits-35-villages-in-dinajpur
[10] http://www.disaster-report.com/2015/05/storm-in-dinajpur-bangladesh-leaves.html
[11]Government of Bangladesh. 2014. Disaster report 2013. Department of Disaster Management; Ministry of Disaster Management and Relief, Government of Bangladesh, Dhaka.
[12]https://en.climate-data.org/location/969562/

Zone-wise analysis of the rainfall over the period of 1971-2008, in research released by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)[13] funded by the Asian Development Bank, revealed that the annual rainfall increased variably in the Dinajpur region of Bangladesh. The number of annual rainy days was found to be less than 90 days in four stations (Dinajpur, Rajshahi, Satkhira and Tangail). Further, In Dinajpur, the instance of receiving >100 mm per day has shown an increasing trend over the years. Mean annual maximum and minimum temperature showed a rising trend from 1971 to date across the entire country.

A MET report on the climate of Bangladesh found that during the winter season, maximum temperature decreased over Rajshahi division and the regions of Dinajpur, Kushtia, Tangail & Mymensingh[14].

The present project also analysed the past climate trends of Dinajpur city using climate data collected from the Bangladesh Meteorological Department (BMD). The data spans 30 years from 1984 to 2014 for both temperature and rainfall.

Figure 4 shows that the average annual rainfall is decreasing by almost 50mm over the last three decades. This is due to a clear decrease in rainfall across all seasons (Figures 5-8). Rainfall received in 2014 has been very poor with post monsoonal rainfall (September to December) showing 0 mm recorded (Figure 7 and Figure 8). Monsoonal rainfall (Figure 6) is decreasing by a few 100mm.

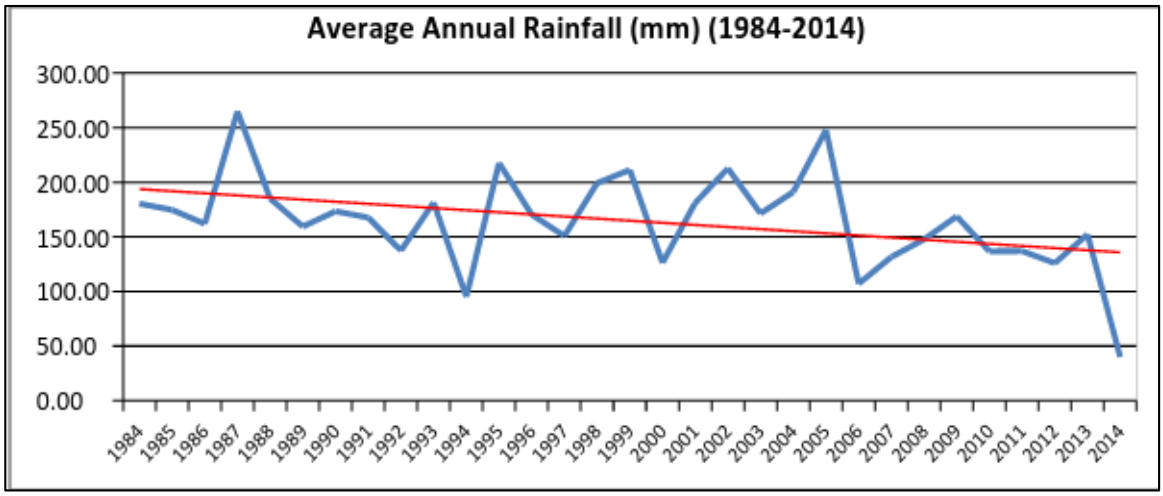

Figure 4: Average Annual Rainfall for Dinajpur City

[13] Deb UK, Islam Nazrul AKM, Al Amin M, Khaled Nafisa, Nabi A, Ahamad MG, Paul Debi Narayan Rudra, Singh NP and Bantilan C. 2013. Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience, Climatic Trends in Bangladesh. Research Report no. 10. Patancheru 502 324, Telangana, India: International Crops Research Institute for the Semi-Arid Tropics. 108 pp.

[14]Khatun M.A., Rashid, M.B. and Hygen H.O. 2016.MET report, Climate of Bangladesh. Norwegian Meteorological Institute. ISSN 2387-4201 http://met.no/filestore/Report08-16ClimateOfBangladesh2.pdf

