City Resilience Strategy

Singra 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

Singra'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.

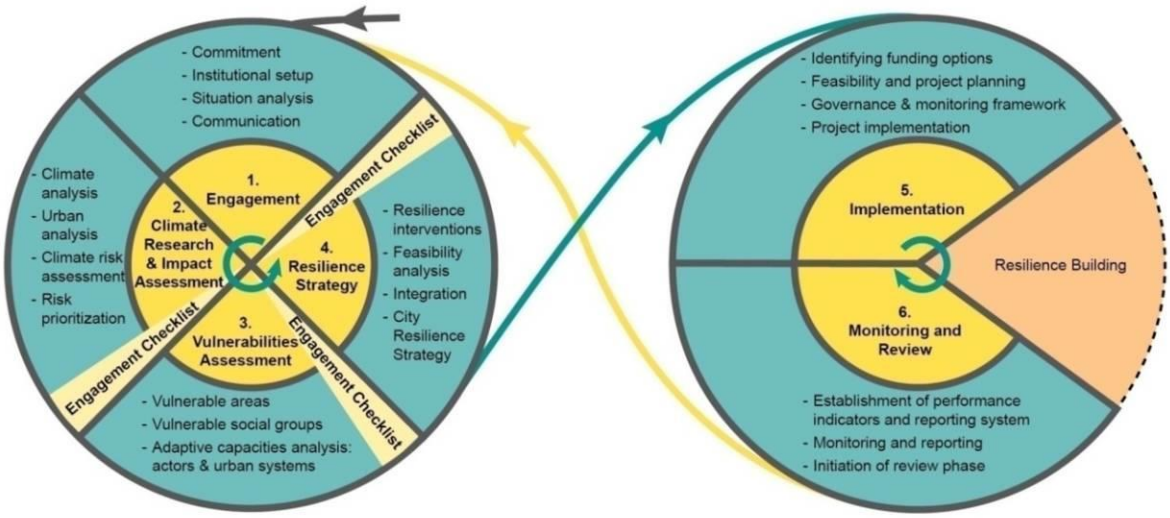

Figure 1: ICLEI ACCCRN Process

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 ACCRN Process (IAP) in Singra City

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

To initiate the IAP, municipal engineers, councillors and other representatives from Singra Municipality, were oriented on the fundamentals of urban development and climate resilience. Simultaneously, members for the Climate Core team and the Stakeholder committee were identified in consultation with the Mayor, Secretary and Municipal Engineer of the Singra 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 Resource Management, (ii) River Plain Management, (iii) Storm Water Drainage, (iv) Solid Waste Management and (v) Sanitation.

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

Through another SLD, 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 Singra. Interlinkages of these resilience interventions with on-going and planned projects were established and further integration into existing city-level plans was explored.

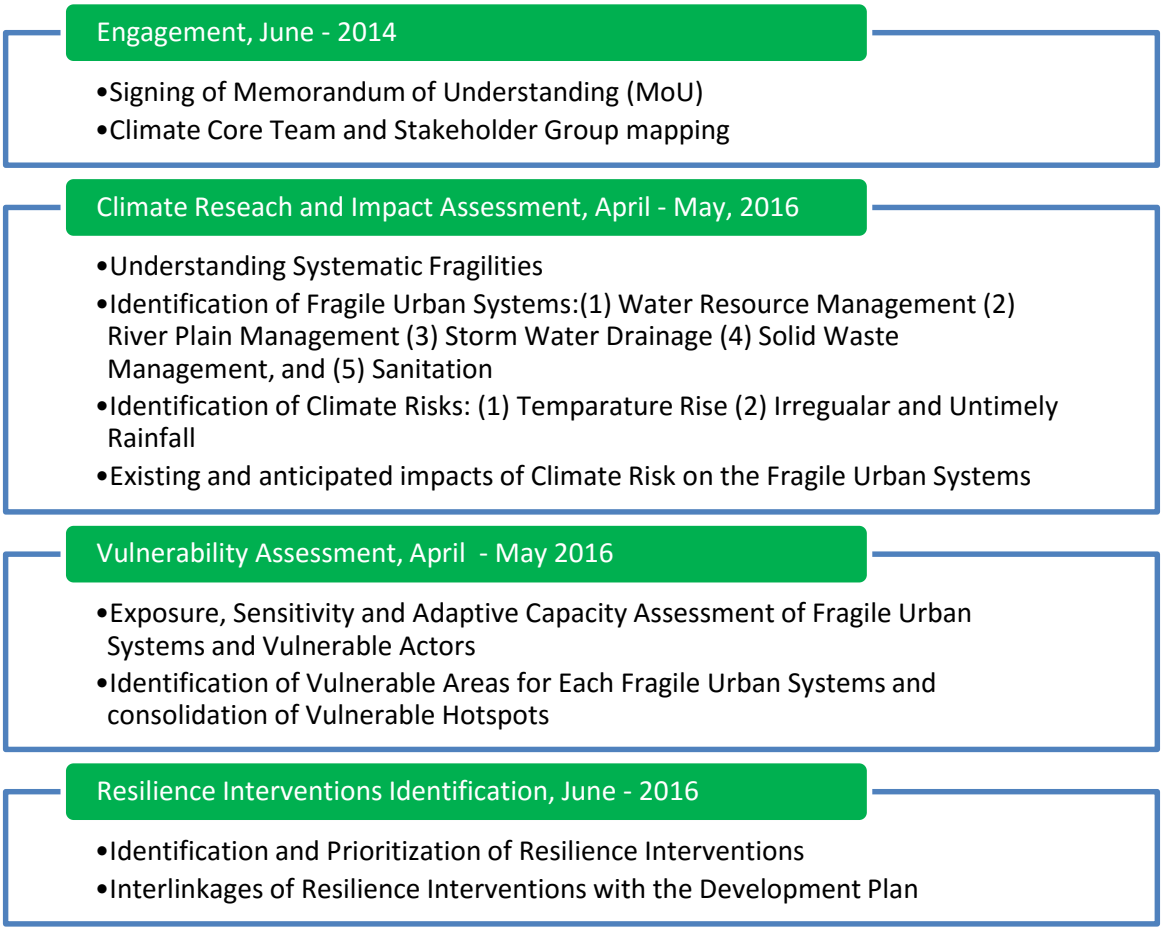

Figure 2: Methodology of IAP in Singra

By implementing this City Resilience Strategy, the Singra Municipality can develop a more resilient city.

2. CITY PROFILE

Singra is a municipality in Natore district in the division of Rajshahi, Bangladesh. The city is surrounded by the historic Chalan Beel and intersected by Natore-Bogra highway in east-west direction. Markets and development activities take place mainly along this highway.

2.1 Location

Singra Municipality is located between 24°24´ and 24°41´ North latitudes and between 89°03´ and 89°20´ East longitudes, located within the flood plain of Atrai River. Singra also falls within the undulating Barind land.

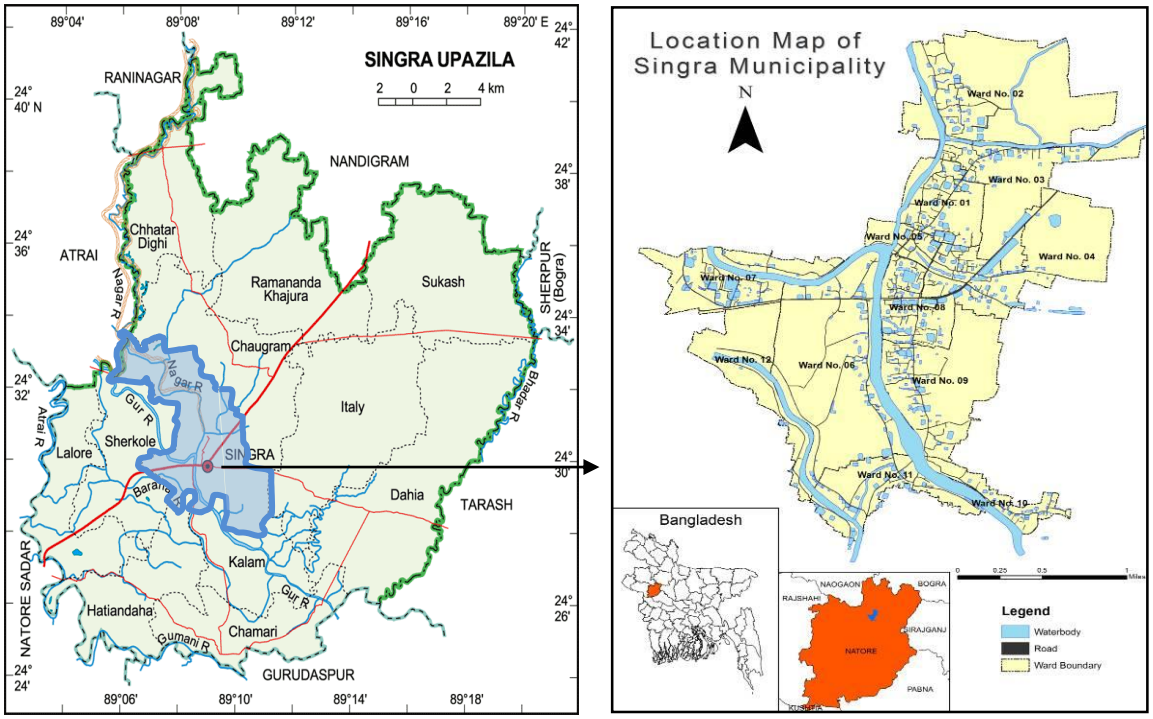

Figure 3: Location of Singra Municipality

2.2 Demography

According to Bangladesh Bureau of Statistics (BBS) population census 2011[7], the population of Singra Municipality was 33,192 including 16,682 males and 16,510 females. Number of total households was 7,894. The population density was 3,034 persons/ sq. km. with ward 4 and 10 being the most and least populous ward respectively. The following table (Table 2) represents the ward wise population and population density of Singra Municipality.

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

Ward No.	Area of Ward (sq.km.)	Total Population	No. of Households	Population Density (Persons/sq.km.)
1	0.57	2952	660	5170
2	1.83	2705	657	1479
3	0.92	2932	641	3174
4	1.21	4734	1090	3914
5	0.21	1909	468	8979
6	2.11	2414	649	1143
7	0.78	2742	685	3520
8	0.50	4730	1124	9451

[7]http://www.bbs.gov.bd/

Ward No.	Area of Ward (sq.km.)	Total Population	No. of Households	Population Density (Persons/sq.km.)
9	1.12	3343	794	2998
10	0.26	1248	313	4751
11	0.70	2041	485	2917
12	0.73	1442	328	1984
Total	**10.94**	**33192**	**7894**	**3034**

Among the total households, the percentages of type of structure are pucca 34.3%, semi-pucca17.8%, kutcha 46.00% and jhupri 2.00%. The percentages of toilet facility are sanitary (with water seal) 37.90%, sanitary (no water seal) 40.00%, non-sanitary 17.80% and none 4.2%.

