URBAN LEDS
URBAN LOW EMISSION DEVELOPMENT STRATEGIES

# CLIMATE RESILIENT CITY ACTION PLAN RAJSHAHI BANGLADESH

SUPPORTED BY

JOINTLY IMPLEMENTED BY

ICLEI Local Governments for Sustainability

UN HABITAT FOR A BETTER URBAN FUTURE

NOVEMBER 2021

**Title: Climate Resilient City Action Plan - Rajshahi**

November 2021


**This document is prepared by:**

ICLEI - Local Governments for Sustainability- South Asia Secretariat under the "Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban LEDS II) project with support from UN-Habitat and ICLEI - Local Governments for Sustainability – World Secretariat and funded by the European Commission.

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**Acknowledgements:**

The project team wishes to thank officials of Rajshahi City Corporation and all other government departments and stakeholders from the city and district for their support and contribution to the data collection and successful compilation of the document.





This project is funded by the European Union. The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. The European Commission is not responsible for any use that may be made of the information contained therein.



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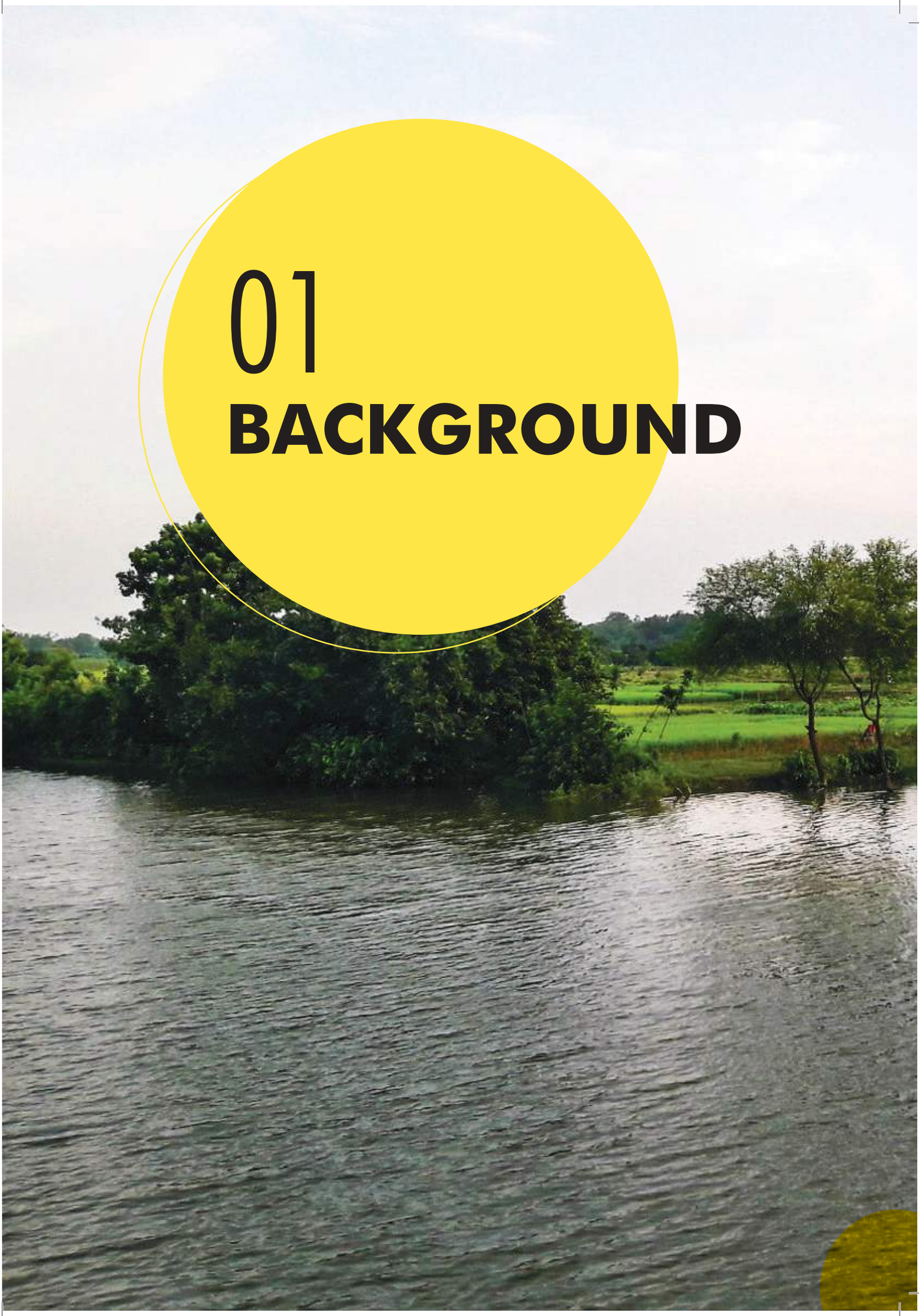


# 01 BACKGROUND

## 1.1 Introduction

Since the beginning of this century, the global and national discourse on sustainable development and subsequently climate resilient development has been significantly shaping the development paradigm in cities, especially in developing countries.

The adoption of several international agreements such as Paris Agreement, 2030 Agenda for Sustainable Development and UN-Habitat's 2016 New Urban Agenda etc. marks a watershed period wherein the role of local governments (LGs) in global climate action has been recognized as well as encouraged.

LGs are central to efforts towards tackling climate change, as has been acknowledged by major agendas such as sustainable development goals (SDGs), Action Agenda and Paris Agreement. Cities can lead climate action by framing strategies and programmes, integrating such actions into ongoing urban development and forging partnerships necessary for effective climate responses.

Globally, cities are at the frontline of climate emergency, responsible for up to 70% of global greenhouse gas (GHG) emissions, 80% of global GDP and constituting 55% of the global population. With two-thirds of the global population expected to live in cities by 2050, cities will have to transform themselves into climate resilient and liveable places for people to live and work. The Intergovernmental Panel on Climate Change (IPCC) 2018 Special Report on Global Warming of 1.5°C (SR1.5) highlighted the need for coordinated actions by all actors including sub-national and non-state, as part of the crucial framework for achieving the 1.5°C goal.

The COVID-19 pandemic has compelled policy makers and other urban stakeholders to reimagine how people live, work and connect in cities. It also brought forth the vulnerability of cities, despite being the country's engines of economic growth. Undoubtedly, the urban growth policies and actions undertaken in the near future will be critical in achieving global climate and sustainability goals.

Bangladesh's urban population growth rate is one of the highest in the world. As per UN projections, the country's urban population will grow to 84 million in 2030 (from 48 million in 2011). Since its independence in 1971, Bangladesh's urban population has grown at a yearly average rate of 6%, and has expanded six-fold. In 2017, almost 35% of the 165 million people lived in metropolitan areas, with 60% of the urban population in the five largest metropolitan regions, Dhaka (18.9 million), Chittagong (7.4 million), Khulna (2.0 million), Sylhet (1.0 million) and Rajshahi (0.85 million)[1]. Given the inevitable urban growth, developing liveable and sustainable cities is critical for Bangladesh's future growth.

As for the city of Rajshahi, continuous development is exerting pressure on land, land use and housing, resulting in overloading of urban infrastructure and transport systems, necessitating their improvement and expansion. Rapid urbanization and the expected expansion of city area in Rajshahi are accompanied by a number of key challenges, including insufficient urban planning and management, lack of coordination among agencies, higher energy consumption and increased greenhouse gas (GHG) emissions, and insufficient solid waste and sewerage management. Resultantly, the city faces environmental issues such as pollution and stress on the already resource constrained urban services. The impact of climate change will further accelerate the urbanization (due to increase in rural to urban migration) as well as deepen the scale and severity of urban poverty.

As climate change disproportionately affects poor and vulnerable populations, it is not only an environmental issue but inextricably linked to challenges the United Nations currently addresses i.e. the 17 interlinked SDGs.

In this regard, the development and implementation of the Climate Resilient City Action Plan or CRCAP for Rajshahi will not only address systemic risks and pursue transformation over the long term, but also help meet immediate needs of creating sustainable jobs, improving urban service delivery and alleviating poverty.

**Globally, cities are responsible for up to 70% of global greenhouse gas (GHG) emissions, 80% of global GDP and constituting 55% of the global population**

1 Bangladesh Bureau of Statistics, Aug 2014

The development of a climate action plan will help Rajshahi to understand and effectively respond to climate change impact. Implementing the actions suggested in the plan will help Rajshahi contribute towards national targets under the Paris Agreement and the SDGs, as well as attract international finance for a green economic recovery following the COVID-19 pandemic. Lastly, it will help distribute the benefits of climate action equitably amongst the city's citizens.

Overall, the CRCAP approach is to create an enabling ecosystem for mainstreaming climate action by creating necessary institutional mechanisms, technical capabilities and communication channels between stakeholders for horizontal and vertical integration. This would facilitate achieving climate compatible urban development that contributes to Bangladesh's Nationally Determined Contributions (NDCs) and ensures achievement of SDGs.

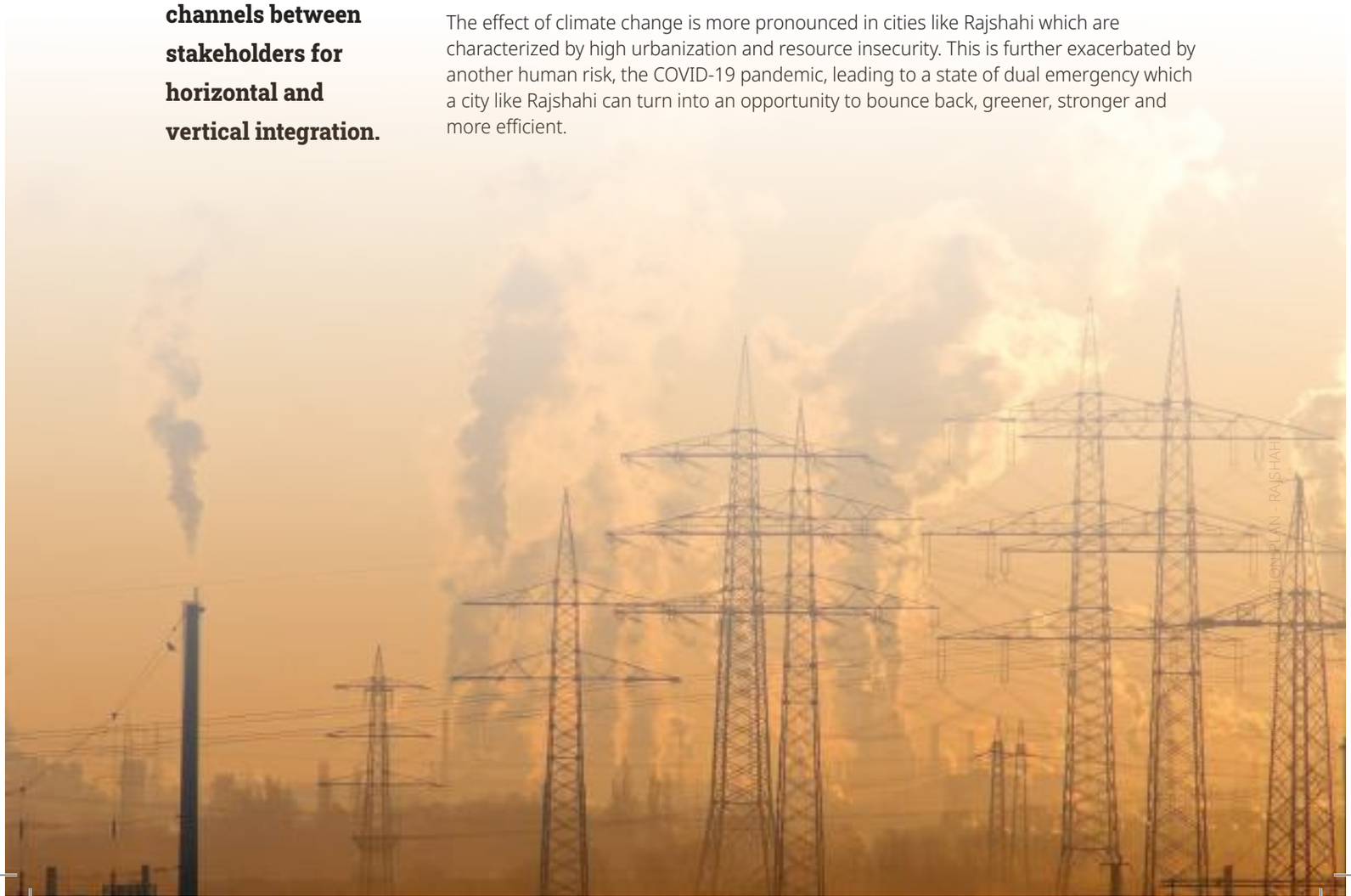
**The CRCAP approach is to create an enabling ecosystem for mainstreaming climate action by creating necessary institutional mechanisms, technical capabilities and communication channels between stakeholders for horizontal and vertical integration.**

## 1.2 Approach

Located along the banks of River Padma, Rajshahi is the fourth largest city of Bangladesh. Despite steady growth in its urban population, the rate of urbanization is slow as compared to other cities in the country. Evolving from a district town, the city became a divisional headquarter in 1947 and achieved the status of city corporation in 1991. The area is characterised by dominant agricultural activity and less industrial activity.

Rajshahi City Corporation (RCC), over the years, has undertaken several initiatives to address the city's vulnerability to climate change through low carbon and climate resilient infrastructure systems and services. However, with increasing population and haphazard development, providing efficient municipal services has become a challenge, further exacerbated due to the impacts of climate change. Rajshahi lacks an efficient public transport system and sewerage network. For fulfilling the water demand, the city depends a great deal on groundwater, with limited and uncertain supply of surface water. Moreover, the city's waste is not managed sustainably.

The effect of climate change is more pronounced in cities like Rajshahi which are characterized by high urbanization and resource insecurity. This is further exacerbated by another human risk, the COVID-19 pandemic, leading to a state of dual emergency which a city like Rajshahi can turn into an opportunity to bounce back, greener, stronger and more efficient.



ICLEI South Asia, in partnership with UN Habitat, is supporting RCC in implementing the Accelerating climate action through the promotion of urban low emission development strategies (Urban-LEDS) Phase II, to transition the city into a low emission, resilient, green, and inclusive urban economy. The Urban LEDS project is being implemented in more than 60 cities in eight countries: Brazil, India, Indonesia, South Africa, Bangladesh, Colombia, Lao PDR and Rwanda. In Bangladesh, two model cities - Narayanganj and Rajshahi - and four satellite cities - Singra, Sirajganj, Faridpur and Mongla Port - are a part the Urban LEDS programme. The ClimateResilientCITIES is the guiding methodology used in planning for LED strategies in the Urban LEDS project cities.

**The Urban LEDS project is being implemented in more than 60 cities in eight countries: Brazil, India, Indonesia, South Africa, Bangladesh, Colombia, Lao PDR and Rwanda**

The CRCAP for Rajshahi is a step in the direction of achieving the long-term vision of integrating comprehensive and resilient approaches in the city's development objectives, planning and processes. Haphazard urbanization, high urban sprawl, increased infrastructure demand and fast-growing energy demand are contributing to environmental and urban service degradation in Rajshahi. There is an urgent need for decisive actions on urban governance, technology, data and innovation in the city. The CRCAP for Rajshahi provides a comprehensive assessment of urban issues, GHG emissions from urban activities and services, and impact of climate change on urban infrastructure; and suggests potential strategies and actions to increase urban climate resilience.

## 1.3 Methodology

### Defining Climate Resilience

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 (Folke 2006)[2]. Therefore, planning for urban resilience should involve considering the activities that release GHGs and proposing actions that not only help reduce the sources of emissions but also help the city to adapt to the challenges of climate change, such as sea level rise, temperature and precipitation changes or extreme events.

The CRCAP for Rajshahi has been developed using the ClimateResilientCITIES methodology, tailor made for LGs, providing step by step guidance for developing a CRCAP that addresses climate change adaptation, mitigation, as well as the linkages therein.

The process equips LGs to:

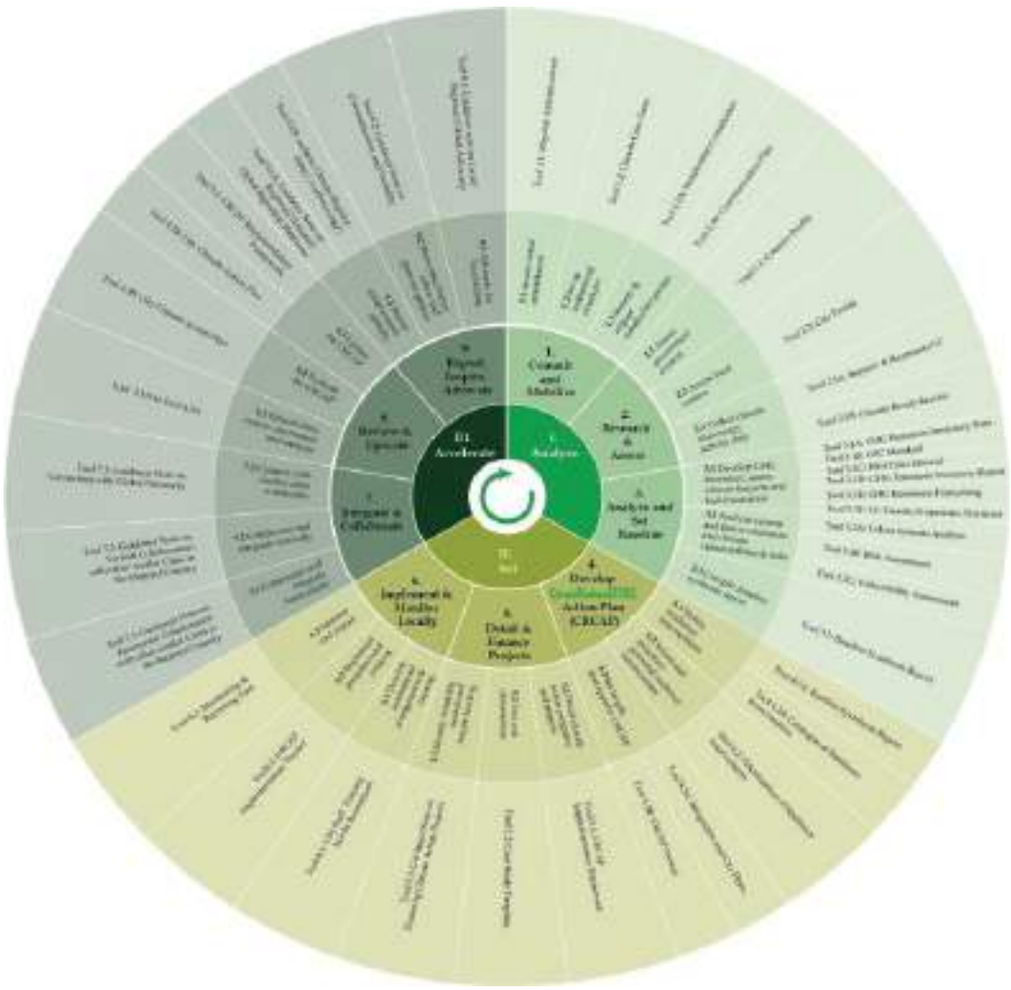
- estimate the GHG emissions intensity of city activities;
- assess the climate risks of various systems in the city in the context of urbanization and vulnerability;
- identify actions to address existing and forecasted climate fragility; and
- develop an implementation and monitoring plan which will not only help the city to adapt to existing and impending climate change impact but also steer the city's focus to climate change mitigation measures.

This process builds on ICLEI's flagship mitigation program i.e., Cities for Climate Protection (CCP) Campaign, the GreenClimateCities (GCC) program and ICLEI's adaptation tool-kit i.e., the ICLEI Asian Cities Climate Change Resilience Network (ACCCRN) Process or IAP toolkit.

2 Folke, C., 2006. Resilience: The emergence of a perspective for social–ecological systems analyses. Global Environmental Change, [online] 16(3), pp.253-267. Available at: <http://dx.doi.org/10.1016/j.gloenvcha.2006.04.002>.

## 1.3.1 Overview of Climate Resilient Cities Methodology

The ClimateResilientCITIES methodology was followed to develop the CRCAP for Rajshahi. The CRCAP is a 9-step process in 3 phases: Analyze, Act and Accelerate - each unfolding into three steps - outlining how climate fragility can be assessed and climate resilient options (to achieve low emissions and climate adaptive development) can be identified and integrated into urban development policies, plans and processes. It consists of a wide range of tools and guidance notes to support LGs to deliver effective local climate action. The figure below shows the steps and various tools used in the methodology.



The following section details the different steps undertaken to prepare the 'first' CRCAP for Rajshahi city.

### Step 1: Commit and Mobilize

**1.1 Secure initial commitment –** It is very important to ensure senior political and local government buy-in to kick-start the process for climate resilient development in the community and provide clear leadership. As political, executive and administrative support are required for successful planning and implementation of climate action plans, Rajshahi city submitted a commitment letter submitted to Global Covenant of Mayors (GCoM) regarding their intention to prepare a CRCAP (Annexure I).

**1.2 Set up institutional structures –** On 10th April 2019, RCC formalized and notified a city level climate core team comprising six nominated officials from various relevant departments of the corporation, including the Mayor and members of the Environmental Standing Committee, chaired by the Chief Engineer (Annexure II).

The core team was involved in all steps of preparing the CRCAP including evaluating climate adaptation and vulnerability aspects, developing resilience strategies to address them, and supporting internal institutional capacity building to effectively fulfil the long-term requirements of the plan by effectively integrating planned initiatives into the city's development plans. The team also helped in the implementation of a related pilot project in Rajshahi city.

**1.3 Identify and engage stakeholder groups -** The climate action planning process should be supported by consultation with other groups in the city, such as government agencies, local NGOs, community leaders, university partners and private sector organizations, to appropriately share responsibilities and ensure ownership. A city level Stakeholder Committee, chaired by the Chief Engineer and comprising 28 members, was formed and notified by RCC on 10th April 2019. The members include key decision makers and administrators from RCC, representatives from Rajshahi Development Authority (RDA), Rajshahi Water Supply and Sewerage Authority (Rajshahi WASA), Barind Multipurpose Development Authority (BMDA), Fire Service and Civil Defence, Bangladesh Road Transport Authority (Rajshahi), Department of Public Health and Engineering (DPHE, Rajshahi), Department of Environment (DoE, Rajshahi), Divisional Forest Officer (Rajshahi), various educational institutions and national and international NGOs working in Rajshahi city. In preparing the CRCAP with the climate core team, the Stakeholder Committee participated in frequent consultations during the preparation and finalisation of the GHG emissions inventory and climate vulnerability assessment.

**To institutionalize climate action planning and implementation, a City level Climate Core Team & Stakeholder Committee was was formed and notified by RCC.**

## Step 2: Research and Assess

- **Assess local context** - It is very important to assess local policies, on-going projects and economic, social and environmental contexts at the local level, which would impact climate resilient development in the city. Local issues with respect to the environment and urban development (socio-economic status, demography, municipal services, energy consumption (electricity and fuel) within the city limit) were identified and discussed with the core team. A baseline assessment of the urban systems was conducted for assessment of climate change impact and influences urban development activities, and to identify the kind of support required by RCC to address such impacts. Based on the information collected, a City Profile was developed for an assessment of climate vulnerable urban systems and carbon intensive activities (See Chapter 2).

## Step 3: Analyze and Set Baseline

**3.1 Develop GHG emissions inventory, assess climate impacts and build scenarios**

- In collaboration with RCC and other external agencies which have access to the required information (utilities), base data (supply and demand-side) was collected for stationary fuel and electricity consumption by all community and government sector entities. City officials and other stakeholders were engaged to validate the data and make it robust to be used for GHG emissions inventory preparation.
- A GHG emissions inventory was developed to determine sources of GHG emissions in RCC operations and at the community level, using the Harmonized Emissions Analysis Tool plus (HEAT+) GHG emissions inventory online software tool and protocols (See Chapter 3). The community inventory includes emissions from community/city-wide activities within the RCC jurisdiction, including emissions from RCC activities and use. This includes emissions from sources and/or activities from stationary units (residential, commercial/institutional, industrial, construction and agricultural), mobile transportation units and waste. This robust analysis provided a strong basis to

develop technically sound and yet ambitious climate resilience interventions.

- Energy consumption forecast was prepared for medium term (until 2030-31) and long term (until 2050-51) planning. Energy consumption from municipal services was forecasted based on population projections, economic and growth assumptions, and municipal service delivery based on existing and future city planning. Based on the energy consumption forecast, the corresponding GHG emissions were calculated.

### 3.2 Identify fragile urban systems, climate vulnerabilities and risks

- Core and secondary urban systems were studied to identify fragile urban systems and examine the impact of climate change on them (See Chapter 4). For each fragile urban system, key vulnerable areas (geographical areas) and the vulnerable population were assessed and identified. The qualitative information gathered from the stakeholder group through Shared Learning Dialogues (SLDs) and quantitative information from the city was studied to assess climate vulnerability. The risk and adaptive capacities of the urban systems were assessed following extensive consultation with stakeholders and the climate core team.

## Step 4: Develop Climate Resilient City Action Plan

### 4.1 Define resilience interventions

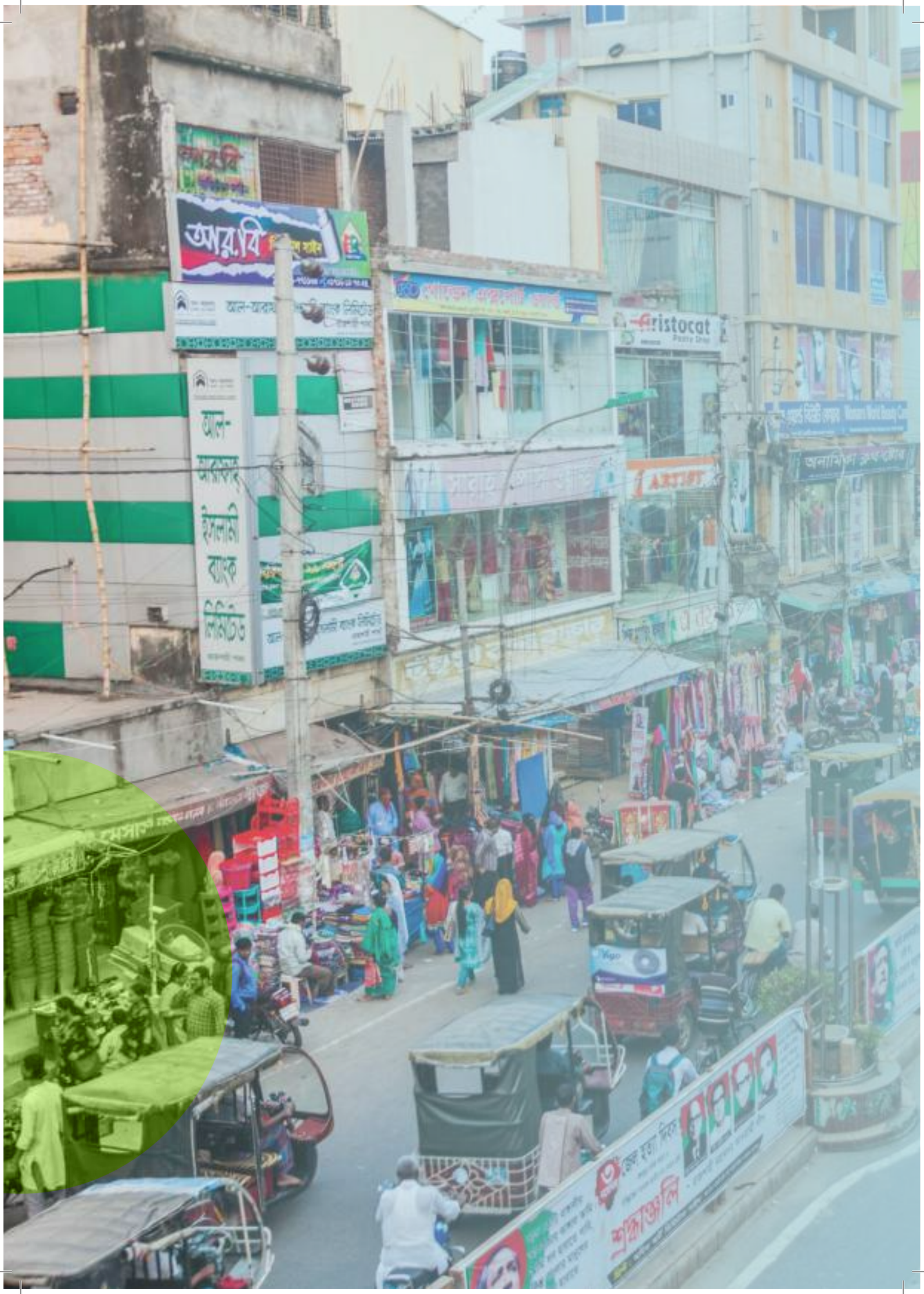
- Various mitigation and adaptation interventions were identified for Rajshahi based on the GHG emissions inventory and urban systems analysis in line with existing city planning. The mitigation and adaptation potential for each intervention along with the financial aspect and implementation mode was identified in line with ongoing projects and RCC's future planning (See Chapter 5).

### 4.2 Screen and prioritize potential resilience interventions

- Prioritization of resilience interventions was done based on feasibility and impact assessment.

### 4.3 Set targets and approve CRCAP

- The resilience interventions were linked to existing/ongoing/planned initiatives within the city to assess possibilities of leveraging existing funding opportunities to implement the action plan. Targets were set to move towards outcomes under the climate action plan, which can relate to GHG emissions "avoidance" or "reduction" and/or achievement of adaptation measures and to socio-economic indicators.
- A formal Municipal Council approval will provide an opportunity for political review, recommendations and adoption of the CRCAP.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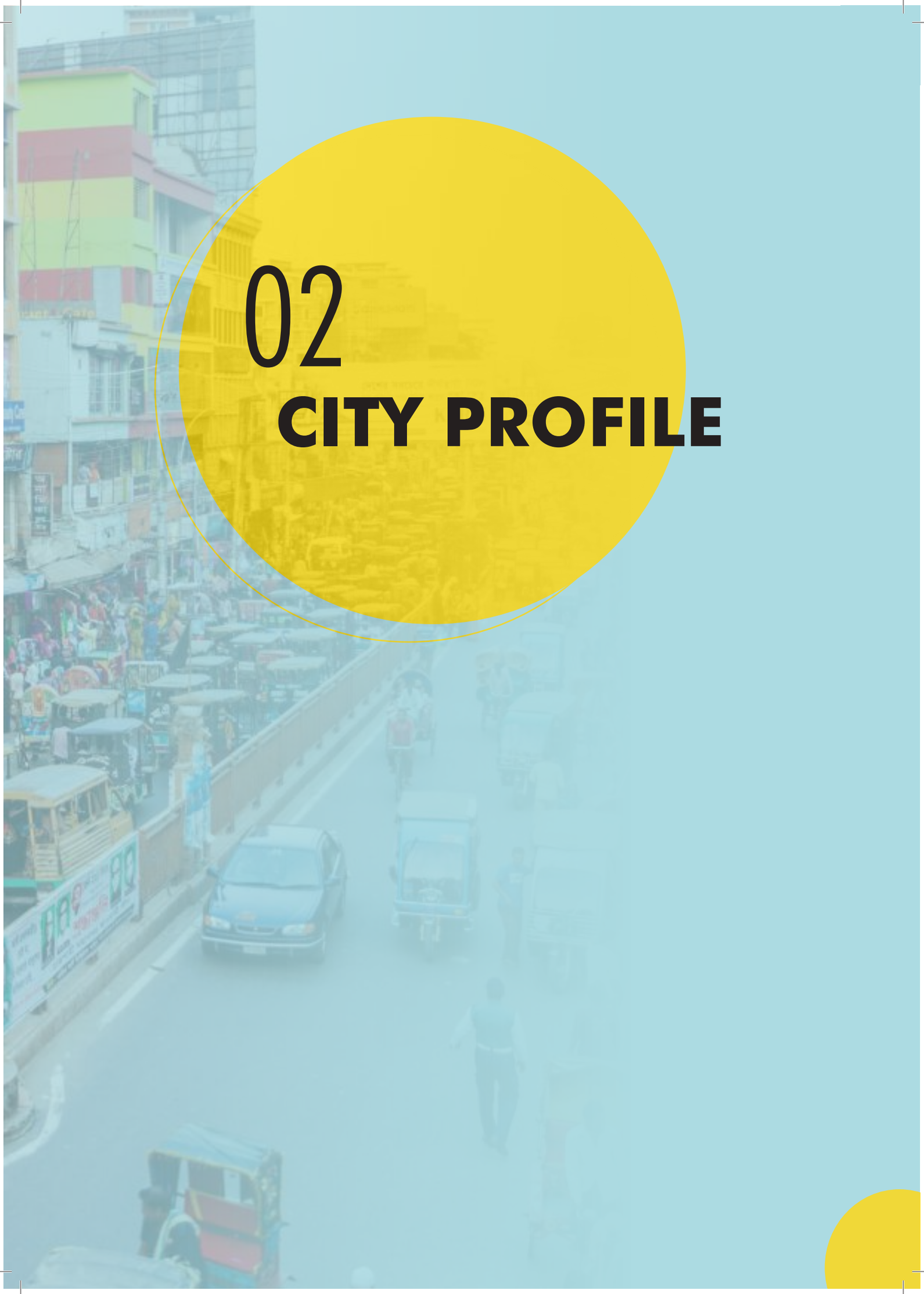


# 02
# CITY PROFILE

Rajshahi City, located on the banks of River Padma, is one of the key administrative divisions of Bangladesh. Rajshahi is a centre of excellence for education with a large number of educational institutions (engineering, medical and universities) and is home to the University of Rajshahi, one of the largest universities in the country. Rajshahi also houses the divisional headquarters of the public and private service departments, and the city's economy primarily depends on these services.

A historical city which was part of the Pundra region of ancient Bengal, Rajshahi is famous for silk and often referred to as Silk City. The city's outstanding efforts, led by RCC, at reducing air pollution have earned it the tags Green City, Clean City etc.

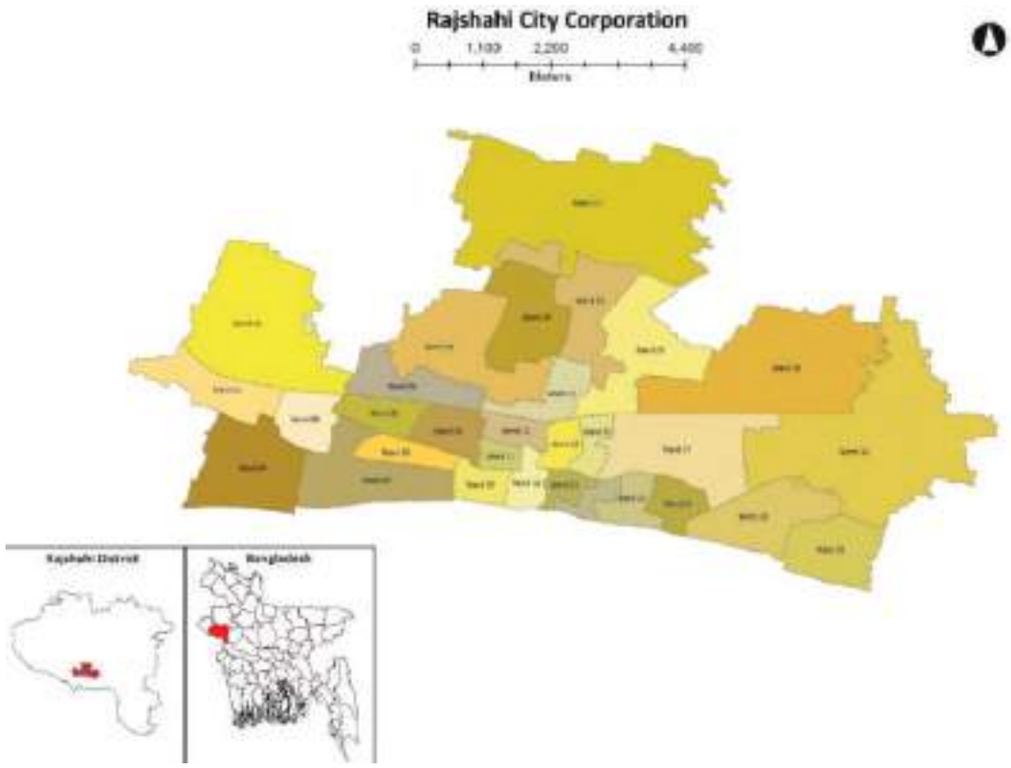
## 2.1 Location

Rajshahi is located within the Barind Tract near the Bangladesh-India border, 23 meters above mean sea level on the north bank of River Padma, bound by Paba Upazila on three sides. The area of Rajshahi city is 97.18 sq. km., between 24°20" to 24°24" N latitude and 88°32" to 88°40" E longitude. 256 km away from the capital city of Dhaka, Rajshahi is well connected with all the major urban centres in the country. Figure 1 shows the location of Rajshahi city.

## 2.2 Connectivity

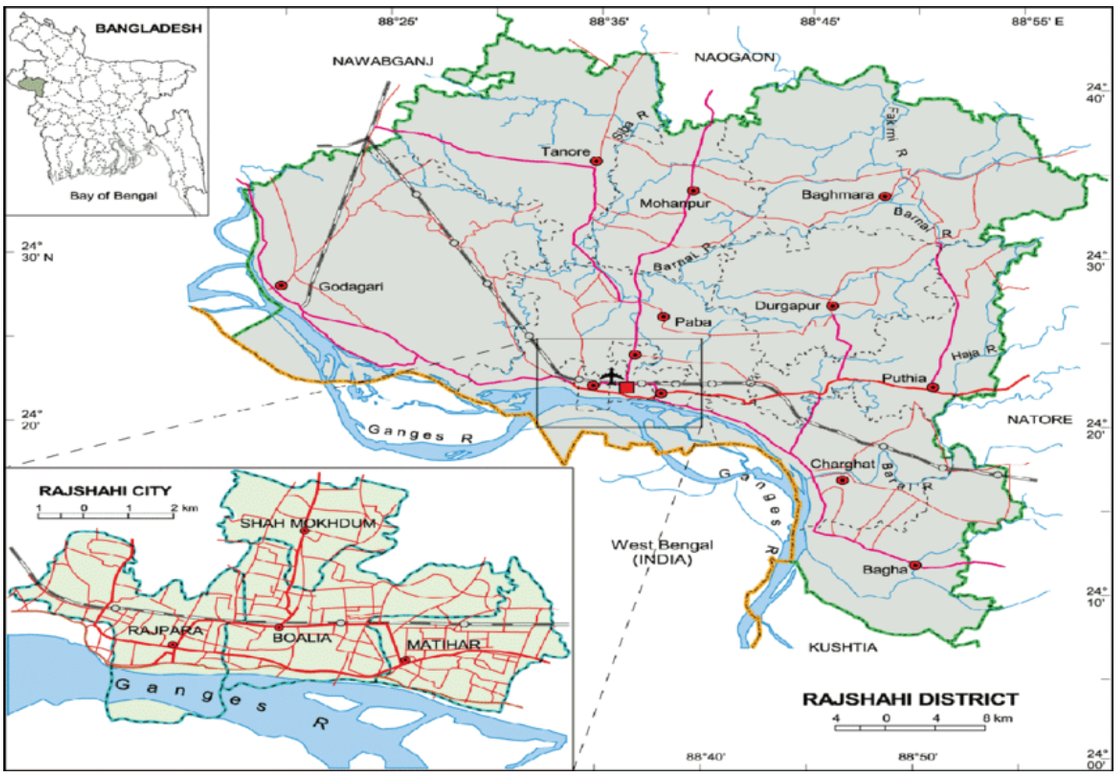
The city is well connected through air, rail and road transport with the capital Dhaka and other cities in Bangladesh. Flights connecting Rajshahi and Dhaka operate from the domestic airport named Shah Makhdum Airport located at Nowhata, 10 km far from Rajshahi. The city has a central railway station and bus terminal. A non-stop train service named Banalata Express was recently launched from Rajshahi to Dhaka. Padma River in Rajshahi does not play a significant role in transportation due to lack of navigability. Figure 2 shows Rajshahi's road and rail network.

**Figure 1 Location of Rajshahi City[3]**




3 GIS Data, Rajshahi Development Authority, 2020

**Figure 2** Road and Rail Network of Rajshahi[4]




## 2.3 Demographic Profile

**Size - 97.18 km²**
**Population - 449,756 (2011)**
**Population growth rate (per annum) – 1.25%**
**Urbanisation rate - 100% urbanization within the city limits**
**City annual budget (US dollars) – 113 million USD (2020-21 budget)**

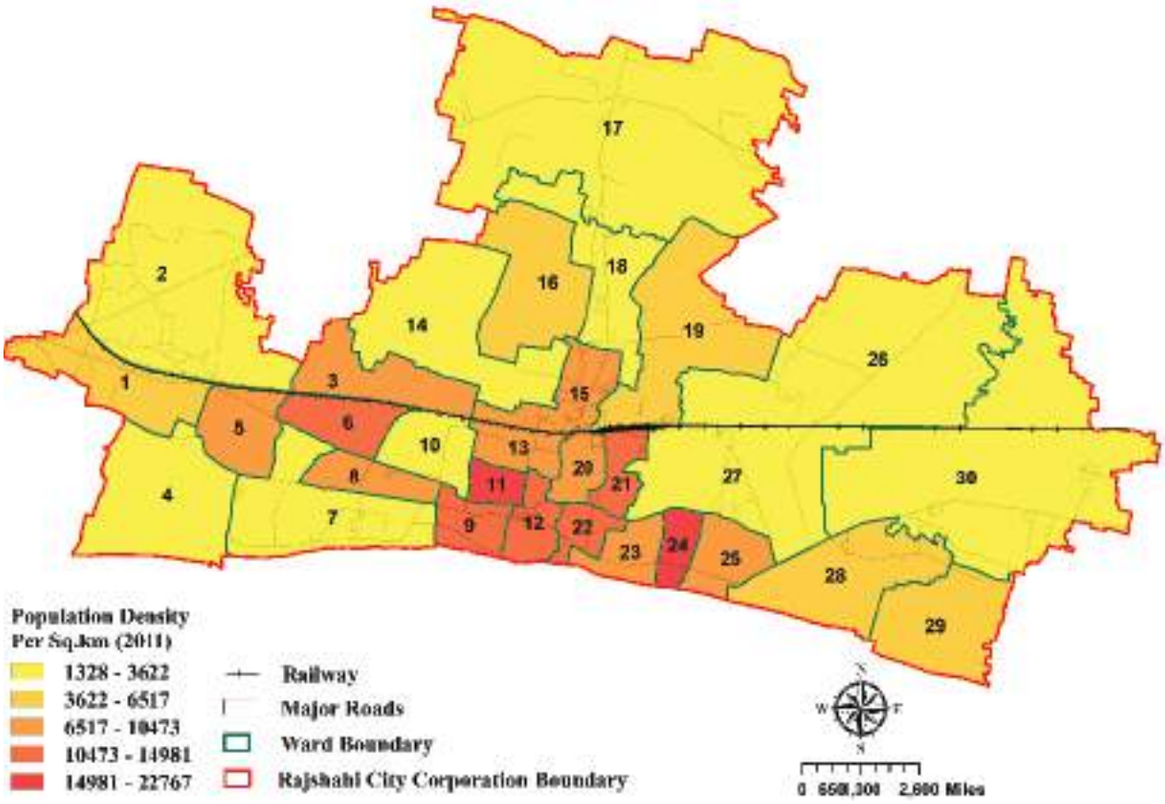
According to the Bangladesh Bureau of Statistics (BBS) population census 2011, the population of Rajshahi city was 449,756 persons in 2011, up from 388,811 in 2001 primarily due to large scale rural-to-urban migration and rapid urbanization. The total number of households stood at 99,097. The density of population was 2,487 persons/ sq. km., with the population distributed among 30 wards. Annexure V presents Rajshahi's ward-wise area and population[5]. The literacy rate of Rajshahi is 73.96%. Table 1 presents Rajshahi city's demographic profile and Figure 3 illustrates the population density of different wards.