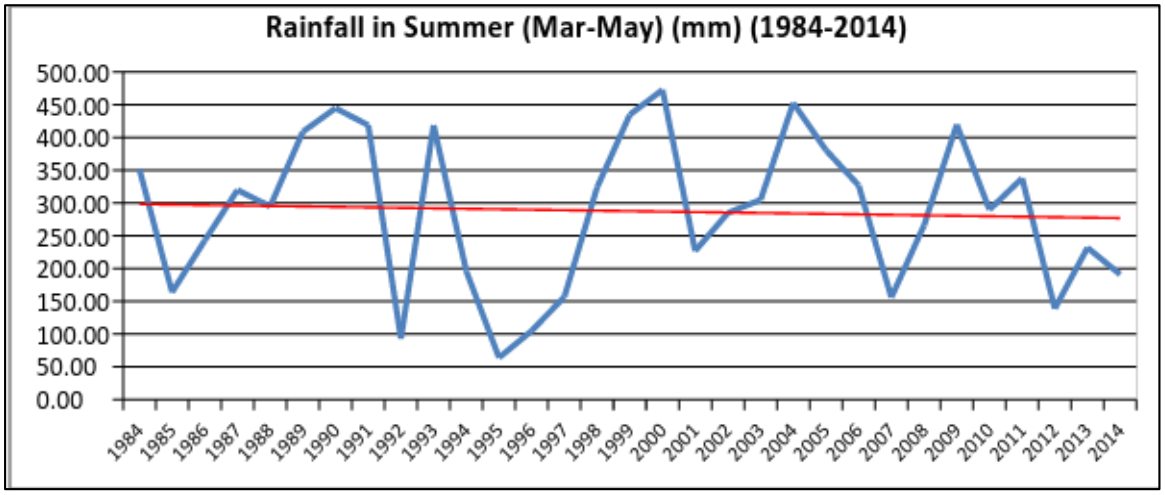

Figure 5: Rainfall in Summer for Dinajpur City

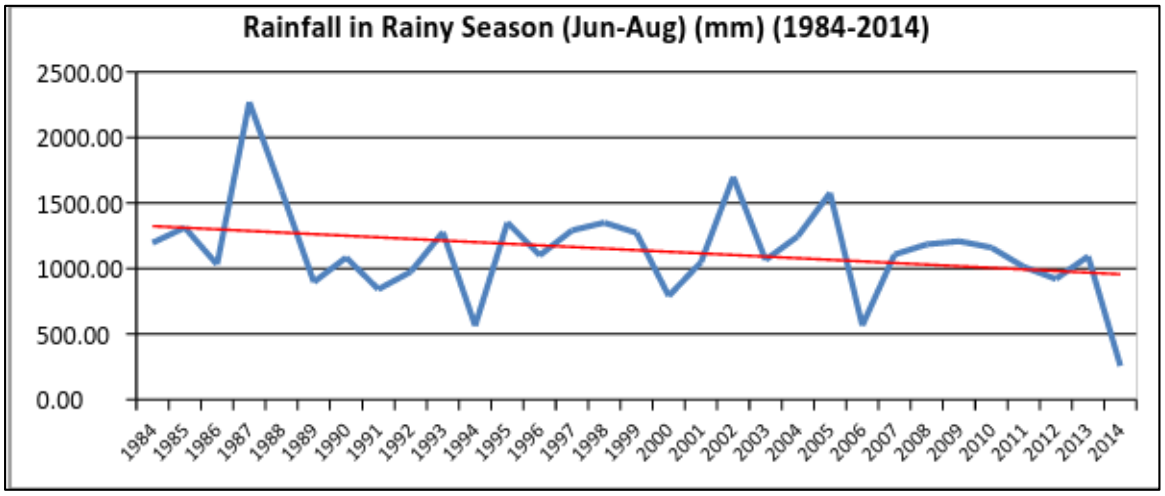

Figure 6: Rainfall in Rainy Season for Dinajpur City

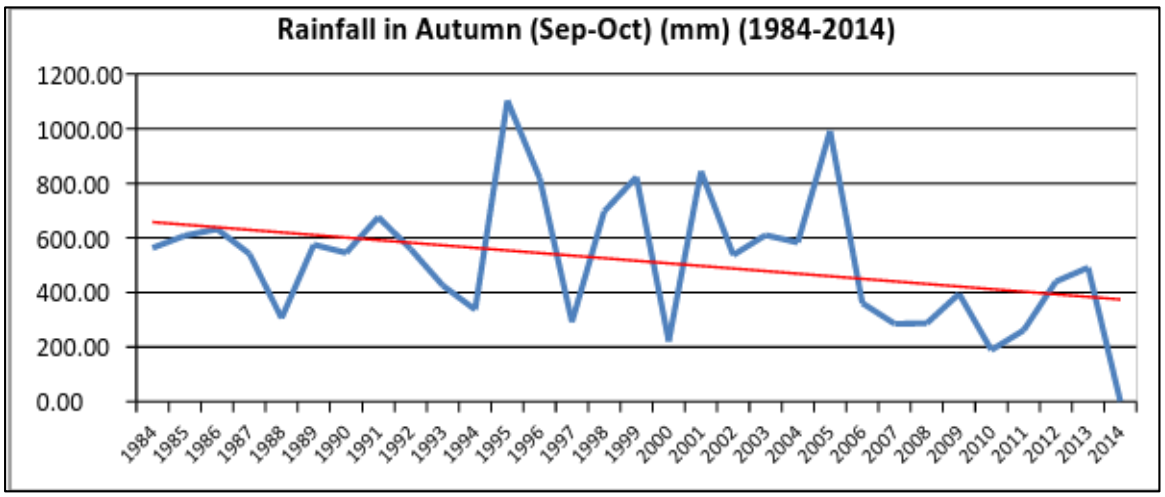

Figure 7: Rainfall in Autumn for Dinajpur City

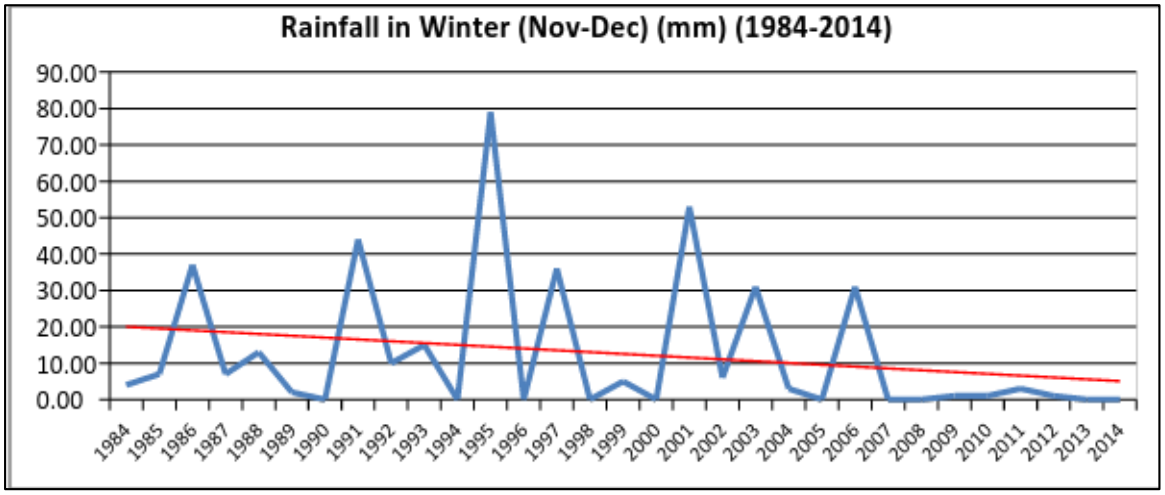

Figure 8: Rainfall in Winter for Dinajpur City

Temperature on the other hand has been steadily increasing over the data period (Figures 9- 11) and annual average temperature shows that the increase in the three decades is almost 0.3°C (Figure 9). Both maximum and minimum temperatures show a rise over the analysis period (Figure 10 and Figure 11).