2.3 Economy and Employment

Economy of Singra city is largely dependent on agriculture and small retail business. The retailers mostly collect their goods from markets located in ward 5 & 8.There are a number of rice processing and saw mills in the city area. So, a majority of the population (42.46%) is involved in agricultural activities.23.98% households are involved in small retail businesses, 2.05% are employed in government/autonomous organization, 2.05% are employed in private organization, and 31.39% are involved in informal activities. About 0.6% of the working force is unemployed in Singra city.

2.4 Municipal Administration

Singra Municipality was constituted in the year 1999 and regulates most of the civic functions and services in the city. At present, the Municipality consists of an elected body comprising of a Mayor, 12 male Councillors, and 4 female Councillors (for the reserved seats), who are responsible for all policy decisions. The Chief Executive Officer (CEO) is the head of municipal administration and is responsible for the functioning of the Municipality including tax collection, estates maintenance, projects, among other things. However, that position is vacant and has not been filled by the central government. The Municipality provides and maintains services which include water supply, solid waste management, street lighting, cleaning of sewerage and drains, and health and family planning services. It also controls, develops and maintains markets, streets and other city structures.

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

a) **Local Government Engineering Department –** responsible for preparing city master plan, construction of roads, culverts etc.

b) **Department of Public Health Engineering –** responsible for conducting survey to find out the water contamination level like arsenic and its solution in the area.

c) **Bangladesh Rural Electrification Board –** provides electricity on the basis of their master plan to the residents and commercial establishment on priority and their capacity basis.

d) **Upazila Agriculture Office –** promotes subsidy for betterment of farmers, distributes fertilizer to the poor farmers, and often arranges trainings for farmers on modern techniques of cultivation.

e) **Upazila Fisheries and Livestock Office –** distributes fertilizers for fish and vaccination of poultry and other livestock. Sometimes takes initiative for afforestation and distribution of saplings.

3. PAST HAZARDS AND CLIMATIC EVENTS

Singra city is located within the flood plain of Atrai and Gurnai River and Barind land. The city area is comparatively low lying and below flood level. Flooding in the area usually occurs due to the over flow of the rivers Atrai and Gurnai. Peripheral areas of the municipality are comparatively low lying and flood each year during the monsoon. The city experienced severe flooding in 1988, 1998 and 2011.

Swirling waters from the Atrai River submerged a 10 km swathe in Singra upazila in Natore district in 2003 and led to the collapse of the Bangladesh Water Development Board (BWDB) embankment. As per BWDB, 35 villages went under water as the Madanbhanga embankment at Shuktihata broke[8].

Over 200 thatched and tin-roofed houses were damaged by a violent storm in five upazilas of Natore district on 22th April, 2015 at night. The storm lasted for two hours, also damaged crops at the affected villages in Natore Sadar, Singra, Gurudaspur and Naldanga upazilas. It uprooted trees and electric poles, disrupting power supply to the upazilas[9].

Details of three major hydro-meteorological and geological hazard events in Singra (city, upazila and district level) are highlighted in Table 3 below.

Table 3: Three Major Disaster Events in the past 30 years

Event	Year	Impact	Affected Area
Tornado	2007	17 families have been affected due to this Tornado.	Kalinagar of Kalam union of Singra upazila.
Flood	2011	Damaged 150 feet flood protection embankment at the place of Taranagar near the river Atrai on July 5, 2011. About fifty thousand people were marooned and thatched houses were in threat and the seed beds of Aman and jute fields went under water.	21 villages of Atrai upazila and five hundred villages of Singra upazila in Natore and Bagmara upazila of Rajshahi were flooded.
Nor'wester	2013	At least 50 people were injured and several hundred houses damaged as a nor'wester lashed Singra upazila of the district on Saturday (March 30, 2013)	The storm lashed 40 villages under Lalor, Sherkol, Hatiyandaho, Tazpur, Kalom, Itali and Dahia union parishads in Singra upazila.

[8] http://archive.thedailystar.net/2003/07/17/d3071701022.htm
[9] http://www.observerbd.com/2015/04/23/85162.php

Event	Year	Impact	Affected Area
		evening. Vast boro fields were damaged and hundreds of trees were uprooted.	

It is to be noted that due to siltation, illegal occupation and cultivation on the riverbed the incidence of flooding in Singra has greatly increased in recent years.

4. CLIMATE SCENARIO IN THE CITY

The climate of Singra falls under a tropical monsoon climate[10]. The annual average maximum and minimum temperatures are 37.8°C and 11.2°C respectively, and annual average rainfall is 1862 mm.

4.1 Past Climate Trends

According to a report[11], since the 1960s there has been widespread warming during both the hot season (March to May) and cool season (December to February). There has been a reduction of the number of cool nights and an increase in the number of warm nights over the period 1970-2000. In terms of precipitation, there has been a small increase over Bangladesh since the 1960s.

As there are no specific regional, local or city level assessments by the government of Bangladesh, hence the past climate trends of Singra city using climate data collected from the Bangladesh Meteorological Department (BMD) have been analysed.

The graphs show that the rainfall has been showing an increasing trend overall (Figures 4-10). The increase is particularly strong after the monsoon season, which implies a shift in the monsoon seasonal rain (Figure 7-9). During the typical monsoon season (Figure 6), however, the rainfall is not showing any significant increase.

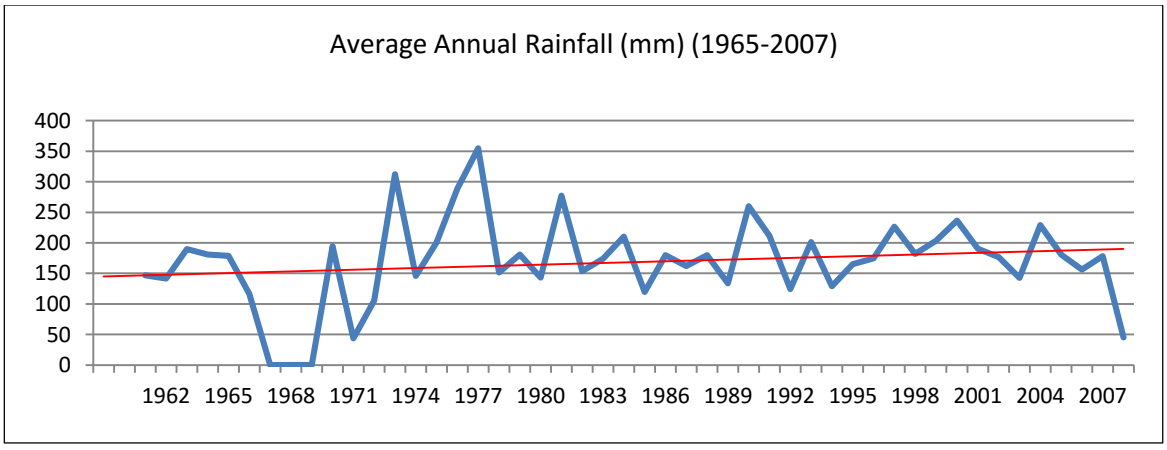

Figure 4: Average Annual Rainfall for Singra City

[10]Soil Resource Development Institute. 1997. Land and Soil Resource development Indicator of Singra Upazila, Soil Resource Development Institute, Dhaka, p.191.
[11]Met office and University of Nottingham.2011. Climate: Observations, projections and impacts: Bangladesh. Developed at the request of the Department of Energy and Climate Change. U.K. http://eprints.nottingham.ac.uk/2040/6/Bangladesh.pdf