**Table 1** Demographic Profile of Rajshahi City

| | Year 2001 | Year 2011 |
|---|---|---|
| Total Population[6] | 388,811 | 449,756 |
| Population Growth Rate (AEGR)[7] | 1.25% | 1.94% |
| Area (sq. km) | 96.72 | |
| Share of ULB area in district (%)[5] | 4% | |
| Density of population (person per sq. km)[5] | 4318 | |
| Literacy Rate (%)[6] | 68.1 | 72.4 |
| Youth, 15 - 24 years (%)[6] | 61% | 72% |
| Working Age Group, 15-59 years (%)[6] | 27.06 | 32.94 |
| Slum Population [6] | 70,000 | |

4 Banglapedia, National Encyclopedia of Bangladesh, Asiatic Society of Bangladesh, 2015
5 District Statistics 2011 – Rajshahi, Bangladesh Bureau of Statistics, June 2013
6 District Statistics-2011, Rajshshi (http://203.112.218.65:8008/WebTestApplication/userfiles/Image/District%20Statistics/Rajshahi.pdf )
7 Population and Housing Census-2011, Rajshahi (http://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78-892733bc06eb/Population-and-Housing-Census)

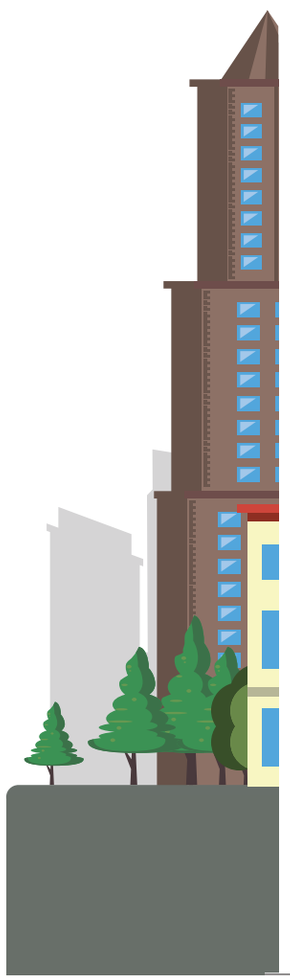
**Figure 3** **Population Density of Different Wards in RCC Area[5,6]**




## 2.4 Spatial Growth Trends and Land Utilization

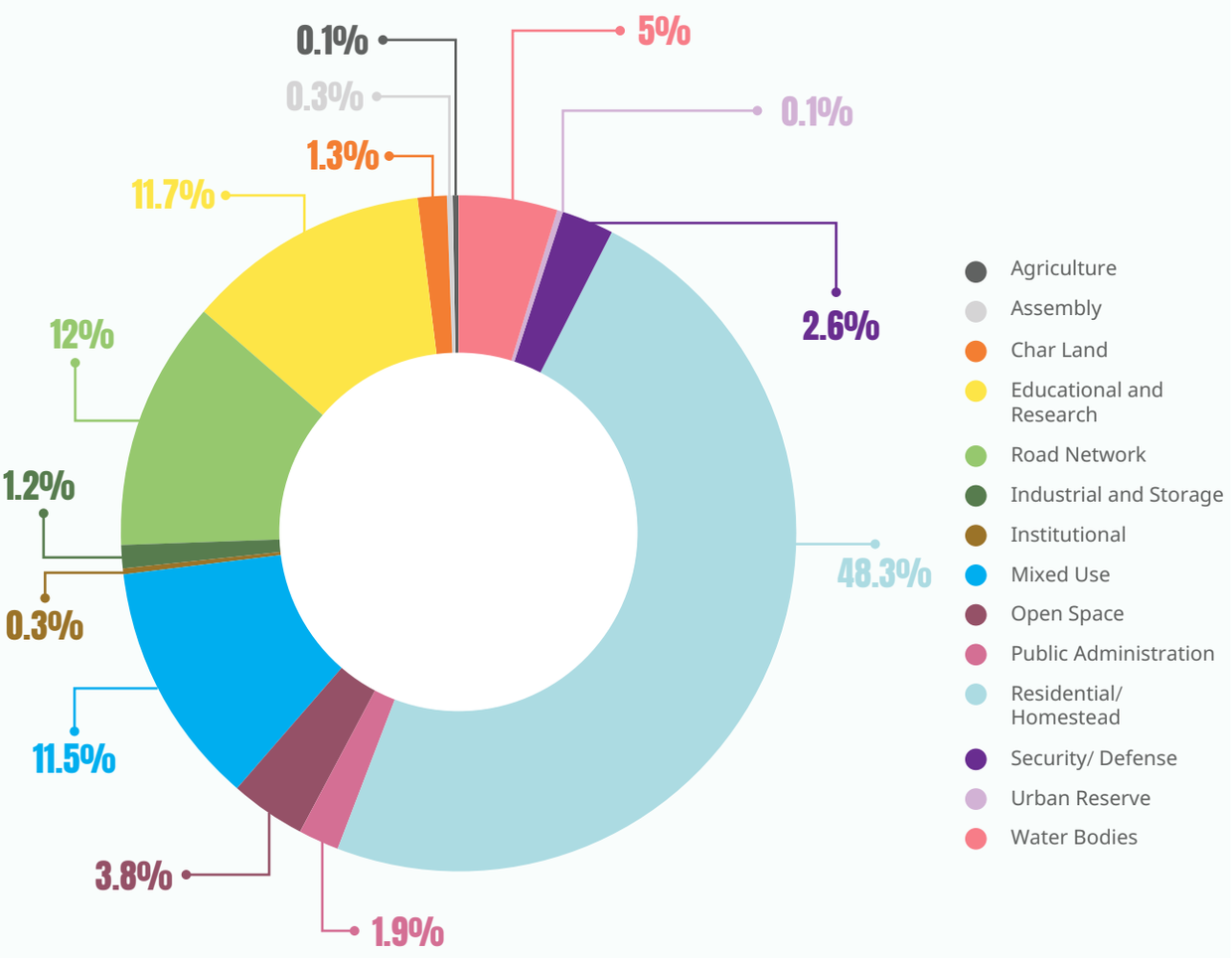
The land use pattern of Rajshahi city has changed significantly in the last decade. Vegetation and agricultural land, that was once a dominant land use type, has significantly decreased over the years (1997-2017) and currently stands at around 8% as per a study[8]. The vegetation and agricultural land tracts were initially converted into fallow land and subsequently changed into built-up areas, thus doubling up the city's built-up area in the last 20 years. Rajshahi city's maximum temperature has risen rapidly in comparison to other major cities in Bangladesh.

Currently, residential area covers 48.3% of the total city area, followed by education/ institutional areas, water bodies, roads, open spaces etc. Figure 4 shows the land use pattern in Rajshahi city.



8 Kafy, A., Islam, M., Khan, A., Ferdous, L. and Hossain, M., 2019. Identifying Most Influential Land Use Parameters Contributing Reduction of Surface Water Bodies in Rajshahi City, Bangladesh: A Remote Sensing Approach. Remote Sensing of Land, 2(2), pp.87-95.

**Figure 4** Percentage of Land Use in RCC Area (2020)[9]




9 Physical Survey, Rajshahi Development Authority, 2020

## 2.5 Climate

Under the Köppen climate classification[10], Rajshahi has a tropical wet and dry climate, generally marked with high temperature, considerable humidity and moderate rainfall. The hot season commences early in March and continues till the middle of July. The maximum mean temperature observed is about 32°C to 36°C during April-July and the minimum temperature recorded in January is about 7°C to 16°C. The highest rainfall is observed during the monsoon months, with annual rainfall in the district about 1,448 mm. Typically, the city witnesses 4 seasons in a year (1) winter from mid-December to February, (2) pre-monsoon with minimal rainfall, high temperatures and evaporation from March to May, (3) monsoon with moderate rain and high temperatures between June to mid-October and (4) post-monsoon with slow decrease in rainfall and temperatures between mid-October to December.

**Under the Köppen climate classification[10], Rajshahi has a tropical wet and dry climate, generally marked with high temperature, considerable humidity and moderate rainfall.**

## 2.6 Economic Activities

Rajshahi and its neighbouring regions are especially suited from various crops such as watermelon, sugarcane, mango and litchi. Despite being an important city and located on a riverbank, industrial development in Rajshahi has not been substantial. The industrial park is mainly home to industries related to the famous Rajshahi silk. Rajshahi is home to a number of jute, textile and sugar mills, and pharmaceutical and mango-based industries. A significant proportion of the city's population is engaged in the tertiary sector, including public/semi-public/non-public sectors, banking, education, trading, business and private sector.

According to the Economic Census of Rajshahi - 2011, 42% of the city's population was employed, as compared to 58% in the entire Rajshahi district. Of the 42% employed population in the city, 95% stay in the RCC area. The per capita GDP of Rajshahi district stands at $3,167 and GDP growth at 6.3%[11].

In order to spur economic growth in the area, the Bangladesh High-Tech Park Authority initiated the establishment of Bangabandhu Sheikh Mujib Hi-Tech Park in Nabinagar Mouza, Paba, Rajshahi in 2016. The project is being executed with an investment of 2,526.1 lakh BDT and is likely to create 14,000 jobs.

## 2.7 Urban Governance

Rajshahi City Corporation or RCC, one of the first municipalities in Bangladesh, was established in 1876 under the name Rampur Boalia Municipality. It functioned as a municipal committee under the Basic Democracies Order of 1959. Rajshahi Paurashava replaced the Rajshahi Municipal Committee under the Bangladesh Local Councils and Municipal Committees (Amendment) Order of 1972. It was declared RCC in 1991. The RCC's elected body, responsible for all policy decisions, is headed by the Mayor and is comprised of 30 Councillors. The Chief Executive Officer (CEO) of RCC is the administrative head and responsible for its functioning including tax collection, estates' maintenance and projects, among other things. This is an administrative cadre service post appointed by the central government. The RCC provides and maintains services including water purification and supply, sewage treatment and disposal, garbage disposal and street cleanliness, solid waste management (SWM), building and maintenance of roads and streets, street lighting, maintenance of parks and open spaces, cemeteries and crematoria, birth and death registration, conservation of heritage sites, disease control including immunization, public corporation schools etc.

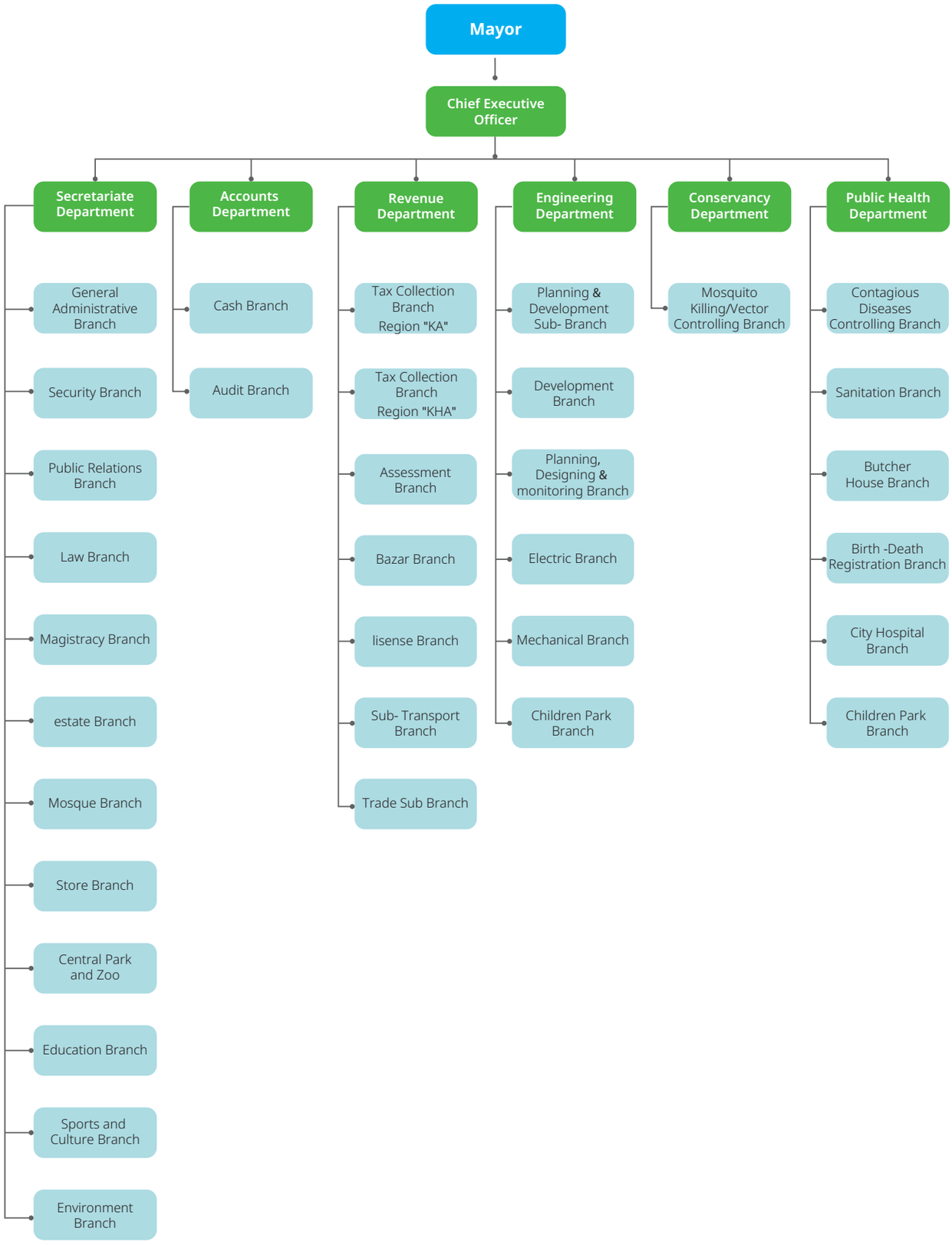
10 Climate-Data.org, Bangladesh, Rajshahi Division. Available at <http://en.climate-data.org/region/2265/>

11 Preliminary Report on Economic Census 2013, Bangladesh Bureau Of Statistics, Nov 2013. Available at <https://bit.ly/2V0Pz37economicstatus>.

Other than RCC, some other government organizations and their responsibilities in implementing development and planning schemes are as follows:

1. **Rajshahi Development Authority (RDA)** – preparing the city master plan and other development policies, and coordinating all the development related work
2. **Rajshahi Water Supply and Sewerage Authority (Rajshahi WASA)** – water supply, sewerage and drainage system within the city corporation area
3. **Bangladesh Parjatan Corporation** – tourism
4. **Bangladesh Railways (BR)** – rail transport
5. **Bangladesh Road Transport Authority (BRTA)** – road transport
6. **Bangladesh Small and Cottage Industries Corporation (BSCIC)** – promoting small and cottage industries
7. **Public Works Department (PWD)**: Construction agency of Government of Bangladesh (GoB) - implementing government construction projects and projects for autonomous bodies as deposit works
8. **Barind Multipurpose Development Authority (BMDA)** – irrigation in drought, flood control and maintenance of flood control embankment
9. **Department of Agricultural Extension (DAE)** – promoting subsidy for betterment of farmers, distributing fertilizers to poor farmers, training farmers on modern techniques of cultivation
10. **Department of Environment (DoE) -** environmental regulation and management
11. **Department of Forest** – forest extension, biodiversity and wildlife conservation
12. **Roads and Highways Department (RHD)** – construction and maintenance of major regional roads and bridge networks
13. **Bangladesh Water Development Board (BWDB)** – flood control, drainage and irrigation activities, enhancing water resource management
14. **Northern Electricity Supply Company Limited (NESCO):** The company took over the North West Zone of Bangladesh Power Development Board which contained Rajshahi and Rangpur divisions in 2016.

**Figure 5** Rajshahi City Corporation Organogram



## 2.8 Major Urban Sectors

Establishing the sectoral baseline and service provision is essential for preparing a well-informed climate action plan and identifying sectoral climate resilience strategies.

The urban profile assessment involved data collection (service level information for key urban sectors) and consultation with city authorities. The profile gives a practical snapshot of sector performance including infrastructure/service delivery gap, and documents sectoral policies and plans, and ongoing and planned projects/initiatives by the city. The urban infrastructure and gap analysis feeds into the GHG emissions inventory forecasting and climate vulnerability assessment.

### Water Supply

#### Water Supply and Treatment

**Out of 95 MLD of total water production, 89 MLD (or 94%) comes from groundwater sources (bore wells)**

RWASA is responsible for providing water supply and water treatment facilities for the city area. RWASA began operations in 2011, before which water supply provision was under RCC's purview.

Groundwater tube wells are the major source of freshwater in Rajshahi. The freshwater demand for RCC in January 2020 as per RWASA records was estimated to be 113 million litres per day (MLD) of which only 95 MLD was supplied by RWASA. Water shortage is estimated to be about 18 MLD, expected to increase to about 67 MLD in 2031[12]. Out of 95 MLD of total water production, 89 MLD (or 94%) comes from groundwater sources (bore wells) and only 6 MLD from surface water, resulting in significant and rapid decrease in Ground Water Table (GWT). Groundwater in Rajshahi district declined at a rate of 0.23 m/year during the period 2000 - 2014[13].

Groundwater is sourced from 103 tube wells and surface water from the Padma River. RWASA, in January 2020, was providing water supply to 463,370 persons, i.e. 84% of the city's estimated total population of 551,630[14]. The increasing gap between demand and supply in Rajshahi worsens during the summer due to increased water demand. RWASA produces around 205 LPCD of water of which residents get around 135 LPCD and the rest is lost to leakages.

RWASA has six water treatment plants with a total capacity of 27 MLD, located at different wards in the city, but producing only 18 MLD treated water daily on an average, primarily due to non-operational water pumps. The total electricity consumption per year for water supply and distribution in 2020 was 6,69,456 kWh[15].

#### Water Distribution

RWASA distributes water in the city through its 712.50 km distribution network. The distribution system is based on both gravity and pumping system. The extent of non-revenue water (NRW) in Rajshahi city is about 34% and efficiency of customer complaints' redressal is about 99.4%. As per RWASA's daily production data, water is supplied for an average of 12 hours in a day. However, some secondary sources of information have recorded issues of variation in pressure and head loss at several places across the water distribution network. RWASA suffers major financial losses as the water production cost is almost twice the average tariff of the water supplied (See Table 2).

12 Rana, M. M., & Adhikary, S. K. 2020. 'A Demand-Driven Water Management Framework For Rajshahi City Corporation In Bangladesh', Proceedings of the 5th International Conference on Civil Engineering for Sustainable Development (ICCESD-2020-5055-1)

13 Hasan, M., Nuruzzaman, M. and Mamun, A., 2019. Contribution of Rainwater to the Irrigation Requirement for Paddy Cultivation at Tanore Upazila in Rajshahi, Bangladesh. Air, Soil and Water Research, 12, p.1178622119837S4.

14 Yearly Report (2011-2018), Rajshahi WASA. Available at <https://rajshahiwasa.org.bd/wp-content/uploads/2018/05/Info-Of-RWASAIBNET.pdf>.

15 Physical survey with Rajshahi WASA in 2020

**Table 2 Status of water supply distribution in Rajshahi**

| Sr. no. | Indicator | Status |
|---|---|---|
| 1 | Coverage of water supply | 84% |
| 2 | Per capita supply | 135 LPCD |
| 3 | Extent of NRW | 34% |
| 4 | Amount of sale of water | 61 MLD |
| 5 | Water production cost | 7.88 BDT/1000 litre |
| 6 | Average water tariff | 4.18 BDT/1000 litre |
| 7 | No of water consumers | 44,894 (as on Jan-2020) |

## Stipulated projects

As per the following data from the authority's official records, RWASA plans to improve water supply by expanding the water supply coverage through several on-going and proposed projects [16,17]

1. 200 MLD surface water treatment plant, for increasing daily water supply to 140 LPCD and extending population coverage from 84% to 100% by June 2022
2. Improving the pipeline network and RWASA's Shahid A. H. M. Kamaruzzaman surface water treatment plant (July 2020 to June 2023)

### Issues Identified

**Availability of water:**

Increasing population and per capita water demand are putting tremendous pressure on the water supply system of Rajshahi city, which is already plagued by issues of total dependence on ground water, water losses and uneven distribution throughout the city; and inadequate and uncertain supply of surface water supply owing to water diversion upstream of Padma River. This is likely to significantly affect residents, especially during dry seasons.

**Smart metering and NRW:**

RWASA has started implementing smart metering system in RCC area, with decent level of acceptance by citizens. For 100% implementation of the system in RCC area, RWASA needs to carry out capacity building and awareness programs.

**Groundwater extraction:**

Rajshahi is situated in the Barind region and its GWT is declining as RWASA depends on groundwater for 94% of its water production. There are no on-going or planned projects by RWASA to enable or encourage rainwater harvesting (RWH) systems. If this remains unaddressed, the city could face alarming level of groundwater depletion in the future.

16 https://rajshahiwasa.org.bd/projects-cat/proposed-projects/
17 https://rajshahiwasa.org.bd/reports-cat/annual-report/

# Solid Waste Management

## Solid Waste Generation

RCC is responsible for collecting and managing the waste generated in the city, the primarily sources being households, institutions, markets and commercial establishments (viz. hotels, restaurants, shops, etc.), vegetable, fruit and fish markets. On average, the total waste generation is approximately 500 MT/day (2019-20), of which about 370 MT/day is collected from the secondary transfer station. There is no waste segregation in Rajshahi, either at household/individual level or at collection points[18].

Municipal waste generated primarily contains organic material (around 63%) followed by plastic (8%), paper (6%), textile, rubber and leather waste, garden waste (wood, straw), metal, glass and others[19].

200 diagnostic centres, clinics and hospitals in RCC area together generate around 4 MT/day of medical waste, of which around 3 MT/day is from the Rajshahi Medical College Hospital (RMCH).

**74% of the households in the city are covered through door-to-door waste collection facilities**

## Solid Waste Collection and Disposal

74% of the households are covered through door-to-door waste collection facilities, while the remaining 26% dump their waste in drains, nearby surface water bodies and River Padma, creating serious environmental and health issues. The city has 44 open Solid Waste Disposal Sites (SDSs) and 190 community bins but no municipal dustbins within RCC area[20].

RCC employs more than 330 rickshaw vans for collecting household waste from 30 wards and transporting it to 40 secondary transfer stations. Finally, the waste is ferried to the Nawdapara waste disposal site (16 acres) situated at approximately three km from the RCC boundary. This is a shallow (3.5 m) and unplanned waste disposal site, lacking proper maintenance, resulting in unpleasant odour and public health hazards.

Rajshahi city lacks a dedicated medical waste collection/management plan. The medical waste is dumped in RCC's bins in and around the hospital areas, collected along with the municipal solid waste (MSW) and disposed in the open dumping site, posing a serious public health hazard[21]. The incinerator used in RMCH premises for disposing of biomedical waste has been out of operation for the last one year. The Hospital burns its wastes in an open place, which is neither safe nor hygienic.

## Solid Waste Treatment

The RCC area has no solid waste treatment plant. With increasing population, structures and commercial activities, RCC is looking for a suitable waste dumping location near the existing dumping site. In order to tackle with the MSW problem, RCC is planning to prepare and implement a waste management plan for Rajshahi City with a budget of around BDT 5,000 million.

18 Physical Survey, Conservancy and Electrical departments, RCC, 2020

19 Amin, N., 2017. Country Chapter State of the 3Rs in Asia and the Pacific. [online] Available at: <https://www.uncrd.or.jp/content/documents/5694[Nov%202017]%20Singapore%20Chapter.pdf>

20 Ahsan, A., Alamgir, M., El-Sergany, M. M., Shams, S., Rowshon, M. K., & Daud, N. N. (2014). Assessment of municipal solid waste management system in a developing country. Chinese Journal of Engineering, 2014.

21 Alam, Md.Z., Annaduzzaman, Md., Bari, Md.N. and Hannan, M.Md.A. (2019). Critical Issues of Present Medical Waste Management Practice in Rajshahi City and its Improvement Strategies. Journal of Environmental Treatment Techniques, [online] 7(3), pp.316–323.

A medical waste management plant is being set up in the RCC area, to collect all waste, including biomedical waste, generated from public and private clinics, diagnostic centres, and hospitals. This will contribute towards hygienic management and disposal of medical waste in Rajshahi city[22,23]

**Table 3 Status of solid waste management in Rajshahi**

| Sr. no. | Indicator | Status |
|---|---|---|
| 1 | Coverage of solid waste collection | 74% |
| 2 | Scientific disposal of solid waste through treatment plants | 0% |
| 3 | Extent of segregation of MSW | 0% |

Tables 4 and 5 provide details of solid waste collection facilities, year wise solid waste generation and collection status in RCC area.

## Ongoing/Planned Project[24]

The city of Rajshahi is planning to establish a Waste to Energy (WTE) plant of capacity between 5-10 MW. However, official feasibility estimation is pending.

## Issues Identified

Waste collection and segregation: Although RCC's door-to-door waste collection service has improved significantly over the years, the city administration still faces difficulties in collection and safe disposal. Around 130 TPD of MSW remains uncollected and is often found by the roadsides, contributing to drains' blockages and ultimately to urban flooding during monsoons.

Waste treatment: Rajshahi lacks any waste treatment or disposal system. Medical waste, although limited in quantity, is disposed of using an incinerator. The rest of the medical and municipal waste remains untreated.

Lack of awareness: Many residents dump their household waste in the open drain, open spaces, water bodies and Padma River, causing environmental pollution and health hazards.

**Around 130 TPD of MSW remains uncollected and is often found by the roadsides, contributing to drains' blockages and ultimately to urban flooding during monsoons**

**Table 4 Solid Waste Collection Facilities[25]**

| Facilities | Quantities in Different Years | |
|---|---|---|
| | 2015 | 2020 |
| Sweepers | 1200 | 1350 |
| Rubbish bins | 12 | 21 |
| Rickshaw vans | 228 | 326 |
| Wheelbarrows | 90 | 113 |
| Garbage Trucks | 3 | 5 |
| Push carts | 150 | 270 |
| Trailers | 3 | 7 |
| Waste disposal site | 12 acre (approx.) | 16 acre (approx.) |

22 Physical Survey, Prism Foundation, 2020

23 2019. Medical waste management plant being established in Rajshahi. The Financial Express, 30 Dec. Available at <https://thefinancialexpress.com.bd/national/medical-waste-management-plant-being-established-in-rajshahi-1577706691>

24 Halder, P., Rahman M. Ali, M.H., Parvez , M.S., Hoque, A.S.M. and Paul, N., 2014. Municipal Solid Waste and its Management in Rajshahi City, Bangladesh: A Source of Energy. International Journal of Renewable Energy Research, [online] 4(1). Available at: <https://www.ijrer.org/ijrer/index.php/ijrer/article/view/1054/pdf>.

25 Source: Physical survey with RCC in 2020

**Table 5 Financial year wise solid waste generation and collection status[26]**

| Financial Year | MSW Generation Rate kg/capita/day | Daily Waste Generation (tonne) | Daily Waste Collection (tonne) |
|---|---|---|---|
| 2019-2020 | 0.70 | 500+ | 370+ |
| 2018-2019 | 0.70 | 450+ | 350+ |
| 2017-2018 | 0.60 | 350 | 263 |
| 2016-2017 | 0.55 | 350 | 263 |
| 2015-2016 | 0.50 | 320+ | 240+ |
| 2014-2015 | 0.48 | 320 | 240 |
| 2013-2014 | 0.45 | 320 | 240 |

## Wastewater

### Wastewater Generation

Rajshahi city lacks a sewerage system; the entire population uses onsite sanitation technologies. The major sources of wastewater generation in RCC include households (around 44%), markets (10%), public toilets (19%) and factories (15%), followed by educational institutes and offices[27]. There is no reliable information on the quantity of wastewater generated. Based on the water consumption, the total wastewater generation is estimated to be 36 MLD (2017-18).

Due to non-existent centralized sewerage network system, residents have to depend on on-site sanitation systems. 80% of the population uses septic tanks and the remaining 20% population uses toilets connected to lined tanks and pits. About 70% of the septic tanks are connected to open drains; 10% of the population uses septic tanks connected to soak pits. In the toilets connected to lined tanks and pits, 12% of the lined tanks have impermeable walls and open bottom, no outlet or overflow; 5% of the lined pits have semi-permeable walls and open bottom, no outlet or overflow; and 3% of the lined tanks are connected to an open drain or storm sewer. There is no open defecation in RCC area. The frequency of septic tank cleaning (or emptying) varies with the number of people using the facility; ranging from 6 months to more than 5 years[28]. There is no documented evidence on septage generation and disposal/treatment, which likely means that all the generated septage is dumped illegally and irregularly on open ground or in water bodies/drains. In Rajshahi city, pits and septic tanks are emptied manually by privately hired sweepers.

Rajshahi lacks a sewer system or sewerage treatment plant. Fecal sludge is discharged at open drains, surrounding ditches and into Padma River or is transported and discharged into the dumpsite. Rajshahi's waste disposal site receives all types of waste (organic, inorganic, solid and fecal sludge) from the city's industries, households, and public and private institutions. No steps have been initiated for recycling and reuse of wastewater in RCC area.

### Issues Identified

- Due to lack of a centralised wastewater management system, households rely on septic tanks and other on-site treatment systems.
- There is no reliable data on the quantity of wastewater generated, waste water quality etc.

26 Physical survey with RCC in 2020

27 WaterAid Bangladesh. (2018). SFD Lite Report Rajshahi Bangladesh. Available at <https://www.susana.org/_resources/documents/default/3-3564-7-1552915661.pdf>.

28 WaterAid Bangladesh. (2018). SFD Lite Report Rajshahi Bangladesh. Available at <https://www.susana.org/_resources/documents/default/3-3564-7-1552915661.pdf>.

- In addition to inadequate legislation pertaining to wastewater management, onsite sanitation and septage management is a major public-health concern throughout the city. Septage clearance service is provided by private agencies and the sector is totally unregulated.
- Septage and effluent overflows from soak pits are dumped into drains and water bodies, resulting in pollution of water resources such as groundwater, water bodies and canals.

**The city has a decent stormwater drainage network with a total length of 136.27 km, which includes 46.80 km of primary drains, 44.69 km of secondary drains and 44.78 km of tertiary drains. Around 15.6% of the city area is not covered by the drainage network**

## Storm water/Drainage

### Present Scenario

The city has a decent stormwater drainage network with a total length of 136.27 km, which includes 46.80 km of primary drains, 44.69 km of secondary drains and 44.78 km of tertiary drains. Around 15.6% of the city area is not covered by the drainage network. Table 6 provides the ward wise drainage coverage in the RCC area[29].

**Table 6 Ward wise drainage coverage (%)**

| Ward Number | Drainage Coverage |
|---|---|
| Ward 1, 2, 3, 4, 27, 28, 29 and 30 | 16.4% |
| Ward 5, 6, 7, 8, 9, and 29 | 16.5% |
| Ward 10, 11, 17, 18 and 19 | 21.1% |
| Ward 12, 13, 14, 15, 16, 20 and 22 | 23.8% |
| Ward 21, 23, 24, 25 and 26 | 22.2% |

Around 75% of RCC areas are expected to be free of water-logging after implementation of an on-going drain construction project. The first two phases of the project have benefited 54% of the area[30].

### Ongoing/Planned Projects

Drain construction for removing water-logging in Rajshahi city (Third Phase) (May 2013 to June 2020)[30] - Construction of 93.40 km drains (67.75 km tertiary and 19.29 km secondary ones are ongoing) at a budget of BDT 1,933 million.

### Issues Identified

- The drainage system covers approximately 84% of Rajshahi city. Improper sizing, design and maintenance make the system inadequate to meet the city's demand.
- The road side drains are degraded due to encroachments, waste dumping, silting, weed growth, low maintenance and inadequate protective measures. Solid waste dumping and wastewater flows make storm drains unusable and turn them into potential pollution, health and hygiene hotspots.

29 Physical Survey , Engineering section, RCC 2020

30 BSS (2019) "75 pc areas to be freed from water-logging in Rajshahi city," 12 November. Available at: https://wp.bssnews.net/?p=301295.

## Transport

RCC is the main authority responsible for constructing and improving new and existing roads in Rajshahi city. RCC also works in collaboration with RDA and Roads and Highway Department to develop new roads to enhance the city's connectivity. The city has a good network of roads with a total length of 250 km. RCC is planning to increase the road network to 20% of the total land use by adding approximately 50 km to the existing network.

At present, the total number of registered vehicles in RCC area is 109,604[31]. Apart from individual vehicles, Intermediate Public Transport (IPT) like rickshaw is the most popular transport mode in Rajshahi due to ease of short-distance travelling and affordability. These rickshaws were hand-pulled until a few years back but have been replaced with battery-driven and rechargeable rickshaws. A large number of the latter (e-rickshaws and locally called easy bikes) were introduced in the city in 2008. More than 10,000 auto-rickshaws operate in RCC area and their number is increasing rapidly, creating traffic congestion at major intersections[32]. The RDA master plan is the only transportation plan in Rajshahi.

Historically, Rajshahi residents have relied primarily on walking, cycling and IPTs for their daily commute. People still prefer to walk/cycle, especially in the city's central area which has narrow and interconnected lanes. The city's expansion has resulted in increased travel distances and greater demand for motorized mobility, especially private vehicles. Personal vehicle use is quickly expanding with rising levels of revenue.

The modal share of Rajshahi city clearly indicates the dominance of private vehicles, especially two-wheelers (around 17.20%). The other modes are truck 10.20%, bus 9.80%, utility 6.80%, car 2.80%, auto-rickshaw 18.80%, bicycle 17.20% and rickshaw (battery) 17.20%[33]. The percentage of commercial vehicles in the city is 63% while 37% are non-commercial vehicles. The average annual growth rate for both categories together is 6.61%[34]. The city lacks a dedicated public transport system.

**More than 10,000 auto-rickshaws operate in RCC area and their number is increasing rapidly, creating traffic congestion at major intersections**

**Bus Services:** Rajshahi is well connected with other districts of Bangladesh by road. Inter-district buses operate along 20 routes and intra-district buses along 12 routes daily.[35] In addition, more than 15 air-conditioned buses operate each way daily between Rajshahi and Dhaka. The average occupancy rate in the intra-district routes is in the order of 75%, while in the inter-district routes, the average occupancy is around 60%. There is no intra city bus service in the city.

Annexure V presents the list of registered vehicles and the completed projects by RCC in the transport sector.

### Ongoing and proposed projects

- **Integrated Urban Infrastructure Development in Rajshahi City (2020 – 2023):** RCC is planning to implement an urban infrastructure development project for Rajshahi city with GoB funding. The main aim of this project is the development of road connectivity in RCC with an approximate cost of BDT 30,000 million. Through this project, RCC will reshuffle the city's road system. In the first phase, 15 roads will be widened to 42 meters each, with 30-meter main road and 6-meter footpath on both sides. An estimated BDT 5,000 million will be spent on road construction while BDT 25,000 million for land acquisition under the project. The project's main components include the following:

31 Physical survey with Bangladesh Road Transport Authority (BRTA), Rajshahi in 2020

32 Nahar, A., Chakma, R., Uddin, N., & Das, A. (2018). Existing Situation of On Street Parking and Impacts on Effective Carriageway Width and V/C Ratio: A Case Study of Rajshahi City Corporation Area. International Journal of Science, Technology and Society, 6(2), 33.

33 Physical survey, Engineering section, RCC 2020

34 Haque, A. "Transport Situation in Rajshahi." Available at: https://www.unescap.org/sites/default/files/2a.3_TransportSituation_Rajshahi_AshrafulHaque.pdf.

35 Working Paper on Transport, Rajshahi Development Authority, 2020

- construction of six flyovers over rail crossing in the RCC area
- widening of three highways passing through the city
- construction of 12 over bridges in front of schools, colleges and universities
- construction of 1,800 internal roads
- improvement of drainage connection
- widening of Rajshahi – Dhaka highway into 6 lanes (two lanes for Non-motorised Transport (NMT) i.e., bicycle and rickshaw)
- construction of 41.92 km footpath and 62.07 km walkways
- construction of 292.34 km tertiary drains, 59.33 km secondary drains and 4.51 km primary drains

◆ **Street modernization and beautification of RCC roads (2018 - present):** RCC is implementing the street modernization project with the help of GoB funding for the beautification of Rajshahi city. Under this project, twenty-five streets have been brought under the lighting scheme with BDT 270 million. To this end, installation of 1,285 poles, including 1,173 LED and 112 solar lights, has been completed. Beautification and installation of lights at nine street-crossings was implemented at the cost of around BDT 27.6 million.

### Issues Identified

◆ Significant increase in construction vehicles due to multiple large scale infrastructure projects in the city

◆ Rise in number of personal or individual vehicles due to increasing household income and in-migration from smaller towns and rural areas

◆ Almost all the road networks and intersections built in the city lack conformity with national road design standards prescribed by Roads and Highway Department and Planning Commission.

◆ The road space does not cater to the needs of pedestrians, cyclists, differently-abled or children.

◆ Issues with multimodal transport are caused, to a significant extent, by fragmented governance.

◆ In the absence of public bus service, most of the people use private vehicles and rickshaws as the principal mode for their daily commute.

◆ Lack of pedestrian friendly street design and facilities, and encroachment of road space by vendors and traders are among the main reasons for traffic congestion in urban areas.

◆ Lack of comprehensive mobility assessment and plan, and inadequate information on vehicle movement and modal mix result in improper implementation of transport policies and projects.

◆ Unregulated movements of electric vehicles

◆ Lack of regulated parking – RCC faces parking hassles due to unavailability of dedicated parking areas in the commercial area. This affects pedestrian movement; unmaintained footpaths and vehicles parked on roadsides leave pedestrians with no other option but to walk on roads.

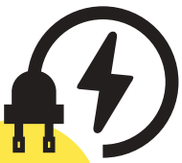
## Urban Planning, Energy and Green Spaces

Urban planning for the city is looked after by Rajshahi Development Authority (RDA), which is authorized to undertake local urban planning and infrastructure and site development activities for housing, commercial and industrial use.

Within the RCC area, there are a variety of housing areas based on the type of dwelling construction, spatial growth, the density of dwellings and access to infrastructure. Planned

housing areas are predominantly located in the northern part of the city beyond the railway line, and include Upashahar Housing Estate, Padma Residential Area, Banalata Residential Area, Parijat Residential Area, Chondima Residential Area, and Seroil Colony.

Central areas of the city (covering wards 9, 12, 13, 20, 22, 23, 24) are mixed-use areas. Shaheb Bazar and adjoining areas are predominantly commercial areas. The western part of the city shows a mix of housing and public institutions. These areas comprise wards 10, 8, 7, 5, 6, 4, 3, 1 and 2. Ward 4 accommodates public housing, while wards 2 and 3 have more private housing.



**In April 2019, the total number of consumers in RCC area were 839,085. The Rajshahi distribution zone consists of 8 districts and 19 Upazila in Rajshahi division.**

## Present Scenario

**Slum Areas in RCC Area:** Slum population has been growing in RCC area. According to Building Resources Across Communities (BRAC), the slum population in RCC area rose from 60,000 in 2018 to 86,000 in 2020[36]. Figure 6 present a list of existing slums in RCC area with population, households and locations.

**Electricity Consumption and Distribution:** Created in 2016, the Northern Electricity Supply Company Limited (NESCO Ltd.) is the power distribution company that looks after the electricity distribution network in Rajshahi and Rangpur zones. Before the establishment of NESCO Ltd., the parent company Bangladesh Power Development Board (BPDB) was responsible for electricity in this area. In April 2019, the total number of consumers in RCC area were 839,085. The Rajshahi distribution zone consists of 8 districts and 19 Upazila in Rajshahi division. The consumer growth rate for both Rajshahi and Rangpur distribution zones is 7.2%. Currently, NESCO Ltd. supplies 258.247 MW against the demand of 420 MW in the city. As per estimates, a large number of battery-driven rickshaws and bikes consume 26.75 MW of electricity from both authentic and illegal sources.

**Total green space decreased from 49.57% in 1999 to 30.66% in 2019**

**Green Spaces/Biodiversity:** A recent study[37] demonstrates that built-up area in the city increased from 16% in 1999 to 21.98% in 2009, with the growth seen mainly in the north-east region of RCC area. In 2019, it has increased to 32.6%. Total green space decreased from 49.57% in 1999 to 30.66% in 2019, i.e., an overall decrease of 18.9%. Further, one of the most important natural resources i.e., water bodies have also diminished in area, by around 4% in the period 1999 - 2019. Based on these estimates, it is projected that by the year 2039, green space would decrease by 35.84% as compared to 1999. Clearly, rapid growth is driving the loss of urban green space and natural resources in RCC area.