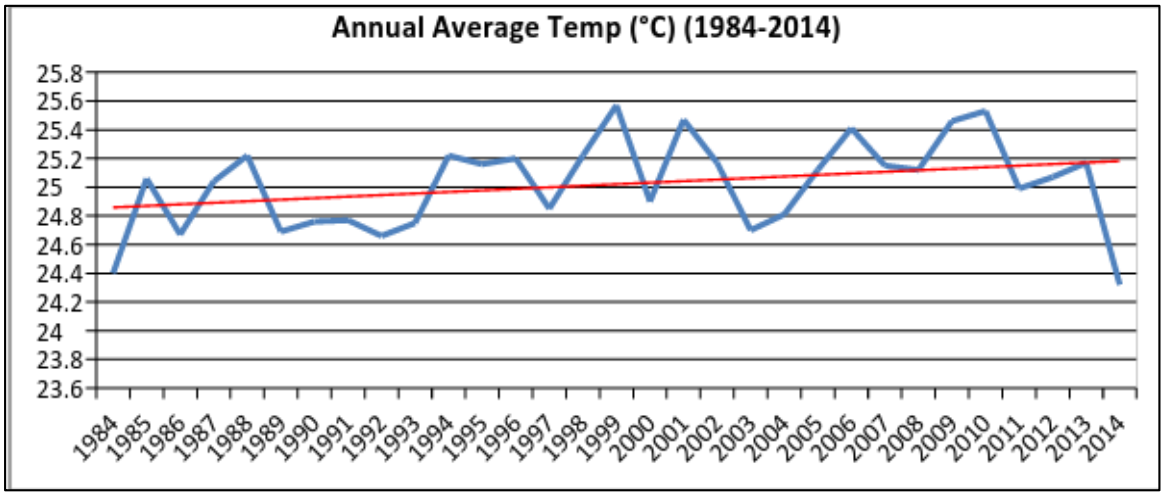

Figure 9: Annual Average Temperature for Dinajpur City

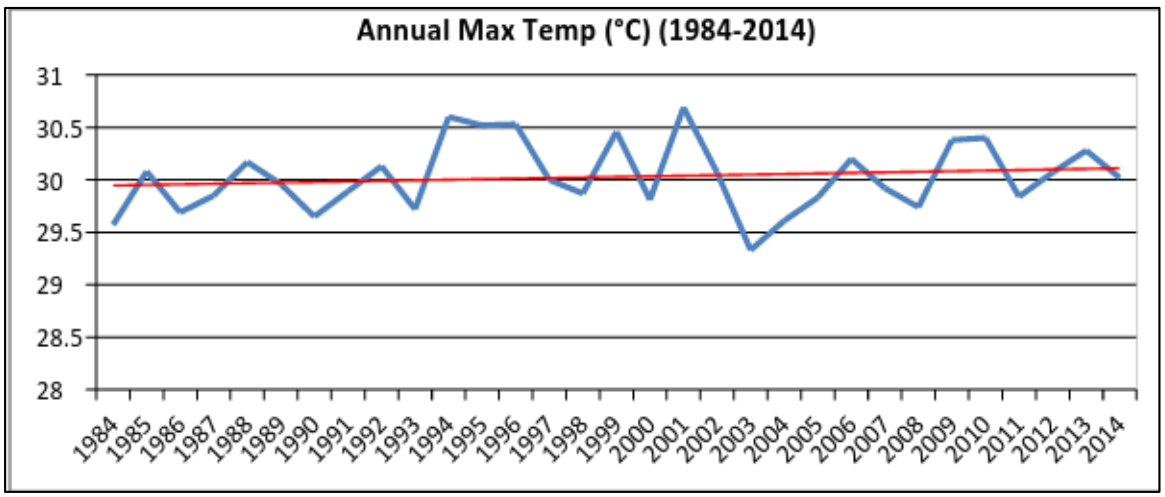

Figure 10: Annual Maximum Temperature for Dinajpur City

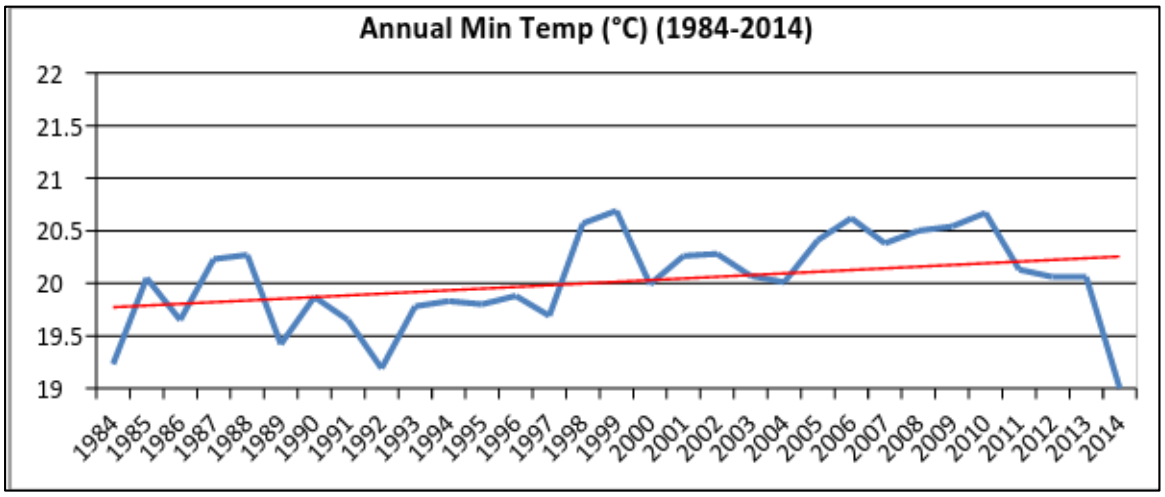

Figure 11: Annual Minimum Temperature for Dinajpur City

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) published by the Government of Bangladesh[15] and the Vulnerability, Risk Reduction and Adaptation to Climate Change, Climate Risk and Adaptation Country profile, (2011) published by World Bank[16] is referred to for the climate projections of the region (Table 3). The National Plan for Disaster Management used a regional climate model PRECIS for Bangladesh.

Table 3: Climate Scenario Statement

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Precipitation change	National Assessment[11]	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[12]	There will be an increase in the amount of run-off, and rainfall intensity.
Temperature change	National Assessment[11]	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 temperature will follow an increasing trend.
	National	Mean temperatures across Bangladesh are projected to

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

[16]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
	Assessment[12]	increase between 1.4°C and 2.4°C by 2050 and 2100, respectively.

The discussions with the Stakeholder Committee however, reveals that the rainfall projections don't seem to hold true for Dinajpur. Stakeholders emphasised that there is higher intensity rainfall in the city but the season is becoming shorter. Thus the climate risks as agreed upon by stakeholders were:
Climate Risk 1: Increased temperature
Climate Risk 2: Short duration high intensity rainfall

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 Dinajpur identified five fragile urban systems through rigorous discussions in the SLDs:

(i) Water Supply
(ii) Biodiversity
(iii) Solid Waste Management
(iv) Economy
(v) Drainage

5.1 Urban Systems Analysis

5.1.1 Water Supply

A majority of the city depends on groundwater for its water supply however only 20 percent is covered by a piped water supply network. There are three treatment plants to remove the iron content of the water extracted from the ground. Only one is functional. As the population grows, the demand for water grows, leading to a decline in the quantity and quality of the groundwater table. This will create severe water stress in future.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Water Supply in Dinajpur, the urban fragility statement of this system is 'The water resource in the city is being depleted because of over extraction of groundwater and reaches only 20 percent of households in the form of piped water supply.'

The climate fragility statement for this system is:

"Climate Risk 1: With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading to health impacts and impacts on an economy which is dependent on water such as agriculture."

5.1.2 Biodiversity

With increasing urbanisation, deforestation and population the biodiversity in the region is decreasing. Loss of habitat has led to a decrease in the different species of birds, animals, and fish. Migrant bird visitors have also declined.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Biodiversity in Dinajpur, the urban fragility statement of this system is 'Biodiversity loss is seen throughout the city with reduction in species of birds, animals, and fish due to loss of habitat.'

The climate fragility statement for this system is:

"Climate Risk 1: Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity."

5.1.3 Solid Waste Management

Waste segregation is not practiced in Dinajpur city. The city lacks a scientific landfill site and there is no form of scientific management of the waste. Therefore, waste ends up being dumped in an already over-capacity open dump site. The municipality has poor resources to collect, manage and process the waste which is compounded by a lack of public awareness and recycling facilities.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Solid Waste Management in Dinajpur, the urban fragility statement of this system is 'Solid waste management is under stress from indiscriminate dumping of waste and poor collection facilities.'

The climate fragility statement for this system is:

"Climate Risk 1: Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season."

5.1.4 Economy

As with the rest of the country the economy in Dinajpur is principally agrarian. Crops like rice and wheat are grown here. A proportion of the population is engaged in fisheries and employed in fruit orchards of mango and litchi. These sectors are tightly linked to climate. Most of the urban poor is engaged as agricultural labour or daily wage earners and are therefore dependent on the natural resources for their livelihoods.

A large percentage of migrants depend on the informal work sector. Thus, any change in the weather, is linked tightly with that of the economy especially in the context of the aforementioned population.

Fragility Statement and Climate Fragility Statement

Considering the present situation of the economy in Dinajpur, the urban fragility statement of this system is 'Agriculture, fishery and fruit orchards are important in providing economic support to the urban poor, the landless and middle class land owners. Food security of the city is also highly dependent on the local agricultural products.'

The climate fragility statement for this system is:

"Climate Risk 1: Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase migration to the city from surrounding areas."

5.1.5 Storm Water Drainage

Only one third of the city is covered by drains. Even the drains that exist have no outlet to the rivers to help the water flow out of the city. In the event of floods, the city therefore suffers for transportation badly apart from the impacts on food security, health, economy and lives of citizens. Short duration and high intensity rainfall that has been occurring lately, is also creating drainage issues because of lack of drainage infrastructure.

Fragility Statement and Climate Fragility Statement

Considering the present situation of the drains in Dinajpur, the urban fragility statement of this system is 'Coverage of drains is poor and water in drains has no outlet leading to permanent water logging in the city.'

The climate fragility statement for this system is:

"Climate Risk 1: Short duration high intensity rainfall will lead to excessive flooding due to clogged drains resulting in health hazards."

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

5.2 Risk Assessment

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.

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 process followed for risk scoring is detailed in Annexure 2. Table 4 shows the risk status of the climate fragility statements.

Table 4: Risk Assessment of Climate Fragility Statements

Urban System	Impacts of Climate Change	Risk Status
Water Supply	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading to health impacts and impacts on an economy which is dependent on water such as agriculture.	High

Urban System	Impacts of Climate Change	Risk Status
Biodiversity	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	Medium
Solid Waste Management	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season.	High
Economy	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase migration to the city from surrounding areas.	High
Drainage	Short duration high intensity rainfall will lead to excessive flooding due to clogged drains resulting in health hazards	High

Based on this risk assessment, water supply, the economy, storm water drainage and solid waste management are at high risk from climatic impacts. Biodiversity which scored medium can be put on a lower priority for the city.

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)[17] 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.

[17]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.

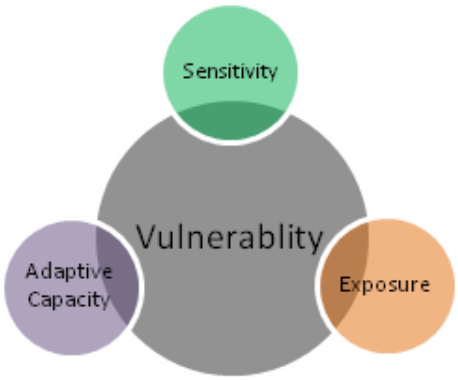

Figure 12: Vulnerability Constituents17

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 Dinajpur 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.

6.2 Identification of vulnerable areas of Fragile Urban Systems

6.2.1 Water Supply: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading	Wards 1, 2, 4, 5, 6, 10 (Figure 13)

to health impacts and impacts on an economy which is dependent on water such as agriculture.	