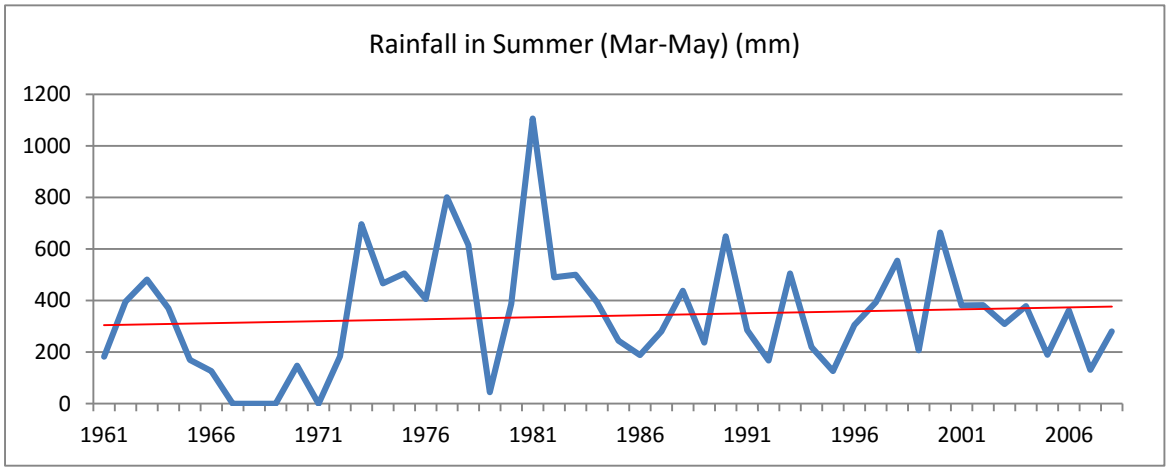

Figure 5: Rainfall in Summer for Singra City

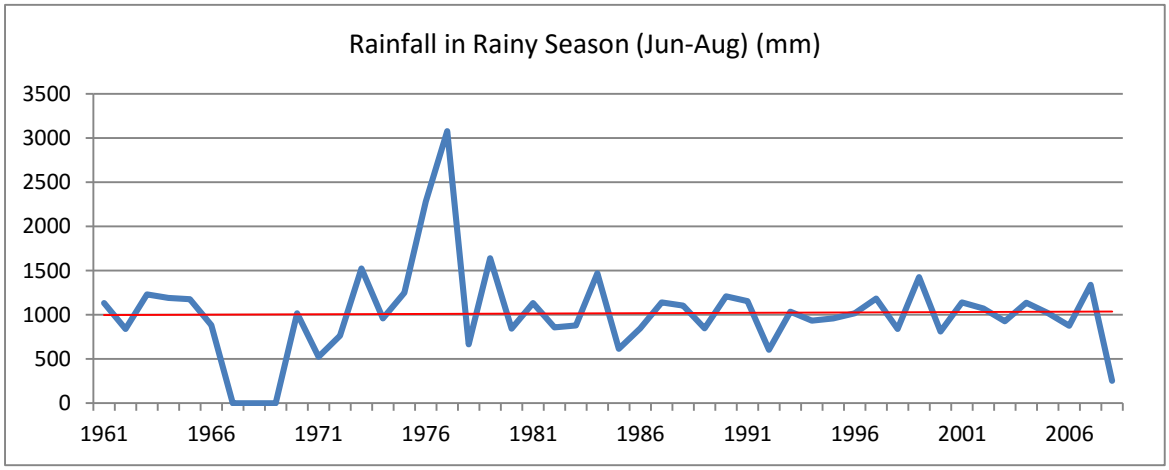

Figure 6: Rainfall in Rainy Season for Singra City

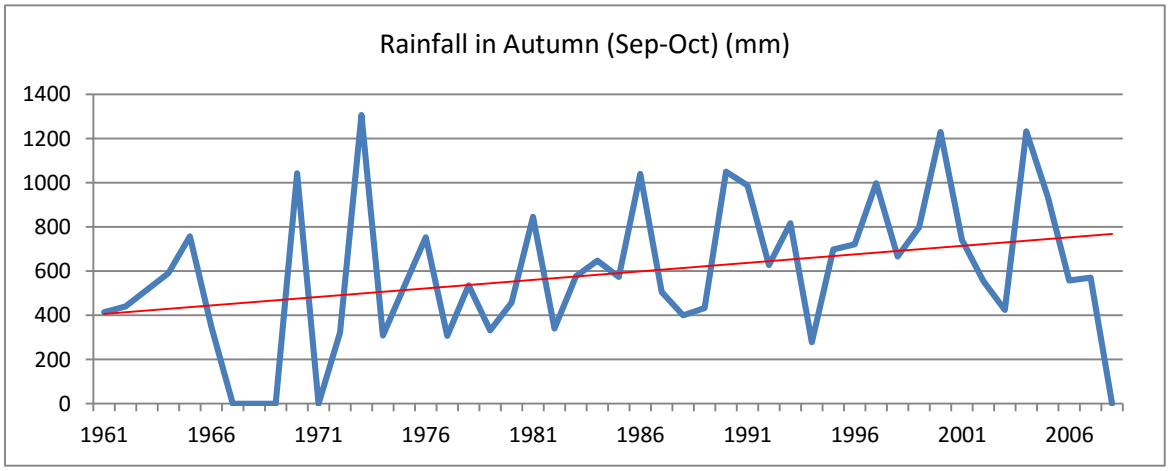

Figure 7: Rainfall in Autumn for Singra City

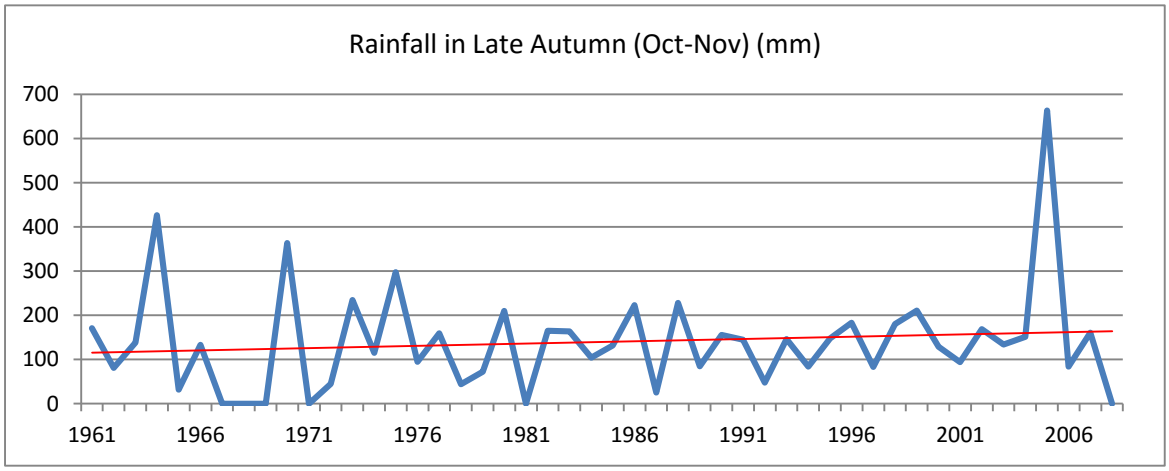

Figure 8: Rainfall in Late Autumn for Singra City

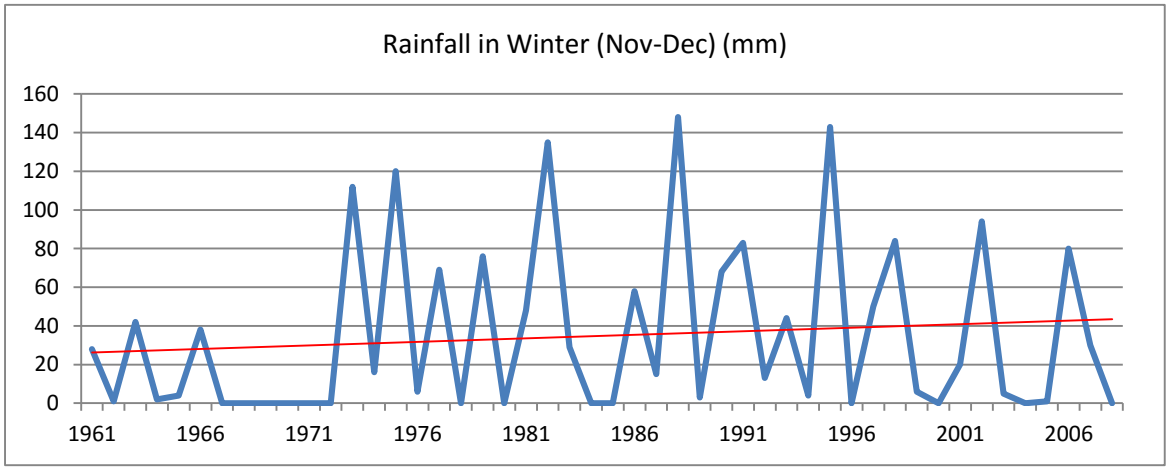

Figure 9: Rainfall in Winter for Singra City

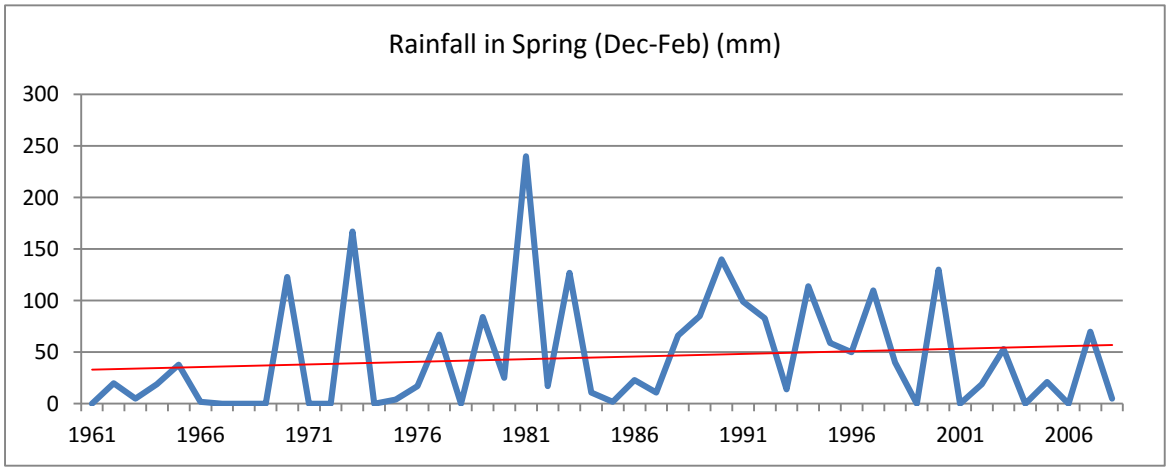

Figure 10: Rainfall in Spring for Singra City

The temperature graphs (Figure 11- 13) also show an increasing trend overall, with the maximum temperature (Figure 12) showing a clear increasing trend over the last 2 decades, while the minimum temperature (Figure 13) has remained more or less the same.