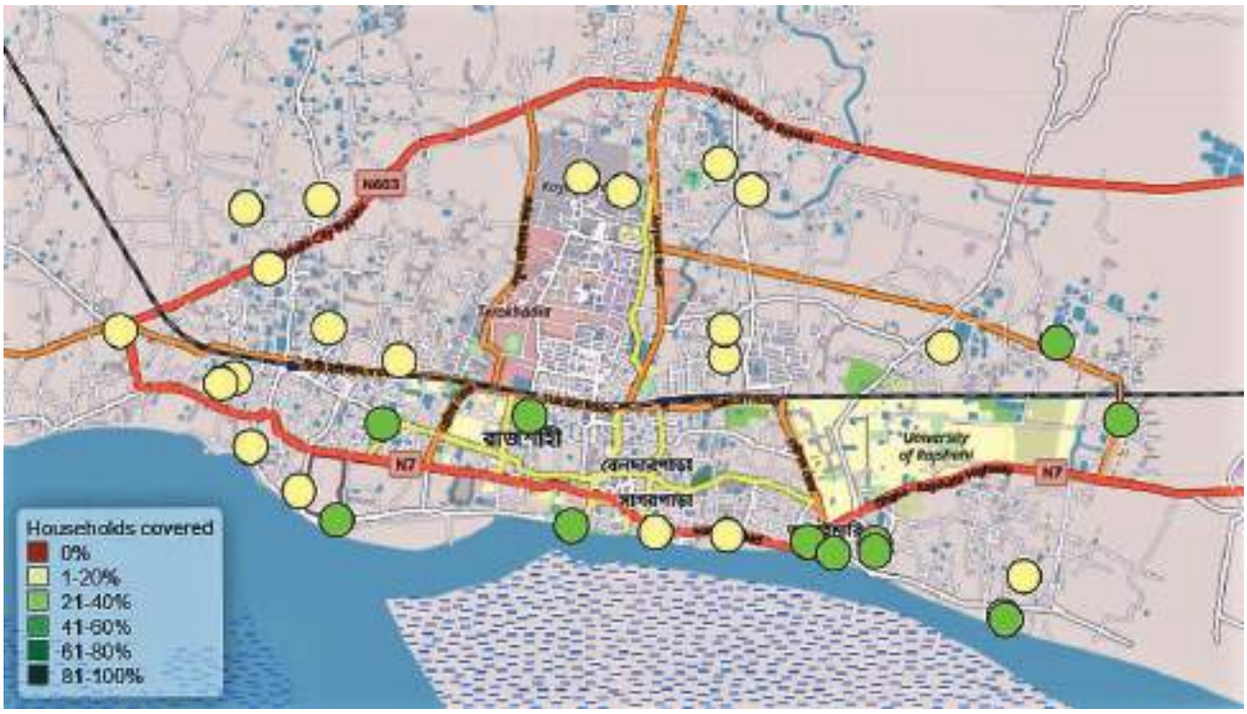
**Air Quality Initiatives in Rajshahi** - A number of initiatives by RCC have contributed to reducing harmful particulate matter in the air and making the city greener and liveable. Brick kilns have been set up far from the city and the ones within the city have been upgraded with better chimneys. Apart from planting a large number of trees over the last few years, avenue plantation has been carried out across the city. These efforts earned the city recognition from the World Health Organization (WHO) in 2014-16 as the most successful city globally in reducing harmful particles PM10 and PM2.5 in the air, in addition to the National Environmental Award in 2013 and several awards for tree plantation.

Greenery in Rajshahi city is the result of RCC's Zero Soil Programme, launched in 2004 to counter the dust blown from the nearby Padma River during the dry season. Besides their own tree plantation programme, RCC annually distributes 500 saplings of different trees – from fruits to flowers – to schools and colleges, for students to plant them and add to the greenery.

36 Physical Survey, BRAC, 2020

37 Kafy, A.- A., Rahman, M.S., Faisal, A.-A.-, Hasan, M.M. and Islam, M., 2020. Modelling future land use land cover changes and their impacts on land surface temperatures in Rajshahi, Bangladesh. Remote Sensing Applications: Society and Environment, 18, p.100314.

**Figure 6 Location of slums in RCC area**[59]




## Ongoing/Planned Projects

- **Integrated Urban Infrastructure Development in Rajshahi City (2020 – 2023):** Through this project, RCC aims to develop the road network and other important infrastructure at a total cost of around BDT 30,000 million. Under this project, four recreational parks will be constructed in RCC area. Further, the project will involve preservation of 19 ponds and construction of sitting arrangement and walkways beside the water bodies.
- **Rajshahi Metropolitan Development Plan (RMDP) (2004 – 2024):** In order to facilitate planned and organized development of Rajshahi city, the Ministry of Housing and Public Works Bangladesh, approved the RMDP project to be implemented by RDA on the 361 sq.km. area under it. Since RCC area is under RDA jurisdiction, RCC will also benefit from this master plan. Currently, efforts for the revision of the functional master plan and detailed area plan to make the RMDP disaster risk sensitive are underway, with a cost of BDT 180 million[38].
- **Urban Development Program (UDP) (2018-2022):** This project aims to make Rajshahi city inclusive, safe and sustainable by improving wellbeing, reducing multidimensional poverty and supporting people living in urban poverty to exercise their rights. This program promotes community-led service integration, social enterprise approaches and public-private-community partnerships for pro-poor urban development and is being jointly implemented by RCC and BRAC[39].
- **Livelihoods Improvement of Urban Poor Communities Project (2016 – 2022):** This project aims to contribute to balanced, sustainable growth by reducing urban poverty in Bangladesh and achieve the SDGs that call for 'leaving no one behind' by 2030. The major objectives of the project include the following:
  - facilitating climate-resilient housing and basic services for low-income households
  - building community organizations

38 FARIDATUL, M. An Assessment on the Implementation of the Physical Development Plans of Rajshahi during 1984 to 2014.

39 Physical survey, BRAC, Rajshahi office, 2020

- providing skills and enterprise development for women and girls
- enhancing adaptive climate capacity of the low-income community through resilient infrastructure
- strengthening municipal capacity for improved urban management, policy and planning

This project is being jointly implemented by United Nations Development Program (UNDP) and RCC in Rajshahi city, with funding support from donor agencies UNDP and Department for International Development (DFID) at an estimated cost of 47 million USD[40].

**As a result of long-term planning for urban development and adoption of the Zero Soil Project, Rajshahi received the "Environment-Friendly City of the Year 2020" award**

- **Rajshahi Division Distribution Line and Substation Extension and Rehabilitation (2019 to 2022)** – The total cost of this project is BDT 10.91 billion. The areas to be covered under this project include RCC area and 21 Upazilas in eight districts under Rajshahi division. The project has been designed for standard upgradation and rehabilitation of twenty 33/11kV sub-stations; installation of 3,851 distribution transformers, 25 circuit breakers, 311 capacitor banks and three new 33/11kV power sub-stations; erection of 2,042.5 km new lines and rehabilitation of 1,411 km dilapidated lines. The Bangladesh Power Development Board (BPDB) has been implementing another mega project in the division involving more than BDT 96.4 million to ensure safe and dependable power supply and meet the increasing demand for electricity till 2025.
- **Zero Soil Project (2011 to present):** This project aims to create an environment-friendly city, covering all topsoil with vegetation. Green trees of several species have been planted on the road in various areas of the city, including pavements. The importance of roof farming is being emphasized in various places in the city. Educational institutions have also been greened. As a result of long-term planning for urban development and adoption of the Zero Soil Programme, Rajshahi received the "Environment-Friendly City of the Year 2020" award for its green look and clean air[41]. In 2019, 14,000 trees were planted along roads and footpaths, including 200 jasmine (sheuli) flower plants and 200 Chhatim (blackboard tree or devil's tree) trees and different colourful flower plants on the embankment from CNB intersection to Bheripara intersection[42].

**Issues Identified**

1. Absence of urban development master plan for the present and future development of RCC area
2. Lack of knowledge about the benefits of solar PV instalment in different buildings
3. No solar PV charging facilities for electric auto rickshaws which consume significant energy
4. Lack of awareness on various green design and technological solutions available for buildings

40 www.bd.undp.org. Livelihoods Improvement of Urban Poor Communities Project. [ONLINE] Available at: https://www.bd.undp.org/content/bangladesh/en/home/projects/livelihoods-improvement-of-urban-poor-communities-project.html.

41 2020. Rajshahi awarded eco-friendly city of the year. The Business Standard, 4 Jan. Available at: https://www.tbsnews.net/bangladesh/rajshahi-awarded-eco-friendly-city-year.

42 Physical survey, Engineering section, RCC, 2020

# 03

# GHG EMISSIONS INVENTORY

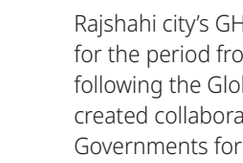
Rajshahi city's GHG emissions inventory was prepared based on the data collected for the period from 2013 to 2017. The GHG emissions inventory was prepared following the Global Protocol for Community Scale GHG Emissions Inventories or GPC created collaboratively by WRI, C40 Cities Climate Leadership Group and ICLEI - Local Governments for Sustainability. In particular, it complies with the BASIC level reporting which covers Scope 1 and Scope 2 emissions from stationery and transportation energy sources, as well as Scope 1 and Scope 3 emissions from waste (Annexure VI).

The GHG emissions inventory consists of two analyses, one for the emissions within the community determined by the geographical boundaries of the city's municipal jurisdiction and the other for urban services provided by RCC.

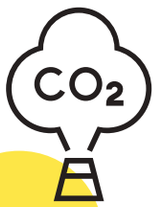
Community-level inventory is a useful tool to establish baseline status of GHG emissions and in developing mitigation actions for the entire city community. It includes emissions from community activities that occur within the municipal government's jurisdiction. This includes emissions due to activities such as residential buildings, commercial/institutional facilities, industrial units and processes, agriculture, forestry and land-use, and mobile transportation units.

Local Government (LG) inventory includes emissions from all local operations that RCC owns or controls. The various sectors considered for this inventory include LG buildings and facilities such as street lighting, traffic lighting, water, waste, sewerage and municipal vehicle fleet. Based on the inventory data for the baseline year, the municipal government can develop innovative approaches to provide sustainable urban services and can demonstrate leadership in pursuing emission mitigation efforts that illustrate the possibilities of different mitigation actions to the community.

A city's GHG inventory is not just the sum of GHG emissions from its community-level activities and from the operations carried out by the local government body to provide basic urban services. Usually, a major part of the emissions due to local government operations is a subset of the community level emissions. Often the community inventory data already accounts for the data pertaining to municipal government operations. Due care should be taken to avoid double accounting of emissions.



**Rajshahi's baseline GHG emissions inventory has been prepared based on energy consumption and municipal operation data for the period 2013-14 to 2017-18**




**The GHGs considered in the GHG emissions inventory are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrogen oxide ($N_2O$), gases that account for nearly 99% of global GHG emissions.**

For example, the electricity consumption in municipal facilities for water supply, sewage treatment and street lighting may already be accounted in the community-wide electricity consumption data based on relevant customer/end-user categories as prescribed under the electricity distribution and tariff arrangements. Adding the electricity consumption data from such facilities, obtained from the respective departments within the LG, to the community-wide data again will result in double accounting of the emissions. Careful handling of data can prevent such overlaps.

However, it is necessary to acknowledge that analysing community-level emissions presents its own challenges, as the natural flow of energy and materials is typically most accurate at the national level. Reducing the spatial area of analysis, from national to sub-national and local levels, results in a less accurate reflection of the material and energy flows. Community level GHG emissions accounting requires a combination of national and local area information to model the emissions. This report identifies the main energy carriers and the intensive GHG emitting sectors that contribute to the local carbon footprint and air pollution within the geographical boundary of RCC.

## 3.1 Methodology for GHG emissions inventory

The GHGs considered in the GHG emissions inventory are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrogen oxide ($N_2O$), gases that account for nearly 99% of global GHG emissions.

The GHG emissions inventory has been reported in terms of emissions of each individual GHG and the total carbon dioxide equivalent ($CO_2e$) emission. To arrive at the $CO_2e$, the global warming potential (GWP) of each gas for a 100-year timeline is factored. The GWP reflects the climate change impact, in terms of the warming effect on the atmosphere, for each GHG with reference to $CO_2$. Table 7 presents the GWP values based on IPCC's Fourth Assessment Report (2007).

**Table 7 100 Year GWPs of the GHGs with respect to $CO_2$**

| Gas | Lifetime (years) | GWP for 100 years |
|---|---|---|
| $CH_4$ | 12 | 25 |
| $N_2O$ | 114 | 298 |

**To arrive at the $CO_2e$, the global warming potential (GWP) of each gas for a 100-year timeline is factored.**

### 3.1.1 Emissions Factors

For estimating GHG emissions from the various activities or sources in a region, carrying out a direct physical measurement of GHGs emitted is not feasible. The common methodology for estimating GHG emissions is using the principle of emissions factor and the relevant activity data to estimate the emissions.

$GHG_A = EF_A \times D_A$
Where $GHG_A$ = GHG emissions resulting from activity A
$EF_A$ = emission factor for activity A
$D_A$ = data for activity A

The emissions factor for a particular activity is dependent on the energy use and the direct emissions of GHGs resulting from the activity. As the emissions factors are dependent on the energy use and the direct GHG emissions, they tend to vary over locations or even for different technologies. For example, the emissions factor per kWh of electricity used would vary over countries or regions due to the varying energy mix, characteristics of fuel used and the efficiency of electricity generation. The emissions factor per km travelled would vary depending on the fuel characteristics, the engine characteristics for the vehicle, the driving and traffic patterns prevalent. For accurately estimating a GHG emissions inventory, it is important to use the emissions factor best suited to the location.

For the present study, relevant emissions factors as available in HEAT+ were used to arrive at GHG emissions from activities in the region. HEAT+ contains numerous country specific emissions factors and energy densities for a wide range of fuels, combustion technologies and waste types. HEAT+ uses these values to calculate the GHG emissions resulting from electricity usage, fuel consumption and waste decomposition.

### 3.1.2 Harmonized Emission Analysis Tool plus (HEAT+)

ICLEI's Harmonized Emission Analysis Tool plus (Heat+) is an online emissions accounting software package that helps local governments to account for GHG emissions and develop a comprehensive energy and carbon inventory of their respective cities. The tool helps them in making informed climate action decisions and was utilized to assist with the accounting of Rajshahi's level of GHG emissions during the 5-year period of the inventory. The Heat+ tool incorporates the latest technical findings (IPCC, 2006) and is based on the International Local Government GHG Emissions Analysis Protocol (IEAP). It also incorporates the new international reporting requirements and standards outlined in the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC).

HEAT+ is now GPC compliant. However, the government module is retained from the differentiation that was brought in with IEAP.

The Harmonized Emissions Analysis Tool (HEAT+) is a specialized online application designed to help local governments:

- Create emissions inventory of GHGs as well as air pollutants such as nitrogen oxides, Sulphur oxides, carbon monoxide, volatile organic compounds, and particulate matter;
- Forecast growth of these emissions for a future year;
- Evaluate policies and measures to reduce emissions of these pollutants; and
- Prepare action plans to reduce emissions.

While ICLEI designed HEAT+ as a GHG planning tool for its local government members to use while undertaking the five-mile stone process of the Cities for Climate Protection Campaign, this tool has been substantially updated to support cities in the implementation of ICLEI's latest Green Climate Cities Program. Decision-makers from other levels of governments as well as from the private sector and non-governmental organizations will also find the tool useful. With an easy to navigate interface, numerous built-in reports, extensive Intergovernmental Panel on Climate Change (IPCC) and country-specific emissions coefficient data sets, HEAT+ provides an unparalleled software environment for everything right from preparing city-specific GHG inventories to evaluating the benefits of individual policies and measures for developing comprehensive action plans.

### 3.1.3 Data Sources and Collection

The baseline year for this study was FY 2017-18. The data was collected for the last 5 years up to 2013-14 from the baseline year. A full inventory includes GHG emissions from energy, waste, forestry and land use change. However, due to limited resources and data constraints, the direct emissions from agriculture, land use change and forestry sectors were not included.

ICLEI South Asia and RCC staff members engaged with a number of municipal, local and sub-national stakeholders to source relevant energy consumption data focusing on the large carbon emitters within the municipal area. Supply and demand side data was collected and analysed. Table 8 elaborates the various sources of energy and other relevant data used in the report.

**Table 8 Sources of the Data Used for GHG Emissions Calculation**

| Fuel Type | Sector | Source of Data |
|---|---|---|
| Electricity | Residential | NESCO Ltd. |
| | Commercial/Institutional | NESCO Ltd. |
| | Manufacturing Industry and Construction | NESCO Ltd. |
| | Waterworks Department – Water Supply | RWASA |
| | Street Lights | NESCO Ltd. |
| Diesel | Community Transport | Jamuna Oil Company, Meghna Petroleum Ltd. |
| | Municipal Vehicles | RCC |
| Petrol | Community Transport | Jamuna Oil Company, Meghna Petroleum Ltd. |
| | Municipal Vehicles | RCC |
| LPG | Residential | Jamuna Oil Company, Meghna Petroleum Ltd. |
| | Commercial/Institutional | Jamuna Oil Company, Meghna Petroleum Ltd. |
| Kerosene | Residential | Jamuna Oil Company, Meghna Petroleum Ltd. |
| PNG | Residential | Pashchimanchal Gas Company Limited (PGCL) |
| | Commercial/Institutional | PGCL |
| | Manufacturing Industry and Construction | PGCL |
| Furnace Oil | Manufacturing Industry and Construction | Meghna Petroleum Ltd. |
| Octane | Manufacturing Industry and Construction | Jamuna Oil Company, Meghna Petroleum Ltd. |
| | Municipal Vehicles | RCC |
| Transport Sector | | RCC |
| SWM | | Conservancy Department, RCC |
| Municipal Water Supply | | RWASA |
| Municipal Street Lighting | | Electrical Department, RCC |

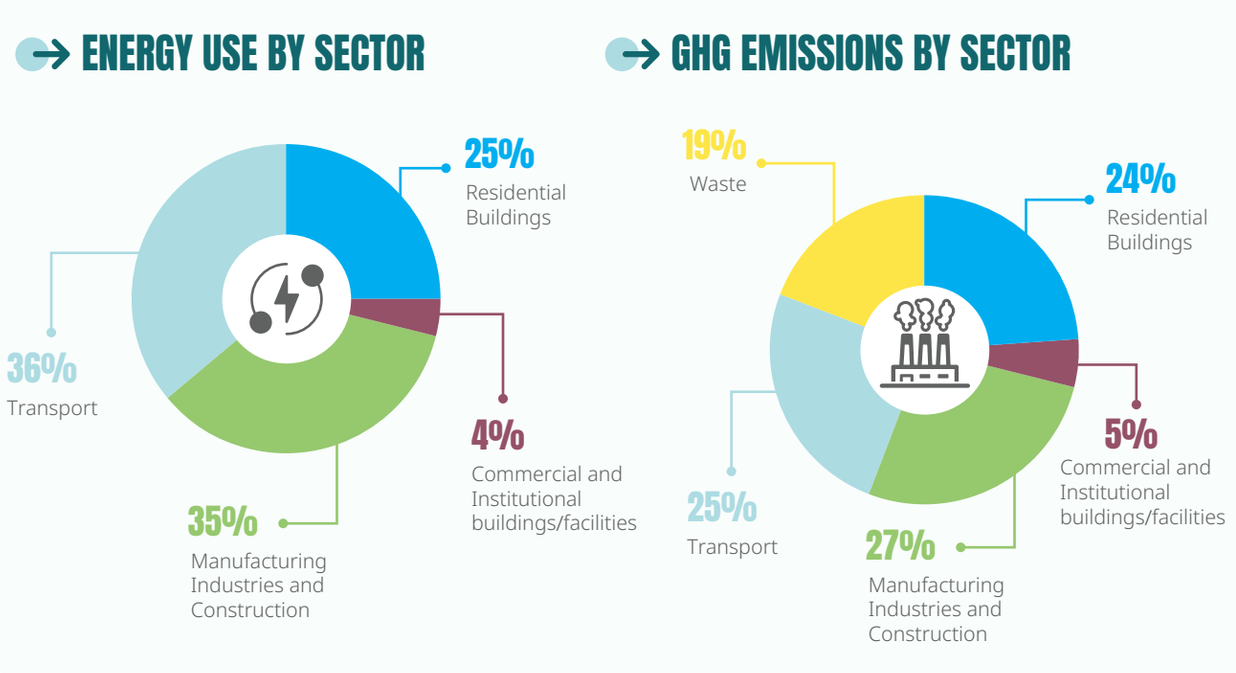
## 3.2 GHG Emissions Inventory of Rajshahi City

- Largest energy consumers: Transportation (36%); Manufacturing Industries and Construction (35%); Residential Buildings (25%); Commercial and Institutional Buildings/Facilities (4%)[43]
- Energy use trend: Rise of 90.64% since 2013-14 (at a CAGR of 13.8%)
- Total community scale GHG emissions in 2017 -18: 620,254 $tCO_2e$
- Largest GHG emitters: Manufacturing Industries and Construction (27%); Transportation (25%); Residential Buildings (24%); Waste (19%); Commercial and Institutional Buildings/Facilities (5%)[44]
- GHG emissions trend: Rise of 58.81% since 2013-14 (at a CAGR of 9.7%)

**Table 9 Rajshahi City Energy Consumption and GHG Emissions (2017-18)**[45]

| | |
|---|---|
| 1 Total Energy Use<br>**5,924,222 GJ** | 2 Total GHG Emission<br>**630,254 Tonnes GHG emissions as $CO_2e$ ($tCO_2e$)** |
| 3 Per Capita Energy Use<br>**11.97 GJ** | 4 Per Capita GHG emissions<br>**1.27 $tCO_2e$** |

**Figure 7 Community Scale Energy Consumption and GHG Emissions (2017-18)**




43 Agricultural energy use is considered negligible
44 Agricultural emissions are considered negligible
45 Includes direct energy use (from combustion of fuels such as kerosene, LPG, petrol, diesel) and indirect energy use (from due to consumption of grid electricity consumption)

**Table 10** **Sector wise Energy Use (GJ) and GHG Emissions ($tCO_2e$)**

| Sector | Energy Use (GJ) | GHG Emissions ($tCO_2e$) |
|---|---|---|
| Residential Buildings | 1,474,906 | 148,564 |
| Commercial and Institutional Buildings/Facilities | 201,818 | 31,991 |
| Manufacturing Industries and Construction | 2,095,008 | 169,081 |
| Agriculture, Forestry and Fishing Activities | 1,080 | 194 |
| Transportation | 2,151,409 | 160,205 |
| Waste | -- | 120,218 |
| **Total** | **5,924,222** | **630,254** |

**Figure 8** **Energy Consumption Trend - 2013 to 2017**

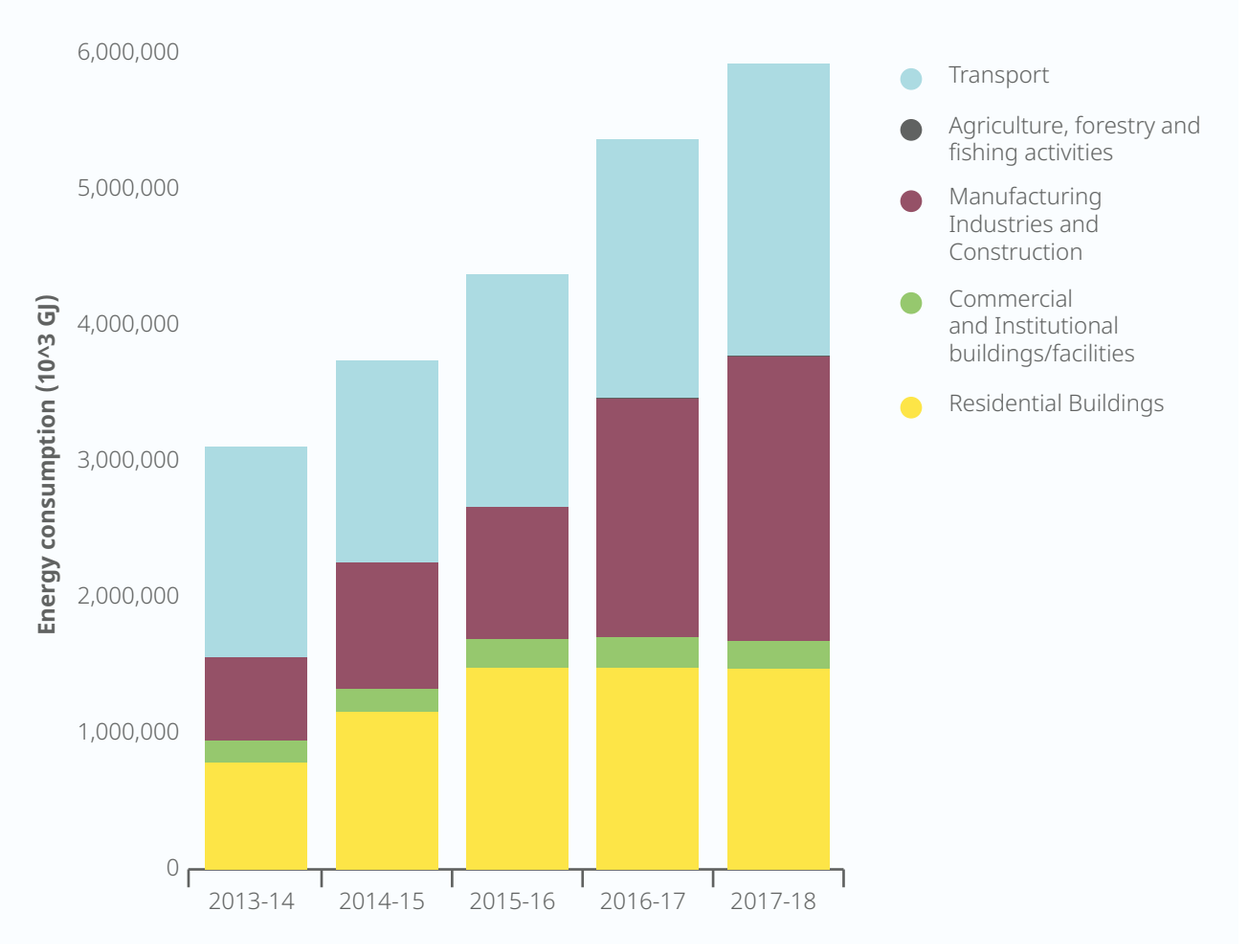
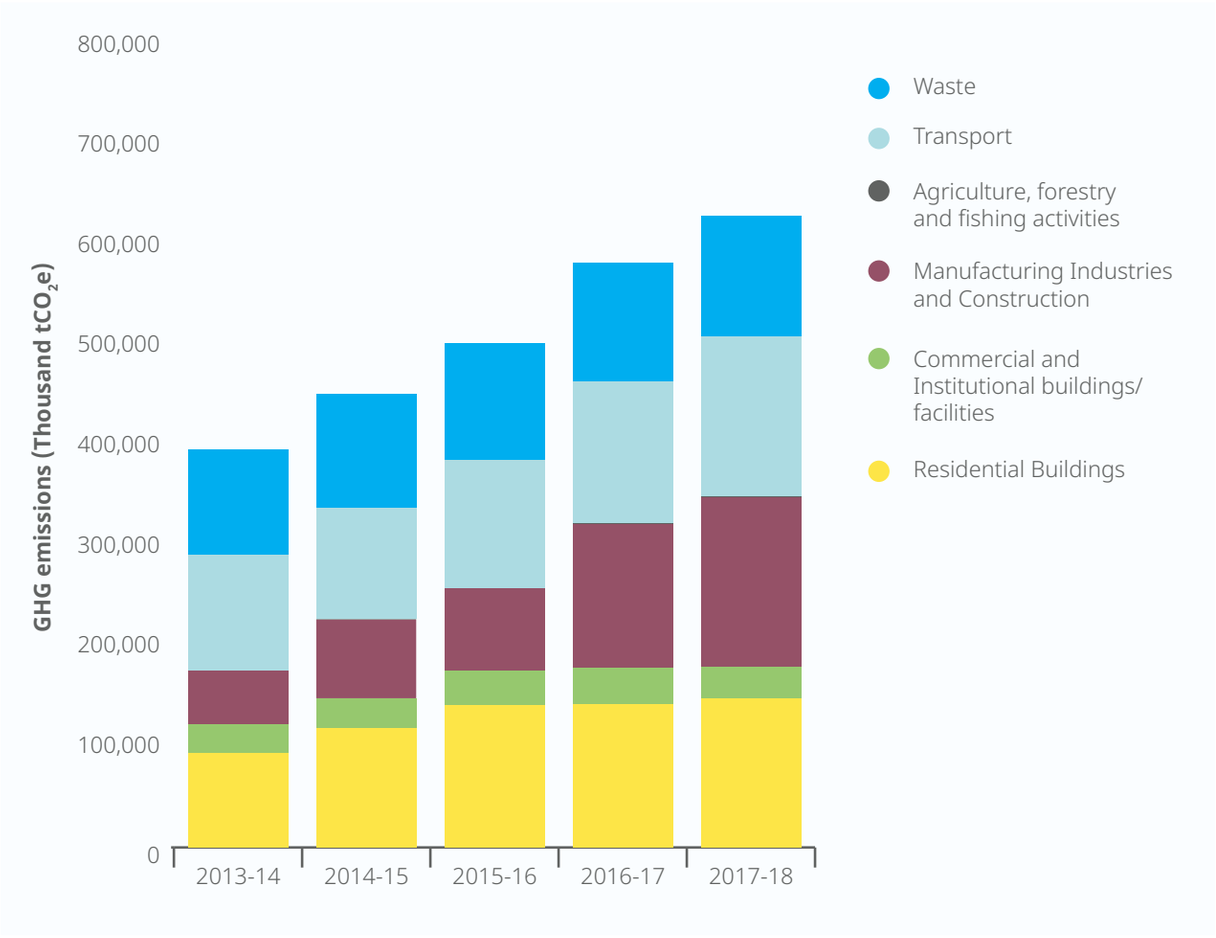


**Figure 9** **GHG Emissions' Trend - 2013 to 2017**




## 3.2.1 Snapshot of Energy Use and Resultant GHG Emissions by Energy Source

**Figure 10** **Snapshot of Energy Use and Resultant GHG Emissions by Energy Source/Fuel (2017-18)**

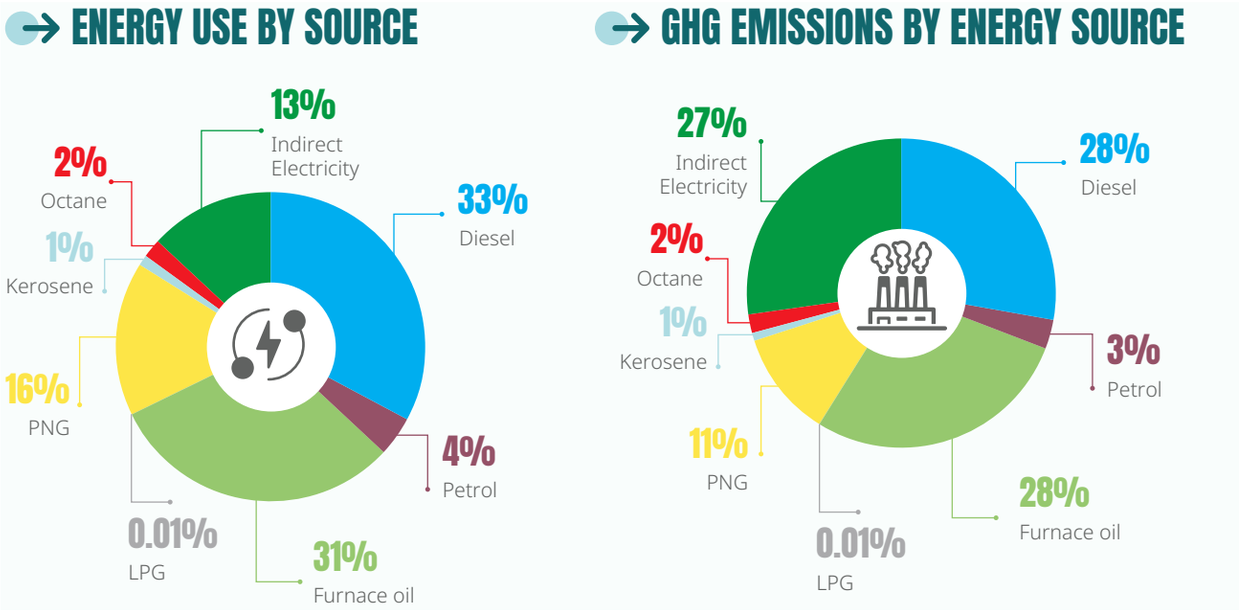


**Table 11** Source Wise Energy Use and GHG emissions

| Fuel/Energy Source | Energy Use (GJ) | GHG emissions ($tCO_2e$) |
|---|---|---|
| Diesel | 1,942,964 | 144,467 |
| Petrol | 207,759 | 14,450 |
| Furnace Oil | 1,858,264 | 144,301 |
| LPG | 568 | 36 |
| PNG | 945,401 | 53,089 |
| Kerosene | 71,611 | 5,167 |
| Octane | 129,379 | 8,996 |
| Indirect Electricity | 768,276 | 138,290 |
| **Total** | **5,924,222** | **508,795** |

- Prominently used energy sources: Diesel (33%); Furnace Oil (31%); PNG (16%) and Electricity (13%)
- Total community scale GHG emissions by energy source in 2017 -18: 508,795 tonnes of $CO_2e$
- Largest GHG emitting energy sources: Diesel (28%); Furnace Oil (28%); Electricity (27%)

### 3.2.2 Sectoral Electricity Consumption and Resulting Indirect GHG Emissions

**Figure 11** Sectoral Electricity Consumption and Resultant Indirect Emissions (2017-18)

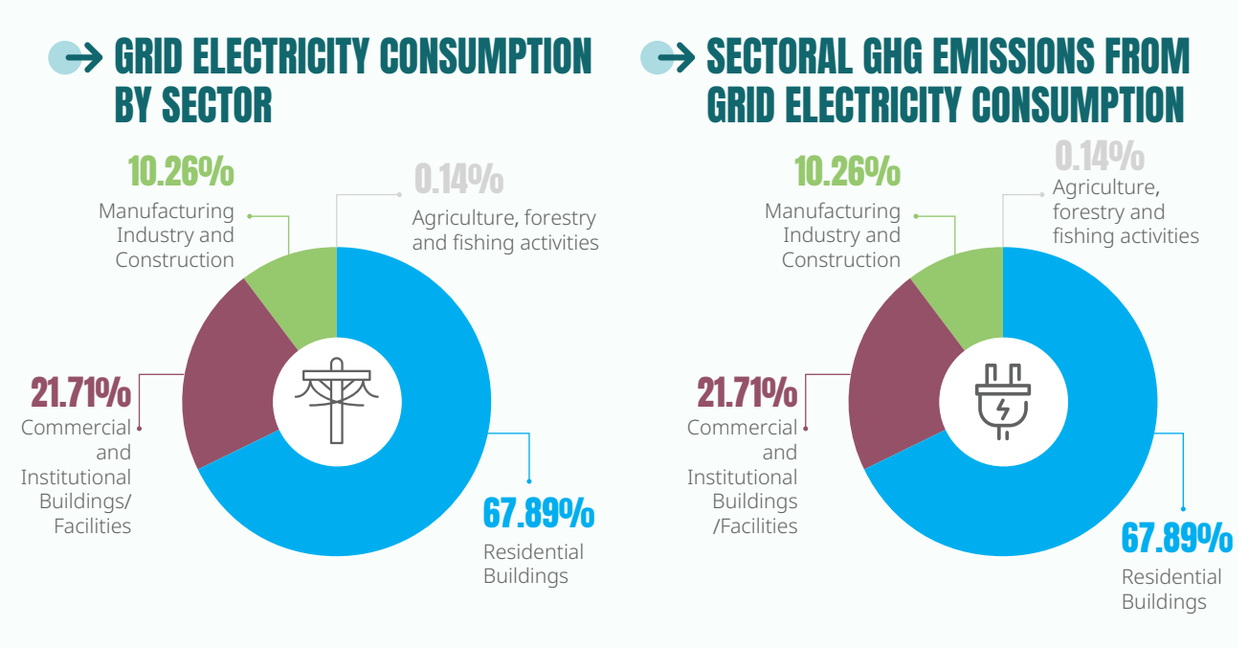
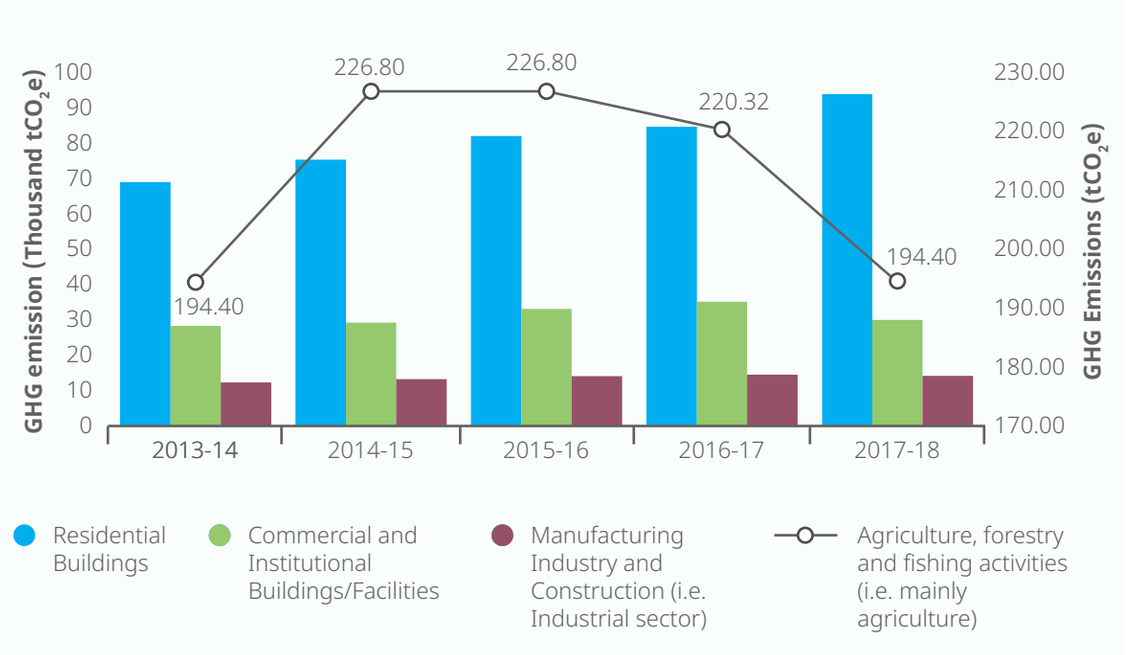


**Table 12 Annual Sectoral Electricity Consumption (Million kWh)**

| Sector/Year | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 |
|---|---|---|---|---|---|
| Residential Buildings | 107 | 116 | 127 | 131 | 145 |
| Commercial and Institutional Buildings/ Facilities | 44 | 45 | 51 | 54 | 46 |
| Manufacturing Industries and Construction | 19 | 20 | 22 | 22 | 22 |
| Agriculture, Forestry, and Fishing Activities | 0.30 | 0.35 | 0.35 | 0.34 | 0.30 |

**Figure 12 Trend of GHG Emissions from Grid Electricity Consumption**

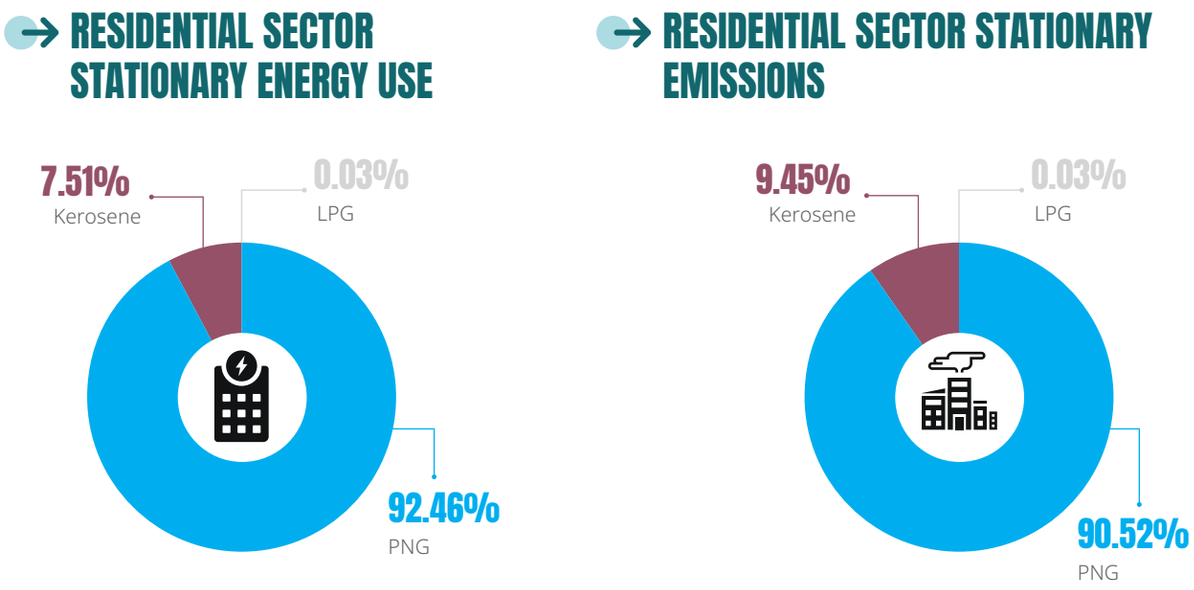



- Total Electricity consumption in 2017-18: 213.41 million kWh
- Electricity consumption per capita: 431.27 kWh
- Largest Electricity consumers: Residential Buildings (67.89%); Commercial and Institutional Buildings/Facilities (21.71%); Manufacturing Industries and Construction (10.26%); Agriculture (0.14%)
- Total GHG emissions from electricity consumption in 2017 -18: 138,290 tonnes of $CO_2e$
- Largest GHG Emitters: Residential Buildings (67.89%); Commercial and Institutional Buildings/Facilities (21.71%); Manufacturing Industries and Construction (10.26%); Agriculture (0.14%)