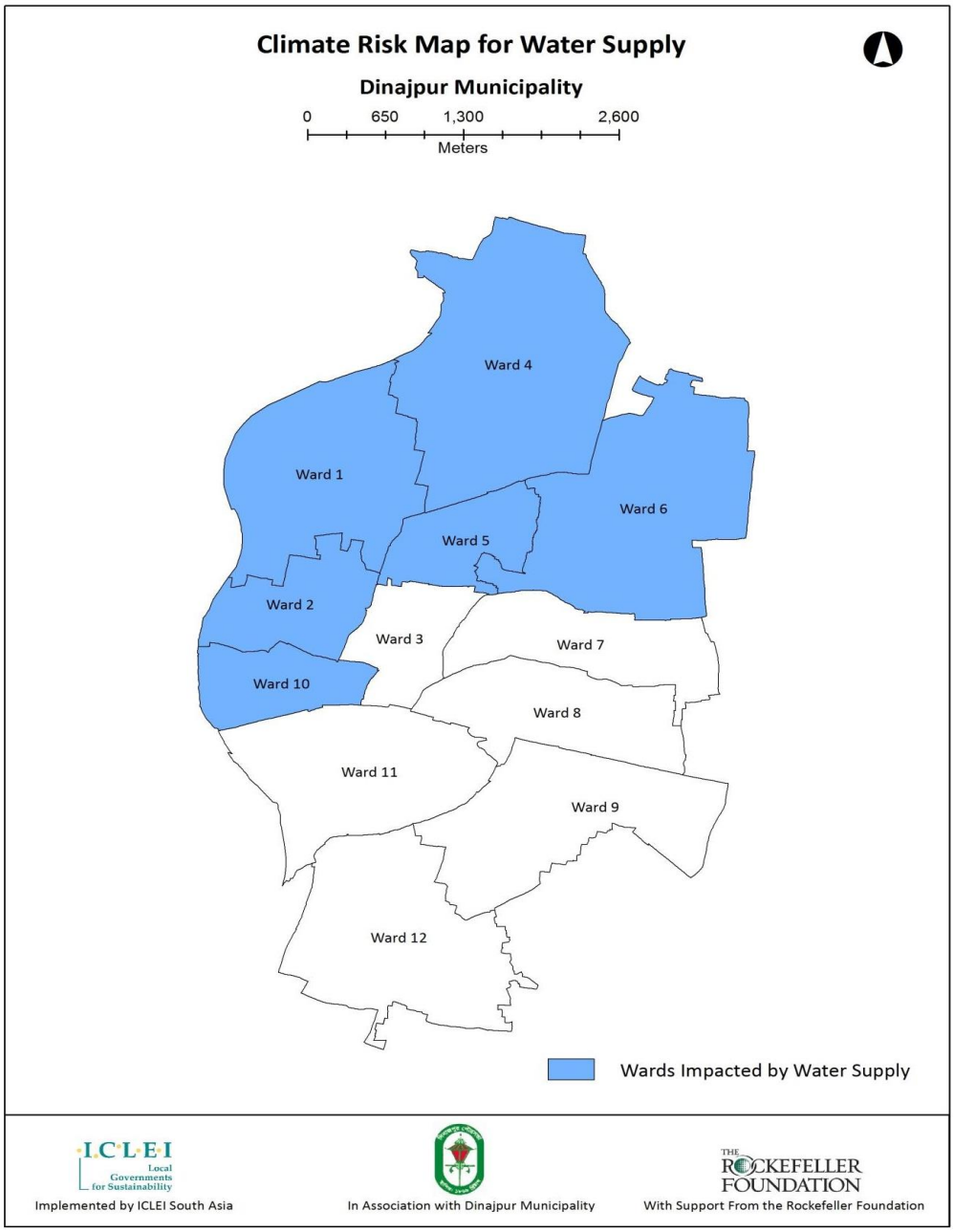

Figure 13: Wards most vulnerable to climate risks in the context of Water Supply, Dinajpur

6.2.2 Biodiversity: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	Wards 1, 6 (Figure 14)

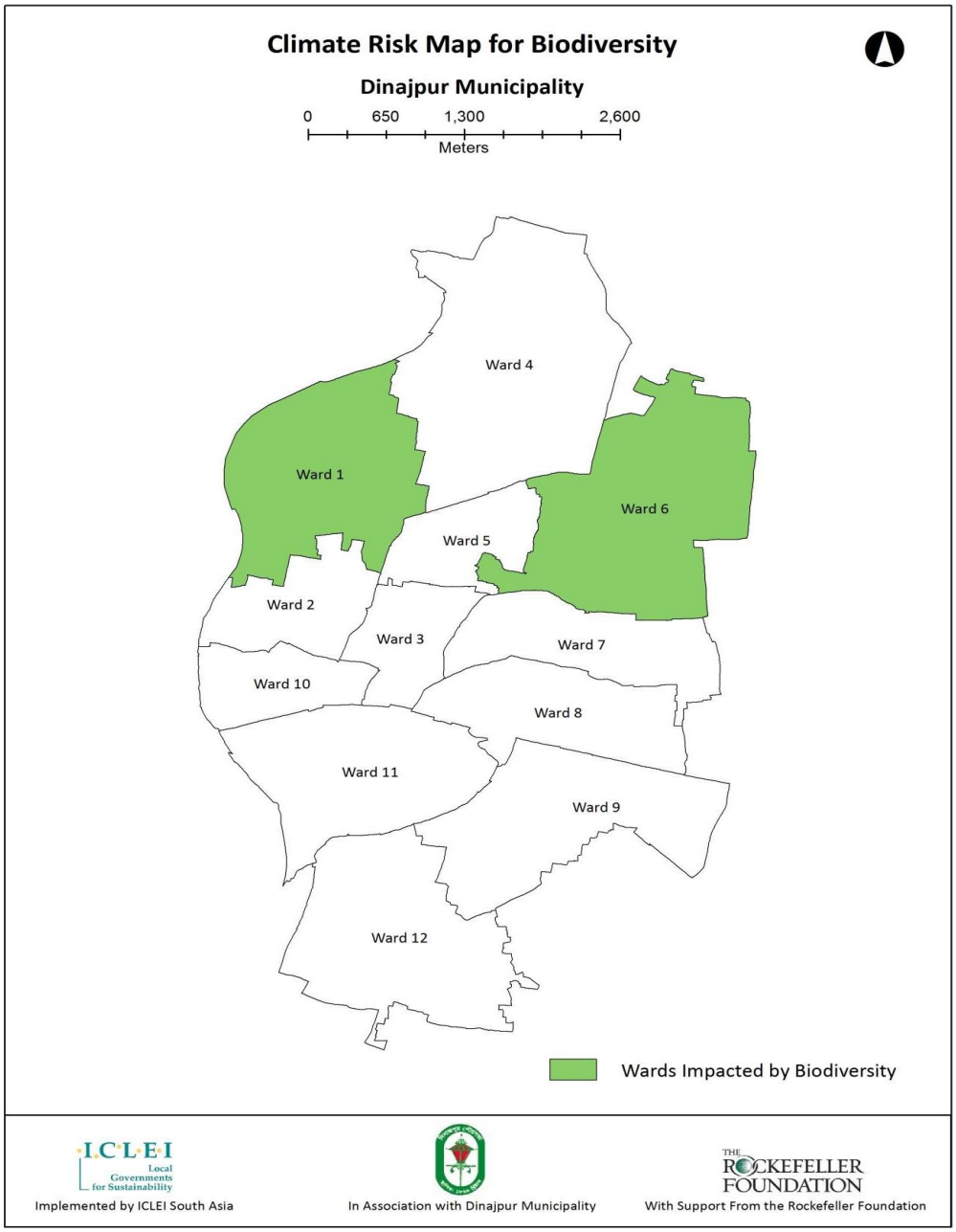

Figure 14: Wards most vulnerable to climate risks in the context of Biodiversity, Dinajpur

6.2.3 Solid Waste Management: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season.	Wards 1, 3, 5, 6, all market areas (Figure 15)