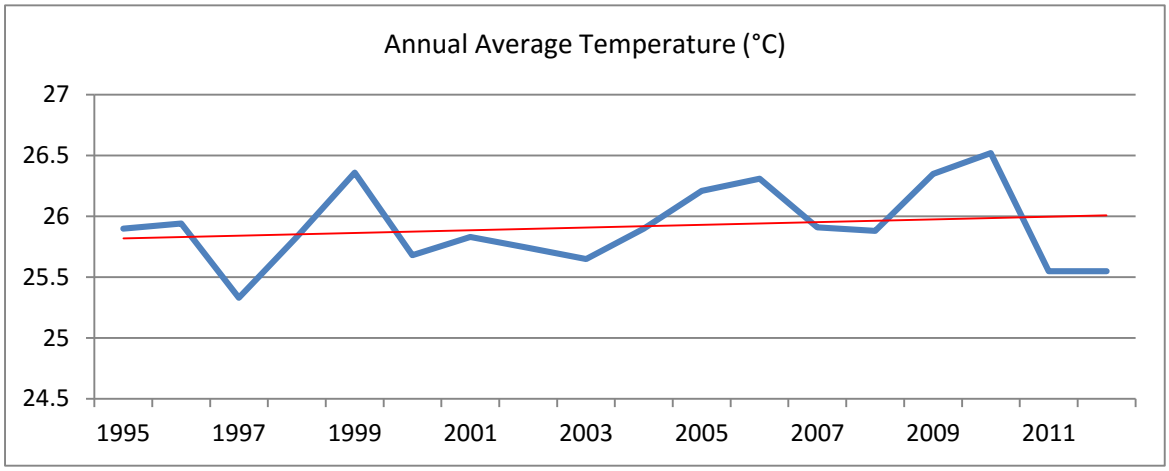

Figure 11: Annual Average Temperature for Singra City

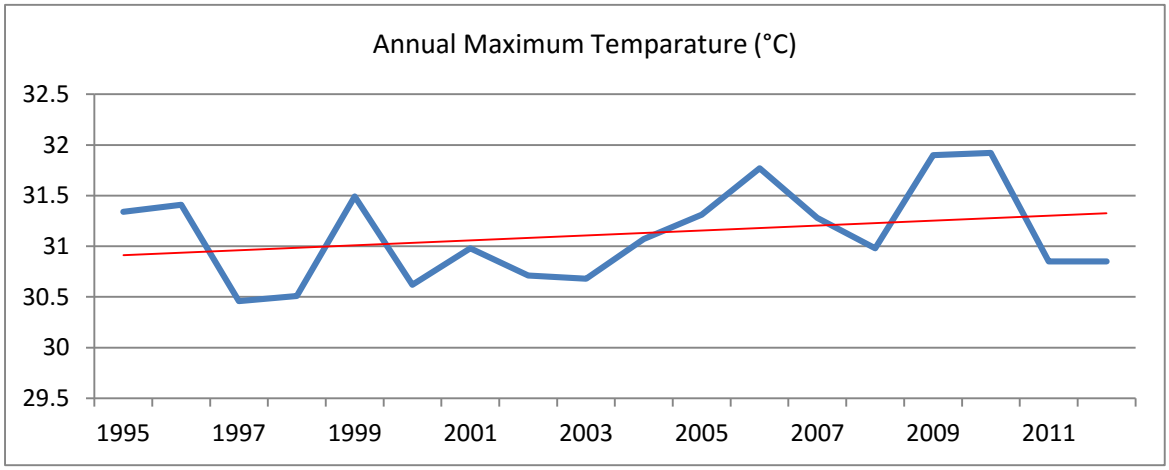

Figure 12: Annual Maximum Temperature for Singra City

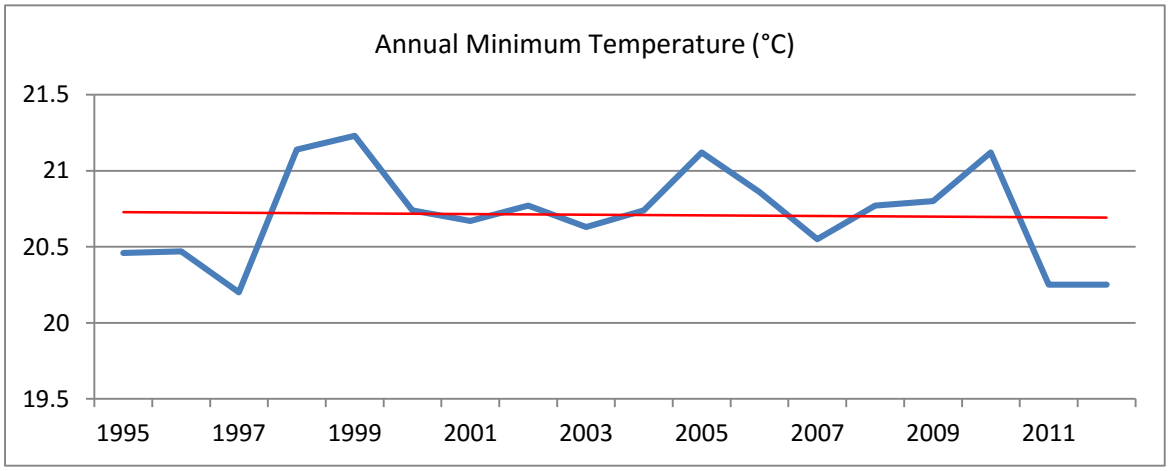

Figure 13: Annual Minimum Temperature for Singra City

4.2 Climate Change Projections and Climate Scenario Statements

Funded by the Department of Energy and Climate Change, a collaboration between the UK Met office and UK universities developed a series on climate observations, projections and impacts for

23 countries in 2011[11]. Projections for Bangladesh are taken from this document as regional level assessments are lacking.

Apart from this, the National Plan for Disaster Management (2010-2015) 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 the World Bank has been referred to[12]. The National Plan for Disaster Management used a regional climate model PRECIS for Bangladesh.

Table 6: Climate Scenario Statement

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Precipitation change	Regional Assessment[11]	Bangladesh is projected to experience increases in precipitation. Increases of up to 20% could occur in the north of the country with more general increases of 5-10% through the rest of the country.
	National Assessment[12]	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. There will be an increase in the amount of run-off, and rainfall intensity.
Temperature change	Regional Assessment[11]	For the A1B emissions scenario projected temperature increases over Bangladesh are in the region of 3 to 3.5°C by 2100.
	National Assessment[12]	Mean temperatures across Bangladesh are projected to increase between 1.4°C and 2.4°C by 2050 and 2100, respectively.

These observations are also corroborated by the observations of the Stakeholder Committee in Singra. The Committee claims that temperatures have been felt to be rising over the years in Singra and rain fall patterns show changes. Rainfall has become irregular and unseasonal.

The two main climate risks identified for Singra are:

Climate risk 1: Increase in temperature

Climate risk 2: Irregular and unseasonal rainfall

[12]World Bank Group. 2011. Vulnerability, Risk Reduction and Adaptation to Climate Change, Climate Risk and Adaptation Country profile, World Bank, Global Facility for Disaster Reduction and Recovery, Climate Investment Funds.

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

(i) Water Resource Management

(ii) River Plain Management

(iii) Storm Water Drainage

(iv) Solid Waste Management

(v) Sanitation

5.1 Urban Systems Analysis

5.1.1 Water Resource Management

Situation Analysis

Singra city is located in the Chalan Beel area which is a wetland into which flow forty seven rivers. A larger part of population is engaged in agriculture and fisheries in this wetland area. Recently it is observed that increasing temperatures in summer and irregular rainfall are contributing to an increase in the incidence of drought. The Beel has shrunk down to 78 sq km and the earth around it is showing deep cracks[13].

A majority of the hand pumps are not functional because of lowering levels of water, resulting in a serious drinking water crisis. Tube-wells are drying up[14]. The Department of Agricultural Extension (DAE) found that many pumps are lying in disuse due to a fall in the ground water level and that farmers are trying to excavate deeper and deeper into the earth in a bid to extract water. Siltation, illegal occupation, and the indiscriminate use of fertilizers are reducing the water flow and water quality of rivers that flow into the Beel.

The Department of Public Health Engineering (DPHE) has cautioned the use of underground water stating that extraction must be kept within safe limits, rain water must be stored, and production capacity of water treatment systems must be increased to solve the crisis.

Fragility Statement and Climate Fragility Statement

Water resources in the city are depleting at a rapid pace due to pollution, encroachment, indiscriminate use and poor management. The water availability is further affected by an increase in seasonal drought creating a drinking water crisis in the city.

The climate fragility statements for Water Resource Management are:

"Climate Risk 1: Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation."

[13] http://www.weeklyholiday.net/env.html
[14] http://dailyasianage.com/news/15765/falling-water-level-causes--chalan-beel-farmers-worry

"Climate Risk 2: Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy."

5.1.2 River Plain Management

Situation Analysis

The land use pattern of Singra and its Beel areas are rapidly changing due to an increasing population. Construction of civic infrastructure like roads and flood embankments, levelling of the Beel in order to cultivate, the mushrooming of houses and booming real estate is resulting in deleterious modification to the Chalan Beel. Due to changes in the original shape, size and depth[15], the capacity of Chalan Beel to store water is compromised. During the monsoons, it fails to hold the excess volume of water, consequently flooding the entire area.

Fragility Statement and Climate Fragility Statement

Construction of roads and bridges, siltation, and illegal encroachment of river beds are changing land use patterns and reducing the recharge of ground water causing floods, increased water scarcity and potential health risks within the municipal area.

The fragility statement for this urban system is

'River plains in the region are being encroached upon for construction of roads, embankments and real estate thereby impacting the ground water recharge of the region as well as polluting seasonal flood water that is important for agriculture'.

The climate fragility statement for this system is:

"Climate Risk 1: Irregular and unseasonal rainfall will result in flooding of encroached areas, that will lead to loss of property and environmental damage to water resources."

5.1.3 Storm Water Drainage

Situation Analysis

The total length of constructed drains in the municipality of Singra is 4km of concrete and 1 km of *kachha* drains[16]. Hence drainage of Singra city is mainly dependent on 2 rivers and 4 canals. Being a low lying area prone to flooding, drainage impacts the citizens even more critically.

The limited coverage, construction design faults, inadequate maintenance, and the poor capacity of the municipality with respect to storm water drainage results in regular water logging during monsoons, especially in wards 4, 5 and 8. The drains are not properly connected with the greater outfall channel and are often blocked by solid waste impairing their ability to discharge storm water. Citizens report that their areas remain waterlogged sometimes for 5 to 7 days.

Fragility Statement and Climate Fragility Statement

[15]Alam, M. S. 2013, Sustainable Land Management: Policy Implication and Sectoral Achievement, PhD Thesis, Institute of Environmental Science, University of Rajshahi. Rajshahi.
[16]Municipality of Singra. 2012. Siingra Municipality: At a Glance. http://www.singramunicipality.com/

The existing drainage system is insufficient to cater to the entire municipality of Singra and is often blocked with litter. This results in regular water logging in the city during heavy rains.

The climate fragility statement for this system is:

"Climate Risk 1: Sudden increase in rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health."

5.1.4 Solid Waste Management

Situation Analysis

In Singra Municipality there is an absence of a good solid waste management system. According to the Singra Master Plan[17] the per capita generation of solid waste is 250gm per day while the total production within the municipality is 8.29 tons per day. Solid waste is not collected at the household level. There are 12 dustbins, 3 vehicles and 6 vans for collection and storage within markets and commercial areas. This is inadequate considering the size of municipal area. There is no designated waste disposal site and the waste collected from the market and other public areas by the municipality is dumped in the low lying areas. Household waste, kitchen waste and medical waste is disposed off into roadside drains, open spaces and water bodies adjacent to houses and markets.

Fragility Statement and Climate Fragility Statement

Absence of door to door collection of waste and uncontrolled littering impacts drain management and pollutes natural water bodies.

The climate fragility statement for this system is:

"Climate Risk 1: Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging."

5.1.5 Sanitation

Situation Analysis

In Singra, sanitation system includes hanging latrines, pit latrines, water sealed latrines, and septic tank based sanitary latrine. Out of all, 19.53% of dwelling households are using sanitary latrines and 70.22% are using non-sanitary latrines, and 10.25% of households do not have latrine facilities[18]. Septic tank based latrines are mostly connected with drains which are uncovered and not managed by the municipality. As a result during rainy season, liquids overflow from septic tanks to contaminate surface water. This causes serious health risk for children and older people and for those using surface water for drinking and their daily works.

[17]Government of Bangladesh. 2011. Singra Paurashava Master Plan: 2011-2031 prepared by Local Government Engineering Department, GOB. Singra.
[18]Taken from the Bangladesh Bureau of Statistics, 2011.

Fragility Statement and Climate Fragility Statement

The city lacks coverage of toilets and requires modern management systems that can help reuse the waste to produce bio gas, bio fuels etc.

The climate fragility statement for this system is:

"Climate Risk 1: Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health."

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 Resource Management	Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation.	Extreme
	Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy.	High
River Plain Management	Irregular and unseasonal rainfall will result in flooding of encroached areas that will lead to loss of property and environmental damage to water resources.	Extreme
Storm Water Drainage	Sudden increase in rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health.	High
Solid Waste Management	Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging.	High
Sanitation	Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health	Medium

Based on this risk assessment, four fragile urban systems Water Resource Management, River Plain Management, Storm Water Drainage, and Solid Waste Management show extreme and high risk. Sanitation scored medium and can be put on a lower priority than the other four. The Water Resource Management and River Plain Management urban system which scored the highest requires most urgent attention.

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)[19] 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 14).