### 3.2.3 Trend of direct emission from stationary combustion at the community level

#### Residential Building Sector

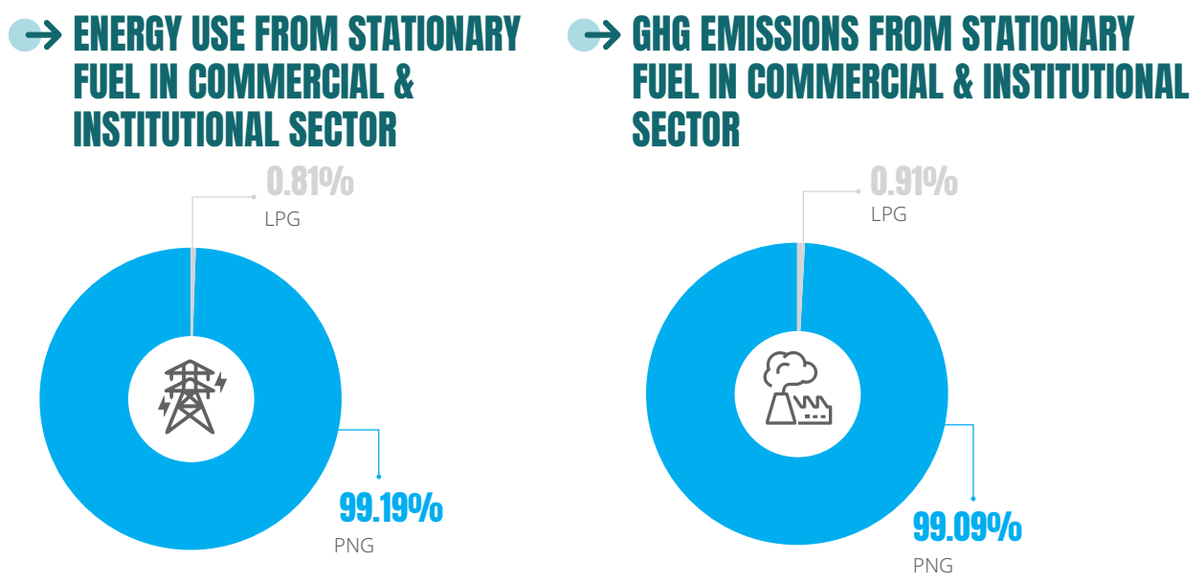
**Figure 13** Energy Use and Resultant GHG Emissions in Residential Buildings




- Total Energy Use from stationary fuel consumption in the sector: 953,338 Giga Joules (GJ)
- Energy Use Trend: rise of 138.31% (at a CAGR of 19%)
- Trend of Kerosene Consumption: decrease of 55.30% (at a CAGR of - 14.9%)
- Trend of LPG Consumption: decrease of 66.67% (at a CAGR of - 19.7%)
- Total GHG emissions from stationary fuel consumption in the sector: 54,682 tonnes of $CO_2e$
- Largest GHG emitting Fuel: PNG (90.52%)

#### Commercial and Institutional Buildings/Facilities

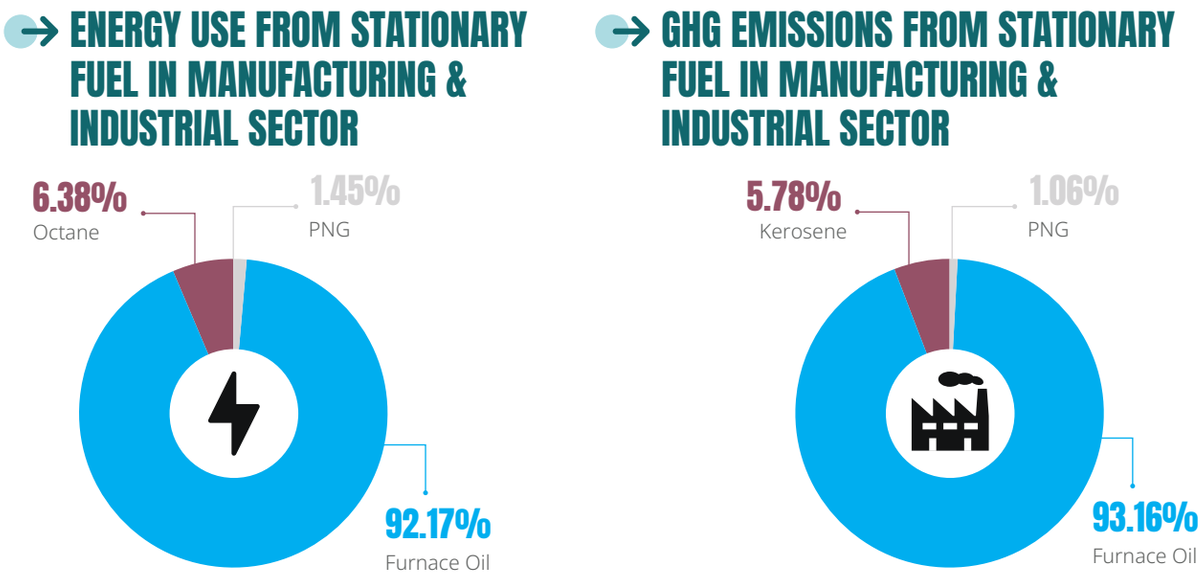
**Figure 14** Energy Use and Resultant GHG Emissions in Commercial Sector



- Total Energy Use from stationary fuel consumption in the sector: 35,030 Giga Joules (GJ)
- Trend of LPG Consumption: decrease of 66.67% (at a CAGR of - 19.7%)
- Total GHG emissions from stationary fuel consumption in the sector: 1,969 tonnes of $CO_2e$
- Largest GHG emitting Fuel: PNG (99.09%)

### Manufacturing Industries and Construction Sector

**Figure 15 Energy Use and Resultant GHG Emissions in Industrial Sector**




- Total Energy Use from stationary fuel consumption in the sector: 2,016,168 Giga Joules (GJ)
- Trend of Octane Consumption: rise of 72.39% (at a CAGR of 11.5%)
- Trend of PNG consumption: rise of 29.52% (at a CAGR of 5.3%)
- Total GHG emissions from stationary fuel consumption in the sector: 154,889 tonnes of $CO_2e$
- Largest GHG emitting Fuel: Furnace Oil (93.16%)

### Agriculture, forestry and fishing activities (i.e. mainly agriculture)

**Figure 16 Trend of Energy Use in Agriculture Sector**

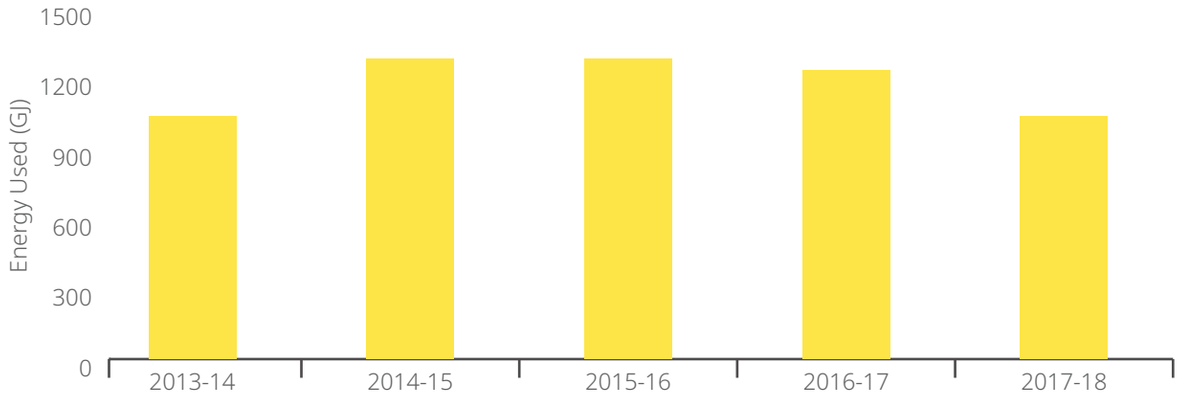
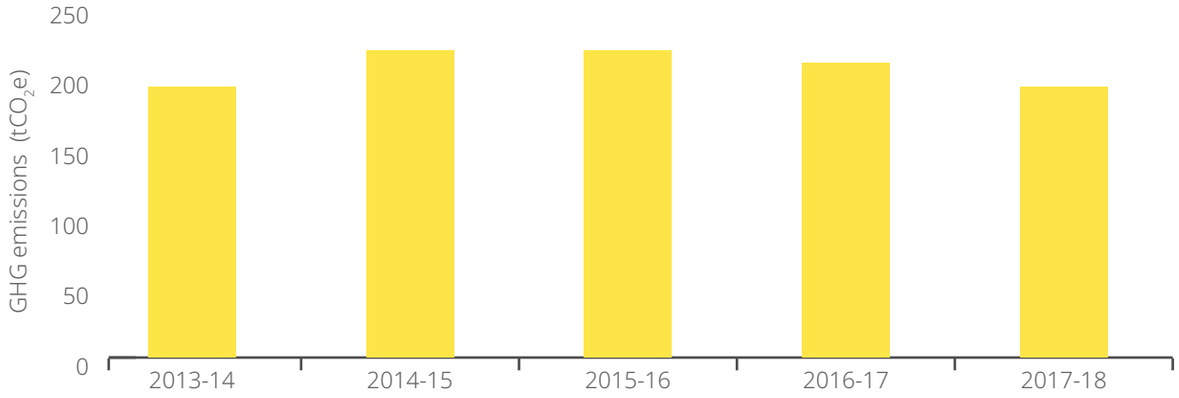


**Figure 17** Trend of GHG Emissions in Agriculture Sector




**Total Energy Use from stationary fuel consumption in the sector:**
**1,080 GJ**

**Total GHG emissions from stationary fuel consumption in the sector:**
**194 tonnes of $CO_2e$**

## 3.2.4 Fuel Use in Transport Sector and Resultant Direct Emissions

**Figure 18** Fuel Use in Transport Sector and Resultant Direct Emissions (2017-18)

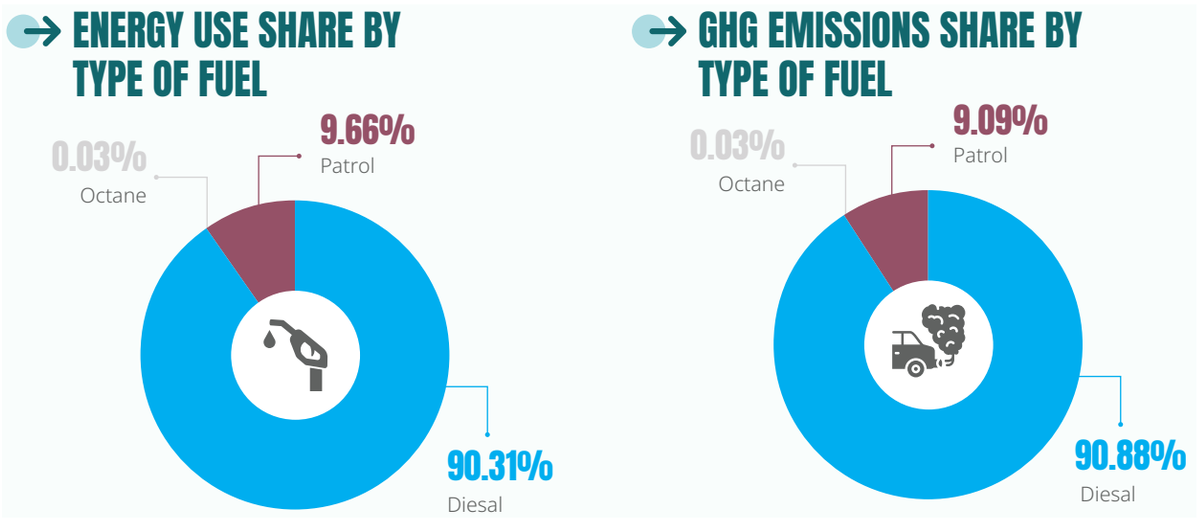
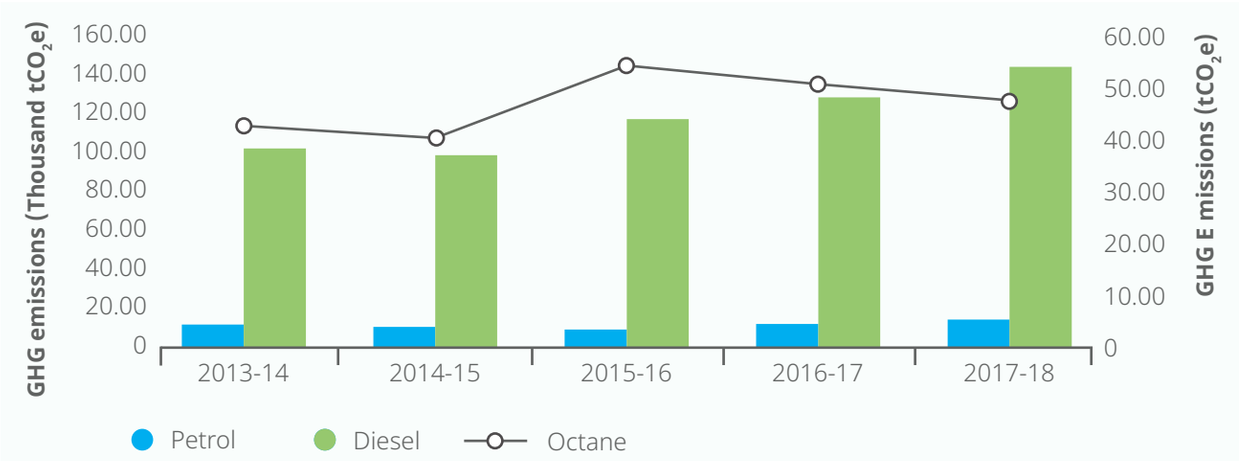



**Table 13** Annual Fuel Consumption by On-Road Transportation

| Financial Year | Octane (Kilolitre) | Petrol (Kilolitre) | Diesel (Kilolitre) |
|---|---|---|---|
| 2013-14 | 15 | 5,157 | 35,911 |
| 2014-15 | 14 | 4,661 | 34,703 |
| 2015-16 | 19 | 4,031 | 41,238 |
| 2016-17 | 18 | 5,329 | 45,139 |
| 2017-18 | 17 | 6,290 | 50,664 |

**Figure 19 Trend of GHG Emissions from On-road transportation**




- Total Energy Consumption in On-Road Transportation in 2017-18: 2,151,409 Giga Joules
- Share of Energy Use in On-Road Transportation: Diesel (90.31%); Petrol (9.66%); Octane (0.03%)
- Total GHG Emissions from Mobile Combustion in Transportation in 2017 -18: 158,965 tonnes of $CO_2e$
- Share of GHG Emissions in On-Road Transportation: Diesel (90.88%); Petrol (9.09%); Octane (0.03%)
- Trend of Emission from Petrol Consumption: rise of 21.97% since 2013-14
- Trend of Emission from Diesel Consumption: rise of 41.08% since 2013-14
- Trend of Emission from Octane Consumption: rise of 11.60% since 2013-14

### Rail Transportation

**Table 14 GHG emissions from Rail Transport**

| Year | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 |
|---|---|---|---|---|---|
| Total Rail Emission ($tCO_2e$) | 1,035 | 1,083 | 1,133 | 1,185 | 1,240 |

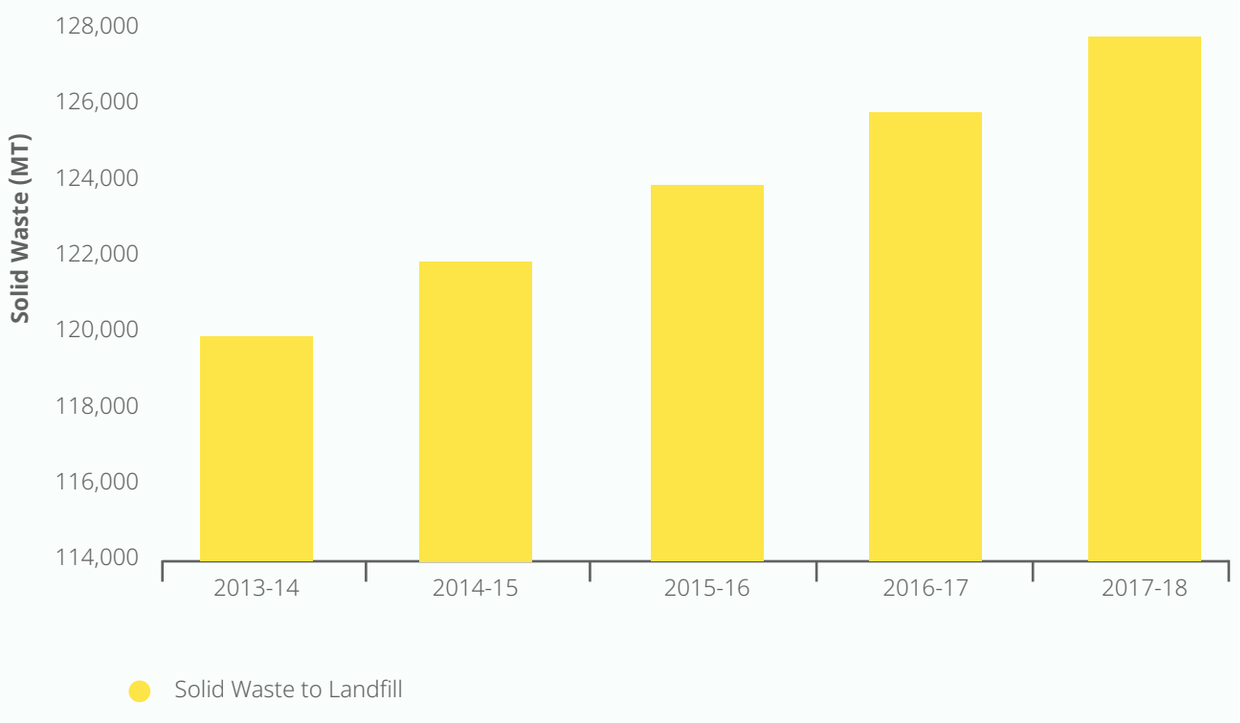
- Total GHG emissions from railway in 2017 -18: 1,240 tonnes of $CO_2e$
- Trend of GHG emissions: Rise of 19.87% since 2013-14
- Share of GHG emissions in railways: Direct emissions (37%); In-direct emissions (63%)

## 3.2.5 Waste Emissions

**Table 15 MSW Generation in the City**

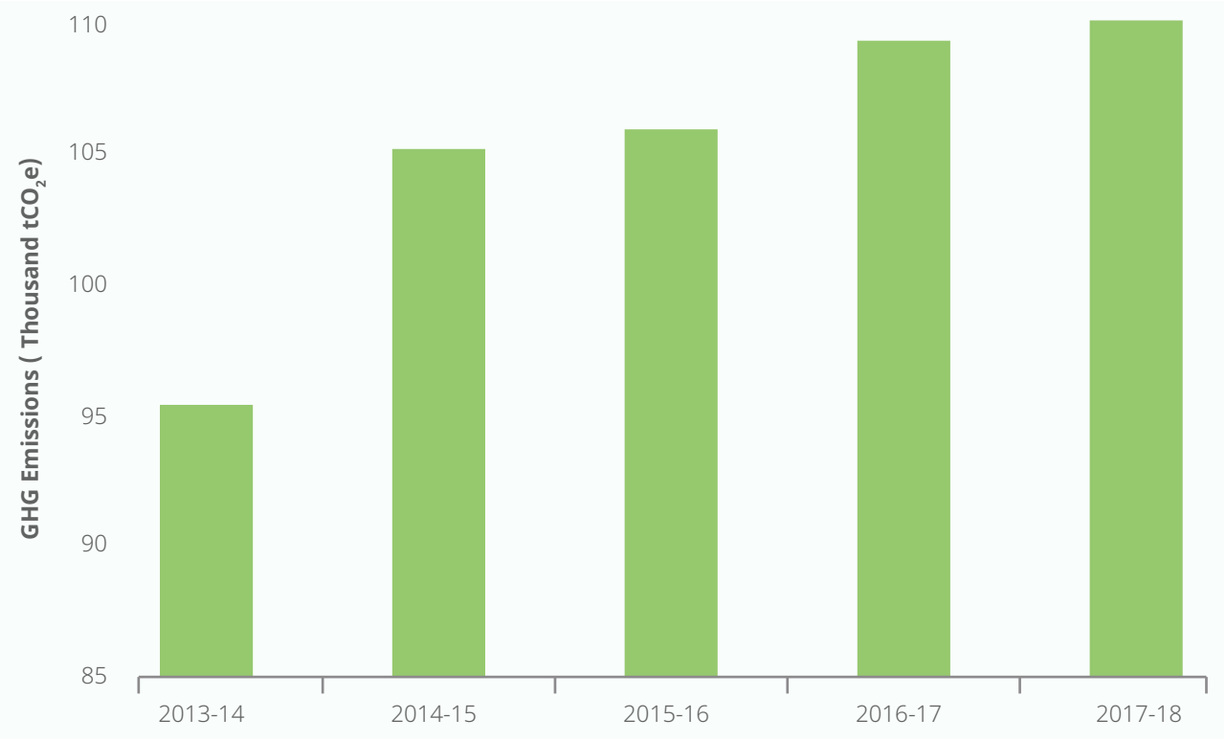
| Financial Year | Annual Waste Generation (Tonnes) |
|---|---|
| 2017-2018 | 127,695 |
| 2016-2017 | 125,699 |
| 2015-2016 | 123,727 |
| 2014-2015 | 121,777 |
| 2013-2014 | 119,850 |

**Figure 20** **Trend of Annual Solid Waste Generation in Rajshahi**




## Emissions from MSW in the City

**Figure 21** **Trend of GHG Emissions from solid-waste disposal**

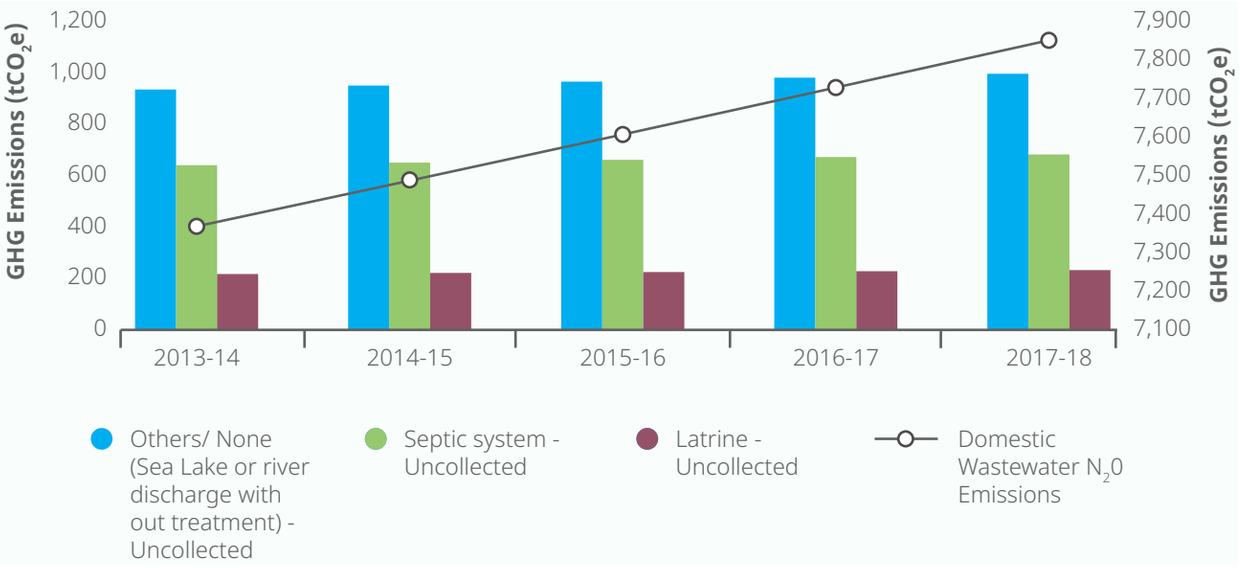


- Annual Waste Generation in 2017-18: 127,695 Tonnes
- Total GHG emissions from solid waste to landfill in 2017-18: 110,456 tonnes of $CO_2e$
- Trend of Annual Waste Generation: Rise of 6.55% since 2013-14.
- Trend of Emissions from Waste going to Landfill: Rise of 14.95% since 2013-14.

**Table 16 Domestic Waste Water Management and Associated Emissions**

| Treatment/ Discharge Pathway or System | GHG emissions ($tCO_2e$) | | | | |
|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 |
| Sewer (collected and aerobic treatment, not well managed) | - | - | - | - | - |
| Sewer (collected and not treated) | - | - | - | - | - |
| Others/ None (Sea Lake or river discharge without treatment) - | 942 | 960 | 978 | 997 | 1,015 |
| Septic system -Uncollected | 645 | 657 | 670 | 683 | 696 |
| Latrine - Uncollected | 219 | 224 | 228 | 232 | 236 |
| Domestic wastewater $N_2O$ emissions | 7,368 | 7,487 | 7,607 | 7,728 | 7,851 |
| Total (tonnes of $CO_2e$) | 9,174 | 9,328 | 9,483 | 9,640 | 9,798 |

**Figure 22 Trend of GHG Emissions from Domestic Wastewater**




- Total emission from wastewater treatment/discharge in 2017 - 18: 9,798 $tCO_2e$
- Trend of emissions from sea, lake or river discharge without treatment waste going to compost: Decrease of 7.74% since 2013-14
- Trend of emissions from septic system: Decrease of 7.90% since 2013-14
- Trend of emissions from latrine - uncollected: Decrease of 7.76% since 2013-14
- Trend of $N_2O$ emissions from domestic wastewater: Rise of 6.55% since 2013-14

## 3.3 Rajshahi City Local Government: Energy Consumption and GHG Emissions (2017-18)

Total Energy Use[46]
**46,804 GJ**

Total GHG emissions
**7,440 $tCO_2e$**

**Figure 23** **Snapshot of Energy Use and Resultant GHG Emissions from Municipal End-use**

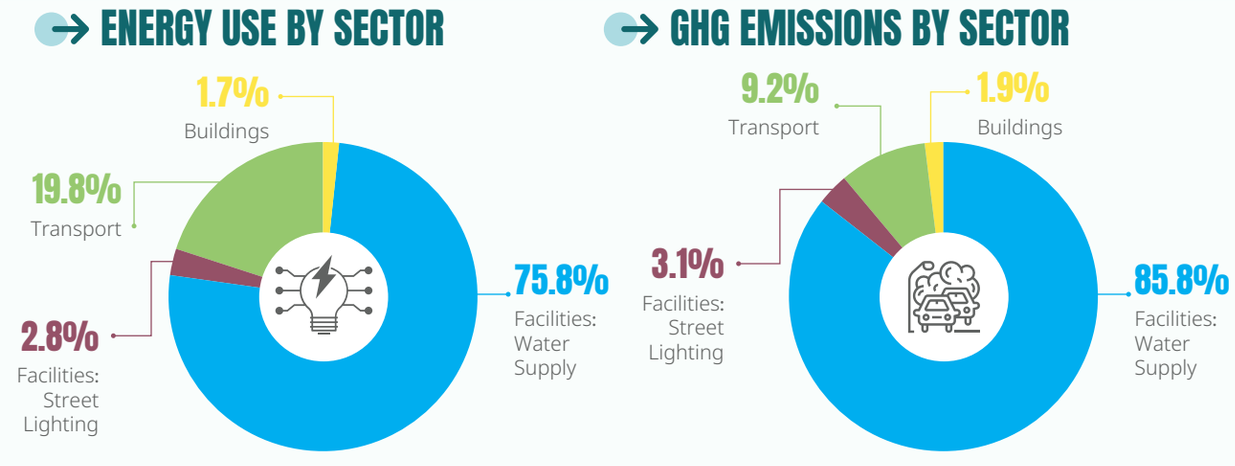



**Table 17** **Sector Wise Energy Use (GJ) and GHG emissions ($tCO_2e$)**

| Sector | Energy Use (GJ) | GHG emissions ($tCO_2e$) |
|---|---|---|
| Local Government Buildings (Electricity) | 778 | 140 |
| Facilities (Electricity Consumption - Waste Water Treatment, Water Supply and Street Lighting) | 36,756 | 6,616 |
| Transportation (Petrol, Diesel and Octane) | 9,270 | 684 |
| **Total** | **46,804** | **7,440** |

**Largest Energy consumers:**

**Facilities (Water Supply)** **75.8%**

**Transport** **19.8%**

**Largest GHG emitting sector:**

**Facilities (Water Supply)** **85.8%**

**Transport** **9.2%**

## 3.4 Energy and GHG Emissions Projection

The CRCAP is prepared for a period of 5 years with a long-term vision for 20-30 years determined by the local authority. Energy consumption and GHG emissions are projected using Tool 3.1E (GHG Emissions Forecasting) for medium term (yearly from 2018-19 to 2030-31) and long-term (2050-51) scenarios.

Stationary fuel and electricity consumptions have been projected by applying the geometric mean method for historic data of the last four years for community sectors. Energy consumption from utility services/facilities (i.e., water supply, drainage and SWM) has been projected based on population growth (by considering average of population projection by arithmetical increase, geometrical increase and incremental increase methods) and RCC's future planning. Based on a forecast of the energy consumption, the corresponding GHG emissions are calculated using the HEAT+ software.

46 Includes direct energy use due to consumption of grid electricity for waste water treatment, street lighting, water supply and lighting in government buildings and consumption of fuels by government vehicles for transportation.

**Table 18 Assumptions for Forecasting and Projections**

| Sector | Assumption |
|---|---|
| Water Supply | Based on existing city planning, the following assumptions were considered:<br>◆ 140 LPCD water supply with 24% NRW until 2026 based on baseline situation<br>◆ Reducing NRW from 34% to 24% due to implementation of smart water metering, water audits, leak detection, and upgradation of pipeline network with ductile iron pipes<br>◆ It is assumed that based on ongoing/proposed initiatives/projects by RWASA, NRW can be reduced to 15% by 2034. |
| Wastewater | ◆ There is no centralized sewer network and treatment system in Rajshahi city. In the projections, it is assumed that the city will be able to start implementing sewer connections by 2030, and 40% of the area could be covered by 2050.<br>◆ In the absence of centralized sewer network and treatment system, septic tanks coverage at household level is expected to reach 31% by 2030, compared to 10% in the baseline year (2017-18). |
| Solid Waste Management | ◆ MSW projection is based on the per capita waste generation (around 700 gm/day/capita in 2017-18) and World Bank's national estimates for Bangladesh. The estimate considers annual per capita growth rate from 2018 to 2030 to be 1.33% and 1.47% from 2031 to 2050.<br>◆ It is assumed that Rajshahi city will be able to establish a composting treatment plant to manage at least 10% of the MSW generated in the city by 2030, which could be scaled up to 20% from 2040 to 2050. |
| Street Lights | ◆ Future projection for street lights was done based on proposed increase in the city area and road length. It is assumed that the city will have 22% more street lights by 2030 and 28% by 2050, as compared to the baseline year (2017-18). |

Projected energy use as per business-as-usual (BAU) scenario for the year 2050-51 is 67,533,208 GJ, which is 11 times higher compared to baseline of 5,924,222 GJ in 2017-18. Projected GHG emissions based on projected energy consumption as per BAU scenario for 2050-51 is 5,951,028 $tCO_2e$, which is approximately 10 times higher compared to baseline of 630,254 $tCO_2e$ in 2017-18. This substantial increase in the energy use and corresponding GHG emissions by 2050 clearly signifies the need for a CRCAP for Rajshahi city. Figures 24 and 25 present the projected energy consumption and GHG emissions trends respectively.

The forecasting trend shows increasing energy consumption from mobile units (transportation), primarily attributed to growth in city limits (area), population and disposable income, enabling residents to have individual vehicles. The second biggest contributor is likely to be manufacturing industries and construction sector. Rural to urban migration for livelihood is already prevalent in the city, but with growing economy and in-migration, energy consumption from the manufacturing industries and construction sector is bound to increase manifold. The third largest growth is seen in the residential sector. Trend of fuel consumption across the all sectors shows increase. Use of diesel in transport sector will increase by 17 times in 2050 compared to the baseline year 2017. Residential sector electricity consumption is likely to grow 12 times. These sectors require prior attention with long and short-term strategies. Increasing the share of renewables for electricity generation and use of e-vehicles, NMT etc. will be critical for bringing down the emissions.

**Figure 24** **Projected Energy Consumption (GJ) – Rajshahi**

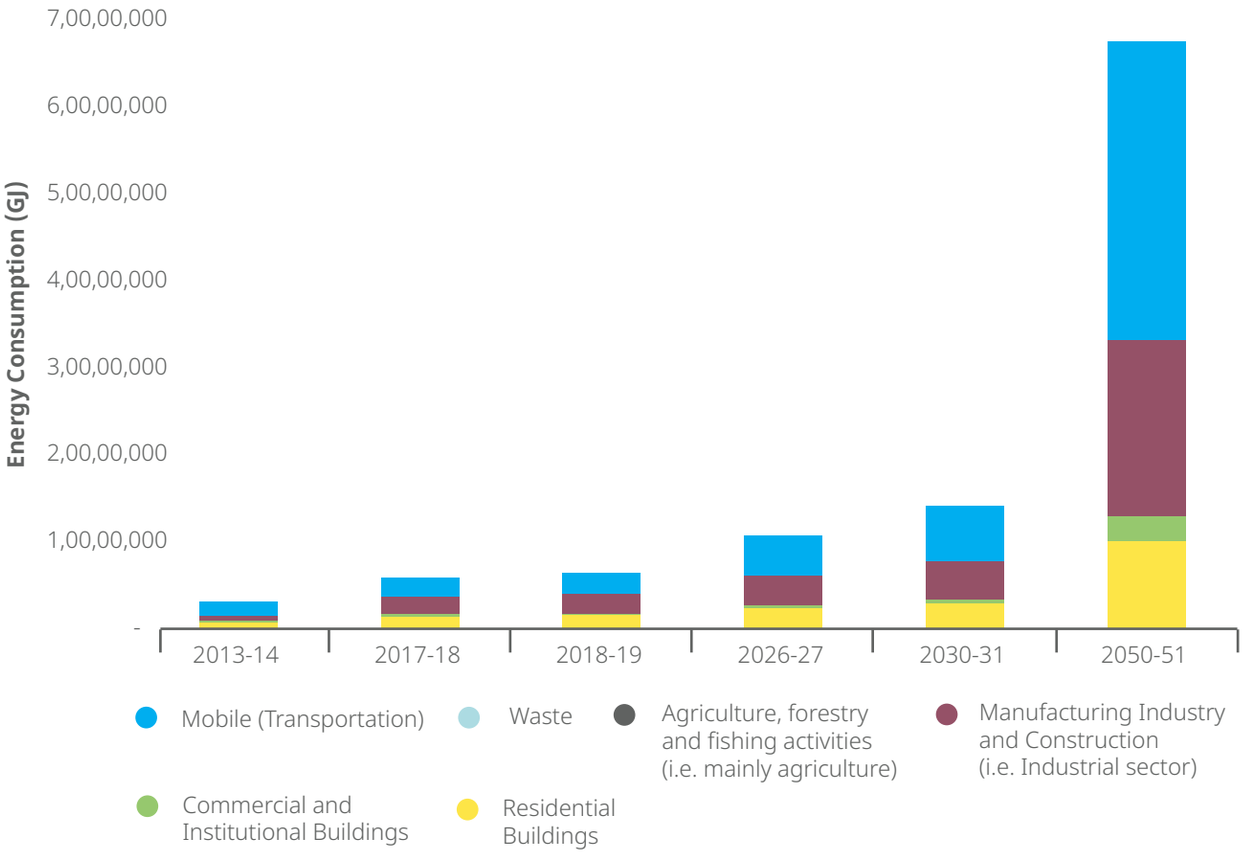



**Figure 25** **Projected GHG Emissions ($tCO_2e$) – Rajshahi**

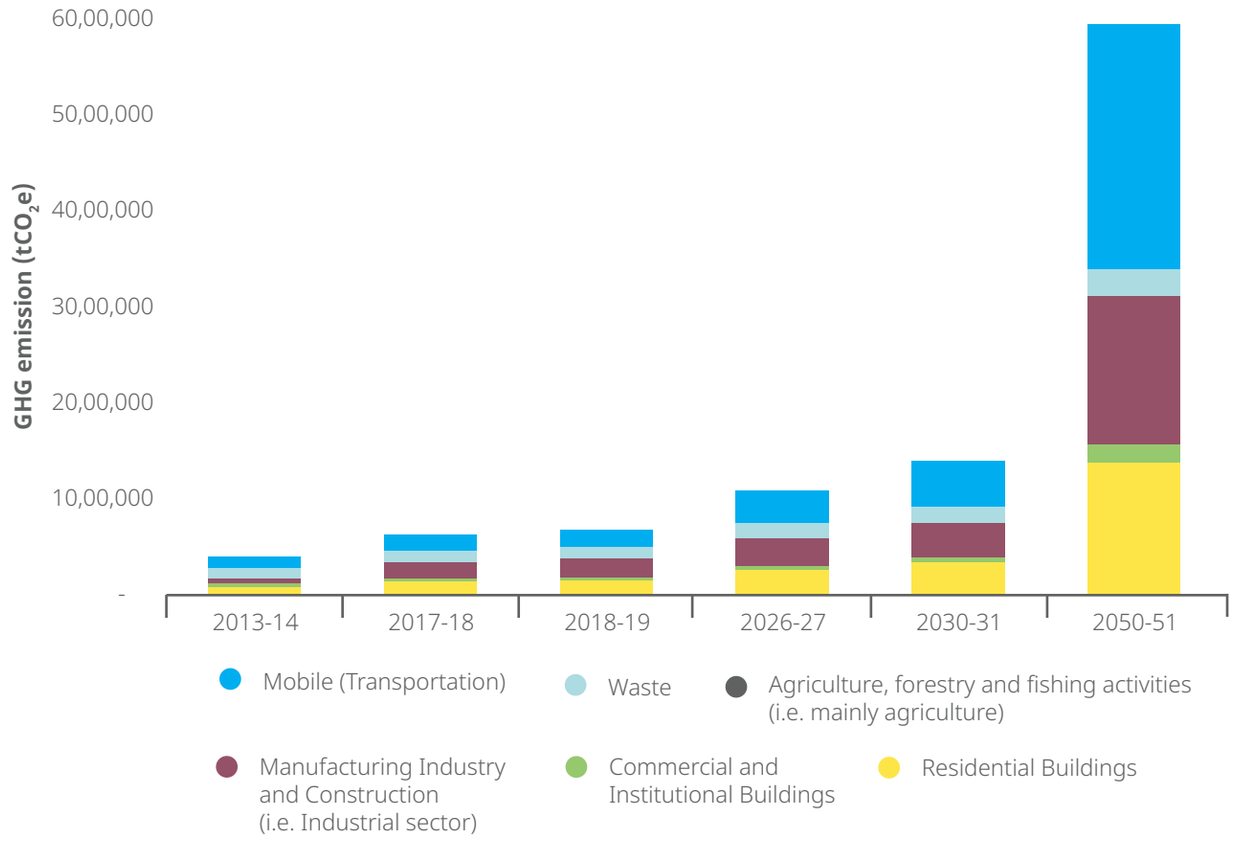
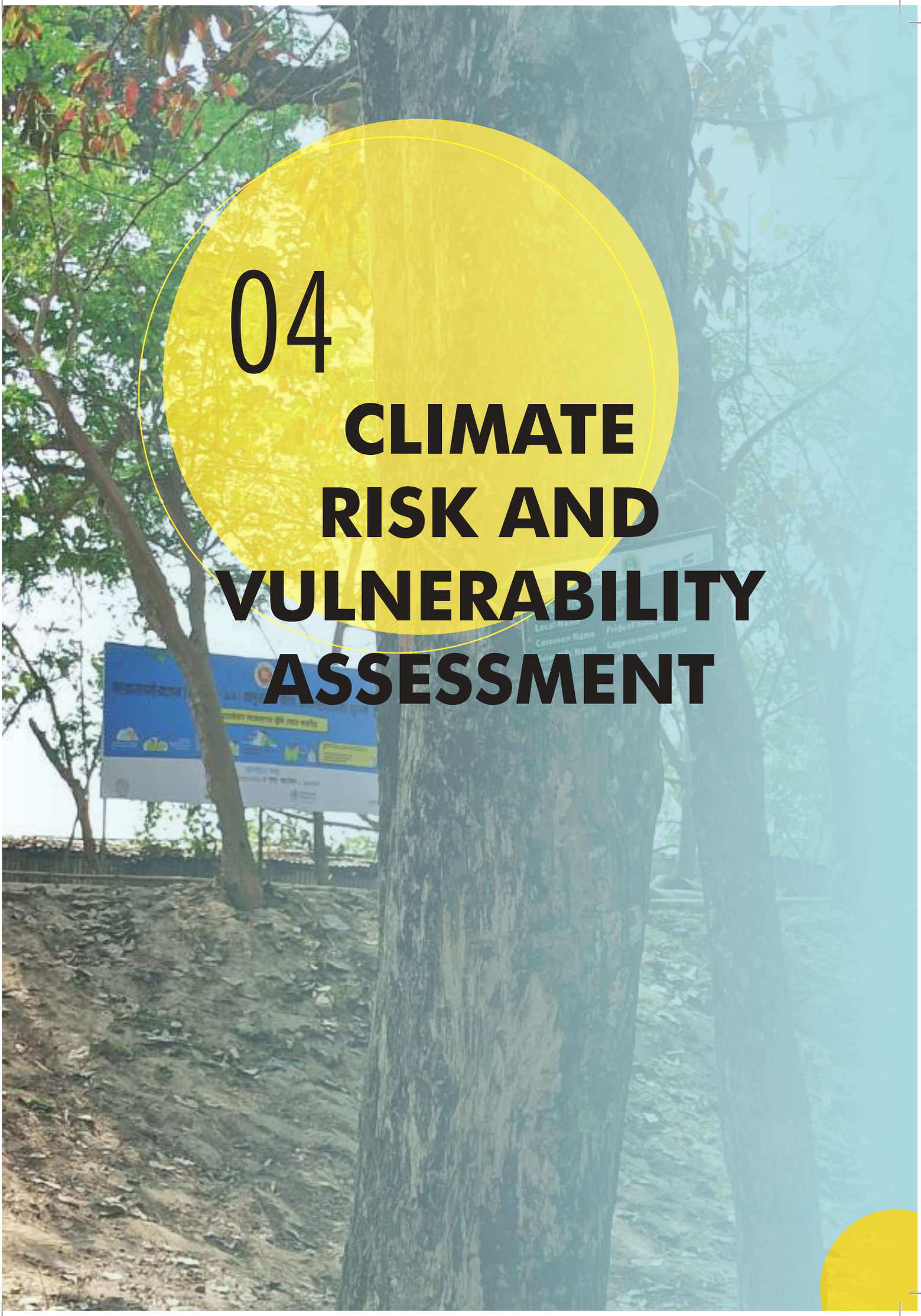


**Table 19** **Projected GHG Emissions ($tCO_2e$)**

| Sectors | Energy Source/ Activity | Baseline GHG emissions ($tCO_2e$) | | Projected GHG emissions (Medium Term scenario) ($tCO_2e$) | | | Projected GHG emissions (Long-term scenario) ($tCO_2e$) |
|---|---|---|---|---|---|---|---|
| | | 2013-14 | 2017-18 | 2018-19 | 2026-27 | 2030-31 | 2050-51 |
| Residential Buildings | Electricity | 69,025 | 93,882 | 1,01,386 | 1,87,557 | 2,55,099 | 11,87,397 |
| | LPG | 54 | 18 | 20 | 42 | 62 | 91 |
| | PNG | 13,420 | 49,497 | 52,739 | 73,853 | 87,116 | 1,94,207 |
| | Kerosene | 11,559 | 5,167 | 4,235 | 846 | 378 | 7 |
| Commercial and Institutional Buildings | Electricity | 28,292 | 30,022 | 30,471 | 34,311 | 36,410 | 48,990 |
| | LPG | 54 | 18 | 20 | 42 | 62 | 91 |
| | PNG | 141 | 1,951 | 2,273 | 6,487 | 10,925 | 1,44,504 |
| Manufacturing Industry and Construction (i.e. Industrial sector) | Electricity | 12,306 | 14,191 | 14,706 | 19,559 | 22,556 | 46,010 |
| | Furnace Oil | 34,848 | 1,44,301 | 1,65,651 | 2,39,685 | 2,87,394 | 6,95,311 |
| | Octane | 5,191 | 8,948 | 10,121 | 30,078 | 51,850 | 7,89,317 |
| | PNG | 1,266 | 1,640 | 1,753 | 2,941 | 3,809 | 13,886 |
| Agriculture, Forestry and Fishing Activities (i.e., Mainly Agriculture) | Electricity | 194 | 194 | 194 | 194 | 194 | 194 |
| Waste | Solid Waste Disposal | 96,089 | 1,10,456 | 1,13,695 | 1,42,955 | 1,50,089 | 2,50,867 |
| | Biological Treatment | - | - | - | - | 1,982 | 7,097 |
| | Incineration and open burning | - | - | - | - | - | - |
| | Wastewater | 9,162 | 9,762 | 10,132 | 14,352 | 16,585 | 23,344 |
| Mobile (Transportation) | Petrol | 11,847 | 14,450 | 15,181 | 22,584 | 27,545 | 74,356 |
| | Diesel | 1,02,399 | 1,44,467 | 1,57,395 | 3,13,281 | 4,41,983 | 24,70,391 |
| | Octane | 43 | 48 | 48 | 60 | 67 | 117 |
| | Rail | 1,035 | 1,240 | 1,295 | 1,832 | 2,179 | 4,852 |
| Total | - | 3,96,925 | 6,30,254 | 6,81,314 | 10,90,659 | 13,96,285 | 59,51,029 |



# 04

# CLIMATE RISK AND VULNERABILITY ASSESSMENT

## 4.1 Past hazards and climatic events

Rajshahi experiences a number of natural disasters such as flood, drought and cold waves, now with increasing frequency and intensity compared to previous years.