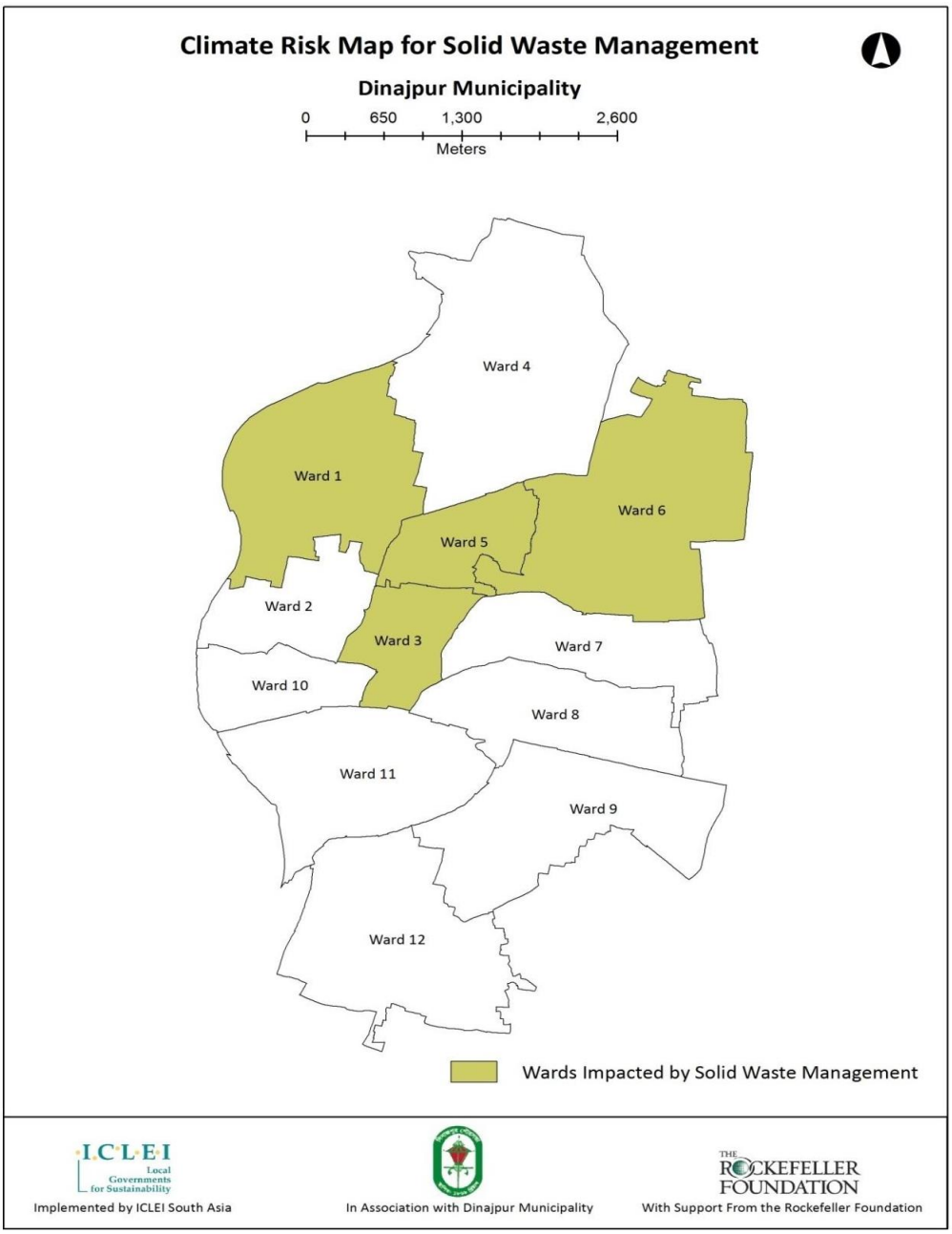

Figure 15: Wards most vulnerable to climate risks in the context of Solid Waste Management, Dinajpur

6.2.4 Economy: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase migration to the city from surrounding areas.	Wards 1, 4, 6, 9 (Figure 16)

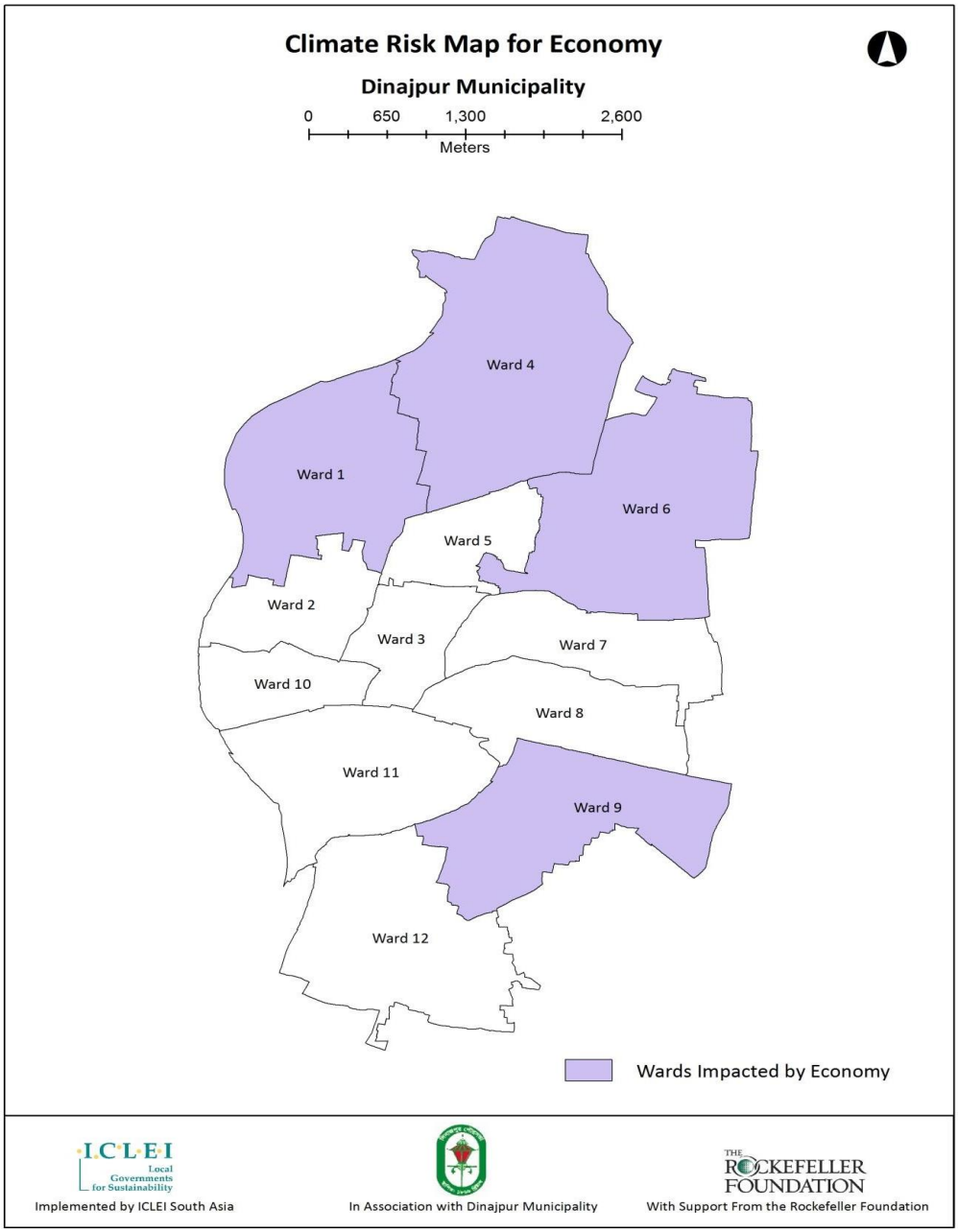

Figure 16: Wards most vulnerable to climate risks in the context of Economy, Dinajpur

6.2.5 Storm Water Drainage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Short duration high intensity rainfall will lead to excessive flooding due to clogged drains resulting in health hazards	Wards 1, 2, 4, 8, 10 (Figure 17)