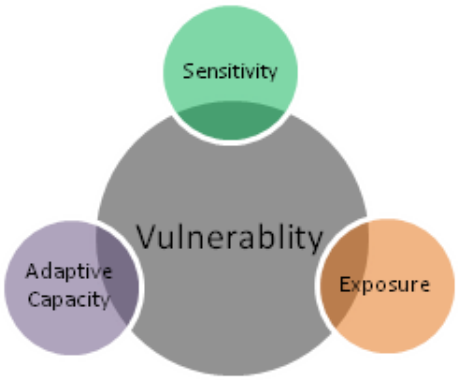

Figure 14: Vulnerability Constituents[19]

Vulnerability assessment through the IAP consists of identification of vulnerable areas and actors for all the prioritized climate fragility statements of the fragile urban systems and analysis of the adaptive capacities. Vulnerability assessment of Singra 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

[19]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.

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 Resource Management: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation.	All wards (Figure 15)
Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy.	

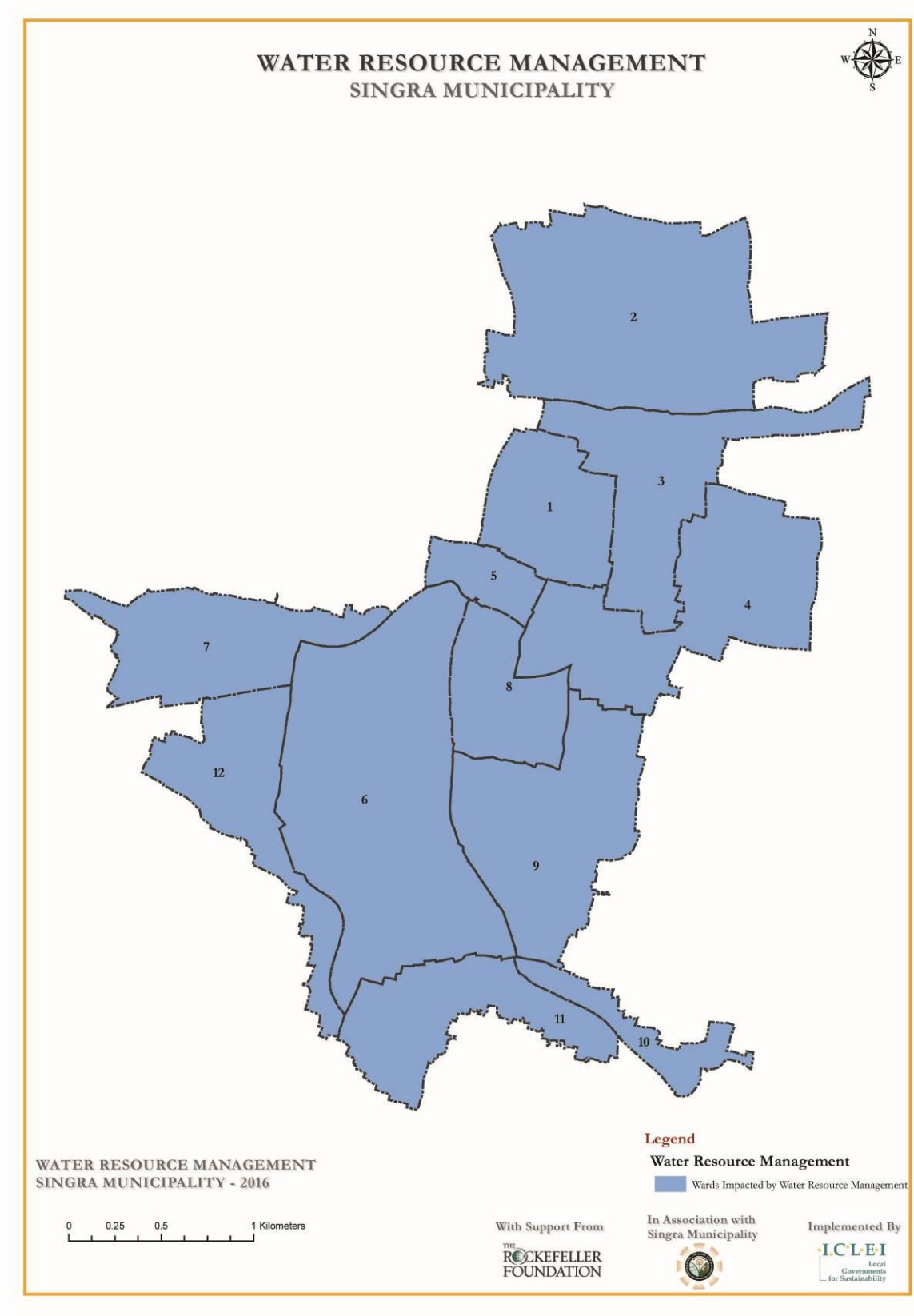

Figure 15: Wards most vulnerable to climate risks in the context of Water Resource Management, Singra

6.2.2 River Plain Management: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Irregular and unseasonal rainfall will result in flooding of encroached areas that will lead to loss of property and environmental damage to water resources.	Ward 5, Ward 6, Ward 7, Ward 8, Ward 9, Ward 10, Ward 11, Ward 12 (Figure 16).

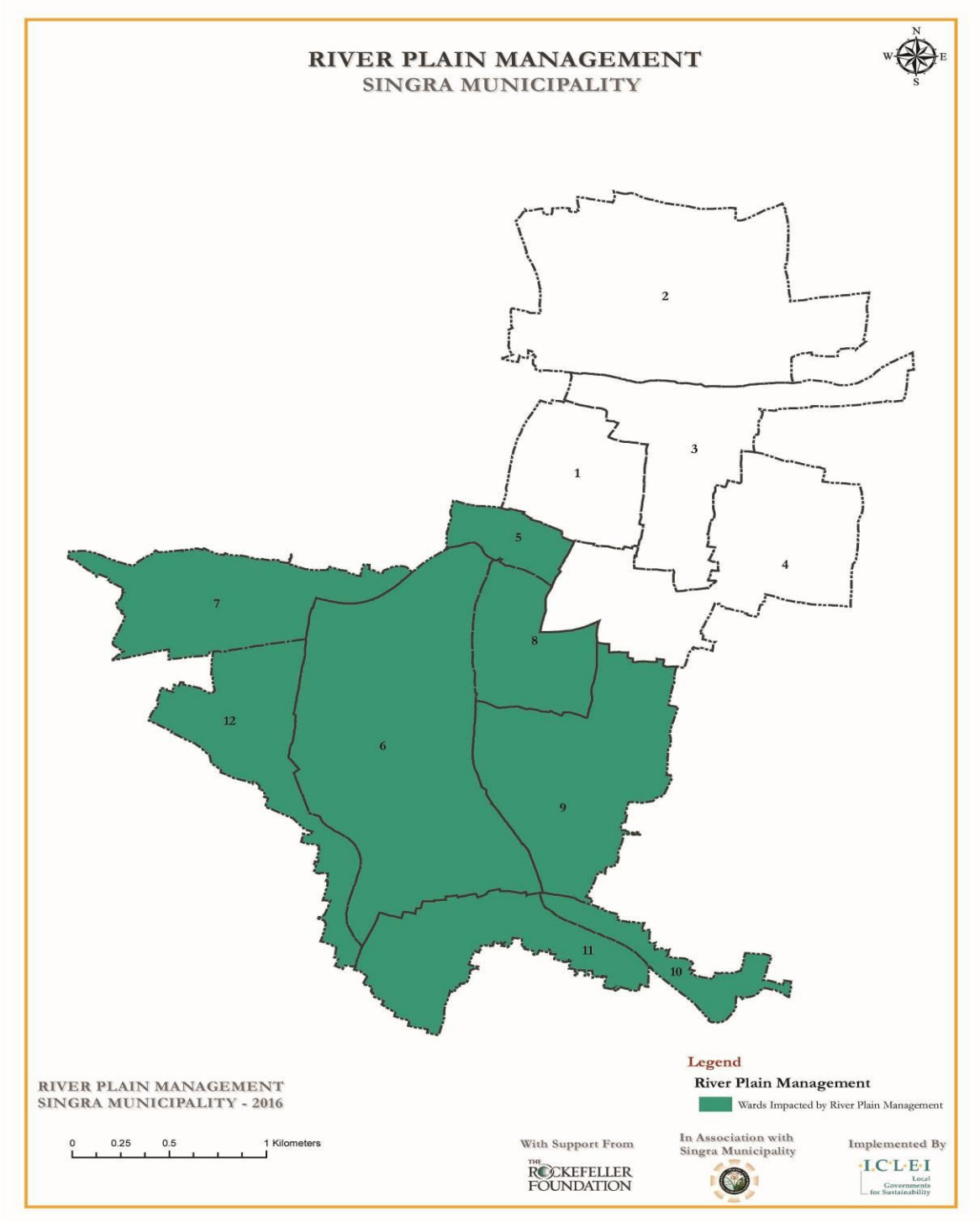

Figure 16: Wards most vulnerable to climate risks in the context of River Plain Management, Singra

6.2.3 Storm Water Drainage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Sudden increase in rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health.	Ward 4, Ward 5 (market areas) (Figure 17)