Rajshahi city is part of the huge drought affected northern area. In a study[47] where Standardized Precipitation Index (SPI) was used to analyse drought events, Rajshahi district was found to have experienced 23 drought events from 1991 to 2009. In 2009, mango production fell by 30% due to drought. A study[48] on the effect of drought on major crops in Bangladesh revealed that T. Aman rice yield has reduced by 62% in Rajshahi, and wheat yield by 50% in Rajshahi, Bogra and Jessore.

**Rajshahi district was found to have experienced 23 drought events from 1991 to 2009**

Heat waves occur every year in Rajshahi. In 2015, heat waves in Rajshahi[49] led to many people being hospitalised due to heat stress and caused adverse impact on domestic animals and the environment. In the 2005 Nor'wester, the Rajshahi Weather Office[50] recorded 29.6 mm rainfall while the storm struck at a speed of 51.52 km/hr. The event resulted in at least five deaths, several others injured and crop damage worth BDT 10 Cr. In the 2015 Nor'wester[51], Rajshahi lost power for at least 20 hours, five people lost their lives and the city incurred a lot of infrastructural damage.

Table 20 presents the details of major hydro-meteorological and geological hazard events in Rajshahi (city, Upazila and district level) in the last 30 years.

**Table 20 Major Disaster Events in the Past 30 years**

| Year | Hazard | Impacts |
|---|---|---|
| 1988, 2003, 2009 | Drought | • Crop damage<br>• Damage to fisheries<br>• Morbidity<br>• Newborn children, differently abled people, pregnant women and elderly face problems.<br>• Scarcity of drinking water<br>• Disrupted communication system<br>• Damage to infrastructure<br>• Scarcity of potable water<br>• Post flood diseases<br>• Loss of lives |
| 2013 | River erosion | |
| 2003, 2013 | Tornado | |
| 1988, 1992, 1995, 1997, 2005, 2006, 2009, 2011, 2015 | Nor'wester | |
| 1989, 1992, 1996, 1999, 2004, 2005, 2007, 2010, 2011, 2012, 2019 | Heat wave | |
| 1988, 1998, 1999, 2000, 2005, 2006, 2013, 2017 | Flood | |
| 2015, 2018 | Cold wave | |

47 Rahman, A T M & Jahan, Chowdhury & Mazumder, Q. & Kamruzzaman, Md & Hosono, Takahiro. (2017). Drought Analysis and Its Implication in Sustainable Water Resource Management in Barind Area, Bangladesh. Journal of the Geological Society of India. 89. 47-56.

48 SAARC Workshop on Drought and Risk Management in South Asia. Kabul, 8-9 August, 2010. Available at https://www.droughtmanagement.info/literature/SAARC_drought_risk_management_south_asia_2010.pdf:.

49 Correspondent (2015) "Rajshahi city life dogged by heat wave," The Independent, June. Available at: https://www.theindependentbd.com/printversion/details/3023.

50 Bdnews24.com (2005) "Nor'wester kills 21 in several districts, launch capsizes in Aricha with 200 passengers," 16 May. Available at: https://bdnews24.com/bangladesh/2005/05/16/nor-wester-kills-21-in-several-districts-launch-capsizes-in-aricha-with-200-passengers.

51 New Age BD (2015) "Norwester Death Toll Reaches 31." Available at: http://newagebd.net/109240/norwester-death-toll-reaches-31/.

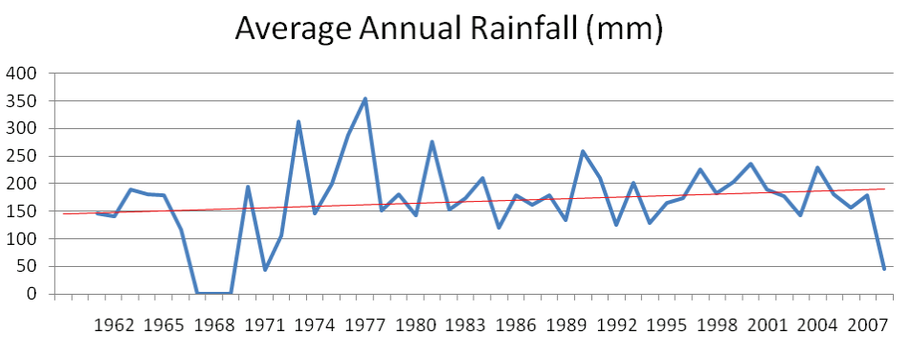
## 4.2 Climate Scenario in the City

### 4.2.1 Past Climate Trends

In 2009, the Climate Change Cell of GoB's Department of Environment released a study on Climate Change and Health Impacts in Bangladesh[52]. The study analysed climate data comprising monthly and annual average maximum and minimum temperature for the period 1976-2005 and monthly and annual rainfall for the period 1990-2004. The long-term changes in annual maximum temperature showed an increasing trend over the period 1976-2005 with an annual increase of 0.003°C. The long-term changes in annual minimum temperature showed the same trend, with an annual increase of 0.004°C. Annual rainfall in Rajshahi showed decline on average by 3.7 mm.

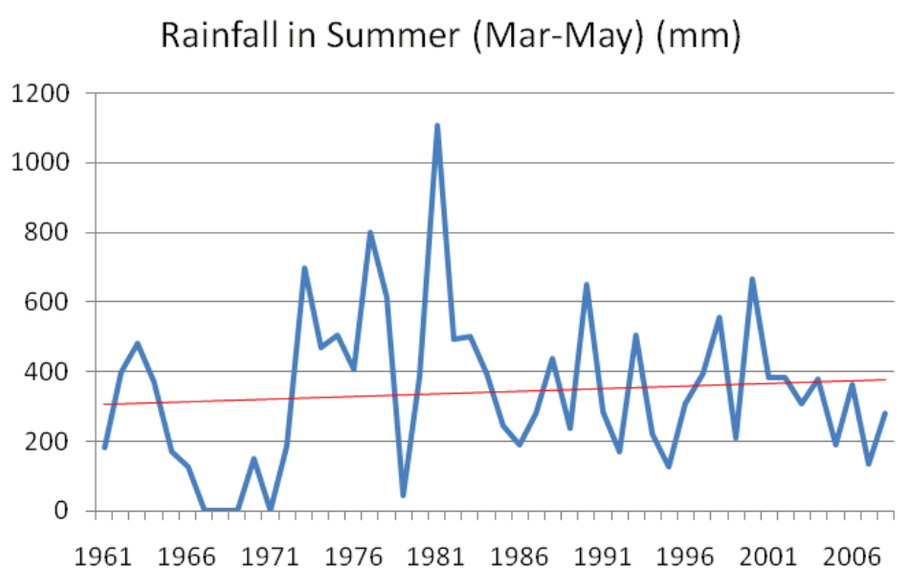
The study also analysed past climate trends of Rajshahi city using climate data collected from the Bangladesh Meteorological Department (BMD). Rainfall data was analysed over a period of 45 years from 1962-2007 and temperature data from 1995-2012.

**Figure 26 Average Annual Rainfall Rajshahi City**




**In 2015, heat waves in Rajshahi led to many people being hospitalised due to heat stress and caused adverse impact on domestic animals and the environment**

**Figure 27 Rainfall in Summer Rajshahi City**




52 CCC. (2009). Climate Change and Health Impacts in Bangladesh. Climate Change Cell. Dhaka: MOEF.

**Figure 28** Rainfall in Rainy Season Rajshahi City

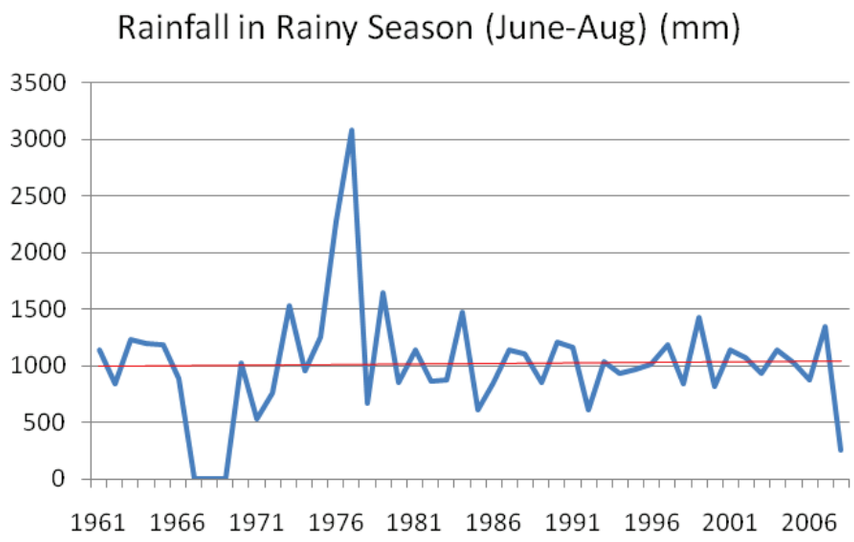



**Figure 29** Rainfall in Autumn Rajshahi City

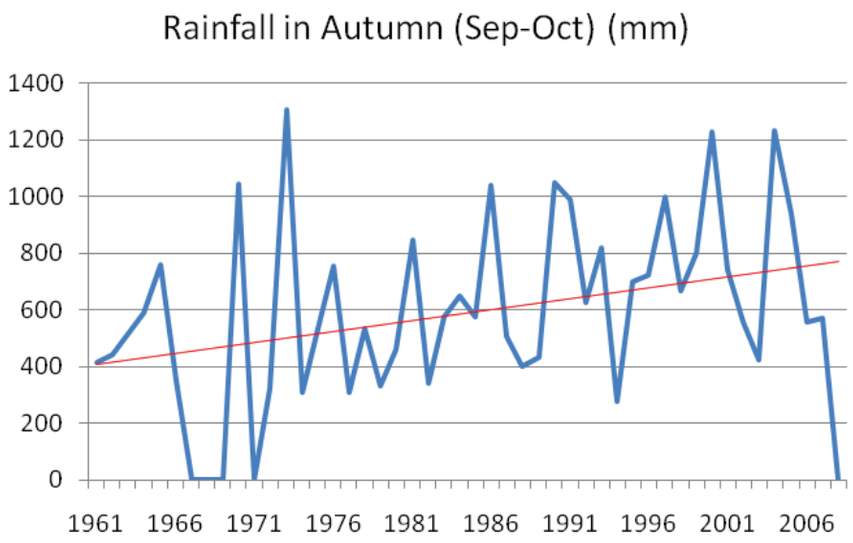
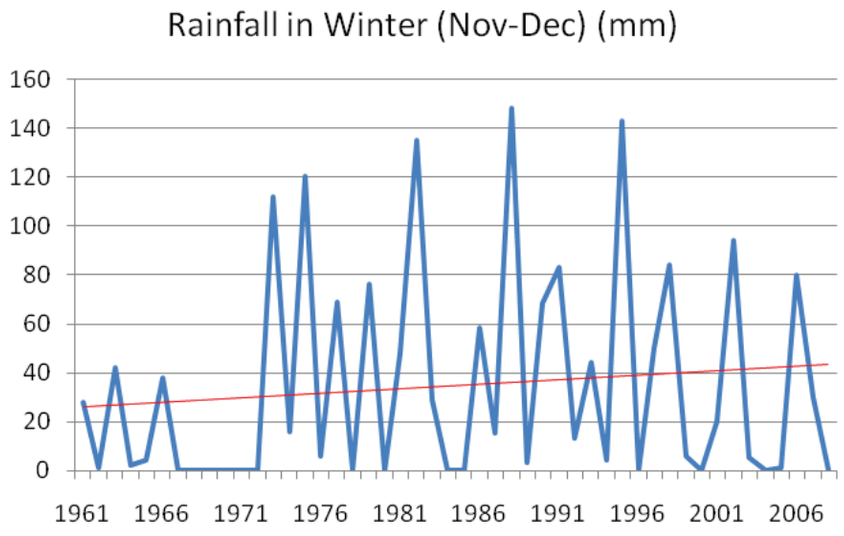



**Figure 30** Rainfall in Winter Rajshahi City



The trend line indicates that annual average rainfall (Figure 26) is increasing over the 45-year period especially during September to December i.e., post monsoon (Figure 29 and Figure 30), indicating a shift in the monsoon season.

**Figure 31 Average Annual Temperature for Rajshahi City**

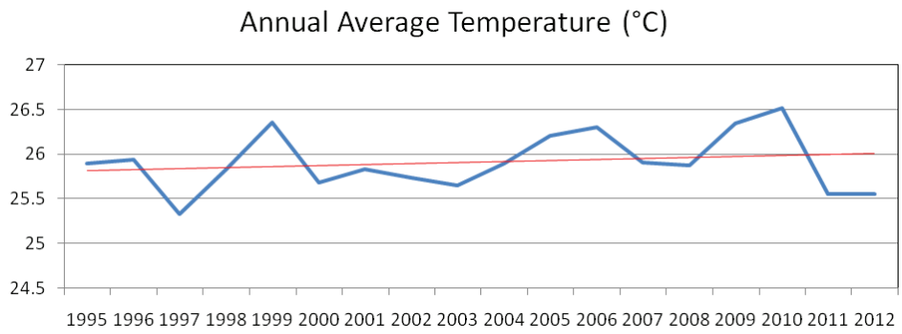
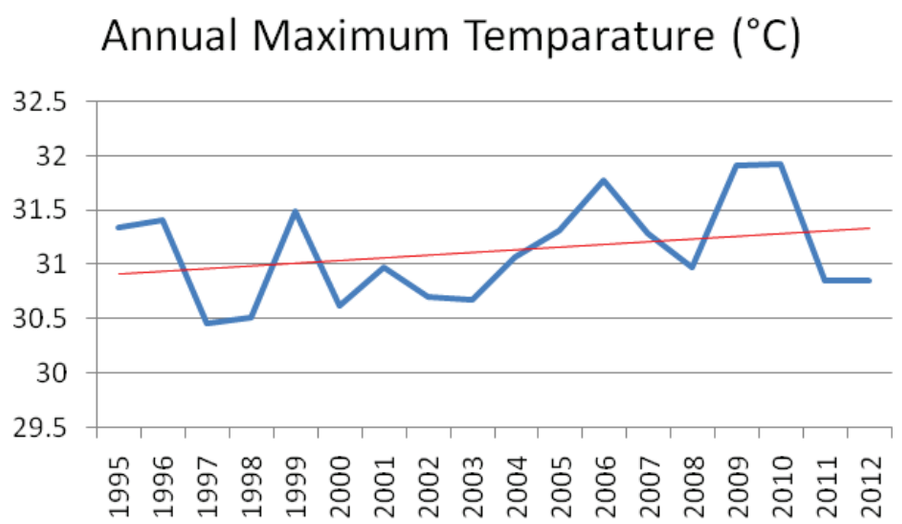



**Figure 32 Average Annual Maximum Temperature for Rajshahi City**




**Annual average temperature also showed a rise of about 0.5°C, which can be attributed to the significant increase in the annual maximum temperature**

Annual average temperature also showed a rise of about 0.5°C (Figure 31) which can be attributed to the significant increase in the annual maximum temperature (Figure 31). Annual minimum temperature on the other hand shows a decrease. Overall, this analysis shows that both temperature and rainfall is showing an increasing trend for the time period over which data has been analysed.

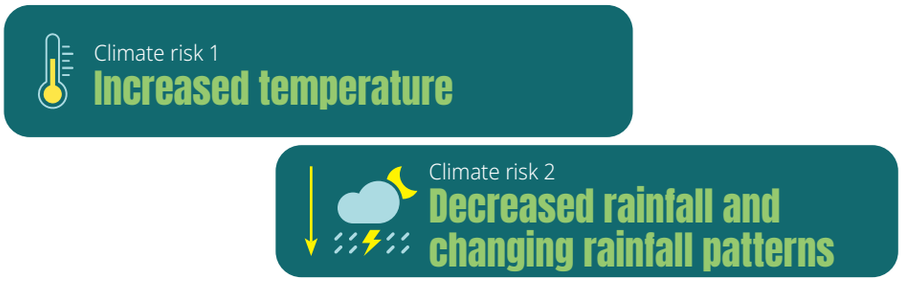
## 4.3 Climate Change Projections and Climate Scenario Statements

The National Plan for Disaster Management (2010-2015) published by the GoB and the Vulnerability, Risk Reduction and Adaptation to Climate Change, Climate Risk and Adaptation Country Profile (2011) published by World Bank were referred to in the absence of dedicated literature detailing climate projections for various regions in Bangladesh. The National Plan for Disaster Management used a regional climate model PRECIS for Bangladesh.

**Table 21 Climate Scenario Statements**

| Changing Climate Conditions | Assessments | Climate Scenario Summary Statements |
|---|---|---|
| Precipitation change | National Assessment[53] | Pre-monsoon rainfall will decrease while monsoon and post-monsoon rainfall will increase. 2051 onwards annual average rainfall and monsoon rainfall will follow a higher increasing trend |
| | National Assessment[54] | There will be an increase in the amount of run-off, and rainfall intensity. |
| Temperature change | National Assessment[53] | 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 Assessment[54] | Mean temperatures across Bangladesh are projected to increase between 1.4°C and 2.4°C by 2050 and 2100, respectively. |

These projections were discussed in detail during the stakeholder consultation. The stakeholders observed that although temperature seems to be increasing over the years, rainfall seems to be decreasing. It is possible that the shift in monsoon as evidenced by the trend analysis in the previous section is leading to this perception of decreased rainfall since the usual rainfall months are not getting enough rain. Therefore, the main climate risks identified are:




## 4.4 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 the running of the city and 'secondary systems' such as health, education, sanitation which rely on the core systems. The urban system analysis identified sic fragile urban systems for Rajshahi through rigorous discussions in the Shared Learning Dialogues (SLDs):


53 Government of Bangladesh. "National Plan for Disaster Management, 2010 – 2015", Disaster Management Bureau Disaster Management & Relief Division, Government of Bangladesh. (2010)

54 Dyoulgerov, Milen, A. Bucher, and F. Zermoglio. "Vulnerability, risk reduction, and adaptation to climate change: Bangladesh." Country profiles. Washington DC: The World Bank Group. (2011).

## 4.4.1 Urban Systems Analysis

### Water Supply

**Situation Analysis**

Rajshahi is located in a region which is highly water stressed and prone to drought. At present, groundwater is the main source for water supply to the city. The conditions become very poor during the dry season. Surface water sources such as ponds are being filled up or encroached upon. The present ground water levels cannot even cater to the present population let alone catering to the future population.

**Fragility Statement and Climate Fragility Statement**

Considering the present situation of Water Supply in Rajshahi, the urban fragility statement for this system is 'The water resources in the city are reducing because of extraction of ground water and encroachment of ponds.

The climate fragility statement for Water Supply is:

"With increasing temperature and decreasing or irregular rainfall in the region, the water resource in the city will be under greater stress, leading to impacts on health and economic activities such as agriculture that are dependent on water."

### Health

**Situation Analysis**

The health system of the city includes public and private facilities, including primary health centres. Health care facilities are reasonably good in the RCC area, including a general hospital, the Rajshahi Medical College Hospital, with 550 beds, and three specialized hospitals, including a 150 bed TB hospital and a 20 bed infectious diseases hospital. The RCC has also established seven primary health care centres run by NGOs as part of a project with the Asian Development Bank (ADB), to provide health services to women and children. The city also has a Nursing Training Institute and a Family Welfare Visitors Training Institute. In addition to the government facilities, there were 25 private clinics in the city in 1998; this number has increased over the years[55]. At present, there are sufficient facilities catering to residents of Rajshahi. However, as the surrounding regions also depend on these facilities, they are under stress, unable to meet the demand.

**Fragility Statement and Climate Fragility Statement**

Considering the present situation of Health in Rajshahi, the urban fragility statement for this system is 'Health care facilities in the region cater to the city and its surrounding regions, and are therefore under stress due to lack of facilities and beds to cater to patients.'

If the number of patients increases drastically due to climatic events, then the health system may not be able to cope with the additional demand/pressure.

The climate fragility statement for this system is:

"In case of health risks due to sudden climatic impacts of increasing temperature and decreasing rainfall, the health system may fail in the city if there are suddenly more patients."

55 Clemett, A., Amin, M.M., Ara, S., and Akan, M.M.R. 2006. Background Information for Rajshahi City, Bangladesh. WASPA Asia Project Report, accessed from https://core.ac.uk/download/pdf/6405035.pdf.

## Biodiversity and urban green spaces

### Situation Analysis

With the city expanding due to urbanisation and population growth, and a loss of green and open space areas and ponds, biodiversity is steadily decreasing. Different species of birds, animals and fish are on the decline due to loss of habitat. Local orchards are also declining.

### Fragility Statement and Climate Fragility Statement

Considering the present situation of Biodiversity in Rajshahi, the urban fragility statement for 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 statements for this system are:

"Increasing temperatures and decreasing or irregular rainfall can exacerbate habitat loss already caused by urbanisation that will further reduce urban biodiversity."

## Solid Waste Management

### Situation Analysis

About 500 tons of waste is produced each day in the city, of which 12 tons are hazardous wastes[56]. Solid wastes are produced from different sources such as residential, medical, industrial, construction and demolition, agricultural, institutional and municipal. Around 74% of the city area is covered by 'door to door waste collection' facilities. The remaining households dump the waste near lampposts on roads, in ponds and drains etc.

There is one dumping site with 3.5 ft. depth and an area of 15.98 acre at 'Nawdapara' and 35 secondary collection points. Of the total waste generated in the city, 370 MT/day is collected and disposed off in the waste disposal area, while 130 MT is left uncollected.

### Fragility Statement and Climate Fragility Statement

Considering the present situation of Solid Waste Management in Rajshahi, the urban fragility statement for this system is 'Solid waste management is crucial to maintenance of water bodies and drainage, which are under stress from indiscriminate dumping of waste and poor collection facilities.'

The climate fragility statement for this system is:

"Increasing temperatures and decreasing 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

### Situation Analysis

The urban poor and the landless rely for their main source of income on the primary sector (agriculture, fishery, fruit cultivation) where they work as agricultural labour. Women especially are dependent on agriculture. In an economy dependent on agriculture and natural resources (fishery and fruit orchards), periods of drought or climate disaster events can severely impact the livelihood of people.

56 Atik, S.M. 2013. Rajshahi waste management in disarray, online edition, The Daily New Age.

**Fragility Statement and Climate Fragility Statement**

Considering the present situation of the economy in Rajshahi, the urban fragility statement for this system is 'Agriculture, fishery and fruit orchards are important in providing economic support to landless, women, and urban poor. Middle class is also dependent on agriculture and own land. Any impact on the productivity can impact a large section of population.'

The climate fragility statements for this system are:

"Increasing temperature and decreasing rainfall will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Daily labourers and vendors will be impacted since they will be unable to work in harsh climate."

## WasteWater

**Situation Analysis**

Waste water sources including domestic and commercial activities, apart from agricultural operations which release many pollutants above their permeable limits. Many people from various parts of the country come to Rajshahi city for studies, seeking jobs and working in the city's cottage and small industries. Multi-storey buildings, clinics, hospitals, diagnostic centres and small industrial units are increasing in the city. All these sources and along with Rajshahi Medical College Hospital dispose a large amount of wastewater into the nearby Padma River through open drains. Moreover, effluents without any treatment from the BSCIC industrial units and textile industries also find their way into the river system.

**Fragility Statement and Climate Fragility Statement**

Considering the present situation of Waste water generation and disposal in Rajshahi, the urban fragility statement for this system is 'Wastewater management is crucial to maintain the quality of ground and surface water bodies and household waste water (grey water) post treatment can be used watering the trees and agricultural product which is under stress in majority of the wards because of unplanned waste water dumping in the river through drainage network and no initiative by RCC regarding this issue.

The climate fragility statements for this system are:

"**Climate Risk 1:** In case of sudden high intensity rainfall, drains may overflow, particularly if there is solid waste choking the drains".

"**Climate Risk 2:** In high temperature, decomposition is high with odour".

## 4.5 Risk Assessment

The climate risks associated with the fragilities of these systems were calculated through a risk assessment exercise conducted by the stakeholder group during an 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. Table 22 shows the risk status of the climate fragility statements.

**Table 22 Risk Assessment of Climate Fragility Statements**

| Urban System | Impacts of Climate Change | Risk Status |
|---|---|---|
| Water Supply | With increasing temperature and decreasing or irregular 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. | Extreme |
| Health | In case of health risks due to sudden climatic impacts of increasing temperature and decreasing rainfall, the health system may fail in the city if there are suddenly more patients. | Extreme |
| Biodiversity | Increasing temperatures and decreasing or irregular rainfall can exacerbate habitat loss caused by urbanization that will further reduce urban biodiversity. | Extreme |
| Solid Waste Management | Increasing temperatures and decreasing 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. | High |
| Economy | Increasing temperature and decreasing rainfall will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Daily labourers and vendors will be impacted since they will be unable to work in harsh climate. | Extreme |
| Waste Water | In case of sudden high intensity rainfall, drains may overflow, particularly if there is solid waste choking the drains.<br><br>In high temperature, decomposition is high with odor. | Medium |

Based on this risk assessment, four fragile urban systems, namely Water Supply, Health, Biodiversity and Economy are at extreme risk while SWM is at high risk. Wastewater is categorised as 'medium' risk.

## 4.6 Climate Vulnerability Assessment

In order to build resilience, the extent of the city's vulnerability to climate change must be understood. This vulnerability depends upon the geographical location, demography, infrastructure, and socio economic and ecological condition of the city. IPCC, 2007[57] 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.

57 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 33** Vulnerability Constituents


**The adaptive capacity was determined in the context of economy, technology/ infrastructure, governance, social systems and ecosystems.**

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

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

The subsequent sections identify the vulnerable areas, vulnerable actors and the adaptive capacity of the fragile urban systems using the climate fragility statements developed in consultation with the stakeholder group.

## Identification of vulnerable areas of Fragile Urban Systems

**Water Supply: Vulnerable Areas**

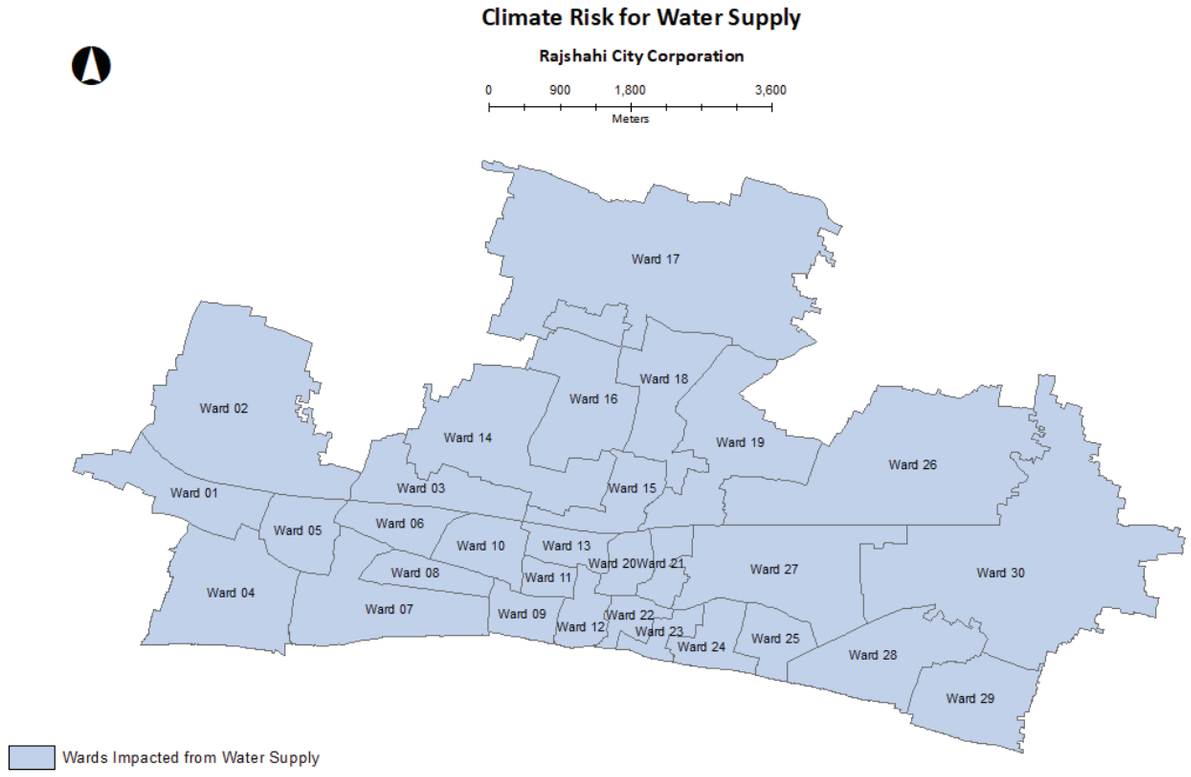
### Climate Fragility Statements

With increasing temperature and decreasing or irregular 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.

### Area/Ward Most Vulnerable

All wards in the city are affected; Water level is going down in all areas to a similar extent (Figure 34).

**Figure 34 Wards most vulnerable to climate risks in the context of water supply, Rajshahi**



## Health: Vulnerable Areas

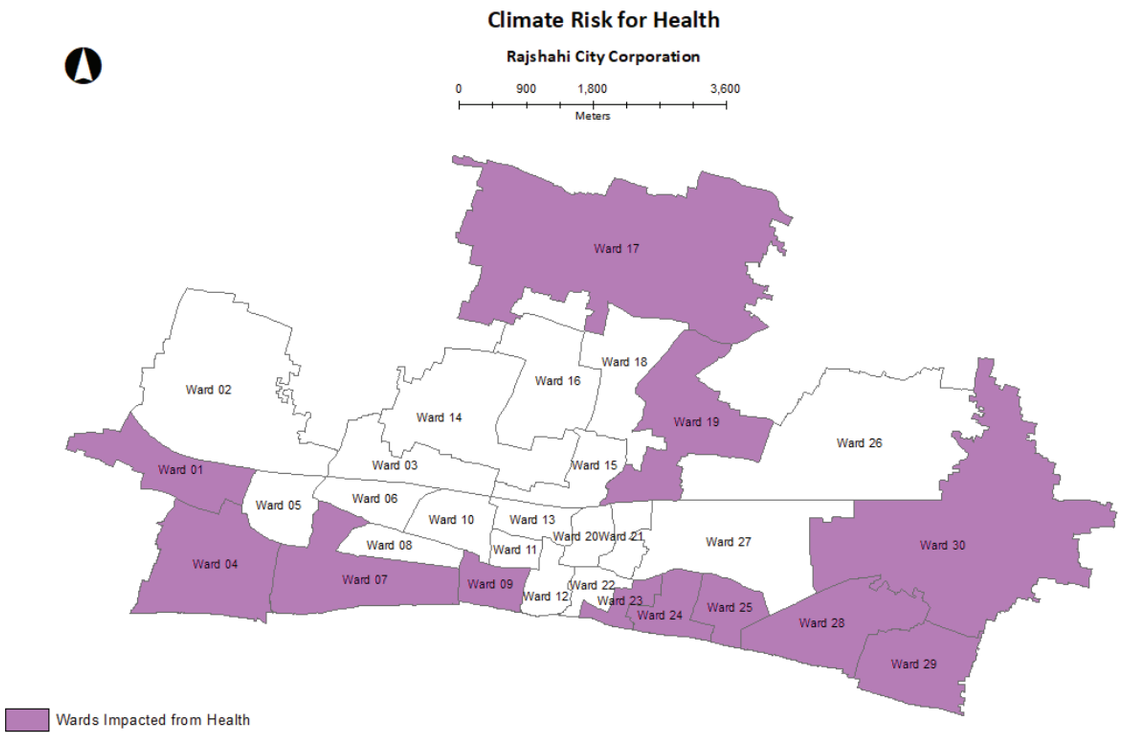
### Climate Fragility Statements

In case of health risks due to sudden climatic impacts of increasing temperature and decreasing rainfall, the health system may fail in the city if there are suddenly more patients.

### Area/Ward Most Vulnerable

Slums and low income communities in ward 1, 4, 7, 9, 17, 19, 22, 23, 24, 25, 28, 29, 30 (Figure 35).

**Figure 35** **Wards most vulnerable to climate risks in the context of health, Rajshahi**



## Biodiversity: Vulnerable Areas

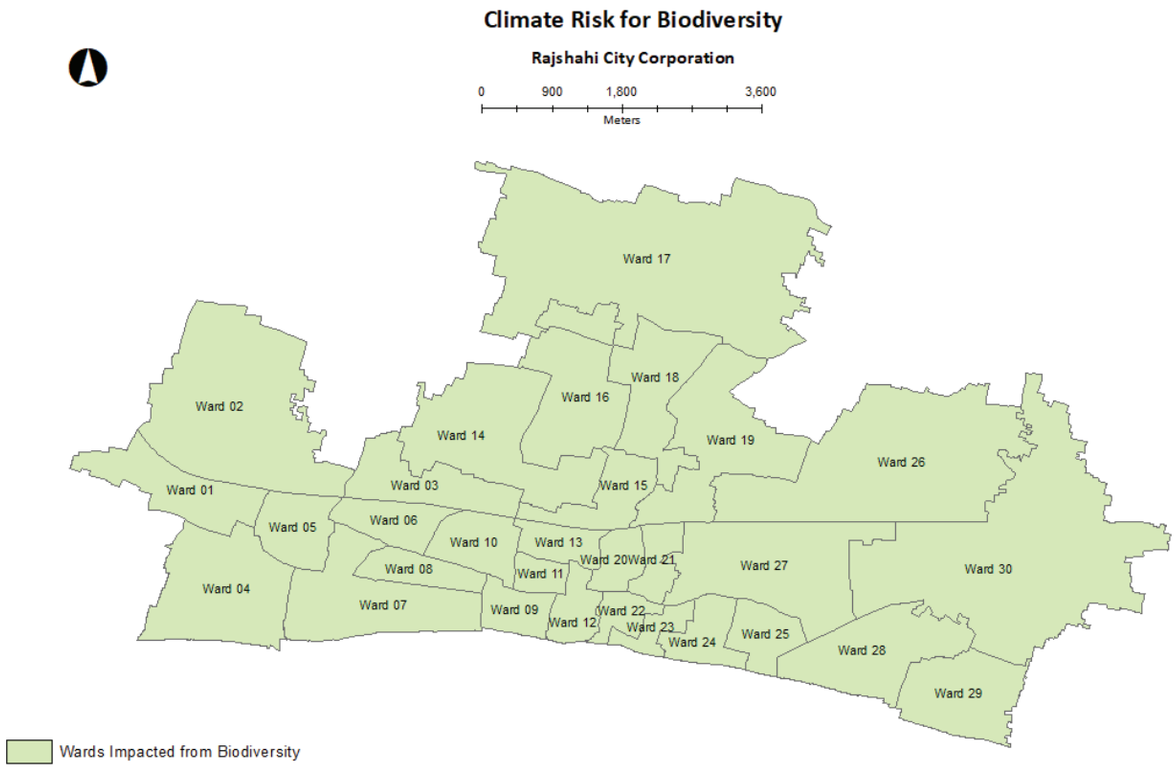
### Climate Fragility Statements

Increasing temperatures and decreasing or irregular rainfall can exacerbate habitat loss caused by urbanization that will further reduce urban biodiversity.

### Area/Ward Most Vulnerable

All wards, particularly Rajshahi University area, Central Park and Zoo and river bank (Figure 36).

**Figure 36 Wards most vulnerable to climate risks in the context of biodiversity, Rajshahi**



## Solid Waste Management: Vulnerable Areas

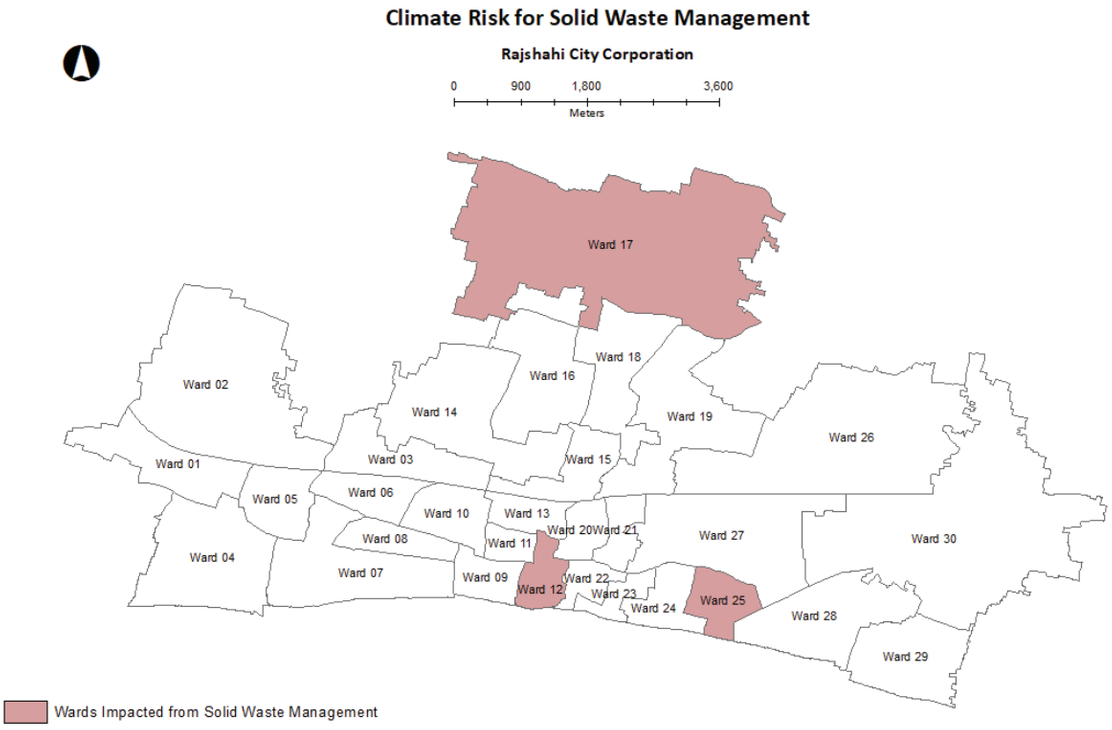
### Climate Fragility Statements

Increasing temperatures and decreasing 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.

### Area/Ward Most Vulnerable

Ward 17, market areas of ward 12, water logged area of ward 25 (Figure 37).