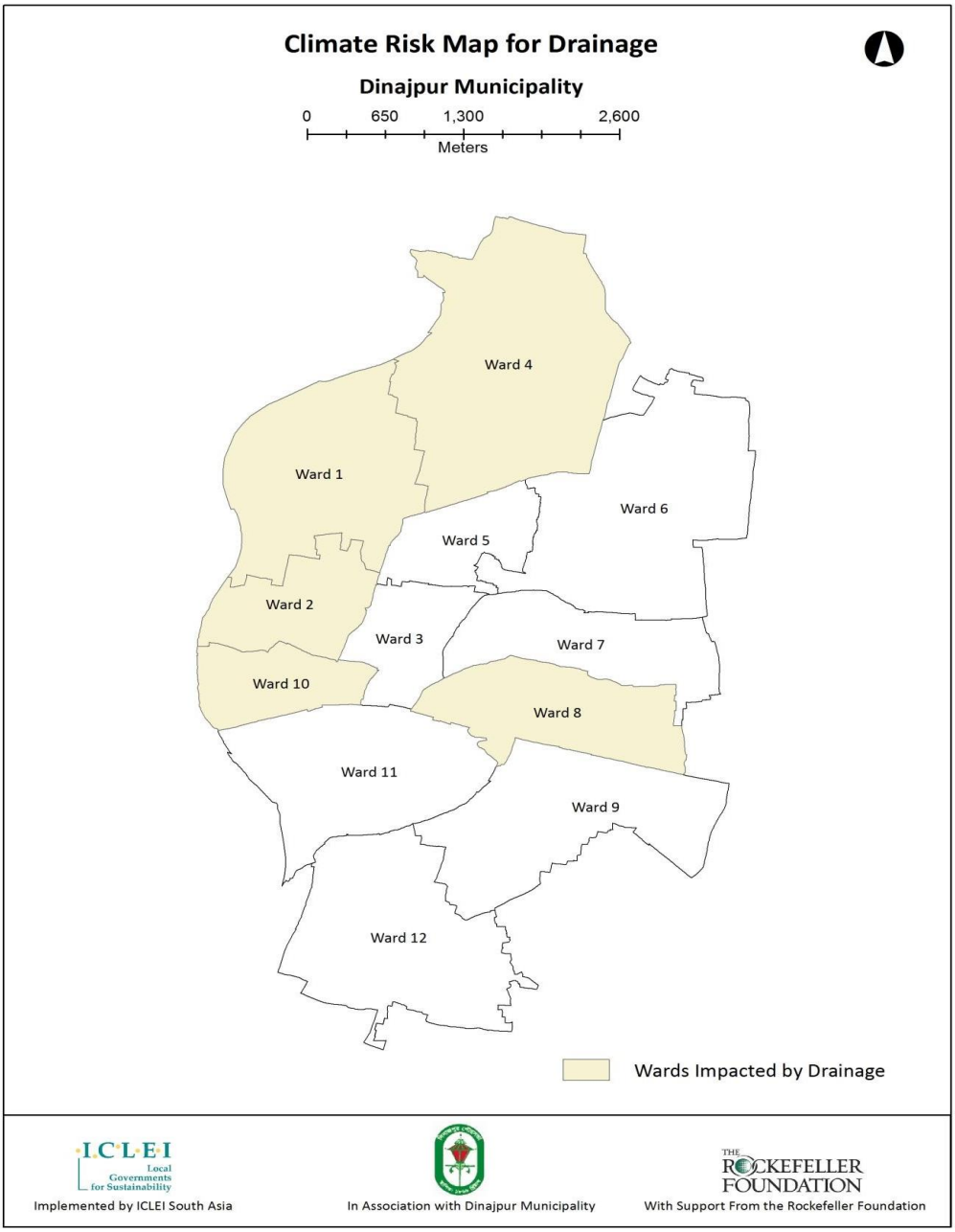

Figure 17: Wards most vulnerable to climate risks in the context of Drainage, Dinajpur

Many areas in the city are impacted by more than one fragile urban system. These areas need more attention as they face threats from multiple fragile urban systems and are referred to as the vulnerability hotspots. In Dinajpur ward 1 was identified as the vulnerable hotspot and was affected by all five urban systems. Ward 6 is affected by four urban systems followed by ward 4 which is affected by three urban systems. These wards are located towards the outer areas of the city and have population dependent on agriculture as well as poor drainage.

The vulnerability hotspot map (Figure 18) helps to identify the wards which must be focused on for future interventions to build resilience that are identified in later chapters.

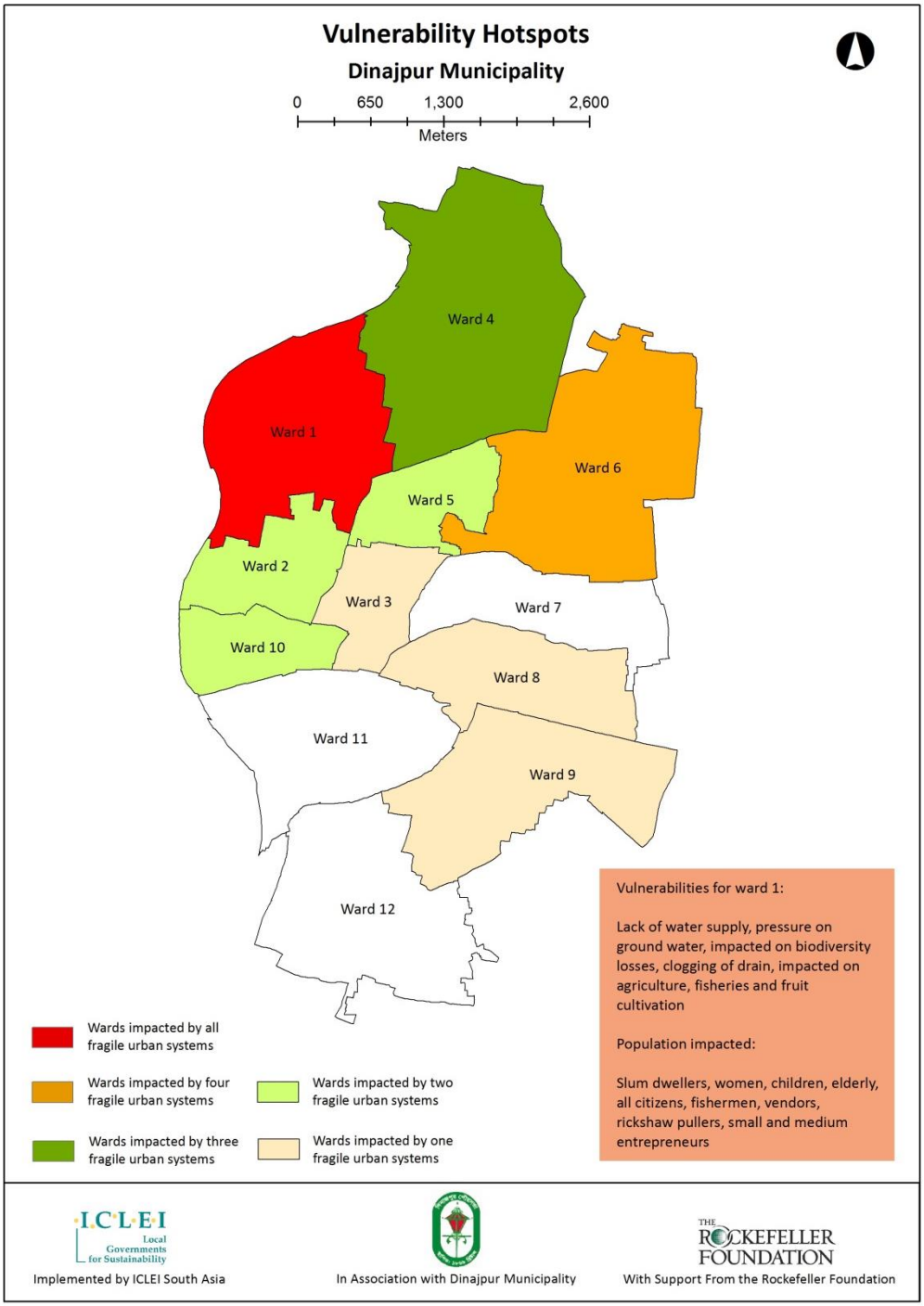

Figure 18: Consolidated Vulnerable Hotspots for Dinajpur city.

6.3 Actor Analysis

This section focuses on the analysis of the adaptive capacities of urban actors identified within the vulnerable wards. This section focuses on the analysis of the adaptive capacities of urban actors identified within the vulnerable wards. On the basis of their capacity to respond to climatic impacts, the actors are divided into vulnerable actors or supporting actors. Table 5 below shows the adaptive capacities of the actors for each fragile urban system.

The municipality and government departments like the Department of Environment, Department of Forests, Department of Livestock, Department of Fisheries, Department of Agricultural Extension, Department of Public Health and Engineering (DPHE) scored

Table 5: 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	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading to health impacts and impacts on an economy which is dependent on water such as agriculture.	Wards 1, 2, 4, 5, 6, 10	Slum dwellers	Low
			DPHE	High
			Municipality	Medium
			Women	Low
			Children	Low
			Elderly	Low
			Govt. General Hospital	Medium
			Private Hospital	Medium
			NGOs	Medium
			LGED	High
			Town Level Coordination Committee (TLCC)	Medium
Biodiversity	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	Wards 1, 6	Citizens	Low
			Municipality	Medium
			Department of Environment	High
			Department of Forest	High
			Department of Livestock	Medium
			Department of Fisheries	Medium
			Department of Agricultural Extension	High
			Veterinary Doctors & Medical Staff	Medium
			NGOs	Medium
			Farmers	Low
			District Information	Medium

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
			Office	
			Media	Medium
			TLCC	Medium
Solid Waste Management	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season.	Wards 1, 3, 5, 6	Municipality	Medium
			Citizens	Low
			NGOs	Medium
			Department of Health	Medium
			Sanitary Workers	Low
			CDCs	Medium
			LGED	High
			Schools & Colleges	Medium
			Media	Medium
			TLCC	Medium
Economy	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase migration to the city from surrounding areas.	Wards 1, 4, 6, 9	Farmers	Low
			Chamber of Commerce	High
			Municipality	Medium
			Department of Environment	High
			Department of Livestock	Medium
			Department of Fisheries	Medium
			Fishermen	Low
			Business Associations	High
			NGOs	Medium
			Vendors	Low
			Rickshaw	Low
			Labour Unions	Medium
			Small & Medium Entrepreneurs	High
			Town Federation	Medium