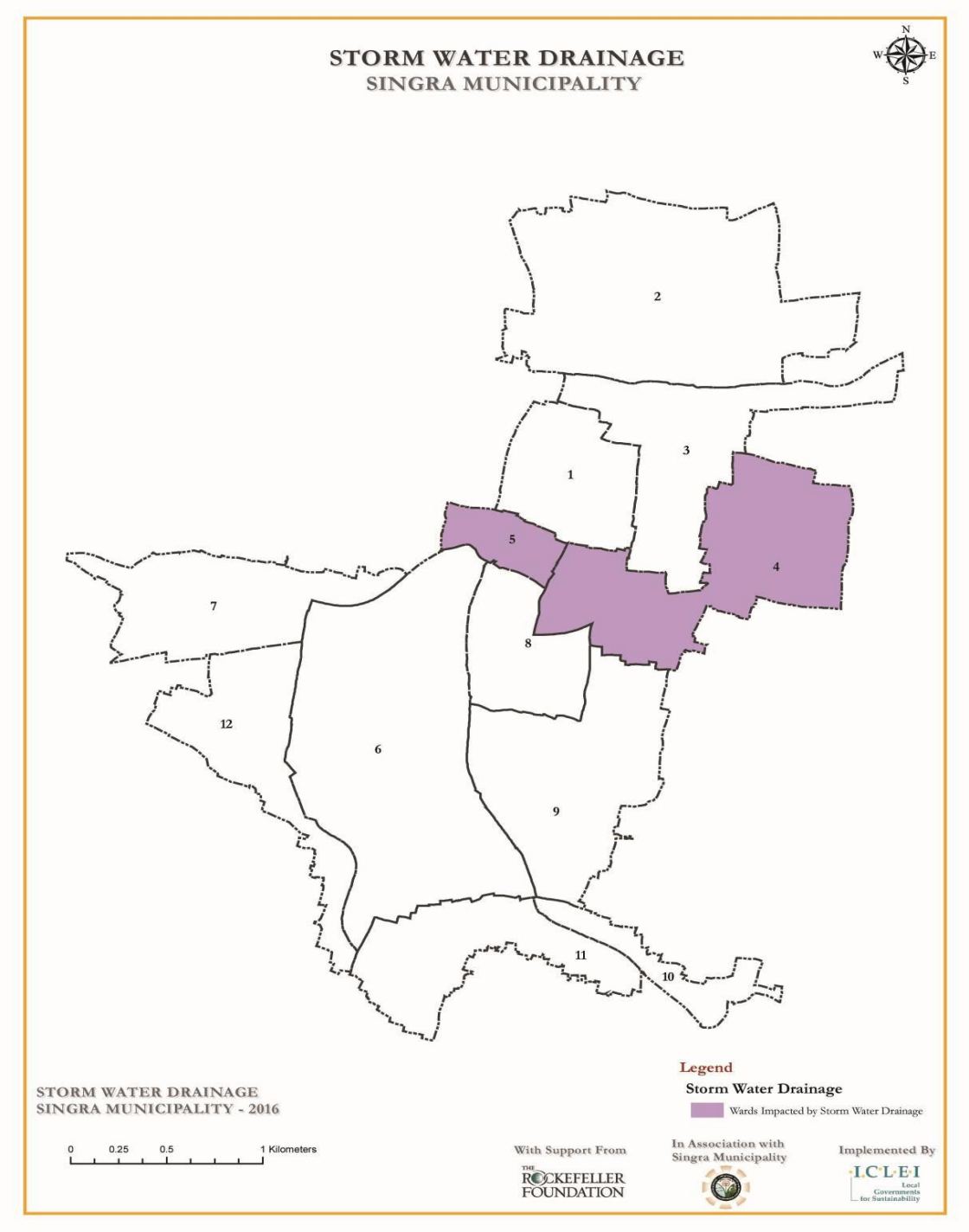

Figure 17: Wards most vulnerable to climate risks in the context of Storm Water Drainage, Singra

6.2.4 Solid Waste Management: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging.	Ward 4 (bus stand area), Ward 8 (small ponds) (Figure 18).

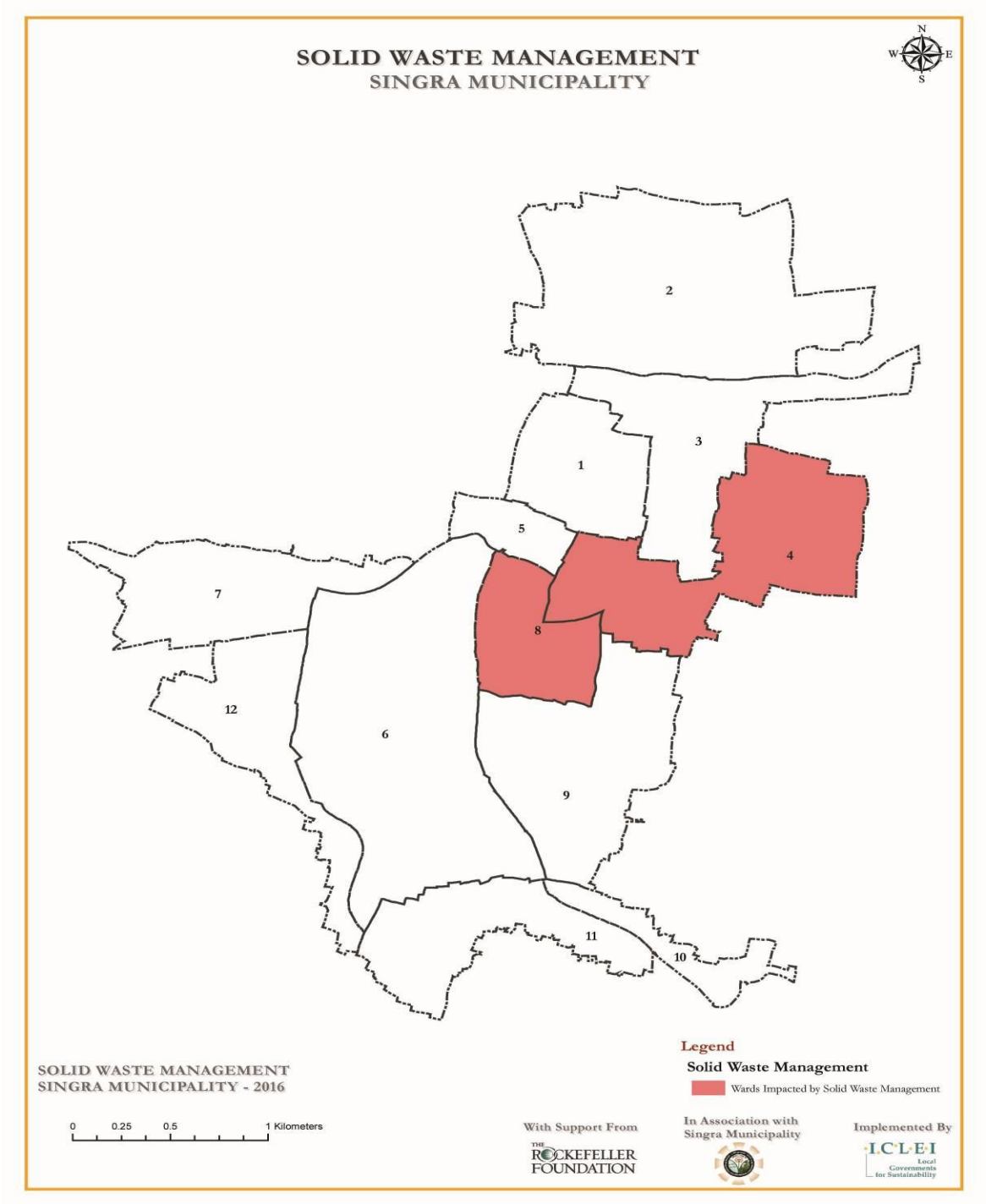

Figure 18: Wards most vulnerable to climate risks in the context of Solid Waste Management, Singra

6.2.5 Sanitation: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health.	All wards (Figure 19).

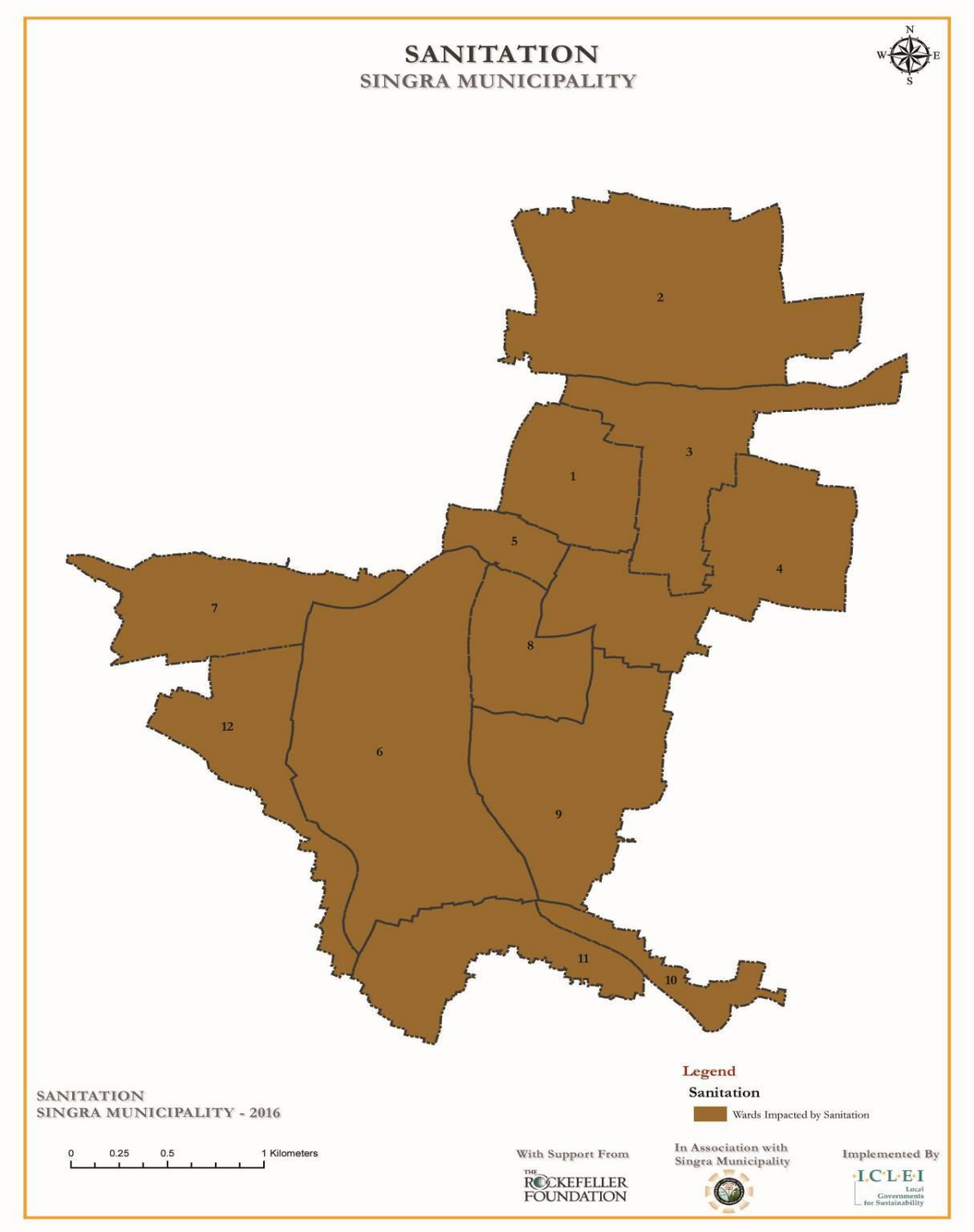

Figure 19: Wards most vulnerable to climate risks in the context of Sanitation, Singra

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.

Through these assessments, the areas found to be most vulnerable are wards 4, 5 and 8 that are vulnerable to 4 fragile urban systems out of the 5 assessed. Ward numbers 6, 7, 9, 10, 11, 12 are impacted by 3 fragile systems while the wards 1, 2 and 3 are impacted by 2 fragile systems. It is to be noted that the entire city is impacted by 2 or more fragile systems as per the assessment.