**Figure 37 Wards most vulnerable to climate risks in the context of solid waste management, Rajshahi**



## Economy: Vulnerable Areas

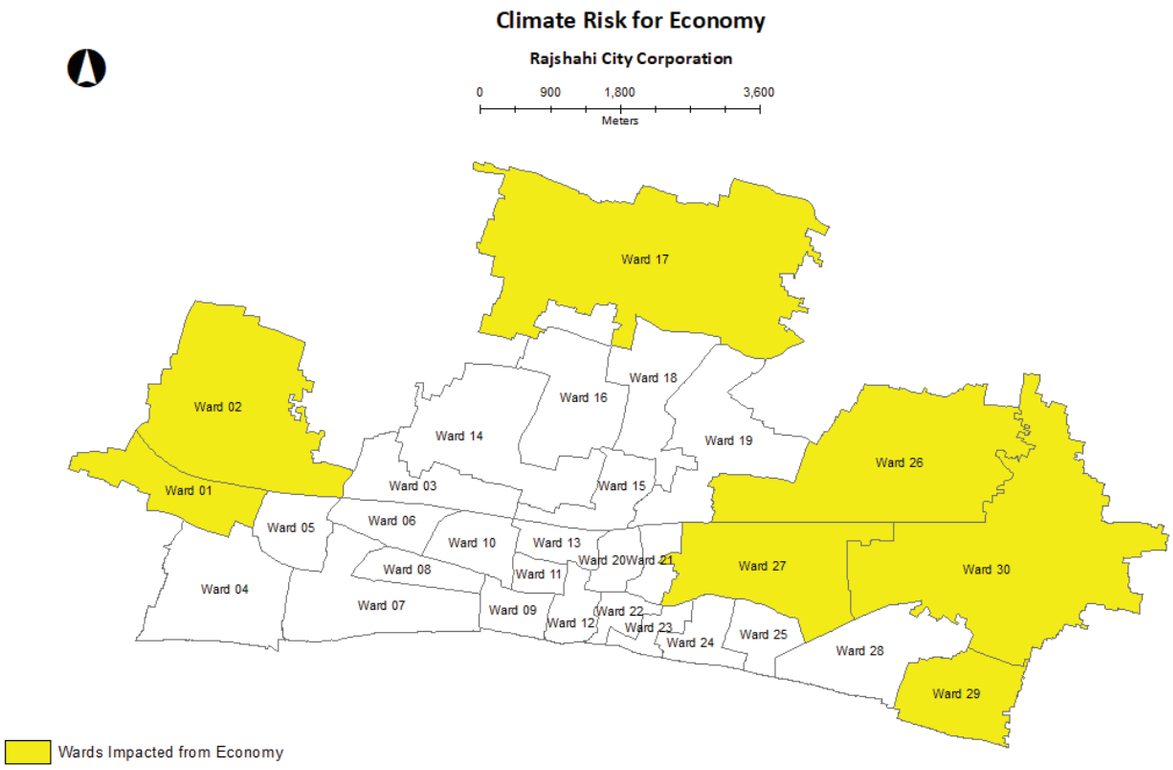
### Climate Fragility Statements

Increasing temperature and decreasing rainfall will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Daily labourers and vendors will be impacted since they will be unable to work in harsh climate.

### Area/Ward Most Vulnerable

Peri-urban areas of ward 1, and ward 2, 17, 30, 26, 27 & 29 (Figure 38)

**Figure 38 Wards most vulnerable to climate risks in the context of economy, Rajshahi**



## Waste Water: Vulnerable Areas

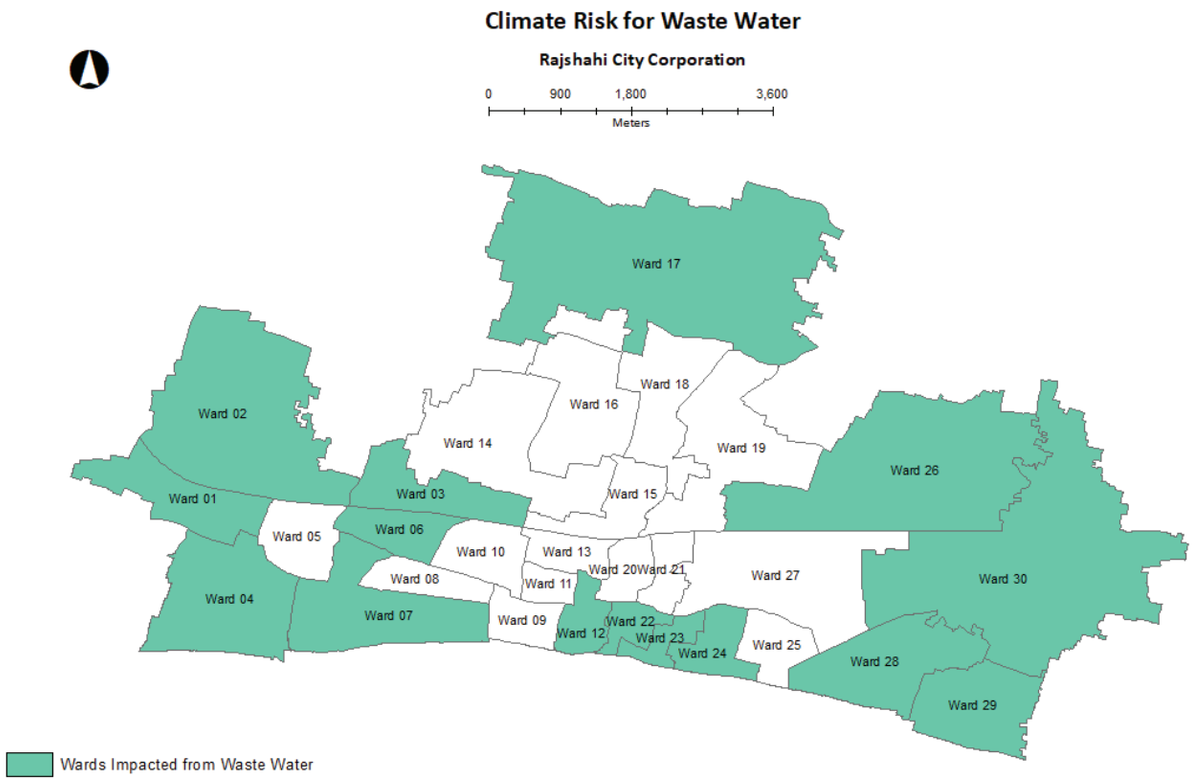
### Climate Fragility Statements

In case of sudden high intensity rainfall, drains may overflow, particularly if there is solid waste choking the drains. In high temperature, decomposition is high with odor.

### Area/Ward Most Vulnerable

Ward 1 - Guripara, Raipara and Kanthalbari, Ward 2 - Asrayan colony, Lily Cinema Hall, Mollapara, PDB office, Ward 3- Daspukur, Ward 4 - Bulonpur ruver side, Ward 6 - Jhautala more, Ward 7 - srirampur river side, Ward 12 - Zero point, Bhubanmahan park, phutkipara, Ward 22 - Kumarpara, Ward 23 - Shekher Chowk, panchabati, Ward 24 - ramchandrapur, Baje Kajla, Hadir more, Ward 26 - Meher Chandi, kadaitala, Ward 28 - dharampur, Dashmari, Ward 29 - khojapur, Jahaj Ghat, Ward 30 - Pashchim Boothpara, Maulabi Boodhpara (Figure 39)

**Figure 39 Wards most vulnerable to climate risks in the context of wastewater, Rajshahi**

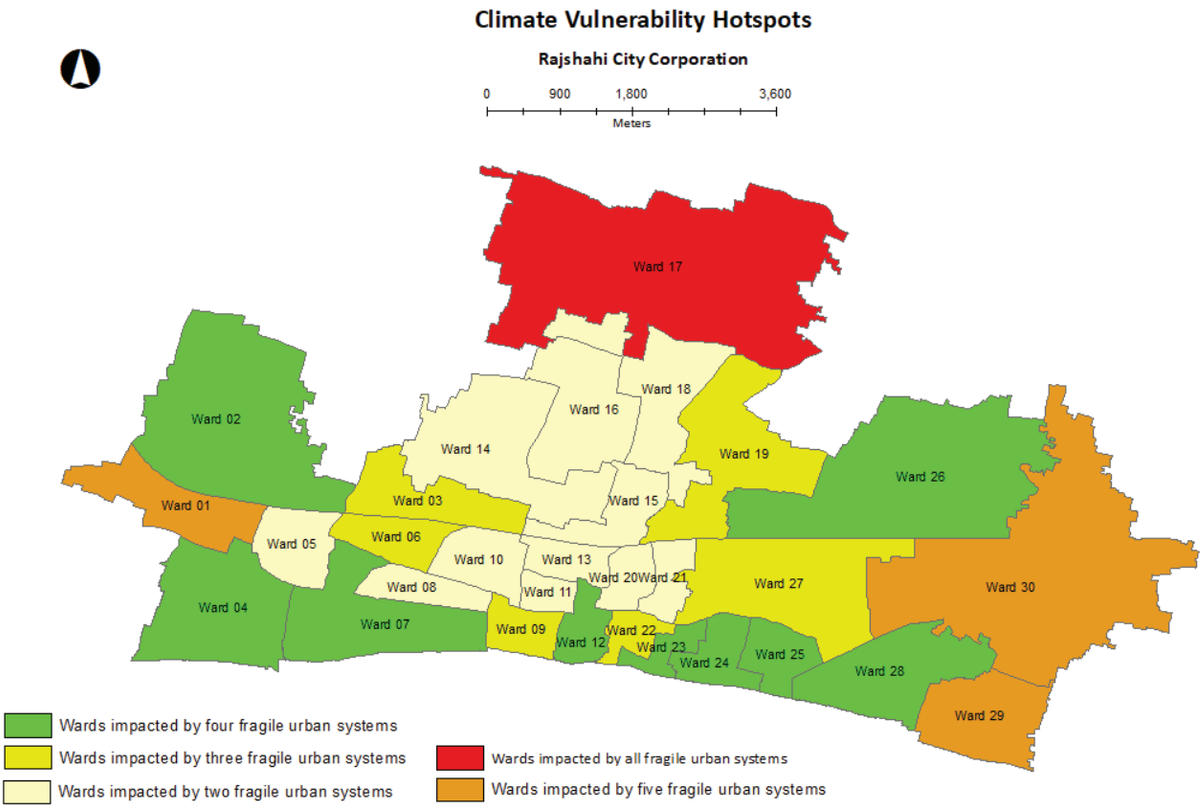



Through these assessments, the areas that were found to be most vulnerable can be summed up as follows:

- Ward 17 - vulnerable to all six fragile urban systems
- Wards 1, 29 and 30 - vulnerable to five fragile urban systems
- Wards 2, 4, 7, 12, 23, 24, 25, 26, and 28 - vulnerable to four fragile urban systems; these wards are mostly close to the river and have slum population
- Wards 1, 17, 29 and 30 are located on the peripheral edges of the city and lack coverage of basic services.

The vulnerability hotspot map (Figure 40) helps identify the wards to be focused on for future interventions to build resilience (identified in later chapters).

**Figure 40** **Consolidated Vulnerable Hotspots for Rajshahi city**




Through these assessments, the area found to be most vulnerable i.e., to all six fragile urban systems is ward 17, while wards 1, 29 and 30 are vulnerable to five fragile urban systems.

## 4.7 Identification of Actors and their Adaptive Capacities

Analysis of the actors within the wards identified as vulnerable revealed that they had very poor levels of adaptive capacities. The RCC have high adaptive capacity since they have access to resources, information and ability to respond to stress. This is also true for government agencies like RWASA or for NGOs. However, common citizens including farmers, daily labourers, fishermen, vendors, women, children, elderly and others lack the capacity to adequately respond to stress and therefore have low adaptive capacity, due to either lack of information and education, or of financial resources. Most of them are also dependent heavily on ecosystem-based employment, and therefore are easily impacted by climate changes. Table 23 shows the adaptive capacities of the actors for each fragile urban system.

**Table 23 Analysis of the adaptive capacities of the 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 in the region, the water resources in the city will be under greater stress, leading to health impacts and impacts on economy dependent on water such as agriculture. | All wards in the city are affected; water level is receding in all areas to a similar extent. | Children | Low |
| | | | Elderly | Low |
| | | | Women | Low |
| | | | Farmer | Low |
| | | | Slum dwellers | Low |
| | | | RWASA | High |
| | | | RCC | High |
| | | | City Development Committee (CDC) | Medium |
| Health | In case of health risks due to sudden climate impacts of increasing temperature and decreasing rainfall, the health system may fail in the city if there are suddenly more patients. | Slums and low income communities; wards 1, 4, 7,9, 17, 19, 22, 23, 24, 25, 28,29, 30 | Children | Low |
| | | | Elderly | Low |
| | | | Women | Low |
| | | | Daily labourers | Low |
| | | | Slum dwellers | Low |
| | | | Health staff | Medium |
| | | | Rickshaw pullers | Low |
| | | | Vendors | Low |
| | | | NGOs/CSOs | High |
| | | | CDC | Medium |
| Biodiversity | Increasing temperatures and decreasing rainfall can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity. | All wards, particularly Rajshahi University area, Central Park, Zoo and river bank | Fishermen | Low |
| | | | Residents | Low |
| | | | RCC | High |
| Solid Waste Management | Increasing temperatures and decreasing 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. | Wards 1, 4, 7,9; market areas of wards 12, 17,22,23,24; water logged area of wards 25, 28, 29 | RCC | High |
| | | | SWM workers | Low |
| | | | Children | Low |
| | | | Elderly | Low |
| Economy | Increasing temperature and decreasing rainfall will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Daily labourers and vendors will be impacted since they will be unable to work in harsh climate. | Peri-urban areas of ward 1; wards 2, 17, 30, 26, 27, 29 | Farmers | Low |
| | | | Farm labourers | Low |
| | | | Women | Low |
| | | | Entrepreneurs | Medium |
| | | | Slum dwellers | Low |
| | | | Daily labourers | Low |
| | | | Vendors | Low |
| | | | Rickshaw pullers | Low |

| Fragile Urban System | Climate Fragility Statements | Area/Ward most vulnerable | Actors | Level of Adaptive Capacity |
|---|---|---|---|---|
| Waste Water | In case of sudden high intensity rainfall, drains may overflow, particularly if there is solid waste choking the drains. In high temperature, decomposition is high with odour. | Ward 1 -Guripara, Raipara, Kanthalbari<br>Ward 2 -Asrayan Colony, Lily Cinema Hall, Mollapara, PDB office<br>Ward 3 - Daspukur<br>Ward 4 -Bulonpur Riverside<br>Ward 6 -Jhautala More<br>Ward 7 -Srirampur Riverside<br>Ward 12 - Zeropoint, Bhubanmahan park, Phutkipara<br>Ward 22 -Kumarpara<br>Ward 23 - Shekher Chowk, Panchabati<br>Ward 24 – Ramchandrapur, Baje Kajla, Hadir More<br>Ward 26 – Meher Chandi, Kadaitala<br>Ward 28 - Dharampur, Dashmari<br>Ward 29 - Khojapur, Jahaj Ghat<br>Ward 30 - Pashchim Boothpara, Maulabi Boodhpara | Farmers | Low |
| | | | Farm labourers | Low |
| | | | Agriculturalists | High |
| | | | Women | Low |
| | | | Entrepreneurs | High |
| | | | Slum dwellers | Low |
| | | | Daily labourers | Low |
| | | | Vendors | Low |
| | | | Rickshaw Pullers | Low |
| | | | RWASA | High |

## 4.8 Adaptive Capacity of Fragile Urban Systems

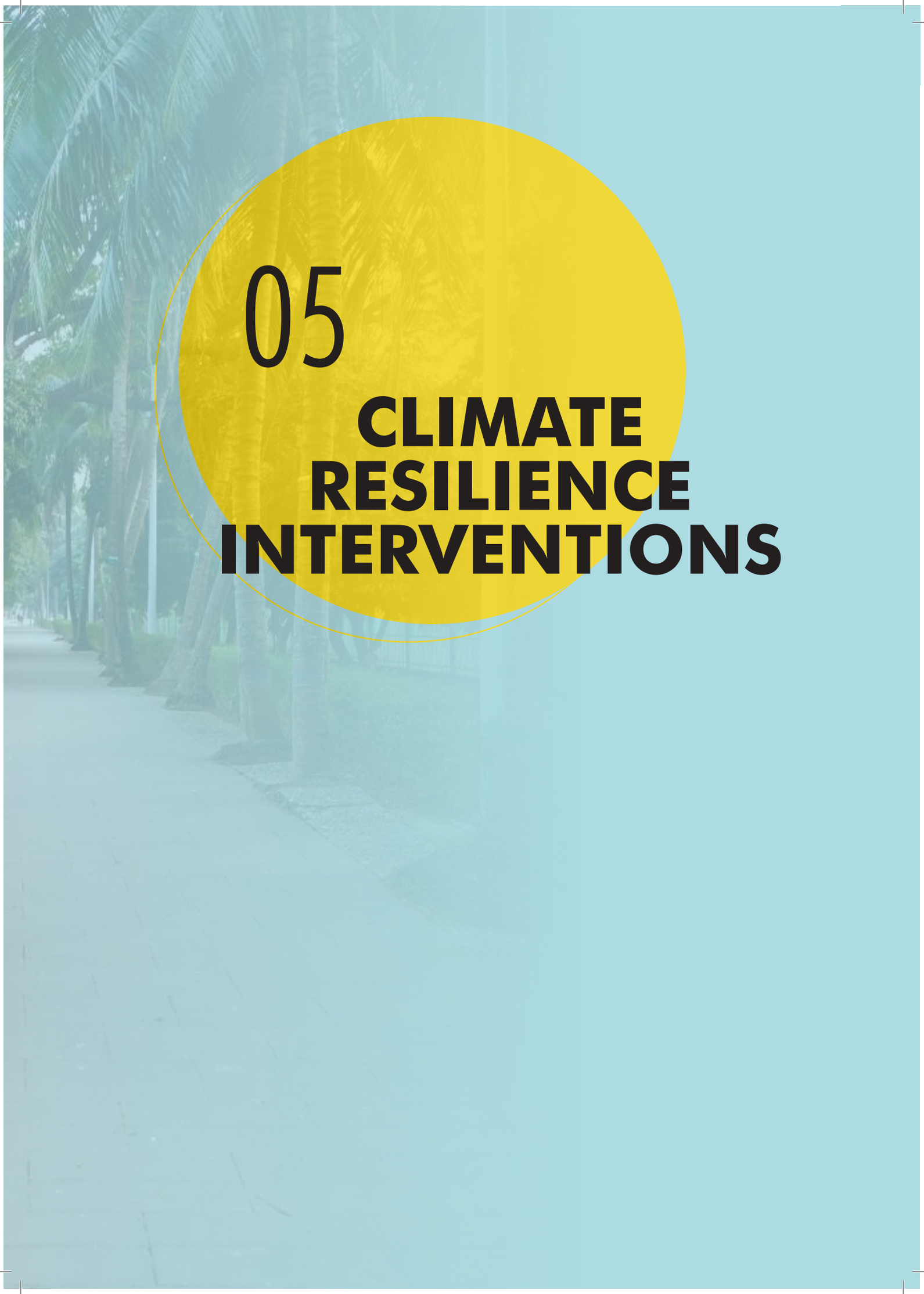
The adaptive capacities of the six fragile urban systems were assessed during the SLDs against the five parameters of economy, technology, governance, societal and ecosystem services (Table 24). Overall, all the urban systems score low or medium on adaptive capacity. Medium score for the technological/infrastructural parameter indicates that across the five systems, the city has good access to and/or knowledge of technology and infrastructure to adapt to climate impacts. The leadership in the RCC is consistent and visionary, with fair amount of inter departmental coordination especially for the systems of SWM and water supply where governance has been scored 'medium'. There is low inherent economic adaptive capacity for the systems of water supply, biodiversity and economy to adapt to impacts of climate risk. Ecosystem services scored low for SWM, economy and water supply indicating that the city should focus on integrated management of its water resources which impact both water supply and the productivity of the economy as well as improve the sustainability of the current SWM system.

**Table 24 Adaptive Capacity of Fragile Urban Systems in Rajshahi**

| Fragile Urban System | Climate Fragility Statement | Vulnerable Areas | Urban Actors | | Adaptive Capacity of the System | | |
|---|---|---|---|---|---|---|---|
| | | | Vulnerable | Potential Supporting | Low | Medium | High |
| Water Supply | With increasing temperature and decreasing rainfall in the region, the water resources in the city will be under greater stress, leading to health impacts and impacts on economy dependent on water such as agriculture. | All wards in the city are affected; water level is receding in all areas to a similar extent. | - Children<br>- Elderly<br>- Women<br>- Farmers<br>- Slum dwellers | - RWASA<br>- RCC<br>- CDC | - Economic<br>- Societal<br>- Ecosystem Services | - Technological/ Infrastructural<br>- Governance | |
| Health | In case of health risks due to sudden climate impacts of increasing temperature and decreasing rainfall, the health system may fail in the city if there are suddenly more patients. | Slums and low income communities; wards 1, 4, 7,9, 17, 19, 22,23, 24, 25, 28, 29, 30 | - Children<br>- Elderly<br>- Women<br>- Daily labourers<br>- Slum dwellers<br>- Rickshaw pullers<br>- Vendors | - Health staff<br>- NGOs/CBOs<br>- CDC | - Governance<br>- Societal | - Economic<br>- Technologic al/ Infrastructural<br>- Ecosystem Services | |

| Fragile Urban System | Climate Fragility Statement | Vulnerable Areas | Urban Actors | | Adaptive Capacity of the System | | |
|---|---|---|---|---|---|---|---|
| | | | Vulnerable | Potential Supporting | Low | Medium | High |
| Biodiversity | Increasing temperatures and decreasing rainfall can exacerbate habitat loss caused by urbanisation that will further reduce urban biodiversity. | All wards, particularly Rajshahi University area, Central Park, Zoo and river bank | - Fishermen<br>- Residents | - RCC | - Economic | - Technologic al/ Infrastructural<br>- Governance<br>- Societal<br>- Ecosystem Services | |
| Solid Waste Management | Increasing temperatures and decreasing 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. | Wards 1, 4, 7,9; market areas of wards 12, 17,22,23,24; water logged area of wards 25, 28, 29 | - SWM workers<br>- Children<br>- Elderly | - RCC | - Ecosystem Services | - Economic<br>- Technologic al/ Infrastructural<br>- Governance<br>- Societal | |
| Economy | Increasing temperature and decreasing rainfall will impact agriculture, fishery, fruit cultivation, and thereby economy of the city. It can also increase immigration to the city from surrounding areas. Daily labourers and vendors will be impacted since they will be unable to work in harsh climate. | Peri-urban areas of ward 1; wards 2, 17, 30, 26, 27, 29 | - Farmers<br>- Farm labourers<br>- Women<br>- Entrepreneurs<br>- Slum dwellers<br>- Daily labourers<br>- Vendors<br>- Rickshaw pullers | - Entrepreneurs | - Economic<br>- Ecosystem Services | - Technologic al/ Infrastructural<br>- Governance<br>- Societal | |

| Fragile Urban System | Climate Fragility Statement | Vulnerable Areas | Urban Actors | | Adaptive Capacity of the System | | |
|---|---|---|---|---|---|---|---|
| | | | Vulnerable | Potential Supporting | Low | Medium | High |
| Waste Water | In case of sudden high intensity rainfall, drains may overflow, particularly if there is solid waste choking the drains.<br>In high temperature, decomposition is high with odour. | Ward 1 -Guripara, Raipara, Kanthalbari<br>Ward 2 -Asrayan Colony, Lily Cinema Hall, Mollapara, PDB office<br>Ward 3 - Daspukur<br>Ward 4 – Bulonpur Riverside<br>Ward 6 -Jhautala More<br>Ward 7 - Srirampur Riverside<br>Ward 12 - Zeropoint, Bhubanmahan park, Phutkipara<br>Ward 22 - Kumarpara<br>Ward 23 – Shekher Chowk, Panchabati<br>Ward 24 - Ramchandrapur, Baje Kajla, Hadir More<br>Ward 26 – Meher Chandi, Kadaitala<br>Ward 28 - Dharampur, Dashmari<br>Ward 29 - Khojapur, Jahaj Ghat<br>Ward 30<br>- Pashchim Boothpara, Maulabi Boodhpara | - Farmers<br>- Farm labourers<br>- Women<br>- Slum dwellers<br>- Daily labourers<br>- Vendors<br>- Rickshaw pullers | - Agriculturalists<br>- Entrepreneurs<br>- RWASA | - Governance<br>- Societal | - Economic<br>- Technology<br>- Ecosystem Services | |



# 05

# CLIMATE RESILIENCE INTERVENTIONS

The CRCAP of Rajshahi includes climate resilience interventions in the residential, commercial, institutional, industrial and municipal service sectors. Municipal services and facilities such as water supply, sewerage, storm water, SWM, transport, street lighting, municipal buildings, and green spaces/cover are addressed in the action plan. The resilience interventions included in the CRCAP are informed by the baseline sectoral GHG emissions and identified climate vulnerabilities. Identified sectoral interventions are prioritized based on their resilience capacity, which is assessed in terms of their propensity to increase the redundancy, flexibility, and responsiveness of the relevant systems as well as GHG emissions reduction potential. The interventions are then assessed for feasibility (technical, financial and political) and their impact (short, medium or long term). As far as possible, the prioritized interventions are linked to existing city plans and schemes to ensure that the required interventions are integrated, with little or no additional resources, into existing departmental programs or projects. The interventions were discussed and approved by the climate core committee of the city.

Sections 5.1 and 5.2 provide information on selected climate resilience interventions that make up the CRCAP of Rajshahi. Sector specific information, including energy consumption and GHG emissions for the baseline as well as the projected BAU scenario, along with overall GHG emissions mitigation potential and possible energy savings from all interventions in the sector, are also indicated in the table. The SDGs addressed by the proposed interventions for the sector are included to reflect overall contribution to sustainability.

For each of the interventions, the specific target location where the intervention should be sited (where relevant), scale of intervention, climate and other co-benefits, ballpark cost estimates, proposed implementation strategies, mode of implementation, entities that are primarily responsible for the implementation and various schemes and programmes that can support the intervention, are also indicated. In order to assess the bankability of the interventions, a detailed techno-commercial assessment is required to determine RCC's ability to access budgetary resources as well as repay loans and generate revenue.

**CRCAP Duration: 5 years (2022-23 to 2026-27)**

**Mitigation Target:**

The Climate Resilient City Action Plan (2022-26) proposes actions with an annual GHG emission mitigation potential of 9.64% by 2026-27 over the 2017-2018 baseline.

**Adaptation Goal:**

The city of Rajshahi aims to become a sustainable, climate resilient city that sustainably manages risks of drought, water scarcity and heat, while furthering inclusive urban development and SDG achievement that addresses the needs of all residents.

## 5.1 Summary of Key Strategies and Measures for Climate Resilience

**Residential sector (47%), SWM (31%), and manufacturing and industrial sector (12%) are expected to provide the maximum GHG emissions reduction benefits**

The CRCAP for Rajshahi city is comprised of 31 actions (structural) delineated across 10 thematic areas/sectors that provide a pathway for Rajshahi to enhance climate resilience and move towards a low carbon urban development pathway. These proposed interventions can deliver significant benefits in terms of reducing GHG emissions by lowering energy consumption, as well as reducing municipal expenditure on fuel and electricity.

The identified strategies will not only help reduce GHG emissions and better manage local climate risks, but also support the city in achieving SDGs. Residential sector (47%), SWM (31%), and manuf acturing and industrial sector (12%) are expected to provide the maximum GHG emissions reduction benefits.

While the 31 structural actions have immediate, direct GHG emissions reduction impacts, the CRCAP also recommends several additional 'Enabling strategies and actions' that have indirect impacts by enabling or building capacity for longer-term actions. For example, preparation of city-wide 'Integrated Solid Waste Management Plan' and increasing door to door collection and waste segregation.

Figure 42 shows the GHG emissions reduction scenario on implementation of the CRCAP as compared to the BAU emissions trajectory. Table 25 summarizes information on the key strategies and measures that were modelled for the actions in the GHG emissions reduction scenario in Figure 42. Through implementation of ambitious but achievable actions under the CRCAP, the city's GHG emissions can be reduced by 9.64% by 2026-27, from the base year 2017-18.

**Table 25 Summary of Climate Resilient City Action Plan for Rajshahi**

| Sectors | Key Strategies | Mitigation Potential ($tCO_2e$) | Overall Climate Resilience Impact |
|---|---|---|---|
| Buildings Residential | **1 Structural strategies:** Promote renewable energy (RE) (solar PV and solar water heating (SWH)) and energy efficiency (EE) retrofits (BLDC fans, energy saving lights (LEDs), refrigerators, ACs etc.) **2 Enabling strategies:** Pilot green/eco-building design | 28,803 | Reduced grid dependency, improved self-sufficiency from decentralized RE generation, enhanced thermal comfort and energy cost savings |
| Solid Waste | **1 Structural strategies:** Improved SWM and disposal (100 TPD composting plant and 20 TPD biomethanation plant) **2 Enabling strategies:** Integrated Solid Waste Management Plan and increasing door to door collection and waste segregation | 18,816 | Higher resource efficiency, lower air and land pollution and public health risks, reduced waste going to landfill, improved resilience from decentralized systems |
| Urban Biodiversity and Green Space | **1 Structural strategies:** Sequester carbon through increased green infrastructure (trees, plants, soil) and natural areas **2 Enabling strategies:** Develop a comprehensive Local Biodiversity Strategy and Action Plan (LBSAP), implement a programme to promote adoption of rooftop urban farming and initiate a 'green space stewardship programme'; strengthen institutional capacity to develop and maintain urban biodiversity related data and maps, and identify and designate ecologically important areas as "Heritage spaces" | 7,603 | Green spaces as carbon sinks improve public health, reduce the heat island effect, filter storm water runoff and provide other ecosystem services. |
| Buildings - Commercial and Institutional | **1 Structural strategies:** Promote RE (net metered solar PV and SWH in hospitals and hotels) and EE retrofits (energy saving lights (LEDs), fans, ACs etc.) **2 Enabling strategies:** Promote building EE through policy and research (mandate energy audits, develop and implement bye-laws to promote and incentivise EE measures etc.) | 4,187 | Reduced grid dependency, improved self-sufficiency from decentralized RE generation, enhanced thermal comfort and energy cost savings |
| Transport | **1 Structural strategies:** Promote use of non-motorised transportation in the city through public bicycle sharing schemes (PBS) and introduce public city bus service (electric powered) **2 Enabling strategies:** Adopt context sensitive street design standards and develop Comprehensive Mobility Plan (CMP) with focus on promoting low carbon transport | 370 | Reduction of GHG emissions from private vehicles, improved air quality, public safety and reduced traffic congestion |

| Sectors | Key Strategies | Mitigation Potential ($tCO_2e$) | Overall Climate Resilience Impact |
|---|---|---|---|
| Water Supply | **1 Structural strategies:** Reduce physical water losses and NRW, install solar PV system to supply electricity at water plant and promote dual plumbing, grey water reuse<br>**2 Enabling strategies:** Prepare city-level water conservation policy, develop an integrated urban water management plan and promote RWH through an incentive program | 367 | Freshwater conservation; improved groundwater recharge; better water access; enhanced water availability, quality and security; reduced risk of waterlogging; lower public health risks |
| Manufacturing Industries and Construction | **1 Structural strategies:** Promote RE (net metered solar PV) and EE retrofits (energy saving lights and fans) | 334 | Reduced grid dependency, improved self-sufficiency from decentralized RE generation, enhanced thermal comfort and energy cost savings |
| Street Lighting | **1 Structural strategies:** Replacement of existing street lighting with LED lights and install EE Street Lighting Control and Management System (Voltage Controller and Timer)<br>**2 Enabling strategies:** Undertake a technical study for design of EE street lighting | 260 | Electricity and cost savings, improved visibility, improved service quality, reliability and life of streetlights |
| Street Lighting | **1 Enabling strategies:** Develop a city-wide drainage master plan; promote grey water reuse and recycling for non-potable uses such as landscape irrigation, gardening, flushing; initiate public awareness activities to prevent waste dumping into drains and canals | | Reduced water pollution, decrease in water borne disease outbreak, reduced contamination of ground water, improved surface and groundwater quality, enhanced sanitation |

**Total → 60,748**

**Figure 41** **Total Annual Mitigation Potential of CRCAP**

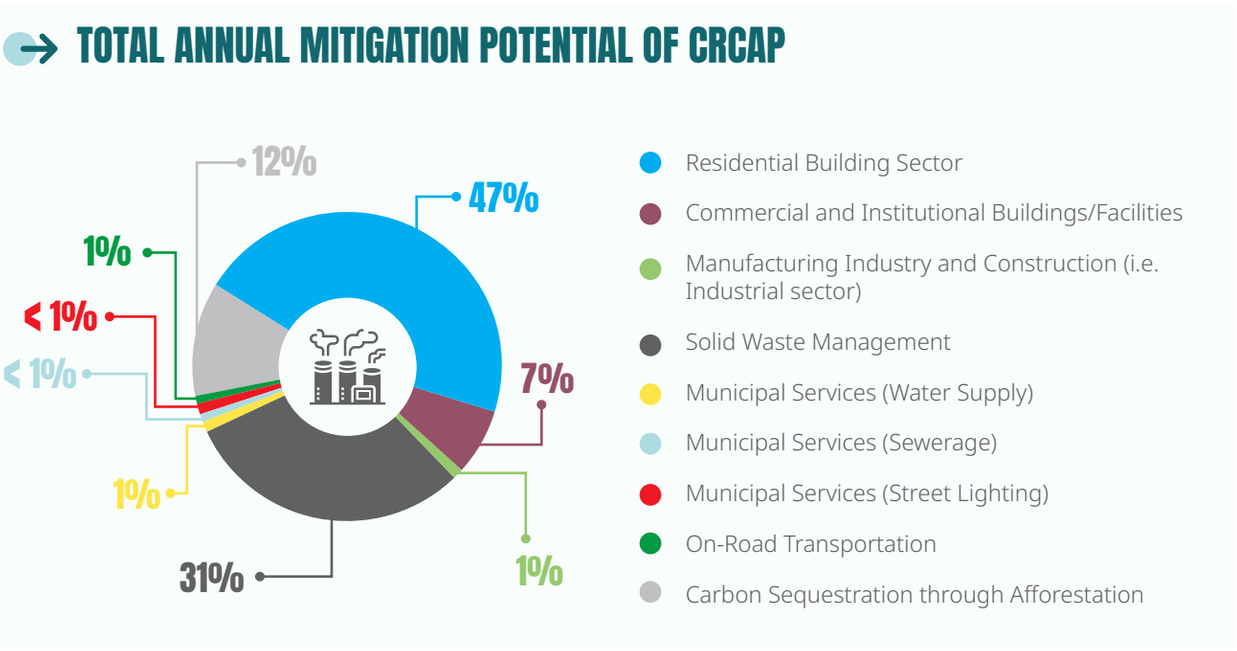
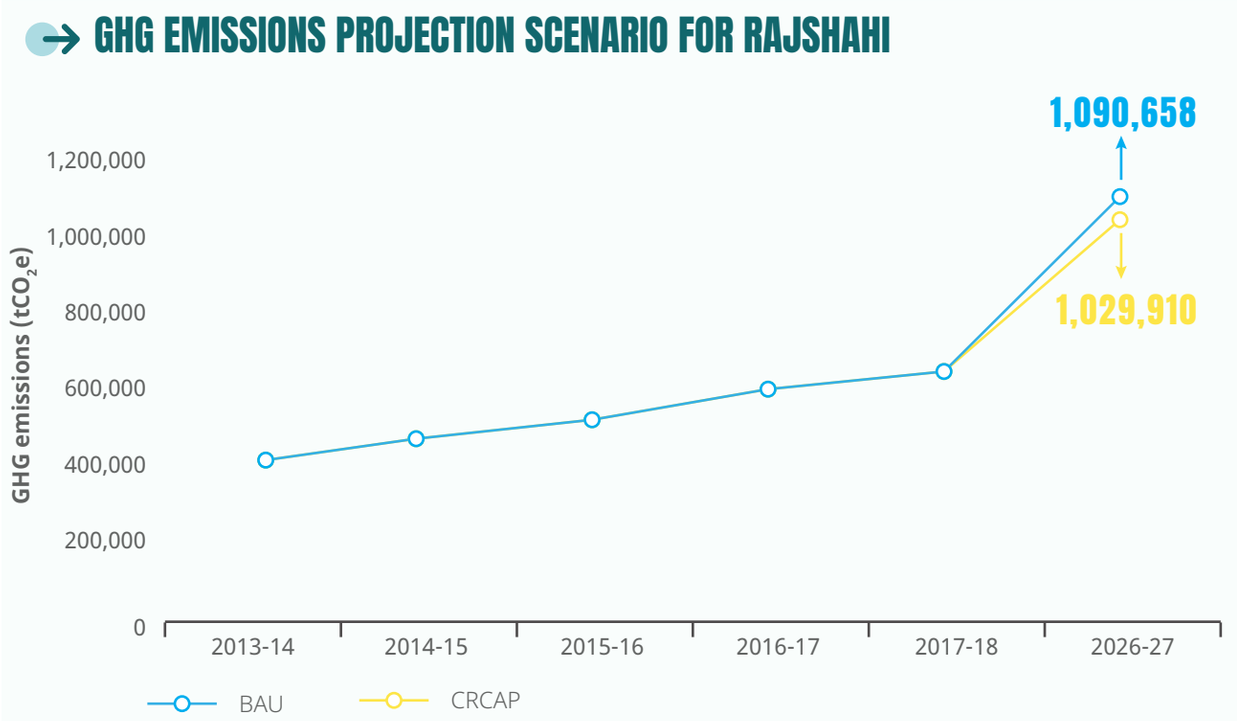



**Figure 42** **GHG Emissions Projection Scenario Rajshahi**



# 5.2 SECTORAL CLIMATE RESILIENCE INTERVENTIONS FOR RAJSHAHI

## 5.2.1 Residential Buildings

**2017-18**
Energy consumption
**1,474,906 GJ**

**2017-18**
GHG emission
**148,564 $tCO_2e$**

**Contributes to (2017-18)**
**68%** of the city's electricity consumption

**Baseline analysis and issues**

- Growing electricity demand: 36% increase in the consumption between 2013-14 to 2017-18
- Lack of awareness and effective initiative of government and users toward RE
- Contribution of energy consumption from residential sector is third highest among all sectors. With the growing population and expanding urban services, the consumption trend and associated emissions will rapidly increase in the future.
- City's average annual temperatures are rising, which is expected to drive the cooling demand and electricity consumption.
- City lacks benchmark data on energy consumption from the sector; no previous baseline study on potential energy and GHG emissions reduction by introducing RE sources

**Potential climate impacts and BAU scenario**

- 2026-27 (projected): Energy consumption – 2,367,171 GJ
- 2026-27 (projected): GHG emissions – 262,298 $tCO_2e$
- Total GHG emissions are expected to increase around 1.7 times between 2017-18 and 2026-27.
- Residential electricity demand is expected to double by 2026-27 as compared to the baseline (2017-18).