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
			Department of Cooperative Societies	Medium
Drainage	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will lead to excessive flooding due to clogged drains resulting in health hazards.	Wards 1, 2, 4, 8, 10	Municipality	Medium
			LGED	High
			Ward Committee	Medium
			CBOs	Medium
			Drainage Cleaners	Low
			Children	Low
			Elderly	Low
			Citizens	Low
			Media	Medium
			Schools & Colleges	Medium
			Religious Institutions (mosque, temple)	Medium
			Market Union Committee	Medium
			Department of Cooperative Societies	Medium

6.4 Adaptive Capacity of Fragile Urban Systems

The adaptive capacities of the five fragile urban systems were assessed during the SLD against the five parameters of economy, technology, governance, societal and ecosystem services. The adaptive capacities in terms of societal and governance aspects are low for all systems, with little policy level interventions at the city level and lack of awareness among citizens especially with regard to solid waste management and drainage. Economic adaptive capacity is medium for all systems, since the Dinajpur Municipality has some amount of funding available for the various fragile systems. However technological adaptive capacity varies for the different systems since availability of technological resources for the systems vary for the municipality. Technological knowhow is however poor in the city and staff needs capacity building.

Table 6: Consolidated vulnerability analysis of Fragile Urban Systems identified for Dinajpur city

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
Water Supply	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading to health impacts and impacts on an economy which is dependent on water such as agriculture.	Wards 1, 2, 4, 5, 6, 10	- Slum dwellers - Women - Children - Elderly	- DPHE - Municipality - Govt. General Hospital - Private Hospitals - NGOs - LGED - Town Level Coordination Committee	- Societal - Governance - Ecosystem services	- Economic	- Technological/ Infrastructure
Biodiversity	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	Wards 1, 6	- Citizens - Farmers	- Municipality - Department of Environment - Department of Forest - Department of Livestock - Department of Fisheries - District Information	- Societal - Governance - Ecosystem services	- Economic - Technological/ infrastructure	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
				Office - Media - Town Level Coordination Committee			
Solid Waste Management	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season.	Wards 1, 3, 5, 6, all market areas	- Citizens - Sanitary Workers	- Municipality - NGOs - Department of Health - CDCs - LGED - Schools & Colleges - Media - Town Level Coordination Committee	- Societal - Governance - Ecosystem services	- Economic - Technological/infrastructure	-
Economy	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can	Wards 1, 4, 6, 9	- Farmers - Fishermen - Vendors	- Chamber of Commerce - Municipality - Department of Environment - Department	- Societal - Governance - Ecosystem services - Economic - Technological/infrastru	-	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	also increase migration to the city from surrounding areas.			of Fisheries - Department of Livestock - Business Associations - NGOs - Rickshaw Labour Union - Small & Medium Entrepreneurs - Labour Association - Town Federation - Department of Cooperative Societies	cture		
Drainage	Short duration high intensity rainfall will lead to excessive flooding due to clogged drains resulting in	Wards 1, 2, 4, 8, 10	- Children - Elderly - Citizens	- Municipality - LGED - Department of Health	- Societal - Governance - Ecosystem services	- Economic - Technological/infrastructure	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
	health hazards.			- Town Level Coordination Committee - Ward Committee - CBOs - Drainage Cleaners - Media - Schools & Colleges - Religious Institutions (mosque, temple) - Market Committees - Department of Cooperative Societies			

7. RESILIENCE INTERVENTIONS

Possible adaptation interventions were identified for the five fragile urban systems in Dinajpur 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 28 resilience interventions have been identified in the process as listed in **Table 7.** 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 7: Prioritised Resilience Interventions against Resilience Indicators

Prioritised	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 System						
Policy/ Non-Infrastructural Measures						
Prevention of encroachment on ponds and their filling up through policy level interventions	Medium	Medium	Medium term	Medium term	Low	Preservation of urban biodiversity, better drainage
Awareness generation among users like campaign, message via NGOs, etc. Municipality can make advertisements and broadcast in local TV channel; capacity building of municipal staff through trainings; campaign on keeping water pollution free and conservation of water	High	High	Long term	Short term	Low	Can be used for other systems together
Preparation of water pipeline layout plan for future distribution and planning	High	High-medium	Long term	Short term	Medium	
Infrastructural Measures						
Extension of coverage to include sub-distribution	Medium	Medium	Long term	Medium	High	
RWH to reduce pressure on	Medium	High	Long term	Short	Low	Can maintain

Prioritised	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
groundwater; Ground water recharge & reduced pressure on ground water by using surface water						water resources, soil preservation
Establishment of water treatment plant	High	Medium	Long term	Medium	High	
River dredging to increase depth for better drainage and maintaining water flow	Medium	Medium	Short term	Short	High	
Biodiversity						
Policy/ Non-Infrastructural Measures						
Development of a land use plan for the urban and peri-urban areas	High	Medium	**Long term**	Short	Medium	
Infrastructural Measures						
Afforestation with native tree species	Low	High	Long term	Short	Low	Develop habitation for birds and urban biodiversity
Limiting the development of brick kilns	Average	Low	Medium term	Medium	Medium	Improved health
Keep river water pollution free and maintain the river depth with	Medium	Medium	Short term	Short	High	Improved health

Prioritised	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
proper excavation						
Solid Waste Management						
Policy/ Non-Infrastructural Measures						
Awareness building of citizens to prevent dumping of waste onto roads; capacity building of municipal staff through trainings	High	High	Long term	Short	Medium	Can be used for other systems together
Development of an integrated Solid Waste Management Plan.	High	High	Long term	Short	Medium	
Infrastructural Measures						
Setting up of a waste processing centre and a waste recycling centre.	High	Medium	Short term	Short	High	Can generate alternate jobs, material recovery
Implement a waste collection system throughout the city ensuring 100% door-to-door collection of segregated waste.	Medium	High-medium	Long term	Short	High	Can generate alternate jobs, material recovery
Develop a sanitary landfill	High	Medium	Long term	Medium	High	Improved health
Economy						
Policy/ Non-Infrastructural Measures						
Prevent land conversion (land use change)	Medium	Medium	Long term	Long	Medium	Improved urban service delivery

Prioritised	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
Infrastructural Measures						
Use of climate resilient varieties of rice	Medium	High-medium	Short term	Short	Medium	Food security
Adoption urban farming especially in slums which use newer technologies.	Medium	High-medium	Short term	Short	Medium	Food security
Drainage						
Policy/ Non-Infrastructural Measures						
Development of drainage layout plan based on city master plan	High	High	Long term	Short	Medium	
Operation and maintenance needs to be improved	Average	Medium-high	Short term	Short	Medium	Technically competent staff
Infrastructural Measures						
Implementation of drainage layout plan	High	Medium-low	Long term	Short	High	
Installing covers over all open drains	Average	High-medium	Medium term	Short	High	Better solid waste management
Regular maintenance and cleaning of drains	Average	High	Long term	Short	Medium	Improved health
Construction of pucca drains	Medium	High-Medium	Long term	Medium	High	Improved health
Dredging and cleaning of Khagra	Average	Medium	Short term	Medium	High	

Prioritised	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
canal						
Removal of illegal occupants of the canal to increase the space of the canal	Average	Medium	Short term	Medium	Medium	
Installation of more dustbins to prevent people from throwing waste in the drains	Medium	High-medium	Medium term	Short	High	

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

Water Supply

Issues:	The water resource in the city is being depleted because of over extraction of ground water and reaches only 20 percent of households in the form of piped water supply	
Potential Climate Impacts:	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, water resources in the city will be under greater stress, leading to health impacts and impacts on an economy which is dependent on water such as agriculture.	
Potentially Impacted Areas:	Wards 1, 2, 4, 5, 6, 10	
Risk Status:	High	
Actors:	Vulnerable Actors - Slum dwellers - Women - Children - Elderly	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Awareness generation among users like campaign, message via NGOs, etc. Municipality can make advertisements s and broadcast in local TV channel; capacity building of municipal staff through trainings; campaign on keeping water pollution free and conservation of water	Cost of IEC materials, publications, materials, trainings, meetings, staff costs, logistics	USD 2500 for technical training of 30-50 people
Infrastructural Measures		
RWH to reduce pressure on groundwater; Ground water recharge & reduce pressure on ground water by using surface water	Civil and construction costs, labour, materials, staff costs, training, meeting	USD 10000 per unit