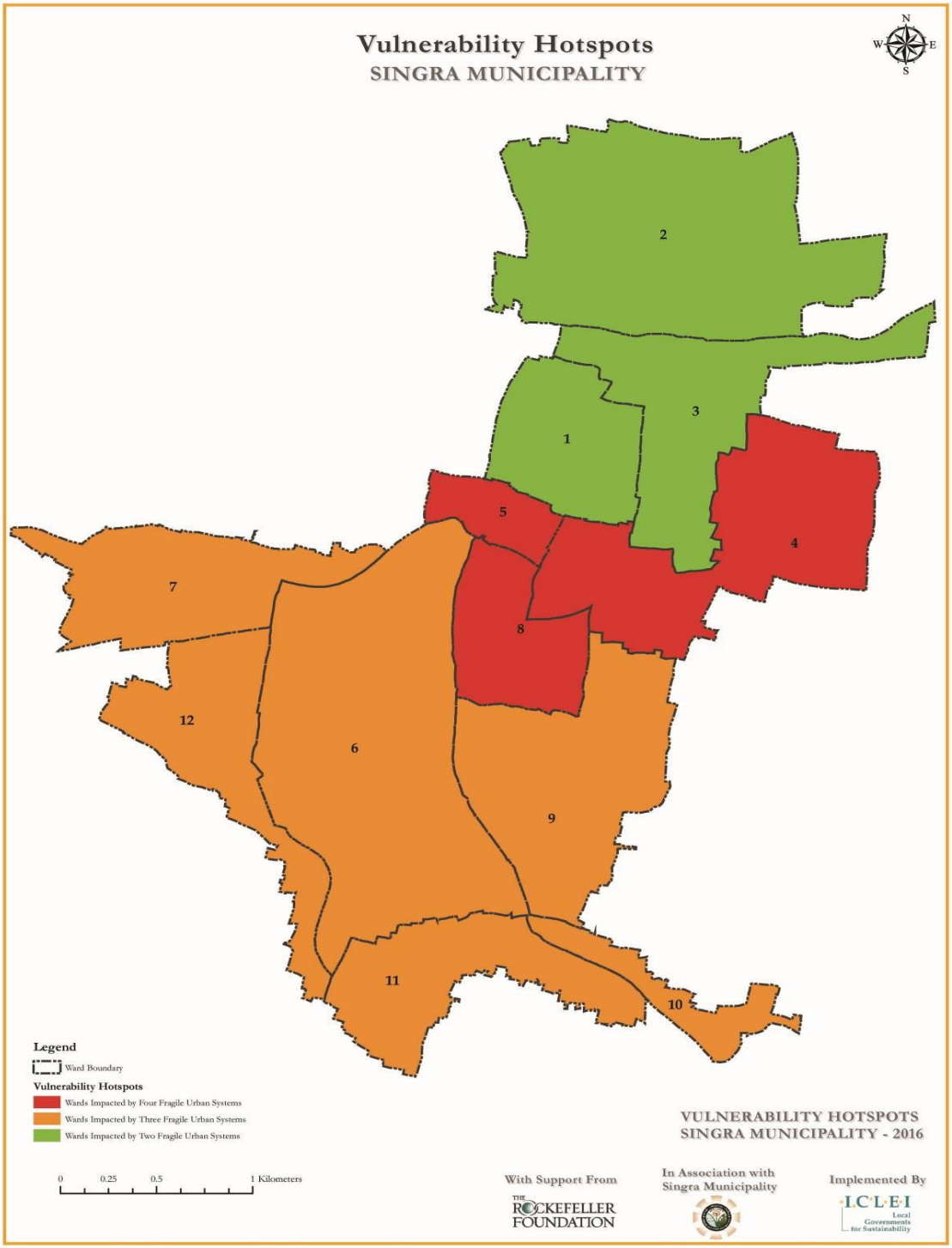

Figure 20: Consolidated Vulnerable Hotspots for Singra city

6.3 Actor Analysis

Identification of actors and their level of adaptive capacities were assessed through an SLD in Singra. Among all these actors, the Department of Public Health & Engineering (DPHE) scored high because of its technical capacities and strength of manpower. Budgetary allocation from the concerned ministry is also adequate for its demand. In Singra, the DPHE supports the Municipality in operation and management of water and sanitation facilities. NGOs, hospitals are scored as medium because of their lower technical strengths. Hospitals are unable to provide services in emergencies or any disaster period. Other low scored actors are from the low income groups, women and children who are not able to properly responding the case of disaster events. Their major limitations are their level of education, livelihood types and economic condition.

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 Resource Management	Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation. Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy.	All wards	Urban poor	Low
			Women	Low
			Children	Low
			Farmers	Low
			Singra Municipality	Low
			NGOs	Medium
			Department of Public Health & Engineering (DPHE)	High
			Hospitals	Medium
River Plain Management	Irregular and unseasonal rainfall will result in flooding of encroached areas that will lead to loss of property and environmental damage to water resources.	Ward 5, Ward 6, Ward 7, Ward 8, Ward 9, Ward 10, Ward 11, Ward 12	Fishermen	Low
			Residents	Low
			Singra Municipality	Low
Storm Water Drainage	Sudden increase in rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health.	Ward 4, Ward 5 (market areas)	Residents	Low
			Urban poor	Low
			Children	Low
			Small business owner	Low
			Singra Municipality	Low

Fragile Urban System	Climate Fragility Statements	Area/ward most vulnerable	Actors	Level of Adaptive Capacity
Solid Waste Management	Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging.	Ward 4 (bus stand area), Ward 8 (small ponds)	Singra Municipality	Low
			Residents	Low
			Urban poor	Low
Sanitation	Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health.	All wards	Singra Municipality	Low
			Residents	Low
			Children	Low
			Women	Low
			Urban poor	Low
			NGOs	Medium
			Department of Public Health & Engineering (DPHE)	High

6.4 Adaptive Capacity of Fragile Urban Systems

The adaptive capacities of the five fragile urban systems were assessed against the five parameters of economy, technology, governance, societal and ecosystem services through discussions with municipal staff.

Water resource management, storm water drainage and solid waste management were scored low in their economic capacity because of poor revenue income and limited access to funds by the municipality and other potential actors who are responsible for development works.

Ecosystem services, governance and societal parameters ranked medium in adaptive capacity for all of the urban systems. Community level understanding of climate impacts, adaptation and preventing disasters was average. To establish better governance and societal condition for sanitation and solid waste management, people have to be familiarized with more technical information by the government and local NGOs.

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

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
Water Resource Management	Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation. Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy.	All wards	- Urban poor - Women - Children - Farmers	- Singra Municipality - NGOs - Department of Public Health (DPHE) - Hospitals	- Economic - Technology/ Infrastructure	- Ecosystem Services - Governance - Societal	
River Plain Management	Irregular and unseasonal rainfall will result in flooding of encroached areas, that will lead to loss of property and environmental damage to water resources.	Ward 5, Ward 6, Ward 7, Ward 8, Ward 9, Ward 10, Ward 11, Ward 12	- Fishermen - Residents	- Singra Municipality	- Technology - Societal	- Economic - Governance - Ecosystem Services	
Storm Water	Sudden increase in	Ward 4,	- Residents	- Singra	- Economic	- Societal	- Governanc

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive Capacity of the System		
			Vulnerable	Potential Supporting	Low	Medium	High
Drainage	rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health.	Ward 5 (market areas)	- Urban poor - Children - Small business owner	Municipality	- Technology/ Infrastructure	- Ecosystem Services	e
Solid Waste Management	Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging.	Ward 4 (bus stand area), Ward 8 (small ponds)	- Residents - Urban poor	- Singra Municipality	- Economic - Technology/ Infrastructure	- Governanc e - Societal - Ecosystem Services	
Sanitation	Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health.	All wards	- Urban poor - Women - Children - Farmers	- Singra Municipality - NGOs - Department of Public Health (DPHE) - Hospitals	- Societal - Governance	- Economic - Technology / Infrastruct ure - Ecosystem Services	

7. RESILIENCE INTERVENTIONS

Possible adaptation interventions were identified for the five fragile urban systems in Singra 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 24 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 Resilience 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 Resource Management						
Policy/Non-Infrastructural Measures						
Awareness building program using propaganda on water conservation and management	High	High	Short Term	Short term	Low	Can be used simultaneously to provide information on water related health impacts
Promoting conservation of water by creating a water bill/ disconnection of water supply	Average	High	Long Term	Long term	Low	
Infrastructural Measures						
Rain Water Harvesting – Training workshops for technical personnel on developing rain water harvesting structures and construction in public buildings	Medium	High	Long Term	Long term	Medium	Can help reduce runoff and prevent soil degradation
Metering of water connections to prevent loss of water due to Unaccounted for Water. Slab-wise rating to accommodate poor and	Average	Medium	Medium Term	Long term	High	Can prevent theft of water and provide financial resources to

Prioritised Resilience 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
vulnerable communities						municipality for developmental work
River Plain Management						
Policy/Non-Infrastructural Measures						
During construction approval process, permission from Singra Municipality to be made mandatory	Average	High	Long Term	Long term	Low	Mandatory permissions will prevent illegal encroachment
UDD-LGED liaison should be improved to ensure collaboration of efforts for water and river plain management.	Average	Low	Medium Term	Medium term	Low	Can help in better developmental planning for the city
Infrastructural Measures						
River embankment to prevent water ingress into residential areas during excessive rainfall. Maintenance of river banks to prevent river bank erosion	Average	Medium	Long Term	Long term	High	Can help in soil protection and conservation.
Plantation to improve conservation of water and improvement of microclimate	High	High	Long Term	Long term	High	Can help in soil conservation.
Dredging of river beds at regular intervals to improve draining of	Low	Low	Short Term	Short term	High	Can help in better drainage.

Prioritised Resilience 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
flood waters						
Storm Water Drainage and Sanitation						
Infrastructural Measures						
Maintenance of drains to allow flood waters to drain quickly	Medium	High	Medium Term	Long term	Medium	
Coverage of drains need to be increased to prevent water logging	High	Medium	Short Term	Long term	High	Can help reduce incidences of vector borne diseases in places with water logging problems
Drains to be delinked with sewerage to avoid water pollution especially in rivers	Average	Low	Long Term	Medium term	High	Increased drainage efficiency
Soak wells to be built for proper septage management.	Average	High	Short Term	Short term	Low	
Septic tank management using septage suction machines and composting of septage. This is essential to avoid water pollution by release of contaminated water and health hazards.	Average	Medium	Short Term	Short term	Medium	Can help reduce ground water pollution
Solid Waste Management						
Policy/Non-Infrastructural Measures						

Prioritised Resilience 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
Awareness generation activities for women and sweepers like providing – 2 bins in households	High	High	Long Term	Long term	Low	Can help in preventing water logging by keeping drains clean.
Interaction with NGOs for spreading awareness on segregation and solid waste.	Average	High	Short Term	Short term	Low	Can help in preventing water logging by keeping drains clean.
Training of local government staff for technical components of solid waste management	Medium	High	Short Term	Short term	Low	
Mobile based communication to residents regarding awareness on solid waste management.	Average	High	Medium Term	Medium term	Medium	
Infrastructural Measures						
Segregation of waste into organic and inorganic fractions	Medium	High	Short Term	Long term	Low	Can help in reduction of waste dumping, better recycling and improve economic opportunities of

Prioritised Resilience 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
						people involved in recycling of waste.
Bio gas production from segregated organic waste	Average	High	Medium Term	Medium term	Medium	Helps reduce waste and provides fuel
Composting of organic waste.	Medium	High	Medium Term	Medium term	Medium	Helps reduce waste in landfills and provides compost for agriculture
Conversion of plastic to fuel for waste reduction and recycling	Average	High	Short Term	Short term	Medium	Helps reduce waste and provides fuel, and also helps to keep drains from getting clogged with plastic
Complaint system for better management of solid waste (phone based)	Average	High	Medium Term	Short term	Medium	
Pilot demonstration of segregation of waste into organic and inorganic waste & waste collection from	Medium	High	Short Term	Short term	Low	Can help promote good practices by being an example

Prioritised Resilience 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
door to door						

7.1 Integration into City Plans

The following projects are underway in Singra which relate the fragile urban systems of Water Resource Management, Storm Water Drainage and Sanitation,

The Asian Development Bank under the 'Third Urban Governance and Infrastructure Improvement Project (UGIIP III)' is investing 40.097496 Bangladeshi Taka in drainage works. The collaboration with the Local Government Engineering department will fund the construction and maintenance of 3660m of drains in the year 2016-2017.