**Climate resilience potential of the sector**

- 2026-27: 44 million kWh
- 2026-27: 28,803 $tCO_2e$ (47% of baseline emissions)
- 2026-27: Net projected GHG emissions post implementation of interventions: 233,495 $tCO_2e$

Reduced grid dependency, improved self-sufficiency from reduced grid dependency and decentralized RE generation, enhanced thermal comfort and energy cost savings

Total cost of climate resilience interventions: BDT 1,524 million

**SDGs**

GOAL 7:
Affordable & Clean Energy

GOAL 11:
Sustainable Cities & Communities

GOAL 12:
Responsible Consumption & Production

GOAL 13:
Climate Action

**Note:**

Status of each intervention is defined as - Ongoing action: Already under implementation; Planned action: Being considered and planned for; New action: Proposed for the first time in the CRCAP

Climate resilient potential of each intervention is defined as very high, high, medium or low considering the aspects of redundancy, flexibility, responsiveness, access to technology, implementation duration and GHG emissions reduction potential

Duration of implementation - Long-term: 5 to 10 years, Mid-term: 2-4 years, Short-term: 1-2 years

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Promote use of solar water heaters in place of conventional geysers in households** | • 100 LPD each in 3% of the total households in the city (3243; high-income and upper middle-income homes)<br>• Potential area: large residential buildings in Station Road, New market, Saheb bazar, Uposhohor, Padma residential, Talaimari and Kazla areas of Wards 13, 11, 12, 15, 27, 29 and 30. | • Energy saving: 24 million kWh<br>• GHG reduction: 2935 $tCO_2e$<br>• Energy saving; reduction in GHG emissions<br>• Very high resilience potential | 170 | • **Implementing Entities** - SREDA, local DISCOMs (NESCO) and RCC<br>• **Implementation Model:** CAPEX (Investment by residential, property owners) model, supported by grants from international development agencies, incentives from RCC (holding tax)<br>• Aggregate/pool projects from multiple homes to reduce capital costs | • New Action<br>• Medium-term |
| **Promote and facilitate installation of rooftop solar PV with net-metering** | • 5 kW each in 5% of high-income and upper middle-income homes (162 HHs)<br>• 10 kW each in 10% of high rise (20 multi-storey) buildings (15 buildings)<br>• Potential area: Application potential in Padma and Uposhohor residential areas in the city that are high income areas in wards 14 and 23. | • Energy savings: 1 and 0.28 million kWh<br>• GHG reduction: 671 and 183 $tCO_2e$<br>• High resilience potential | • 57<br>• 15 | • **Implementing Entities** Agencies - SREDA, local DISCOMs (NESCO) and RCC<br>• **Implementation Model:** CAPEX model, supported by grants from international development agencies, incentives from RCC (holding tax) enabled by municipal mandates.<br>• Aggregate/pool projects from multiple homes to reduce capital costs | • New Action<br>• Medium-term |

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Adopt EE lighting to replace conventional lighting** | • 50% of incandescent lamps phased-out and replaced with CFLs and LED lamps<br>• 25% of existing CFLs replaced with LED lamps<br>• 25% of T-8 tube lights replaced with T5 and LED tube lights.<br>• Potential area: large residential buildings in Station road, New market, saheb bazar, Uposhohor and Padma residential areas of Wards 13, 11, 12 , 15 and 27 . Any government building which takes up this initiative can serve as an example of good practice for others to replicate and adopt. | • Energy saving: 17.88 million kWh<br>• GHG reduction: 11,586 $tCO_2e$<br>• High resilience potential | 53 | • **Implementing Entities** Agencies - local DISCOMs (NESCO) and RCC<br>• **Implementation model-**CAPEX model, supported by grants from international development agencies, incentives from RCC (holding tax)<br>• Aggregate/pool projects from multiple homes to reduce capital costs<br>• Investment by residential property owners, supported by grants/ incentives from govt. and mandates by RCC. | • New Action<br>• Medium-term |
| **Adopt EE ceiling fans to replace conventional fans** | • Conventional ceiling fans replaced in 25% of homes with Alternating current (AC) type efficient fans and 10% of homes with super-efficient brushless type DC fans[58]<br>• Potential area: large residential buildings in Station Road, New market, saheb bazar, Uposhohor and Padma residential areas of Wards 13, 11, 12, 15 and 27. Any government building which takes up this initiative can serve as an example of good practice for others to showcase, replicate and adopt. | • Energy saving: 15 million kWh<br>• GHG reduction: 9432 $tCO_2e$<br>• High resilience potential | 697 | | • New Action<br>• Medium-term |
| **Encourage use of EE air conditioners** | • EE ACs in 10% of high-income and upper middle-income homes[59]<br>• Potential area: large residential buildings in Station road, New market, saheb bazar, Uposhohor and Padma residential areas of Wards 13, 11, 12 , 15 and 27 . | • Energy saving: 4.35 million kWh<br>• GHG reduction: 2817 $tCO_2e$<br>• High resilience potential | 369 | • **Implementing Entities** - SREDA, local DISCOMs (NESCO) and RCC<br>• **Implementation model-**CAPEX model, supported by grants from international development agencies, incentives from RCC (holding tax)<br>• Aggregate/pool projects from multiple homes to reduce capital costs<br>• Investment by residential property owners, supported by grants/ incentives from govt. and mandates by RCC. | • New Action<br>• Medium-term |

58 AC fans proposed for 20% of replacements and super-efficient brushless DC fans proposed for 5% of replacements

59 Purchasing capacity and penetration predominant in high-income and upper mid-income groups

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Encourage use of EE refrigerators** | • EE refrigerators in 10% of high-income and upper middle-income homes<br>• Potential area: large residential buildings in Station road, New market, saheb bazar, Uposhohor and Padma residential areas of Wards 13, 11, 12 , 15 and 27. | • Energy saving: 1.79 million kWh<br>• GHG reduction: 1162 $tCO_2e$<br>• High resilience potential | 164 | • **Implementing Entities** - SREDA, local DISCOMs (NESCO) and RCC<br>• **Implementation model-**CAPEX model, supported by grants from international development agencies, incentives from RCC (holding tax)<br>• Aggregate/pool projects from multiple homes to reduce capital costs<br>• Investment by residential property owners, supported by grants/ incentives from govt. and mandates by RCC. | • New Action<br>• Medium-term |
| **Adopt LED lights for common area lighting in multi-storey buildings** | • 25% of all multi-storey buildings adopt LED lights for common area lighting.<br>• Potential area: large residential buildings in Station road, New market, saheb bazar, Uposhohor, Padma residential , Talaimari and Kazla areas of Wards 13, 11, 12 , 15, 27, 29 and 30 .Khanpur, Isdair, Masdair, Amlapara, Tanbazar and Jamtola | • Energy saving: 0.03 million kWh<br>• GHG reduction: 17 $tCO_2e$<br>• High resilience potential | 0.2 | • **Implementing Entities** - local DISCOMs (NESCO) and RCC<br>• **Implementation mode:** CAPEX mode with purchase by consumer.<br>• Resident/building associations can be helped with bulk procurement from suppliers for wide-scale adoption at lower costs.<br>• Investment by residential property owners, supported by grants/ incentives from govt. and mandates by RCC. | • New Action<br>• Medium-term |
| **Pilot Green/ Eco-building design** | • Pilot green/eco-building concept in new large residential buildings in Uposhohor and Padma residential area in Wards 15 and 27 and highrise buildings that are planned in Saheb Bazar, New Market, Laxmipur following SREDA's Building Energy Efficiency and Environment Rating (BEEER) standard (Draft), 2020<br>• Potential area: In mixed use high-rise buildings planned at Saheb Bazar, New Market, Laxmipur. | • Lower energy use and GHG emissions<br>• Improved indoor thermal comfort, lower water and resource use<br>• High Resilience Potential | | Implementing Authority: RCC, RDA, and Real Estate and Developers Association, Rajshahi<br>Implementation mode – Fiscal incentives to builders and home owners.<br>RCC can implement building design guidelines on a pilot basis. | • New Action<br>• Short-term |

## 5.2.2 Commercial and Institutional Buildings

2017-18
Energy consumption
201,818 GJ

2017-18
GHG emission
31,991 $tCO_2e$

**Baseline analysis and issues**

- Lack of awareness and effective initiative of government and users toward RE
- City's average annual temperatures are rising, which is expected the drive the cooling demand and electricity consumption.
- Inadequate empirical benchmark data on energy consumption from commercial and institutional buildings
- Limited information about the benefits of EE investments and technologies, lack of familiarity with EE products, lack of awareness of benefits, and a perceived risk when evaluating potential investments
- Inadequate enforcement, standards and labelling; EE equipment ecosystem not fully mature; limited availability, product distribution networks and local capacity

**Potential climate impact and BAU scenario**

- 2026-27 (projected): Energy consumption – 306,605 GJ
- 2026-27 (projected): GHG emissions – 40,841 $tCO_2e$
- 20% increase in electricity consumption from 2017-18 to 2026-27

**Climate resilience potential of the sector**

- 2026-27: Annual energy saving: 6 million kWh
- 2026-27: Annual GHG emissions reduction: 4,187 $tCO_2e$ (6.9% of 2017-18 baseline)
- 2026-27: Net projected GHG emissions post implementation of interventions: 36,654 $tCO_2e$
- Reduced grid dependency, improved self-sufficiency from decentralized RE generation, enhanced thermal comfort and energy cost savings

Total cost of climate resilience interventions: BDT 88 million

**SDGs**

GOAL 7:
Affordable & Clean Energy

GOAL 11:
Sustainable Cities & Communities

GOAL 12:
Responsible Consumption & Production

GOAL 13:
Climate Action

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Adopt EE lighting to replace conventional lighting** | • 25% of conventional fitting replaced with LED in fully commercial buildings.<br>• 25% of conventional fitting is replaced with LED in mixed commercial buildings.<br>• Potential areas: Commercial areas such as Station road, New market, saheb bazar, Lakshmipur, Uposhohor areas of Wards 6,8, 10, 13, 11, 12 , 15 and 27 . | • Energy saving: 4.77 million kWh<br>• GHG reduction: 3093 $tCO_2e$<br>• High resilience potential | 38 | **Implementing Entities** –Business owners, institutional and public entities, RCC, technology providers, SREDA | • New Action<br>• Short-term |
| **Adopt EE ceiling fans to replace conventional fans** | • 25% of conventional ceiling fans replaced with EE fans in fully commercial buildings;<br>• 25% of conventional ceiling fans were replaced with EE fans in mixed commercial buildings.<br>• Potential areas: commercial areas such as Station road, New market, saheb bazar, Lakshmipur, Uposhohor areas of Wards 6,8, 10, 13, 11, 12 , 15 and 27 . | • Energy saving: 0.91 million kWh<br>• GHG reduction: 590 $tCO_2e$<br>• EE ceiling fans deliver thermal comfort with lower energy use to address rising temperature risk<br>• High resilience potential | 12 | **Implementation mode** – Purchase by end-users (CAPEX). Bulk procurement for consumers facilitated by SREDA and RCC to reduce costs. | • New Action<br>• Short-term |
| **Replacement of Conventional ACs with EE AC in large public office and bank buildings** | • 50% of these establishments adopt EE ACs<br>• Potential areas: commercial, institutional and mixed use areas such as Station road, New market, saheb bazar, Lakshmipur, Uposhohor, Talaimari, Kazla, Ammcottor areas of Wards 6,8, 10, 13, 11, 12 , 15-18 and 26-30 wards . | • Energy saving: 0.08 million kWh<br>• GHG reduction: 53 $tCO_2e$<br>• delivers thermal comfort with lower energy use to address rising temperature risk<br>• High resilience potential | 4.88 | **Implementing Entities** – RCC, public institutions, technology providers, SREDA<br><br>**Implementation mode** – Purchase by public sector/ institutions (CAPEX). Programs/ mechanisms from product suppliers to support exchange of inefficient stock for new efficient appliance. | • New Action<br>• Long-term |

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Promote use of solar water heaters in place of conventional geysers in large hospitals** | • 20,000 LPD capacity of SWH installed in hospitals<br>• Potential areas: Laxmipur and Ammchottor in areas with medical centres and hospitals ( wards 9, 10, and 17) | • Energy saving: 0.28 million kWh<br>• GHG reduction: 181 $tCO_2e$<br>• Very high resilience potential | 3 | **Implementing Entities** – Business owners, institutional and public entities, RCC, technology providers, SREDA<br><br>**Implementation mode** –CAPEX Investment by end-users, supported by grants from international agencies, incentives from RCC (holding tax rebates) and mandates for large buildings. Aggregation of multiple projects facilitated by RCC to reduce capital costs | • New Action<br>• Medium-term |
| **Promote and facilitate installation of rooftop solar PV with net-metering** | • 10 kW each in 10% of commercial and institutional buildings (114kWp cumulative capacity)<br>• Potential areas: mixed use areas such as Station road, New market, saheb bazar, Laksmipur, Uposhohor, Talaimari and Kazla areas of Wards 6,8, 10, 13, 11, 12 , 15, 26-30 wards. | • Energy saving: 0.16 million kWh<br>• GHG reduction: 102 $tCO_2e$<br>• Improved redundancy and flexibility of power supply from decentralized renewable energy generation<br>• Very high resilience potential | • 7.8 | **Implementing Entities** – RCC, local DISCOMs (NESCO), business owners, institutional and public entities, technology providers, SREDA<br><br>**Implementation mode** –Net-metering Policy, 2019. CAPEX Investment by end-users, supported by grants from international agencies, incentives from RCC (holding tax rebates). Aggregation of multiple projects facilitated by RCC to reduce capital costs | • New Action<br>• Medium-term |

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Promote building energy efficiency in commercial and institutional buildings through policy and research** | • RDA in collaboration with RCC develops and implements a bye-law by that mandates and supports all new buildings and existing buildings to adopt EE measures.<br>• Identify pilot neighborhoods for implementation to develop a replicable, scalable model<br>• Develop an implementation roadmap and guideline document highlighting potential EE actions for new and existing building owners to choose from.<br>• Develop energy saving awareness campaigns to promote behavior change through marketing of technologies, communication and education programmes<br>• Mandate energy audits to develop Energy Benchmarking of commercial and institutional buildings in Rajshahi<br>• Potential areas: In phased manner, large government, residential and commercials buildings in Station road, New market, saheb bazar, Uposhohor and Padma residential areas of Wards 13, 11, 12 , 15 and 27 . | • Lower energy use and GHG emissions<br>• improves thermal comfort<br>• Reduce urban Heat Island due to AC usage<br>• High resilience potential | | **Implementing Entities:** RDA, RCC and Real Estate and Developers Association, Rajshahi<br><br>**Implementation mode** – Fiscal incentives to builders and home owners.<br><br>In collaboration with national and international technical agencies develop and implement innovative financial instruments, including internationally available climate finance that encourages electricity users to implement energy efficiency interventions | • New Action<br>• Long term |

## 5.2.3 Manufacturing Industries and Construction

2017-18
Energy consumption
2,095,008 GJ

2017-18
GHG emission
169,081 $tCO_2e$

**Baseline status**

- Limited information about the benefits of EE investments and technologies, lack of familiarity with EE products, lack of awareness of benefits, and a perceived risk when evaluating potential investments
- Inadequate enforcement, standards and labelling, EE equipment ecosystem not fully mature, limited availability, product distribution networks and local capacity
- Inadequate investments in supporting institutional mechanisms and human resources
- Inadequate empirical benchmark data on energy consumption for lighting and ventilation in local industrial units

**Potential climate impact and BAU scenario**

- 2026-27 (projected): Energy consumption – 3,470,644 GJ
- 2026-27 (projected): GHG emissions – 292,262 $tCO_2e$
- 36% (30 million kWh) increase in total electricity consumption by 2026-27 as compared to 2017-18 (21.90 kWh)

**Climate Resilience Potential of the sector**

- 2026-27: Annual energy saving: 1 million kWh
- 2026-27: Annual GHG emissions reduction: 334 $tCO_2e$ (<1% of 2017-18 baseline)
- 2026-27: Net projected GHG emissions post implementation of interventions: 291,928 $tCO_2e$
- Reduced grid dependency, improved self-sufficiency from decentralized RE generation, enhanced thermal comfort and energy cost savings
- Total cost of climate resilience interventions: BDT 21 million

**SDGs**

GOAL 7:
Affordable & Clean Energy

GOAL 8:
Decent Work & Economic Growth

GOAL 9:
Industry, Innovation & Infrastructure

GOAL 11:
Sustainable Cities and Communities

GOAL 12:
Responsible Consumption & Production

GOAL 13:
Climate Action

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Adopt EE lighting to replace conventional lighting** | • 30% of conventional lighting (T8) replaced with LED in small, medium and large industries.<br>• Potential areas: Agro based industries, silk industries rice and saw mills in Shopura, Shalbagan and Choto Bongram areas in the city that mainly occupied by the industries in wards 8, 15 and 16 | • Energy saving: 0.12 million kWh<br>• GHG reduction: 75 $tCO_2e$<br>• High resilience potential | 0.52 | **Implementing Entities**<br>Business/industry owners, BEPZA, industry associations, RCC, technology providers, SREDA<br><br>**Implementation mode**<br>Purchase by end-users (CAPEX). Bulk procurement for consumers facilitated by BEPZA, industry associations and SREDA to reduce costs. Tax incentives from BEPZA / industrial authorities and RCC. Financial support may be sought through IDCOL's financing schemes targeted specifically for industries. | • New Action<br>• Short-term |
| **Adopt EE ceiling fans to replace conventional fans** | • 30% of conventional ceiling fan with EE ceiling fans in small and medium industries; 20% replacement of conventional ceiling fan with EE ceiling fans and 10% BLDC in large industries<br>• Potential areas: Agro based industries, silk industries rice and saw mills in Shopura, Shalbagan and Choto Bongram areas in the city that mainly occupied by the industries in wards 8, 15 and 16 | • Energy saving: 0.06 million kWh<br>• GHG reduction: 40 $tCO_2e$<br>• High resilience potential | 1.4 | | • New Action<br>• Short-term |
| **Promote and facilitate installation of rooftop solar PV with net-metering** | • 25% of potential rooftop area on utilized for solar rooftop PV system (271kWp cumulative capacity)<br>• Potential areas: Agro based industries, silk industries rice and saw mills in Shopura, Shalbagan and Choto Bongram areas in the city that mainly occupied by the industries in wards 8, 15 and 16 | • Energy saving: 0.34 million kWh<br>• GHG reduction: 218 $tCO_2e$<br>• Very high resilience potential | • 19 | **Implementing Entities**<br>Business/industry owners, Industry associations, RCC, local DISCOMs (NESCO), technology providers, SREDA<br>**Implementation mode**<br>Net-metering Policy, 2019. Investment by end-users, supported by grants from international agencies. Financial support may be sought through IDCOL's financing schemes and renewable energy service company (RESCO) model where third-party invests capital costs can be explored. Mandates and appropriate tax incentives from BEPZA / industrial authorities can support. | • New Action<br>• Medium term |

## 5.2.4 Municipal Solid Waste

**Energy consumption and GHG emissions**

2017-18 GHG emissions from Waste disposal: 110,456 $tCO_2e$

2017-18 Annual Waste Generation: 127,695 Tonnes

2017-18 Trend of Annual Waste Generation: Rise of 6.55% since 2013-14

**Baseline status**

- Around 130 TPD of MSW remains uncollected. Uncollected waste is dumped in open drains, open spaces, local ponds, canals and rivers. This blocks the drains and leads to water logging and flooding during monsoons.
- The city does not have any waste treatment or disposal system.
- Limited public awareness - Many households throw their solid waste in the open drain, open spaces, water bodies, and Padma River, causing environmental pollution and health hazards.
- Lack of household waste segregation inhibiting opportunities for waste treatment and processing

**Existing and Planned Measures by RCC**

- Rajshahi city is planning to establish a Waste to Energy (WTE) plant. The capacity of the plant is expected to be between 5-10 MW. However, official feasibility estimation is pending.

**Potential climate impact and BAU scenario**

- 2026-27 (projected): GHG emissions: 142,954 $tCO_2e$
- Total emissions from waste disposal to increase by 30% by 2026-27 as compared to baseline year (2017-18)
- Per day waste generation in RCC area is expected to increase to 450 tonnes by 2026-27 as compared to 350 tonnes per day in 2017-18

Climate risk status: High: High risk due to increased temperature and decreased rainfall and changing rainfall patterns

**Climate resilience potential of the sector**

- 2026-27: Annual GHG emissions reduction: 18,816 $tCO_2e$ (31% of 2017-18 baseline)
- 2026-27: Net projected GHG emissions post implementation of interventions: 124,138 $tCO_2e$
- Higher resource efficiency, lower air and land pollution and public health risks, reduced waste going to landfill, improved resilience from decentralized systems
- Total cost of climate resilience interventions: appx. BDT 90-92 million

**SDGs**

GOAL 3: Good Health & Well-being

GOAL 6: Clean Water & Sanitation

GOAL 7: Affordable & Clean Energy

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption & Production

GOAL 13: Climate Action

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Improved municipal solid waste management and disposal** | RCC installs and commissions following:<br>• 100 TPD windrow composting plant<br>• 20 TPD bio-methanation plant<br><br>Potential locations: Shaheb bazar, Alupotti, Ammcottor, City hat, Ramchandropur and Talaimari in wards 12, 17 and 25. | • GHG reduction: 19,385 $tCO_2e$<br>• Higher resource efficiency, lower local pollution and public health risks, reduced waste going to disposal, alternate power source, improved climate resilience<br>• Very high resilience potential | 1) 45<br><br>2) 40 | **Implementing Entities**<br><br>RCC, local NGOs, private sector, citizens<br><br>**Implementation mode**<br><br>• Financing through municipal budget and GoB schemes/ programs. Also, feasible to secure technical services (project preparation facilities) and finance through international agencies and organizations.<br>• Private sector financing through PPP or BOT model.<br>• PoA for accessing carbon credits | • New Action<br>• Medium term |
| **Develop an Integrated Solid Waste Management Plan** | Rajshahi city develops an Integrated Solid Waste Management Plan which encourages reduction, reuse and recycling of waste to the maximum extent possible, with technological solutions for organic and inorganic fractions of waste that are financially feasible (compost, Biomethanation, Refuse Derived Fuel, Waste to Energy WTE) | • Aligned with 3 R principle (reduce, reuse and recycle) principle.<br>• Increase the redundancy and flexibility of the waste management system by effective waste segregation, waste collection, treatment and increase the treatment efficiency.<br>• Very high resilience potential | 5-7[60] | **Implementing Entities**<br>RCC, local NGOs, private sector, citizens<br><br>• **Implementation mode** Financing through municipal budget and GoB schemes/ programs.<br>• Also, feasible to secure technical services (project preparation facilities) and finance through international agencies and organizations. | • New Action<br>• Short term |

60 Indicative number, actual may vary depending on scope and other factors

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Enforce waste segregation at source and door-to-door waste collection efforts to eliminate roadside waste littering and dumping in drains** | To reduce quantum of uncollected municipal solid waste in the city, RCC should:<br>• Promote bin-free approaches as far as possible<br>• Allocate designated locations (secondary transport stations / points) for litter-free waste transportation.<br>• Ensure effective street sweeping and cleaning programs as well as citizen awareness programs to prevent littering in public places / streets and canal / drains.<br>• Engage actively with stakeholders to initiate the implementation of community led decentralized projects (in housing complexes) in order to pave the way for waste minimization. | • Increase the redundancy and flexibility of the waste management system by effective waste segregation, waste collection, treatment and increase the treatment efficiency.<br>• High resilience potential | Approximate cost will vary as it can be achieved through multiple interventions | **Implementing Entities**<br>RCC, local NGOs, private sector, citizens<br>**Implementation mode**<br>Financing through municipal budget and GoB schemes/ programs. Also, feasible to secure technical services and finance through international agencies and organizations. | • New Action<br>• Long Term |

## 5.2.5 Water Supply

**2017-18**
Energy consumption **35,460 GJ**
Total electricity consumption **9.85 million kWh**

**2017-18**
GHG emission **6,383 $tCO_2e$**

**Contributing**
**86%** of total GHG emissions from municipal services

### Baseline status

- Increasing population and water demand are putting tremendous pressure on the water supply system.
- Limited availability and uncertainty of supply of surface water is a major issue for the city.
- Total dependence on groundwater (96% of total water supplied), increasing per capita water demand coupled with water losses and uneven distribution throughout the city are likely to have a significant impact on the residents in the future, especially during dry seasons.
- High rate of NRW (34%)
- Water scarcity in the non-monsoon months
- Flooding during intense rainfall, and contamination of water supply leads to severe health issues.
- Water resources in the city are reducing because of extraction of ground water and encroachment of ponds.

### Existing and Planned Measures by RCC

- 200 MLD RWASA surface water treatment plant
- 'Rehabilitation of Water Supply System in Rajshahi City' project
- Improvement of pipeline network and Shahid A. H. M. Kamaruzzaman surface water treatment plant of RWASA

### Potential climate impact and BAU scenario

- 2026-27 (projected): Electricity consumption – 17.34 million kWh
- 2026-27 (projected): GHG emissions – 11,239 $tCO_2e$
- Water demand expected to grow by 1.5 times between 2017-18 and 2026-27
- Climate risk status: Extreme: risk due to increased temperature, decreased rainfall and changing rainfall patterns

### Climate resilience potential of the sector

- 2026-27: Annual electricity savings: 0.4 million kWh
- 2026-27: Annual GHG emissions reduction: (NRW reduction, solar PV installation at pump houses and dual plumbing) – 367.3 $tCO_2e$ (less than 1% of the baseline 2017-18)
- 2026-27 - Net projected GHG emissions post implementation of interventions: 10,872 $tCO_2e$
- Freshwater conservation; improved groundwater recharge; better water access; enhanced water availability, quality and security; reduced risk of waterlogging; lower public health risks
- Total cost of climate resilience interventions: appx. BDT 18-20 million

**SDGs**

GOAL 3: Good Health & Well-being
GOAL 6: Clean Water & Sanitation
GOAL 7: Affordable & Clean Energy
GOAL 10: Reduced Inequalities
GOAL 11: Sustainable Cities and Communities
GOAL 12: Responsible Consumption & Production
GOAL 13: Climate Action

| Resilience interventions | Details of intervention | Climate resilient impact | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Reduce physical water losses and non-revenue water** | RCC in collaboration with RWASA is able to bring down the NRW from 34% to 24% through smart water metering, water audits, leak detection, up gradation of pipeline network with ductile iron pipes. | • Energy Saving 0.11 million kWh<br>• GHG reduction 68.11 $tCO_2e$<br>• Long term benefits through reducing water and energy losses. The proportionate water supply will increase resiliency of poor communities in vulnerable areas.<br>• Very high resilience potential | Cost will vary as it can be achieved through multiple interventions | **Implementing Agency:** RCC and RWASA<br><br>**Implementation mode:** Since these interventions are envisaged to be long term and cost intensive infrastructure projects, the project financing will have to primarily met through GoB funding and international loans. | • New action<br>• Medium term |
| **Introduce and promote rainwater harvesting (RWH) for groundwater recharge in residential, public/ institutional and industrial properties** | RCC in collaboration with RWASA undertakes following:<br><br>• Conduct a technical study to identify areas with high groundwater extraction rate and sites with RWH potential<br>• Introduce RWH in existing as well as new large residential buildings and new apartments in future<br>• Initially, RWH for rooftop buildings can be applied on the large government and commercial buildings in Laxmipur, CNB intersection, Railway Station Road, New Market and Shaheb Bazar along with its peripheral area of Wards 6, 14, 11 and 12.<br>• Potential areas for GW recharge include Kayerdara (Ward 1), Ammchottor (Ward 17), Raypara (Ward 19), Court Railway Station (Ward 26), Vodra (Ward 27), Kazla (Ward 28) and Talaimari (Ward 29), these areas considered due to their declining groundwater level. | • Increase resilience through ground water recharge, and improving soil condition.<br>• Lower energy consumption and GHG emissions due to reduction in electricity consumption for water supply.<br>• Lower freshwater consumption and ground water extraction<br>• Very high resilience potential | | **Implementing Entities** – RCC and RWASA<br><br>**Implementation mode:** Implementation in public building and spaces through municipal and GoB financial sources.<br><br>Private sector involvement through introducing incentives (reducing holding and property tax) by RCC.<br><br>Investment by residential, public/ institutional and industrial property owners, supported by grants/incentives from govt. and mandates by RCC. | • New action<br>• Medium term |

| Resilience interventions | Details of intervention | Climate resilient impact | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Install solar PV systems at water supply plants** | RCC and RWASA jointly work and install 100 kWp solar PV capacity at ongoing Rajshahi WASA Surface Water Treatment Plant (rooftop or ground-mounted systems based on technical assessments by solar PV installers). | • Energy Saving 0.12 million kWh<br>• GHG reduction 80.61 $tCO_2e$<br>• Very high resilience potential | 10 | • **Implementing Entities** – RCC and RWASA and SREDA<br>• **Implementation mode**- through PPP mode with public co-financing from municipal and GoB budget; private equity or loans from international lending agencies. | • New Action<br>• Short term |
| **Prepare city-level water conservation policy** | RCC and RWASA will develop and operationalize a city bye-law/policy to help regulate and control surface water and groundwater use and pollution, reduce water wastage, support introduction of water meters | • Reduce water pollution, over extraction of ground and surface water, and reduce waste of water, and thus will maintain suitable water table and reduce GHG emissions<br>• Very high resilience potential | | • **Implementing Entities** – RWASA and RCC<br>• **Implementation mode** Implementation through multi-stakeholder group to develop policy, implement and monitor its progress.<br>• Funding from municipal budget and GoB schemes, potentially Bangladesh Climate Change Trust Fund (BCCTF). | • New action<br>• Medium term |
| **Developing integrated urban water management plan** | RCC and RWASA will develop an integrated urban water management plan with following key activities –<br>• Assess existing baseline scenario including source and demand analysis (water budgeting and assessing water balance)<br>• Assess impact of climate change on water demand and supply infrastructure (including drought management)<br>• Identify strategies for augmenting local water resources (groundwater recharge, rainwater harvesting, and wastewater reuse) | • The plan would help the city to address the issues related to urban water sectors in a sustainable and inclusive manner by developing an understanding of the interlink ages with other urban sectors<br>• Very high resilience potential | 8-10[61] | • **Implementing Entities** – RWASA and RCC<br>• **Implementation mode** Implementation through multi-stakeholder group to develop policy, implement and monitor its progress.<br>• Funding from municipal budget and GoB schemes, potentially Bangladesh Climate Change Trust Fund (BCCTF). | • New action<br>• Medium term |

61 Actual cost will depend on scope, timeline and other factors

| Resilience interventions | Details of intervention | Climate resilient impact | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Application of Dual Plumbing System and Recycling of Greywater in Homes** | • RCC and RWASA jointly formulate and implement dual plumbing guidelines in a phase wise manner. Initially covering high- and middle-income households (2.74% of total households in the city) and commercial (hotels, shopping complexes), public buildings (schools, colleges, etc.). This intervention can be applied phase wise for the entire Rajshahi city. | • Energy Saving 0.22 million kWh<br>• GHG reduction 218 $tCO_2e$<br>• Medium resilience potential<br>• Freshwater conservation, improved groundwater resource, enhanced water availability and security | | • **Implementing Entities** – RWASA and RCC<br>• **Implementation mode** Implementation through multi-stakeholder group to develop policy, implement and monitor its progress.<br>• Funding from municipal budget and GoB schemes, public buildings can be covered through private sector CSR funding.<br>• Investment by residential, public/ institutional and industrial property owners, supported by grants/incentives from govt. and mandates by RCC. | • New action<br>• Long term |

## 5.2.6 Wastewater (Sewerage)

2017-18
GHG emission
9,762 $tCO_2e$

2017-18
Wastewater (estimated)
36 MLD

More than
80% households use septic tanks

**Baseline analysis and issues**

- Due to non-existent sewerage collection and treatment system, the city population (more than 80%) have to depend on on-site disposal system like septic tanks.
- Lacks adequate infrastructure and capacity for fecal sludge management (treatment and disposal)
- There is no documented estimation of septage generation and disposal/treatment, which means all the generated septage is dumped illegally and irregularly on open ground or in water bodies/drains.

**Potential climate impact and BAU scenario**

- 2026-27 (projected): GHG emissions – 14,352 $tCO_2e$
- Total GHG emissions from wastewater are expected to rise by almost 50% in 2026-27 as compared to baseline year.
- Surface and groundwater contamination due to absence of centralized sewerage system
- Climate risk status: Medium | Medium risk due to increased temperature, decreased rainfall and changing rainfall patterns

**Climate resilience potential of the sector**

- 2026-27 Annual GHG emissions reduction: 8.4 $tCO_2e$. (less than 1% of the baseline 2017-18)
- 2026-27: Net projected GHG emissions post implementation of interventions: 14,344 $tCO_2e$
- Reduced water pollution, decrease in water borne disease outbreak, reduced contamination of ground water, improved surface and groundwater quality, enhanced sanitation
- Total cost of climate resilience interventions: Appx. BDT 28-35 million

**SDGs**

GOAL 3: Good Health & Well-being

GOAL 6: Clean Water & Sanitation

GOAL 7: Affordable & Clean Energy

GOAL 11: Sustainable Cities and Communities

GOAL 13: Climate Action

GOAL 14: Life Below Water

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Pilot decentralized wastewater treatment systems (DeWATS) for households** | • Implement DeWATS pilots of 245 kLD for sustainable wastewater treatment of 500+ households<br>• Encourage adoption of anaerobic technology based DeWATS in large hospitals and public/ institutional campuses.<br>• To facilitate this RWASA will need to establish a dedicated 'wastewater management department/cell'.<br>• Potential areas: Mollapara, Laxmipur, Uposhohor and Padma Residential Area, Bilshimla, Tikapara, Talaimari and Binodpur areas under Wards 1-5, 15, 17, 27-30. | • GHG reduction 8.41 $tCO_2e$<br>• Reduced water pollution and public health risk, improved flexibility and redundancy of wastewater treatment, biogas production for energy generation<br>• Very high resilience potential | 9.77 | **Implementing Entities** – RCC and RWASA<br>**Implementation mode** – Municipal budget and GoB funding.<br>Involvement of private sector through PPP or BOT mode.<br>Funding from international lending agencies like JICA and ADB. | • New Action<br>• Medium-term |
| **Prepare Policy and Plan for fecal sludge management (FSM)** | • RCC will undertake technical assessment to prepare a city-scale Policy and Plan for developing FSM system<br>• The documents should address regulations to prevent untreated discharge, measures improve existing/ establish new on-site sanitation systems (household and group-level), identify mechanisms for sludge transfer, establishment of treatment facilities and options for sludge end-use as fertilizer | • Reduced land, groundwater and surface water pollution, improved water resources quality, improved sanitation and reduced public health impacts<br>• High resilience potential | 8-10[62] | **Implementing Entities** – RCC and RWASA<br>**Implementation mode** – Municipal budget and GoB funding.<br>Funding from international lending agencies like JICA and ADB.<br>Implementation through a multi-stakeholder group to develop policy, implement and monitor its progress. | • New Action<br>• Short-term |

62 Actual cost will depend on scope, timeline and other factors

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Prepare Master Plan to introduce sewerage system** | • RCC in collaboration with RWASA develops a detailed Sewerage Master Plan to guide introduction of centralized sewer network and treatment system in a phased manner | • Improvement of Surrounding Environment and Public hygiene; Prevention of Flooding; Preservation of Water Quality in Public Water Bodies<br>• High resilience potential | 10-15[63] | **Implementing Entities** – RCC and RWASA<br>**Implementation mode** – Municipal budget and GoB funding.<br>Funding from international lending agencies like JICA and ADB.<br>Implementation through a multi-stakeholder group to develop policy, implement and monitor its progress. | • New Action<br>• Medium-term |
| **Awareness generation activities on hygiene, appropriate sewage disposal alternatives, solid waste disposal** | • RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize sewerage and septage dumping in the drains. | • Intervention has potential to reduce health hazards and improve flood resilience<br>• High resilience potential | Cost would depend upon scale and duration of the awareness campaign and activities | **Implementing Entities** – RCC and RWASA<br>**Implementation mode –** financial resources secured through municipal budgets, GoB schemes; technical and financial support from civil society and NGOs (domestic and international) | • New Action<br>• Long term |

63 Actual cost will depend on scope, timeline and other factors

## 5.2.7 Drainage

**Baseline analysis and issues**

- Most of the drains are in poor condition. Unregulated encroachment, waste dumping and improper maintenance are the primary reasons.

**Existing and Planned Measures by RCC**

- Drain Construction for Removing Water-logging in Rajshahi city (Third Phase)

**Potential climate impact and BAU scenario**

- Climate Risk Status: medium | medium risk due to increases temperature and decreased rainfall and changing rainfall patterns

**Climate resilience potential of the sector**

- Reduced water pollution, decrease in water borne disease outbreak, reduced contamination of ground water
- Total cost of climate resilience interventions: BDT 5-7 million

**SDGs**

GOAL 3: Good Health & Well-being

GOAL 6: Clean Water & Sanitation

GOAL 7: Affordable & Clean Energy

GOAL 11: Sustainable Cities and Communities

GOAL 13: Climate Action

GOAL 14: Life Below Water

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Develop city-wide drainage master plan** | • RCC in collaboration with other agencies develops a drainage master plan to improve condition of existing drainage network, design and construct new drains with capacity to respond to high intensity rainfall<br>• Identify measures to minimize untreated wastewater discharge and clogging due to solid waste disposal. | • Help in reducing waterlogging in the city. Reduce chances of vector borne diseases and surface water contamination.<br>• Medium resilience potential | 5-7[64] | **Implementing Entities:** RCC, RWASA,<br><br>**Implementation mode: i**n collaboration with international development and lending agency for technical and financial resources. | • New Action<br>• Medium-term |
| **Promote grey water reuse and recycling for non-potable uses such as landscape irrigation, gardening, flushing** | • RCC in collaboration with other agencies develops a municipal bye-law that promotes and incentivizes grey water reuse in buildings for landscape irrigation, gardening, and flushing thereby reducing waste water flow in the drainage system. | • Reduce wastewater load on the drainage system, water pollution and urban flooding during monsoons.<br>• High resilience potential | Cost would depend on the scope, technology and other factors. | **Implementing Entities:** RCC, RDA, Bangladesh Water Development Board<br><br>**Implementation mode:** in collaboration with technical agencies, CSO or NGOs working on the issue/sector | • New Action<br>• Long-term |
| **Public awareness initiatives on prevention of waste dumping into drains and canals** | • RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize waste dumping (solid waste, sewerage and septage) in the drains. | • Intervention has potential to reduce health hazards and improve flood resilience<br>• Medium resilience potential | Cost would depend upon scale and duration of the awareness campaign and activities | **Implementing Entities** – RCC and RWASA<br><br>**Implementation mode** – financial resources secured through municipal budgets, GoB schemes; technical and financial support from civil society and NGOs (domestic and international) | • New Action<br>• Long-term |

64 Indicative number, actual may vary depending on scope and other factors

## 5.2.8 Street Lighting

2017-18

Energy consumption
**360,000 kWh**

**Baseline analysis and issues**

- All the areas aren't covered by street lighting.
- There are still some conventional lights.
- Street lights lack proper infrastructure design

**Potential climate impact and BAU scenario**

- 2026-27 (projected): Electricity consumption – 430,000 kWh
- 2026-27 (projected): GHG emissions – 279 $tCO_2e$

**Climate Resilience Potential of the sector**

- 2026-27: Annual GHG emissions reduction – 259.7 $tCO_2eq$ (around 0.4% of baseline emissions)
- 2026-27: Net projected GHG emissions post implementation of interventions: 19 $tCO_2e$
- Total cost of climate resilience interventions: Appx. BDT 15-16 million
- Electricity and cost savings, Improved visibility; improved service quality, reliability and life of streetlights.

**SDGs**

GOAL 7:
Affordable & Clean Energy

GOAL 11:
Sustainable Cities and Communities

GOAL 12:
Responsible Consumption & Production

GOAL 13:
Climate Action

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Replacement of existing Street lighting with LED lights** | • RCC in collaboration with NESCO replaces 1339 conventional lamp street lights with LEDS lamps.<br>• Potential area: Major and secondary roads in the city, where conventional lights are currently functional. | • Energy Saving: 0.42 million kWh<br>• GHG reduction: 273 $tCO_2e$<br>• Improving energy efficiency and reducing energy consumption and resulting emissions<br>• Very high resilience potential | 7.10 | **Implementing Entities** – RCC, NESCO<br><br>**Implementation mode** –Municipal budget and GoB funding. Technical and financial resources secured through international agencies like ADB and JICA<br><br>Private sector through ESCO or PPP mode. | • New Action<br>• short-term |
| **Undertake a technical study for design of EE street lighting** | • Undertake a detailed technical field survey and investment grade energy audit to ensure proper infrastructure design, up gradation and adoption of well illuminated LED street lighting as per national lighting standards<br>• Study should include identification of primary specifications, delivery model and long-term post-installation maintenance agreements with vendors | • Reduce electricity consumption, deliver dependable lighting and minimize maintenance cost while significantly improving the service<br>• Very high resilience potential | 7-8[65] | **Implementing Entities** – RCC, NESCO<br><br>**Implementation mode** – primarily through municipal budget and GoB funding. Technical and financial resources secured through international agencies like ADB and JICA | • New Action<br>• short-term |
| **Install EE Street Lighting Control and Management System (Voltage Controller and Timer)** | • RCC installs street light control systems of 6 kW size at 15 street lighting feeder panels/switching points for EE operation (auto on/off, voltage regulation)<br>• Identify appropriate locations to install control systems with technology providers.<br>• The interventions can be applied phase wise in major loads of Rajshahi city. | • Energy Saving: 0.14 million kWh<br>• GHG reduction: 91.47 $tCO_2e$<br>• With increasing energy demand, this intervention will reduce pressure on power grid and save significant amount of energy and emission from this sector.<br>• Very high resilience potential | 1.35 | **Implementing Entities** – RCC, NESCO<br><br>**Implementation mode** – primarily through municipal budget and GoB funding. Technical and financial resources secured through international agencies like ADB and JICA | • New Action<br>• short-term |

65 Indicative number, actual may vary depending on scope and other factors

## 5.2.9 Transport

**Energy consumption and GHG emissions**

2017-18
Energy consumption
2,151,409 GJ

2017-18
GHG emission
1,60,205 $tCO_2e$

Share of energy use in on-road transportation
Rise of 41.08% between 2013-14 and 2017-18

**Baseline analysis and issues**

- Significant increase in construction vehicles due to multiple large scale infrastructure projects in the city
- Rise in the number of personal or individual vehicles due to increasing household income and in-migration from smaller towns and rural areas
- Almost all road networks and intersections built in the city lack conformity with national road design standards prescribed by Roads and Highway Department and Planning Commission.
- The road space does not cater to the needs of the pedestrians, cyclists, differently abled or children.
- Issues with multimodal transport are caused, to a significant extent, by fragmented governance.
- In absence of public bus service, most of the people use private vehicles and rickshaws as the principal mode for their daily commute.
- Insufficient number of traffic police and traffic signals, flaws in traffic markings, violation of traffic rules and regulations, lack of pedestrian facilities, encroachment of road space by vendors and traders are some of the main reasons for traffic congestion in urban areas.
- Lack of comprehensive mobility assessment and plan, and inadequate information on vehicle movement and modal mix result in improper implementation of transport policies and projects.

**Potential climate impact and BAU scenario**

- 2026-27 (projected): Energy consumption – 4,540,487 GJ
- 2026-27 (projected): GHG emissions – 337,757 $tCO_2e$
- Due to climate change, the road network is likely to suffer from increased flood and erosion damage, increased fatigue damage (due to exposure to extreme temperatures). As a result, the repair, operations and maintenance costs of road infrastructure will increase due to the impacts.
- Increased vehicular movement and traffic congestion will result in air quality degradation and urban heat island effect.

**Climate Resilience Potential of the sector**

- 2026-27: Annual fuel saving: 161 kiloliters of petrol
- 2026-27: Annual GHG emissions reduction: 370 $tCO_2e$ (less than 1% of 2017-18 baseline)
- 2026-27: Net projected GHG emissions post implementation of interventions: 337,387 $tCO_2e$
- Reduced traffic congestion, improved air quality, lower public health risk, better mobility and accessibility
- Total cost of climate resilience interventions: appx. BDT 1748 million

**SDGs**

GOAL 3:
Good Health & Well-being

GOAL 9:
Industry, Innovation & Infrastructure

GOAL 11:
Sustainable Cities and Communities

GOAL 13:
Climate Action

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Promote non-motorized transport in the city** | • To replace at least 10% of 2-wheeler trips made in the city with bicycles (public bike sharing through deployment of around 9000 bicycles)<br>• Potential locations: near to educational areas (wards 17, 25-30). | • Fuel saving: 161 kiloliters of petrol<br>• GHG reduction: 369.76 $tCO_2e$<br>• High resilience potential<br>• Reduced traffic congestion, lower fuel consumption, improved local air quality and public health, improved pedestrian safety | 1,740 | **Implementing Entities:** Rajshahi City Corporation, Bangladesh Road Transport Authority (BRTA)<br><br>**Implementation model(s):** Municipal budget; GoB funds; support from international technical agencies and funds<br><br>PPP/CSR funding or BOT model<br><br>PoA for accessing carbon credits | • New Action<br>• Medium-term |
| **Adopt context sensitive street design standards** | • The city in collaboration with BRTA and other technical agencies develops and adopts context sensitive street design standards that make street construction less expensive and more practical, and biking and walking safer. | • Medium resilience potential<br>• Reduce traffic congestion, improve local air quality and reduce urban heat island effect. Improve public safety. | | **Implementing Entities:** Rajshahi City Corporation, Bangladesh Road Transport Authority (BRTA)<br><br>**Implementation model(s):**<br><br>Municipal budget; GoB funds; support from international technical agencies and funds | • New Action<br>• Medium-term |
| **Develop Comprehensive Mobility Plan (CMP) with focus on promoting 'Low Carbon Transport'** | • Rajshahi city in collaboration with BRTA, RDA and other technical agencies develop and adopts a comprehensive mobility plan (CMP) presenting a long-term vision of desirable mobility patterns (people and goods/ freight) for the city and provides strategy and policy measures to reduce congestion, promote sustainable low carbon transport options including electric vehicles and E-rickshaws, waterways, freight, non-motorized transit. | • Very high resilience potential<br>• Reduce traffic congestion, increase fuel efficiency, improve local air quality and reduce urban heat island effect. Improve public safety. | 7-8[66] | **Implementing Entities:** Rajshahi City Corporation, Bangladesh Road Transport Authority (BRTA) and RDA<br><br>**Implementation model(s):**<br><br>CMP development could be funded either through municipal budget, GoB funds or support from international technical agencies and funds. | • New Action<br>• Medium-term |

66 Indicative costs, actual will depend on scope and multiple external factors.

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Introduce public city bus service** | • Introduce electric-mini-buses on pilot mode based on technical assessments to offer reliable and sustainable public transport system | • Very high resilience potential<br>• Reduce traffic congestion, increase fuel efficiency, improve local air quality and reduce urban heat island effect. Improve public safety. | 13-14/per vehicle[67] | **Implementing Entities** – RCC, BRTA, private sector<br><br>**Implementation mode** –PPP mode through Municipal budget; GoB funds or international loans; BOT model; PoA for accessing carbon credits | • New Action<br>• Long-term |

67 Benchmark cost for a 9 mts e-bus in India (https://shaktifoundation.in/wp-content/uploads/2020/01/Fiscal-Incentives-to-scale-up-electric-buses.pdf)

## 5.2.10 Urban Biodiversity and Green Spaces

**Baseline analysis and issues**

- The land cover change assessment of RCC shows over 19% decrease of the green cover area and an increment by 9°C in maximum Land Surface Temperature (LST) in the last 20 years due to rapid urbanization.
- The city faces inadequate cross-departmental planning and coordination.
- No baseline in place for evaluating the value or impact of ecosystem services.
- With urban expansion and population growth, wooded areas and ponds are on the decline, as are different species of birds, animals and fish due to loss of habitat. Local orchards are also declining.