Biodiversity

Issues:	Biodiversity loss is seen throughout the city with reduction in species of birds, animals, and fish due to loss of habitat	
Potential Climate Impacts:	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	
Potentially Impacted Areas:	Wards 1, 6	
Risk Status:	Medium	
Actors:	Vulnerable - Citizens - Farmers	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Development of a land use plan for the urban and peri-urban areas	Cost of consultants, materials, meetings, trainings	USD 15000 to develop the plan
Infrastructural Measures		
Afforestation with native tree species	Cost of trees, labour, materials, staff costs, training	USD 20000 per plantative drive

Solid Waste Management

Issues:	Solid waste management is under stress from indiscriminate dumping of waste and poor collection facilities	
Potential Climate Impacts:	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can affect drainage causing health hazards and water logging in the rainy season.	
Potentially Impacted Areas:	Wards 1, 3, 5, 6	
Risk Status:	High	
Actors:	Vulnerable - Citizens - Sanitary Workers	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Awareness building of citizens to prevent dumping of waste onto roads; capacity building of municipal staff through trainings	Cost of IEC materials, publications, materials, trainings, meetings, staff costs, logistics	USD 2500 for technical training of 30-50 people
Infrastructural Measures		
Implement a waste collection system throughout the city ensuring 100% door-to-door collection of segregated waste.	Cost of collection equipment, route planning, cost of vehicles, labour, staff costs, training	A detailed project report needs to be prepared to establish the collection system in the city.

Economy

Issues:	Agriculture, fishery and fruit orchards are important in providing economic support to the urban poor, the landless and middle class land owners. Food security of the city is also highly dependent on the local agricultural products	
Potential Climate Impacts:	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase migration to the city from surrounding areas.	
Potentially Impacted Areas:	Wards 1, 4, 6, 9	
Risk Status:	High	
Actors:	**Vulnerable** - Farmers - Fishermen - Vendors	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Infrastructural Measures		
Adoption urban farming especially in slums which use newer technologies.	cost of trainings, materials, labour, equipments	A detailed project report needs to be made for each slum. Approximate cost is

		about USD 10000 per slum and training of 25 people

Storm Water Drainage

Issues:	Water in drains has no outlet leading to permanent water logging in the city	
Potential Climate Impacts:	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will lead to excessive flooding due to clogged drains resulting in health hazards.	
Potentially Impacted Areas:	Wards 1, 2, 4, 8, 10	
Risk Status:	High	
Actors:	**Vulnerable** - Children - Elderly - Citizens	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Operation and maintenance of drainage system needs to be improved	Cost of training, cleaning equipments, labour, materials	Approx USD 1500 per drain. A detailed assessment is required for cost estimation.
Infrastructural Measures		
Installing covers over all open drains	Cost of materials, labour, trainings	A detailed project report is required for assessment of costs. Approximate costs are USD 25 per meter of drain.

8. CONCLUSION

The implementation of the IAP toolkit in the city of Dinajpur revealed that the city is very vulnerable to projected climate change impacts of higher temperatures and decreased but short duration, high intensity rainfall. The city needs to adapt to possible impacts of the same. The economy is largely agrarian 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. Five urban systems were identified as fragile - water supply, biodiversity, solid waste management, economy and drainage - and climate fragility statements were formulated for all of them corresponding to the two climate scenarios.

In Dinajpur, ward 1 was identified as the vulnerable hotspot and was affected by all five urban systems. Ward 6 is affected by four urban systems followed by ward 4 which is affected by three urban systems. These wards are located towards the outer areas of the city and have population dependent on agriculture as well as poor drainage.

Dinajpur Municipality and government departments like the Department of Environment, Department of Forests, Department of Livestock, Department of Fisheries, Department of Agricultural Extension, Department of Public Health and Engineering (DPHE) scored high to medium since they have financial resources, trained staff and technical knowledge as well as access to information. They can serve as supporting actors for resilience building for the municipality by collaborating with it and building capacity of the municipal staff so that they are able to tackle the impacts of climate change. NGOs, Cooperatives, Town Level Coordination Committees, as well as business associations and private schools and hospitals scored medium because of their access to financial and technical resources and ability to respond. Residents have low adaptive capacity since they lack financial and technical resources as well as access to adequate information to take action on climate change.

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. Dinajpur 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:

- **Awareness and Capacity Building:** The citizens and municipal staff both require capacity building initiatives so that they can work on climate change on relevant sectors.

- **Collaborative action:** Municipality needs to collaborate with local, national and international NGOs as well as civil society to promote resilience building actions and solicit public support for a resilient city development. This can also help the city procure funds for crucial work that cannot be conducted with municipality's own funds.

- **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.

- **Land use plan:** A good land use plan needs to be established and implemented so that urban service delivery can be improved, as well as natural habitats can be preserved for resource 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 and Climate Fragility Statement

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Fragility statement	Climate Fragility Statement
Water Supply	Ground water is the main source for water supply. Only 20-25 percent households are covered with piped water supply; Though the city has two water treatment plants (especially for iron treatment) only one is in functional stage.	Only 20 percent households are covered with municipal water supply network as a result majority of the households are dependent on ground water leading to declination of water table	The water resource in the city is reducing because of extraction of ground water; only 20 percent city is covered with piped water supply	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, the water resource in the city will be under greater stress, leading to health impacts and impacts on economy dependent on water such as agriculture
Biodiversity	Number of birds, bats, frogs, squirrels, snakes – have been decreased due to habitat loss. Ponds are getting dry due to encroachment resulting loss of fishes. Local orchards are also lost	At present the different species of birds, animals, and fishes are decreased due to rapid urbanisation, deforestation and loss of habitat. Population of migratory birds are also declined.	Biodiversity loss is seen throughout the city with reduction in species of birds, animals, and fish due to loss of habitat.	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanization that will further reduce urban biodiversity.

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Fragility statement	Climate Fragility Statement
Solid Waste Management	Open dumping of mixed municipal solid waste. Dumping site is already exhausted now. City does not practice source segregation. City does not have Scientific landfill site.	Lack of Processing facilitate and public awareness result indiscriminate dumping of waste.	Solid waste management is under stress from indiscriminate dumping of waste and poor collection facilities	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can lead to improper drainage and health hazards to population by water logging in rainy season
Economy	Urban poor and landless are dependent on agriculture, fishery, fruit cultivation as agricultural labour.	Economy of the city is dependent on agriculture, fishery and fruit cultivation which are highly vulnerable to the climate change. Climate change can indirectly impact on income of the urban poor.	Agriculture, fishery and fruit orchards are important in providing economic support to urban poor. Middle class is also dependent on agriculture and own land. It is also important to meet food sustainability of the city.	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Overall decline in fishery is being

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Fragility statement	Climate Fragility Statement
				seen. Agricultural land lost due to river bank erosion.
Drainage	Dumping of solid waste in storm water drains leads blockage of drains resulting urban flooding. Only 1/3 city is covered by storm water drains		Water in drains has no outlet leading to permanent water logging	Increasing temperature and decreasing rainfall (short durtaion high intensity rainfall) will lead to excessive flooding due to clogged drains leading to health hazards.

Annexure-2

Climate Risk Statements		Likelihood	Consequence	Risk score (Likelihood X Consequence)	Risk Status
Urban System	**Impacts of Climate Change**				
Water Supply	With increasing temperature and decreasing rainfall (short duration high intensity rainfall) in the region, the water resource in the city will be under greater stress, leading to health impacts and impacts on economy dependent on water such as agriculture	4	3	12	**High**
Biodiversity	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity.	3	3	9	**Medium**
Solid Waste Management	Increasing temperatures and decreasing rainfall (short duration high intensity rainfall) may cause waste to decompose in open dumps creating health hazards; choking of drains can lead to improper drainage and health hazards to population by water logging in rainy season	4	4	16	**High**
Economy	Increasing temperature and decreasing rainfall (short duration high intensity rainfall) will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Overall decline in fishery is being seen. Agricultural land lost due to river bank erosion.	4	3	12	**High**
Drainage	Increasing temperature and decreasing rainfall short	4	3	12	**High**

Climate Risk Statements		Likelihood	Consequence	Risk score	Risk Status
	duration high intensity rainfall) will lead to excessive flooding due to clogged drains leading to health hazards				