Further, under the Bangladesh Municipal Development Fund (BMDF), which is being funded by the World Bank, the following infrastructure will be added in Singra in the year 2016-17

a. Instalment of 325 no Deep Tubewells in Singra Municipality
b. Instalment of 110 no Street Lights from Balua Basua Moor to Fultala Moor
c. Construction of 700 m RCC Drain from Singra Bus Terminal to Madrasa Moor

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

7.1.1 Water Resource Management

Issues:	The water resource in the city is plagued with pollution and lack of conservation. Ground water is depleting and tubewells are running out of water. Encroachment of river beds needs better management. Even though water from rivers and ground water is available, they are strongly affected by seasonal drought and resource depletion, creating a crisis of drinking water.	
Potential Climate Impacts:	Increased temperatures will increase demand of scarce water resources leading to higher energy consumption to use tube wells for irrigation. Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and have adverse impact on rice production, health and economy.	
Potentially Impacted Areas:	All wards	
Risk Status:	Extreme	
Actors:	- Urban poor - Women - Children - Farmers	- Singra Municipality - NGOs - Department of Public Health (DPHE) - Hospitals

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Promoting conservation of water by creating a water bill/ disconnection of water supply.	Policy intervention can be made by using existing infrastructure, training of staff	USD 2500
Infrastructural Measures		
Rain Water Harvesting – Training workshops for technical personnel on developing rain water harvesting structures and building RWH in municipal buildings.	3000 USD to 10000 USD – since the RWH structures vary, it is difficult to get a unit cost.	15000 USD for a training workshop and construction of 1 RWH structure in one municipal building.

7.1.2 River Plain Management

Issues:	River plains in the region are being silted up and encroached for construction, thereby impacting the ground water of the region and increasing water scarcity, as well as polluting seasonal flood water that is important for agriculture.	
Potential Climate Impacts:	Irregular and unseasonal rainfall will result in flooding of encroached areas that will lead to loss of property and environmental damage to water resources.	
Potentially Impacted Areas:	Ward 5, Ward 6, Ward 7, Ward 8, Ward 9, Ward 10, Ward 11, Ward 12	
Risk Status:	Extreme	
Actors:	Fishermen Residents	Singra Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
UDD-LGED liaison should be improved to ensure collaboration of efforts for water and river plain management.	Meetings can be regularized	USD 1000 per year can be allocated for this
Infrastructural Measures		

River embankment to prevent water ingress into residential areas during excessive rainfall. Maintenance of river banks to prevent river bank erosion	30000 to 100000 USD depending on the height of the embankment, and materials used.	50000 USD

7.1.3 Solid Waste Management

Issues:	Absence of door to door collection of waste and uncontrolled littering impacts drain management and pollutes natural water bodies.	
Potential Climate Impacts:	Littering and open dumping can cause health impacts under higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall, that will create water logging.	
Potentially Impacted Areas:	Wards 4 and 8	
Risk Status:	High	
Actors:	Vulnerable - Residents - Urban poor	Supporting -Singra Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Interaction with NGOs for spreading awareness on segregation and solid waste.	Workshop with NGOs to understand their interest and motivate them to work with the municipality. Cost can be about 1000 USD per workshop	1000 USD
Infrastructural Measures		
Composting of organic waste	Household or community level composting can be carried out, that can be used in the nearby agricultural fields for mulching. Low cost systems of pit composting are suitable in the area. Cost is about 10000USD for 1 TPD unit	10000 USD

7.1.4 Storm Water Drainage and Sanitation

Issues:	The city lacks coverage of proper drainage system; existing one is often blocked with litter and results in regular water logging in the city.	
Potential Climate Impacts:	Sudden increase in rainfall generates large volumes of water that cannot be drained by the limited drainage infrastructure increasing water logging, and impacting health.	
Potentially Impacted Areas:	Ward 4, Ward 5 (market areas)	
Risk Status:	High	
Actors:	- Residents - Urban poor - Children - Small business owner	Singra Municipality

Issues:	The city lacks coverage of toilets and requires modern management systems that can help use the waste to produce bio gas bio fuels etc.	
Potential Climate Impacts:	Open defecation can impact scarce water resources by polluting and contaminating them; in higher temperatures during the dry season and in case of excess rainfall this will impact public health.	
Potentially Impacted Areas:	All wards	
Risk Status:	Medium	
Actors:	- Residents - Urban poor - Children - Small business owner	Singra Municipality

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Infrastructural Measures		
Septic tank management using septage suction machines and composting of septage. This is essential to avoid water pollution by release of contaminated water and health hazards.	Suction machine costs between 3000 USD to 10000 USD. This does not include operation and maintenance.	5000 USD

8. CONCLUSION

The implementation of the IAP toolkit in the city of Singra revealed that the city is very vulnerable to projected climate change impacts of higher temperatures and decreased 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. The ICLEI ACCCRN Process helped identify two climate risk scenarios of increased temperature and increased but irregular precipitation. Five urban systems were identified as fragile and climate fragility statements were formulated for all of them corresponding to the two climate scenarios.

The vulnerability map of the city shows wards 4, 5, and 8 as the vulnerable hotspots in the city. Singra Municipality itself is rated low on adaptive capacity in all the systems 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. The Department of Public Health & Engineering (DPHE) has high adaptive capacity, but its responsibility is restricted to water resources management for the city, and because of low level of communication and integrated action by the municipality and the department, effective resilience building measures cannot be undertaken.

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. Singra 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

- **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.

- **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 and corresponding Fragility and Climate Fragility statements

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 resource management	*Flexibility & Diversity:* The system is dependent on tube wells and these may not function in the dry season since the water table is going down.	•No water conservation measures •Encroachment •Pollution •Using tubewell for irrigation - more energy consumption • Ground water depletion • Most of the tubewells have become out of water. Which has resulted in crisis of drinking water •Unplanned embankment causes the fall of ground water level • River beds are drying up during the hot season - demand for proper	The water resource in the city is plagued with pollution and lack of conservation. Ground water is depleting and tubewells are running out of water. Encroachment of river beds needs better management. Even though water from rivers and ground water is available, they are strongly affected by seasonal drought and resource depletion, creating a crisis of drinking water.	Increased temperatures will increase demand of water leading to higher energy consumption to use tubewells for irrigation.

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
	Redundancy: For drinking water, the population largely depends on tubewells withdrawing ground water, and indiscriminate use of ground water is lowering water table.	management		Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and adverse impact on rice production, impacting health and economy.
	Safe failure:			
River plain management	*Flexibility & Diversity:* The rivers are facing siltation, and run dry during the dry season.	• Massive siltation occurred on both sides of rivers - need dredging • Illegal cultivation of paddy on this silted lands - demand for proper planning and zoning for river plains • Ground water is decreasing due to less navigability of river channels	River plains in the region are being silted up and encroached for construction, thereby impacting the ground water of the region and increasing water scarcity, as well as polluting seasonal flood water that is important for agriculture.	Irregular and unseasonal rainfall will result in flooding of encroached areas, that will lead to loss of property and environmental damage to water resources.
	Redundancy:			

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
	Safe failure: The river undergoes regular seasonal flooding, that can damage infrastructure built on the flood plains.			
Storm water drainage	*Flexibility & Diversity:* During heavy rains, drains may get choked due to solid waste littering.	• Water logging • Drains blocked (5 no. ward) - 5 year plan for drainage to address drainage is developed. • There is only one underground drain and there is need for more drain coverage.	The city lacks coverage of proper drainage system; existing one is often blocked with litter and results in regular water logging in the city.	Sudden increase in rainfall generates water that cannot be drained by the single underground drain increasing water logging, and impacting health
	Redundancy: There is no proper drainage system in the town; there is only natural drains which often get choked due to solid waste littering and lead to water logging.			
	Safe failure:			

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	*Flexibility & Diversity:* In the absence of a door to door collection mechanism, collection of waste is not complete from all areas of the town.	Poor waste collection system. Dust bins have been put up in certain locations and these are cleared regularly and dumped outside the city. There is need for a waste management system.	There is no door to door collection of solid waste and no control of littering, creating impacts on drain management and polluting natural water bodies.	Littering and open dumping can cause health impacts in higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall that will create water logging.
	Redundancy: Residents dump waste in nearby ponds and drains in the absence of a door to door collection mechanism.			
	Safe failure:			

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
Sanitation	*Flexibility & Diversity:*	• 90% latrine coverage • Conventional waste management system - need modernization of waste management system • Biodegradation • No segregation of waste.	The city lacks coverage of toilets and requires modern management systems that can help use the waste to produce bio gas bio fuels etc.	Open defecation can impact scarce water resources by polluting and contaminating them in higher temperatures during the dry season and in case of excess rainfall.
	Redundancy:			
	Safe failure: 100% toilet coverage is not present in the town, toilets are also connected to drains instead of a septic tank and soakpit leading to contamination of water and possibilities of health impacts especially during excess rain or flooding.			

Annexure 2

Risk Prioritisation

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
Water resource management	Increased temperatures will increase demand of water leading to higher energy consumption to use tubewells for irrigation	5	4	20	Extreme
	Irregular and unseasonal rainfall, droughts and hailstorms will lead to increased crises of drinking water and adverse impact on rice production, impacting health and economy.	4	4	16	High
River plain management	Irregular and unseasonal rainfall will result in flooding of encroached areas, that will lead to loss of property and environmental damage to water resources.	5	4	20	Extreme
Storm water drainage	Sudden increase in rainfall generates water that cannot be drained by the single underground drain increasing water logging, and impacting health because drains are linked to toilets in most houses.	4	4	16	High
Solid waste management	Littering and open dumping can	3	4	12	High

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
	cause health impacts in higher temperatures that will promote faster decomposition of waste and encourage disease causing vectors like flies and in case of higher rainfall that will create water logging.				
Sanitation	Open defecation can impact scarce water resources by polluting and contaminating them in higher temperatures during the dry season and in case of excess rainfall.	3	3	9	Medium