**Existing and Planned Measures by RCC**

- Integrated Urban Infrastructure Development in Rajshahi City (2020 – 2023)
- Urban Development Program (UDP) (2018-2022)

**Potential climate impact and BAU scenario**

- Climate risk status: Extreme | Extreme risk from high temperature and low and erratic rainfall
- Increasing temperatures and decreasing or irregular rainfall can exacerbate habitat loss caused by urbanization that will further reduce urban biodiversity.

**Climate resilience potential of the sector**

- 2026-27: Annual GHG emissions reduction: 7,603 $tCO_2e$ (12.5% of 2017-18 baseline)
- Green spaces as carbon sinks improve public health, reduce the heat island effect, filter storm water runoff and create other benefits.

**SDGs**

GOAL 3: Good Health & Well-being

GOAL 6: Clean Water & Sanitation

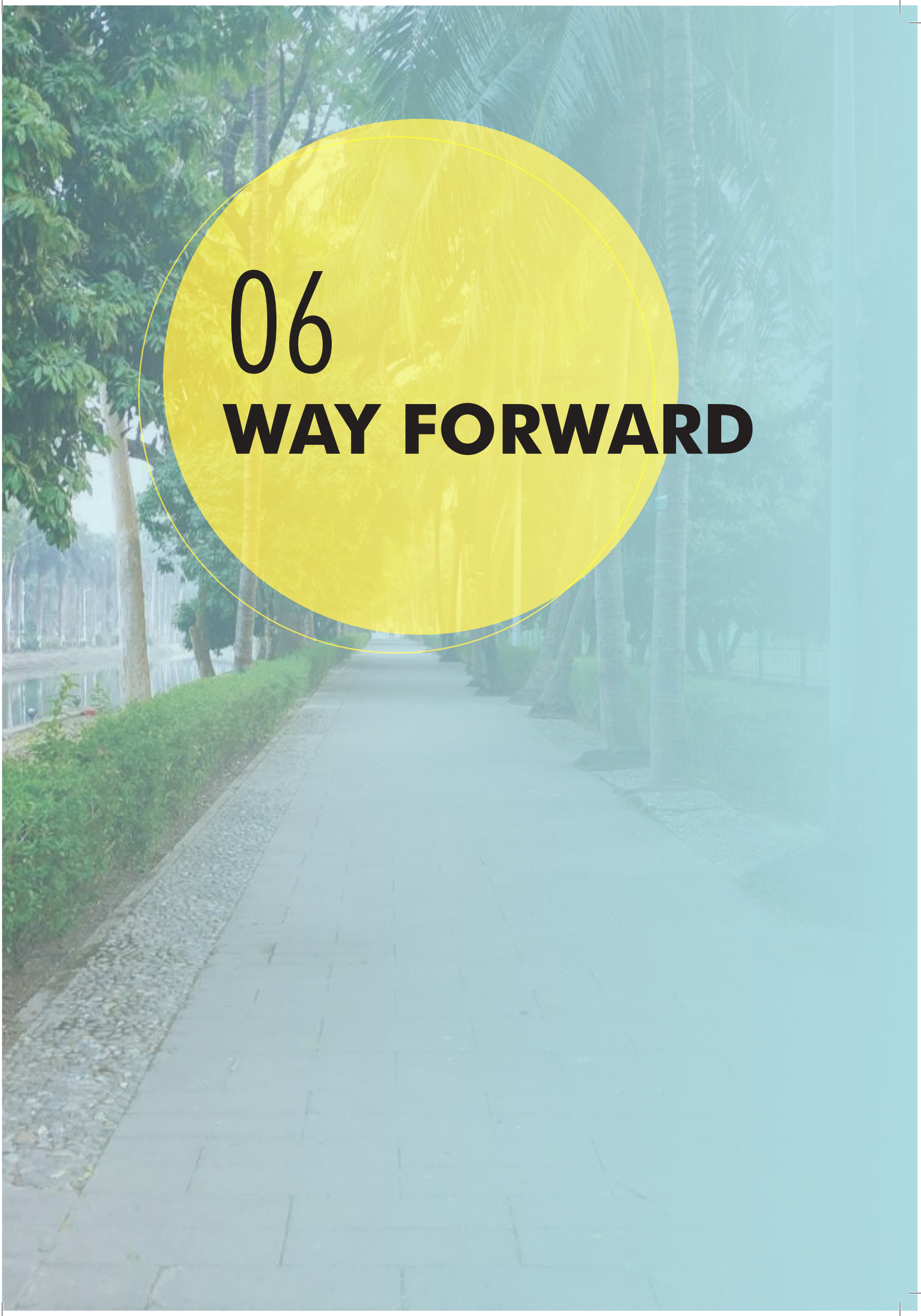
GOAL 11: Sustainable Cities and Communities

GOAL 13: Climate Action

GOAL 15: Life on Land

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Protecting Rajshahi's biodiversity to build climate resilience** | To protect urban biodiversity RCC in partnership with RDA, will:<br>• Offer protection of the natural environment through 'green space stewardship programme'.<br>• Strengthen institutional capacity to develop and maintain urban biodiversity related data and maps.<br>• Develop networks of open spaces to enable migration of flora and fauna.<br>• Identify and designate ecologically important areas as "Heritage spaces." | • These interventions will support RCC with specific guidelines to protect and conserve ecologically important areas. Conserving these areas will enhance biodiversity and contribute to keep balance between nature and ongoing urban development.<br>• Very high resilience potential | Cost would depend upon scale and other factors | • **Implementing Entities :** Rajshahi City Corporation, Rajshahi Development Authority (RDA), landowners, and citizens<br>• **Implementation mode:** Identify and implement additional innovative protection tools and collaborative governance approaches to protect areas of environmental significance (e.g. incentives for private landholders and homeowners in taxes, payment for ecosystem services, etc.<br>• Evaluate and pursue stable, funding sources (municipal and national), financing strategies and incentives to accelerate and sustain urban biodiversity. Innovative finance and technical resources can be secured from national and international agencies or organizations. | • New Action<br>• Medium term |
| **Sequester carbon through increased green infrastructure (trees, plants, soil) and natural areas.** | • The city increases green cover through plantation of fruiting trees on 48 Ha of open space.<br>• Potential area: This intervention can be applied in residential, commercial and mixed use areas of the cities in wards 5,6,10,12,13,14,15,17, 20 , 26 | • GHG reduction: 7603 $tCO_2eq$<br>• Urban heat mitigation, ecology and biodiversity conservation<br>• Very high resilience potential | Cost would depend upon scale and other factors | • **Implementing Entities:** Rajshahi City Corporation, Rajshahi Development Authority (RDA), landowners, and citizens<br>• Implementation Mode:<br>Municipal budget; GoB funds; support from international technical agencies and funds<br>Private sector involvement through CSR | • New Action<br>• Medium term |

| Resilience interventions | Details of intervention | Climate benefits and co-benefits | Indicative cost (million BDT) | Implementation mode and implementing entities | Status and duration of implementation |
|---|---|---|---|---|---|
| **Develop a comprehensive Local Biodiversity Strategy and Action Plan (LBSAP)** | • Rajshahi city develops and adopts a LBSAP detailing a broad strategy, as well as specific actions to implement in order to protect and enhance local biodiversity. | • The LBSAP will support for increasing and utilization of available open spaces in a planned manner. It will improve the quality of urban environments which are impacted by climate change. It will increase better access and safe mobility for the community.<br>• Very high resilience potential | Cost would depend upon scale and other factors | • **Implementing Entities :** Rajshahi City Corporation, Rajshahi Development Authority (RDA), landowners, and citizens<br>• **Implementation Mode:**<br>Municipal budget; GoB funds; support from international technical agencies and funds | • New Action<br>• Short term |
| **Implement a programme to promote adoption of rooftop urban farming** | • RCC develops and implements rooftop urban farming program through which citizens can apply for financial and professional support to set up urban farms.<br>• Potential area: Application potential can be applied in high rise residential and commercial building in Lakshmipur, Upashahar, Padma residential, Saheb Bazar, Talaimari areas of wards 10, 12, 15 and 26 | • Rooftop garden works as a natural thermal and noise insulator. By doing so, it reduces energy requirements for household cooling. Also, vegetation absorbs $CO_2$ from the atmosphere, which reduces GHG emissions. Use of rooftop gardens in farming can have a positive impact on urban food security.<br>• Very high resilience potential | Approximate cost will vary as it will depend on program scale, activities, and duration. | **Implementing Entities :** Rajshahi City Corporation, Rajshahi Development Authority (RDA), landowners, and citizens<br><br>**Implementation mode**<br>-RCC can encourage residential and institutional building owners to adopt rooftop gardening by awarding holding tax rebate | • New Action<br>• Medium term |



# 06
# WAY FORWARD

**The report identifies two major impacts of climate change at the local scale in Rajshahi**


Developing the CRCAP has helped Rajshahi to position itself as a champion of sub-national or city-level climate action in Bangladesh. The CRCAP for RCC was developed using the ClimateResilientCITIES methodology. The report identifies two major impacts of climate change at the local scale in Rajshahi – i) increased temperature, and ii) decreased rainfall and changing rainfall patterns. The primary urban services and systems which will be most severely impacted by climate impacts include water supply, wastewater management, solid waste management, health, drainage and urban biodiversity. These fragile urban systems and their fragility have been identified through SLDs involving the city's Climate Core Team and Stakeholder Committee. The ClimateResilie ntCities methodology also helped identify the broad climate risks to these fragile urban systems and helped identify the most vulnerable areas and the most vulnerable actors within the city that will be impacted by them.

Baseline GHG emissions inventory (2017-18) was prepared using the HEAT+ tool to identify the sectors mainly responsible for GHG emissions within the city, both at municipal and community levels. The sectors responsible for majority of emissions in the city include transport, industries and residential sector. On the basis of the vulnerable urban systems, areas, actors and the GHG emissions information, resilience actions have been identified to help the city reduce carbon emissions and successfully adapt to potential climate impacts in future.

The CRCAP comprises of 31 actions or 'structural strategies' aligned to 10 thematic areas/ sectors that provide a pathway for Rajshahi to enhance climate resilience and move towards low carbon urban development pathway. The resilience interventions included in the CRCAP are informed by the baseline sectoral GHG emissions and identified climate vulnerabilities. Identified sectoral interventions are prioritized based on their resilience capacity, which is assessed in terms of their propensity to increase the redundancy, flexibility and responsiveness of the relevant systems as well as GHG emissions reduction potential. The interventions are then assessed for feasibility (technical, financial and political) and their impact (short, medium or long term). As far as possible, the prioritized interventions are linked to existing city plans and schemes so as to ensure that the required interventions are integrated, with little or no additional resources, into existing departmental programs or projects. Based on the analysis, residential sector, SWM and carbon sequestration through increasing green cover are expected to provide the maximum GHG emissions reduction benefits.

Apart from the structural strategies, the CRCAP also recognized the importance of developing and implementing plans, policies and programs which enable framework creation for climate resilience. Therefore, the plan also lists several 'enabling strategies' to guide and support the city to plan, develop, implement and monitor sectoral actions in future.

An important aspect that emerged from this report is the need for better coordination and communication between different government agencies/departments. As highlighted in section 2.8, responsibilities of many of the critical urban services and sectors such as water supply, sewerage, drainage, transport and electricity are distributed among different government agencies. Thereby, it is necessary for the different government bodies to coordinate their activities. Stricter implementation of regulatory provisions for MSW management and sewerage connections, septage management, conservation of water bodies, littering, encroachment of water bodies, maintenance of green spaces within the city, and traffic control could also help RCC reduce the impacts of sudden disruption to services because of climate impacts and be more resource efficient.

**The CRCAP (2022-26) proposes actions with an annual GHG emissions mitigation potential of approximately 10% by 2026-27 over the 2017-18 baseline.**

Energy Efficiency (EE) in municipal buildings and services, residential and commercial buildings can help realize substantial reduction in the city's energy demand and GHG emissions. Most of these interventions also result in co-benefits. In case of municipal buildings, adoption of solar power can deliver cost savings and mitigation benefits to RCC while also serving as demonstration sites to encourage uptake of RE measures across the community. Formulating and adopting municipal mandates/policies promoting EE can help in this regard.

In case of transportation, promoting NMT and electric vehicles will go a long way in ensuring low carbon transportation growth and improved air quality in the city. Emissions reduction in water supply systems and solid waste systems has distinct co-benefits of improved public health as well as socio-economic benefits for the poor and vulnerable.

The CRCAP (2022-26) proposes actions with an annual GHG emissions mitigation potential of approximately 10% by 2026-27 over the 2017-18 baseline. This target is consistent with Bangladesh's Nationally Determined Contributions (NDCs) goals.

The scale of urban transformation required to achieve the goals of climate resilience can only be realised through strengthening multi-level governance to facilitate a city-wide response. Therefore, the CRCAP emphasises cross-sectoral and multi-stakeholder actions to be implemented in an inclusive and equitable manner. Additionally, successful implementation of the plan will require extensive public participation and open dialogues with all stakeholders including the youth, civil society, academia and research institutions, labour, business and all residents of Rajshahi City.

The CRCAP underlines Rajshahi's commitment to supporting its citizens' well-being and livelihoods by pursuing sustainable, just and low-carbon development. The COVID-19 pandemic has served to highlight the potential severity of another global crisis: climate emergency. Those most affected by the pandemic are predominantly the same groups that are also most vulnerable to climate change. For the benefit of all Rajshahi inhabitants, adoption and successful implementation of the CRCAP will ensure that the Rajshahi of the future is sustainable and climate resilient. The leadership shown by Rajshahi to map climate vulnerability and quantify their GHG emissions, and to undertake evidence-based climate action planning, paves the way for other cities in the country to replicate these efforts and contribute to achievement of Bangladesh's NDC and SDG targets.

# Annexurs

## Annexure 1 - Global Covenant of Mayors for Climate and Energy Commitment of Rajshahi City Corporation


RAJSHAHI CITY CORPORATION
NAGAR BHABAN, RAJSHAHI.
BANGLADESH.
https://erajshahi.portal.gov.bd/

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CHIEF EXECUTIVE OFFICER Office : 0721-773987
Fax : 0721-772140
SECRETARY Office : 0721-775505


GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

**Global Covenant of Mayors for Climate & Energy**
**Commitment of**
**Rajshahi City Corporation**
**Nagar Bhaban, Station Road, Rajshahi- 6200, Bangladesh**

I, Mr. A. H. M. Khairuzzaman Liton, Mayor of Rajshahi City Corporation commit to the Global Covenant of Mayors for Climate & Energy (GCoM), joining thousands of other cities and local governments around the world currently engaged in climate leadership.

GCoM envisions a world where committed mayors and local governments – in alliance with partners – accelerate ambitious, measurable climate and energy initiatives that lead to an inclusive, just, low-emission and climate resilient future, helping to meet and exceed the Paris Agreement objectives.

Whatever the size or location, the mayors and local leaders committed to GCoM stand ready to take concrete measures with long-term impact to tackle the interconnected challenges of climate change mitigation and adaptation, as well as access to sustainable energy.

To implement this vision, we pledge to implement policies and undertake measures to (i) reduce / avoid greenhouse gas (GHG) emissions, (ii) prepare for the impacts of climate change, (iii) increase access to sustainable energy, and (iv) track progress toward these objectives.

Specifically, within three years of this commitment[8], we pledge to develop, adopt[10], use and regularly report on the following:

- A community-scale GHG emission inventory, following the recommended guidance;
- An assessment of climate risks and vulnerabilities;
- Ambitious, measurable and time-bound target(s) to reduce/avoid GHG emissions;
- Ambitious climate change adaptation vision and goals, based on quantified scientific evidence when possible, to increase local resilience to climate change;
- An ambitious and just goal to improve access to secure, sustainable and affordable energy; and
- A formally adopted plan(s) addressing climate change mitigation / low emission development, climate resilience and adaptation, and access to sustainable energy.

The targets and action plans for mitigation / low emission development must be quantified and consistent with or exceed relevant national unconditional[9] commitments defined through the UNFCCC (Intended) Nationally Determined Contribution (NDC). The targets and action plans should

**RAJSHAHI CITY CORPORATION**
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| | |
|---|---|
| PHONE | Office : 0721-775584 |
| MAYOR | Res : 0721-850400 |
| | Fax : 0721-775151 |
| CHIEF EXECUTIVE OFFICER | Office : 0721-772697 |
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| SECRETARY | Office : 0721-775585 |


GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

be in line with National Adaptation Plans, where these exist; and should be consistent with the principles around energy access and urban sustainability embodied in the Sustainable Development Goals (SDGs).

We will explore the allocation of adequate staff resources and institutional arrangements. This includes governance processes, municipal structures and budget allocations to deliver on this commitment and secure continuity.

We acknowledge that there may be additional regional- or country-specific commitments or requirements that we commit to follow, and that may be agreed through our city networks or through our direct engagement with local partners of GCoM.

The Rajshahi City Corporation acknowledges that continued engagement in GCoM and associated Regional or National Covenants, as established, is contingent on complying with the above requirements within established timeframes.

**Name and title of person signing this commitment**

Rajshahi City Corporation,
Nagar Bhaban, Station Road, Rajshahi- 6200, Bangladesh
https://erajshahi.portal.gov.bd/
Mr. A. H. M. Khairuzzaman Liton
Email : khzaman_liton@yahoo.com
Phone No. : +880-17118-10970
800000 Inhabitants, 96.72 sq. kilometres

Bangladesh, https://erajshahi.portal.gov.bd/

এ.এইচ.এম খায়রুজ্জামান
22.11.2020

A.H.M. Khairuzzaman (Liton)
Mayor
Rajshahi City Corporation

Mandated by the Mr. A. H. M. Khairuzzaman Liton on 22 November, 2020.

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[1] "Avoid emission" via low emission development
[2] Flexibility is allowed to suit differentiated local circumstances and needs.
[3] According to the city and local government's procedures
[4] Many countries have submitted two sets of NDC targets: unconditional targets, to be implemented without any explicit external support; and conditional targets. The latter are more ambitious than unconditional targets and require external support for their fulfilment. The cities and local governments committing to the GCoM are required to commit at least to the equivalent of their country's unconditional targets, but are encouraged to be more ambitious where possible.

## Annexure II – Details of Climate Core Committee and Stakeholders Committee


**RAJSHAHI CITY CORPORATION**

NAGAR BHABAN, RAJSHAHI.
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Fax : 0721-772140
SECRETARY Office : 0721-775505


Ref :.....

Date :.....

To
**Mr. Emani Kumar**
Deputy Secretary General, ICLEI Global &
Executive Director, ICLEI South Asia,
New Delhi

**Subject: Regarding Formation of Climate Core Committee and Stakeholders Committee under the Urban Low Emission Development Strategies (Urban LEDS II) Project**

**Reference:** ICLEI South Asia letter to Rajshahi City Corporation, dated 8 April, 2019

Dear Mr. Kumar,

As per the reference letter above, regarding formation of Climate Core Committee and Stakeholders Committee under the project "Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban LEDS II)", Rajshahi City Corporation has formed both the committees. Climate Core Committee will steer and monitor overall project activities while Stakeholders Committee will share its relevant expertise in the field to increase city's efforts toward low emission development activities. Eventually it will assist in achieving intended project objectives.

The list of both committees is attached herewith. The same will be revised as and when required based on the project activities and inputs from the committees.

Sincerely yours,

26.1 10/6/19

Md. Ashraful Haque
Chief Engineer
Rajshahi City Corporation,
Rajshahi, Bangladesh.

**Enclosed:**

1. Climate Core Committee – Annexure I
2. Stakeholder Committee – Annexure II

**Annexure I: Climate Core Committee for Rajshahi City Corporation**

| **Project:** Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban LEDS II) | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Name** | **Organization** | **Designation** | **Contact Details** |
| 1 | A. H. M. Khairuzzaman (Liton) | Rajshahi City Corporation | Mayor | khzaman_liton@yahoo.com<br>+8801711810970 |
| 2 | Member, Environmental Standing Committee | Rajshahi City Corporation | Councilor | |
| 3 | Md. Shaugatul Alam | Rajshahi City Corporation | Chief Executive Officer | shaugat20@gmail.com<br>+8801731658284 |
| 4 | Md. Ashraful Haque | Rajshahi City Corporation | Chief Engineer | ashrafulrbd@yahoo.com<br>+8801711468796 |
| 5 | Md. Reazat Hossain | Rajshahi City Corporation | Executive Engineer (Mechanical & Electrical) | reazatrbd@gmail.com<br>+8801712204828 |
| 6 | Dr. Md. Ittefaqul Azad | Rajshahi City Corporation | Advisor, Environmental Section | +8801715171050 |

**Annexure II: Stakeholder Committee for Rajshahi City Corporation**

| **Project:** Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban LEDS II) | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Name** | **Organization** | **Designation** | **Contact Details (including email & phone no)** |
| 1 | Md. Ashraful Haque | Rajshahi City Corporation | Chief Engineer | ashrafulrbd@yahoo.com +8801711468796 |
| 2 | Md. Reazat Hossain | Rajshahi City Corporation | Executive Engineer (Mechanical & Electrical) | reazatrbd@gmail.com +8801712204828 |
| 3 | Md. Noor Islam | Rajshahi City Corporation | Executive Engineer | nislamtushar@gmail.com +8801711484311 |
| 4 | Md. Golam Morshed | Rajshahi City Corporation | Executive Engineer (Planning) | engr.murshed_rcc@yahoo.com +8801711280850 |
| 5 | SK. Md. Mamun | Rajshahi City Corporation | Chief Conservancy Officer | skmamundollar@gmail.com +8801715844287 |
| 6 | Syed Mahmud Ul Islam | Rajshahi City Corporation | Environmental Development Officer | sunilshuvra@gmail.com +8801793596707 |
| 7 | Abdul Hamid Sarkar | Word No. 22 | Councilor | +8801713098822 |
| 8 | Md. Shahadat Ali Shahu | Word No. 17 | Councilor | +88071711344613 |
| 9 | Md. Arman Ali | Word No. 24 | Councilor | +8801711819631 |
| 10 | Mrs. Nadira begum | Reserved Women Seat No. 08 | Councilor | +8801987239535 |
| 11 | Shoriful Islam Babu | Word No. 12 | Councilor | +8801713701471 |
| 12 | D. Md. Ittefaqul Azad | Rajshahi City Corporation | Advisor, Environmental Section | +8801715171050 |
| 13 | Sohel Rana | Rajshahi Water And Sewerage Authority (RWASA) | Assistant Engineer | msrdon@gmail.com +8801713202306 |
| 14 | Md. Rahanul Islam | Rajshahi Development Authority (RDA) | Asst. Town Planner | islamrony@gmail.com +8801715830000 |
| 15 | Md. Rokonujjaman | Department of Public Health and Engineering (DPHE), Rajshahi | Executive Engineer | ee.rajshahi@dphe.gov.bd +8801710465950 |
| 16 | A.S. M. Kamrul Hassan | Bangladesh Road Transport Authority (BRTA), Rajshahi | Assistant Director (Engineering) | ad_rajshahi@brta.gov.bd +8801966622061 |
| 17 | Md. Mamunur Rashid | Department of Environment (DoE) | Deputy Director | rajshahidist@doe.gov.bd |
| 18 | S. M. Sazzad Hossain | Divisional Forest Officer | Social Forest Division, Rajshahi | smsfdbd@gmail.com |

26/10/19

| **Project:** Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban LEDS II) | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Name** | **Organization** | **Designation** | **Contact Details (including email & phone no)** |
| 19 | Md. Nurul Islam | Fire Service and Civil Defense | Deputy Director | ddrajfire@yahoo.com<br>+8801817095250 |
| 20 | Md. Nazirul Islam | Barind Multipurpose Development Authority | Project Director (Executive Engineer), Drinking Piped Water Supply for Irrigation Deep Tubewell-3rd Phase | +8801711000223 |
| 21 | Md. Iquebal Hossain | Barind Multipurpose Development Authority | Project Director (Executive Engineer), Pre-paid Pump Usage and Energy Measuring System Project (Phase-II) | +8801715023570 |
| 22 | Golam Sabbir Sattar (Tapu) | University of Rajshahi | Professor, Department of Geology & mining, | +8801715601359 |
| 23 | Dr. Md. Niamul Bari | Rajshahi University of Engineering and Technology (RUET) | Professor, Department of Civil Engineering | niamulbari@yahoo.com<br>mnbari@ruet.ac.bd<br>+8801816950251 |
| 24 | Md. Faruk Jahangir Mithu | PRISM Bangladesh Foundation | District Coordinator, Medical Waste Management Program | mithu.f@gmail.com<br>+8801911242937 |
| 25 | Md. Sarwar Jahan | Manab Seba Ovijan | Professor, Economics, Govt. Women's College Rajshahi & Advisor of Manab Seba Ovijan | Kanthel1968@gmail.com<br>+8801817386277 |
| 26 | Farzana Parveen | BRAC International | Regional Coordinator, Urban Development Program | farzana.pa@brac.net<br>+88-01720337415 |
| 27 | Md. Zulfikar Ali | UNDP | Socio-economic and Nutrition Expert, The Livelihoods Improvement of Urban Poor Communities (LIUPC) project also known as National Urban Poverty Reduction Program (NUPRP) under UNDP | +8801711968540 |
| 28 | Md. Enamul Haq | Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Bangladesh | Advisor, Urban Management of Internal Migration due to Climate Change (UMIMCC) Project | enamul.haq@giz.de<br>+8801723761849 |

26.12.19

# Annexure III - Prioritized Resilience Interventions for Rajshahi city

**The prioritization exercise uses 5 key criteria/characteristics described below:**

**Redundancy:** A resilient system can function and achieve results through multiple paths or nodes when one fails and when performance is critical. In contrast, a "single best solution" is not resilient because if this single option fails, the system collapses. Back-up systems, or decentralized nodes for service delivery in a linked network, are preferable. **Flexibility and diversity:** Essential systems should be able to work under a variety of conditions; they should not be rigid or designed only for one specific situation. Any system will fail if overloaded beyond its capacity, but it should be designed to fail under stress in a safe and predictable way, rather than suddenly and catastrophically. **Re-organization and responsiveness:** Under extreme conditions, systems should be able to respond and change to meet unexpected shocks. This requires flexible organizations and access to different kinds of resources (information, skills, equipment, knowledge and experience). It also means a high level of coordination and flexible organizational structures capable of adjusting to new conditions.; **Access to information:** Resilient systems have mechanisms to learn from and build on experience, so that past mistakes are not repeated and lessons from other cities can be integrated into planning. This requires procedures for monitoring and evaluating performance under stress, and requires multiple sources of knowledge and documentation (strengthening "corporate memory"); **Energy saving and GHG emission mitigation potential:** Resilient systems have potential to reduce energy consumption and mitigate GHG emission, which may be integrated into their regular planning. This requires procedures for periodic monitoring and evaluating performance, which requires multiple sources of knowledge and documentation.

## Residential Buildings

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emission mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Promote use of solar water heaters in place of conventional geysers in HHs | • 100 LPD each in 3% of the total HHs in the city (3243; high-income and upper mid-income homes) | Yes | Yes | Yes | Yes | Yes | Very High |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 5 kW each in 5% of high-income and upper mid-income homes (162 HHs)<br>• 10 kW each in 10% of high rise (20 multi-storey) buildings (15 buildings) | Yes | Yes | Yes | Yes | Yes | Very High |
| Adopt EE lighting to replace conventional lighting | • 50% of incandescent lamps phased-out and replaced with CFLs and LED lamps<br>• 25% of existing CFLs replaced with LED lamps<br>• 25% of T-8 tube lights replaced with T5 and LED tube lights. | Yes | | Yes | Yes | Yes | High |
| Adopt EE ceiling fans to replace conventional fans | • Conventional ceiling fans replaced in 25% of homes with Alternating current (AC) type efficient fans and 10% of homes with super-efficient brushless type DC fans | Yes | | Yes | Yes | Yes | High |
| Encourage use of EE air conditioners | • EE ACs in 10% of high-income and upper mid-income homes | Yes | | Yes | Yes | Yes | High |
| Encourage use of EE refrigerators | • EE refrigerators in 10% of high-income and upper mid-income homes | Yes | | Yes | Yes | Yes | High |
| Adopt LED lights for common area lighting in multi-storey buildings | • 25% of all multi-storey buildings adopt LED lights for common area lighting | Yes | | Yes | Yes | Yes | High |
| Pilot Green/Eco-building design | • Pilot green/eco-building concept in new large residential buildings in Uposhohor and Padma residential area in Wards 15 and 27 and highrise buildings that are planned in Saheb Bazar, New Market, Laxmipur following SREDA's Building Energy Efficiency and Environment Rating (BEEER) standard (Draft), 2020 | Yes | | Yes | Yes | Yes | High |

## Commercial and Institutional Buildings

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Adopt EE lighting to replace conventional lighting | • 25% of conventional fitting replaced with LED in fully commercial buildings;<br>• 25% of conventional fitting replaced with LED in mixed commercial buildings. | Yes | | Yes | Yes | Yes | High |
| Adopt EE ceiling fans to replace conventional fans | • 25% of conventional ceiling fans replaced with EE fans in fully commercial buildings;<br>• 25% of conventional ceiling fans replaced with EE fans in mixed commercial buildings. | Yes | | Yes | Yes | Yes | High |
| Replacement of Conventional ACs with EE AC in large public office and bank buildings | • 50% of these establishments adopt EE ACs | Yes | | Yes | Yes | Yes | High |
| Promote use of solar water heaters in place of conventional geysers in large hospitals | • 20,000 LPD capacity of SWH installed in hospitals | Yes | Yes | Yes | Yes | Yes | Very High |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 10 kW each in 10% of commercial and institutional buildings (114kWp cumulative capacity) | Yes | Yes | Yes | Yes | Yes | Very High |
| Promote building energy efficiency in commercial and institutional buildings through policy and research | • RDA in collaboration with RCC develops and implement a by-law by that mandates and supports all new buildings and existing buildings to adopt EE measure.<br>• Identify pilot neighborhoods for implementation to develop a replicable, scalable model<br>• Develop an implementation roadmap and guideline document highlighting potential EE actions for new and existing building owners to choose from.<br>• Develop energy saving awareness campaigns to promote behavior change through marketing of technologies, communication and education programmes<br>• Mandate energy audits to develop Energy Benchmarking of commercial and institutional buildings in Rajshahi | Yes | | Yes | Yes | Yes | High |

## Manufacturing Industries and Construction

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Adopt EE lighting to replace conventional lighting | • 30% of conventional lighting (T8) replaced with LED in small, medium and large industries. | Yes | | Yes | Yes | Yes | High |
| Adopt EE ceiling fans to replace conventional fans | • 30% of conventional ceiling fan with EE ceiling fans in small and medium industries; 20% replacement of conventional ceiling fan with EE ceiling fans and 10% BLDC in large industries | Yes | | Yes | Yes | Yes | High |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 25% of potential rooftop area on utilized for solar rooftop PV system (271kWp cumulative capacity) | Yes | Yes | Yes | Yes | Yes | Very High |

## Municipal Solid Waste Management

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Improved municipal solid waste management and disposal | RCC installs and commissions following:<br>1. 100 TPD windrow composting plant<br>2. 20 TPD Incineration plant<br>3. 20 TPD bio-methanation plant | Yes | Yes | Yes | Yes | Yes | Very High |
| Develop an Integrated Solid Waste Management Plan | Rajshahi city develops an Integrated Solid Waste Management Plan which encourages reduction, reuse and recycling of waste to the maximum extent possible, with technological solutions for organic and inorganic fractions of waste that are financially feasible (compost, biomethanation, WTE) | Yes | Yes | Yes | Yes | Yes | Very High |
| Enforce waste segregation at source and door-to-door waste collection efforts to eliminate roadside waste littering and dumping in drains | To reduce quantum of uncollected municipal solid waste in the city, RCC should:<br>• Promote bin-free approaches as far as possible<br>• Allocate designated locations (secondary transport stations / points) for litter-free waste transportation.<br>• Ensure effective street sweeping and cleaning programs as well as citizen awareness programs to prevent littering in public places / streets and canal / drains.<br>• Participate actively with stakeholders to initiate the implementation of community led decentralized projects (in housing complexes) in order to pave the way for waste minimization.<br>• Promote awareness across stakeholders on waste management | Yes | Yes | | Yes | Yes | High |

## Water Supply

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Reduce physical water losses and non-revenue water | RCC in collaboration with RWASA is able to bring down the NRW from 34% to 24% through, smart water metering, water audits, leak detection, up gradation of pipeline network with ductile iron pipes | Yes | Yes | Yes | Yes | Yes | Very High |
| Introduce and promote rainwater harvesting (RWH) for groundwater recharge in residential, public/ institutional and industrial properties | • Undertake technical study to identify areas with high groundwater extraction rate and sites with RWH potential<br>• Introduce RWH in existing as well as new large residential buildings and new apartments in future | Yes | Yes | Yes | Yes | Yes | Very High |
| Install solar PV systems at water supply plants | RCC and RWASA jointly work and install 100 kWp solar PV capacity at ongoing Rajshahi WASA Surface Water Treatment Plant (rooftop or ground-mounted systems based on technical assessments by solar PV installers) | Yes | Yes | Yes | Yes | Yes | Very High |
| Prepare city-level water conservation policy | RCC and RWASA will develop and operationalize a city bye-law/policy to help regulate and control surface water and groundwater use and pollution, reduce water wastage, support introduction of water meters | Yes | Yes | Yes | Yes | Yes | Very High |
| Developing integrated urban water management plan | RCC and RWASA will develop an integrated urban water management plan with following key activities –<br>• Assess existing baseline scenario including source and demand analysis (water budgeting and assessing water balance)<br>• Assess impact of climate change on water demand and supply infrastructure (including drought management)<br>• Identify strategies for augmenting local water resources (groundwater recharge, rainwater harvesting, and wastewater reuse)<br>Identify interventions to reduce water wastage and increase reuse, recycle, minimize extraction and ensure recharge of groundwater | Yes | Yes | Yes | Yes | Yes | Very High |

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Application of Dual Plumbing System and Recycling of Greywater in Homes | RCC and RWASA jointly formulate and implements dual plumbing guidelines in phase wise manner. Initially covering high- and middle-income HHs (2.74% of total HHs in the city) and commercial (hotels, shopping complexes), public buildings (schools, colleges, etc.) | | Yes | Yes | | Yes | Medium |

### Wastewater (Sewerage)

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Pilot decentralized wastewater treatment systems (DeWATS) for HHs | Implement DeWATS pilots of 245 kLD for sustainable wastewater treatment of 500+ HHs<br>Encourage adoption of anaerobic technology based DeWATS in large hospitals and public/ institutional campuses | Yes | Yes | Yes | Yes | Yes | Very High |
| Prepare Policy and Plan for fecal sludge management (FSM) | RCC will undertake technical assessment to prepare a city-scale Policy and Plan for developing FSM system | Yes | Yes | | Yes | Yes | High |
| Prepare Master Plan to introduce sewerage system | RCC in collaboration with RWASA develops a detailed Sewerage Master Plan to guide introduction of centralized sewer network and treatment system in a phased manner | Yes | Yes | | Yes | Yes | High |
| Awareness generation activities on hygiene, appropriate sewage disposal alternatives, solid waste disposal | RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize sewerage and septage dumping in the drains. | Yes | Yes | Yes | | Yes | High |

## Drainage

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Develop city-wide drainage master plan | RCC in collaboration with other agencies develops a drainage master plan to improve condition of existing drainage network, design and construct new drains with capacity to respond to high intensity rainfall<br>Identify measures to minimize untreated wastewater discharge and clogging due to solid waste disposal. | Yes | Yes | Yes | | | Medium |
| Promote grey water reuse and recycling for non-potable uses such as landscape irrigation, gardening, flushing | RCC in collaboration with other agencies develops a municipal bye-law that promotes and incentives grey water reuse in buildings for landscape irrigation, gardening, and flushing thereby reducing waste water flow in the drainage system. | Yes | Yes | Yes | | Yes | High |
| Public awareness initiatives on prevention of waste dumping into drains and canals | RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize waste dumping (solid waste, sewerage and septage) in the drains. | Yes | Yes | | | Yes | Medium |

## Street Lighting

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Replacement of existing Street lighting with LED lights | RCC in collaboration with NESCO replaces 1339 conventional lamp street lights with LEDS lamps. | Yes | Yes | Yes | Yes | Yes | Very High |
| Undertake a technical study for design of EE street lighting | • Undertake a detailed technical field survey and investment grade energy audit to ensure proper infrastructure design, up gradation and adoption of well illuminated LED street lighting as per national lighting standards<br>• Study should include identification of primary specifications, delivery model and long-term post-installation maintenance agreements with vendors | Yes | Yes | Yes | Yes | Yes | Very High |

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Install EE Street Lighting Control and Management System (Voltage Controller and Timer) | RCC installs street light control systems of 6 kW size at 15 street lighting feeder panels/ switching points for EE operation (auto on/ off, voltage regulation)<br>Identify appropriate locations to install control systems with technology providers | Yes | Yes | Yes | Yes | Yes | Very High |

## Urban Biodiversity and Green Space

| Resilience Interventions | Details of Intervention | Redundancy | Flexibility | Responsiveness | Access to information | Energy saving and GHG emissions mitigation potential | Overall Resilience Score 5/5: very high 4/5: High 3/5: Medium 2/5: Average 1/5: Low |
|---|---|---|---|---|---|---|---|
| Protecting Rajshahi's biodiversity to build climate resilience | • Offer protection of the natural environment through 'green space stewardship programme'.<br>• Strengthen institutional capacity to develop and maintain urban biodiversity related data and maps.<br>• Develop networks of open spaces to enable migration of flora and fauna.<br>• Identify and designate ecologically important areas as "Heritage spaces." | Yes | Yes | Yes | Yes | Yes | Very High |
| Sequester carbon through increased green infrastructure (trees, plants, soil) and natural areas. | The city increases green cover through plantation of fruiting trees on 48 Ha of open space. | Yes | Yes | Yes | Yes | Yes | Very High |
| Develop a comprehensive Local Biodiversity Strategy and Action Plan (LBSAP) | Rajshahi city develops and adopts a LBSAP detailing a broad strategy, as well as specific actions to implement in order to protect and enhance local biodiversity. | Yes | Yes | Yes | Yes | Yes | Very High |
| Implement a programme to promote adoption of rooftop urban farming | RCC develops and implements rooftop urban farming program through which citizens can apply for financial and professional support to set up urban farms. | Yes | Yes | Yes | Yes | Yes | Very High |

# Annexure IV – Feasibility Assessment of the Climate Resilience Interventions

## Municipal Solid Waste Management

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Improved municipal solid waste management and disposal | RCC installs and commissions following:<br>1. 100 TPD windrow composting plant<br>2. 20 TPD Incineration plant<br>3. 20 TPD bio-methanation plant | Medium | High | Medium | Medium Term Period |
| Develop an Integrated Solid Waste Management Plan | Rajshahi city develops an Integrated Solid Waste Management Plan which encourages reduction, reuse and recycling of waste to the maximum extent possible, with technological solutions for organic and inorganic fractions of waste that are financially feasible (compost, biomethanation, WTE) | High | High | High | Short Term Period |
| Enforce waste segregation at source and door-to-door waste collection efforts to eliminate roadside waste littering and dumping in drains | To reduce quantum of uncollected municipal solid waste in the city, RCC should:<br>• Promote bin-free approaches as far as possible<br>• Allocate designated locations (secondary transport stations / points) for litter-free waste transportation.<br>• Ensure effective street sweeping and cleaning programs as well as citizen awareness programs to prevent littering in public places / streets and canal / drains.<br>• Participate actively with stakeholders to initiate the implementation of community led decentralized projects (in housing complexes) in order to pave the way for waste minimization.<br>• Promote awareness across stakeholders on waste management | High | High | High | Long Term Period |

## Water Supply

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Reduce physical water losses and non-revenue water | RCC in collaboration with RWASA is able to bring down the NRW from 34% to 24% through, smart water metering, water audits, leak detection, up gradation of pipeline network with ductile iron pipes | Medium | Medium | Medium | Medium term period |
| Introduce and promote rainwater harvesting (RWH) for groundwater recharge in residential, public/ institutional and industrial properties | • Undertake technical study to identify areas with high groundwater extraction rate and sites with RWH potential<br>• Introduce RWH in existing as well as new large residential buildings and new apartments in future | Medium | Medium | Medium | Medium term period |
| Install solar PV systems at water supply plants | RCC and RWASA jointly work and install 100 kWp solar PV capacity at ongoing Rajshahi WASA Surface Water Treatment Plant (rooftop or ground-mounted systems based on technical assessments by solar PV installers) | Medium | High | High | Short Term Period |

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Prepare city-level water conservation policy | RCC and RWASA will develop and operationalize a city bye-law/policy to help regulate and control surface water and groundwater use and pollution, reduce water wastage, support introduction of water meters | Low | Medium | High | Medium Term Period |
| Developing integrated urban water management plan | RCC and RWASA will develop an integrated urban water management plan with following key activities –<br>• Assess existing baseline scenario including source and demand analysis (water budgeting and assessing water balance)<br>• Assess impact of climate change on water demand and supply infrastructure (including drought management)<br>• Identify strategies for augmenting local water resources (groundwater recharge, rainwater harvesting, and wastewater reuse)<br>Identify interventions to reduce water wastage and increase reuse, recycle, minimize extraction and ensure recharge of groundwater | Medium | Low | Low | Medium Term Period |
| Application of Dual Plumbing System and Recycling of Greywater in Homes | RCC and RWASA jointly formulate and implements dual plumbing guidelines in phase wise manner. Initially covering high- and middle-income HHs (2.74% of total HHs in the city) and commercial (hotels, shopping complexes), public buildings (schools, colleges, etc.) | Low | Low | Low | Long Term Period |

## Wastewater

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Pilot decentralized wastewater treatment systems (DeWATS) for HHs | • Implement DeWATS pilots of 245 kLD for sustainable wastewater treatment of 500+ HHs<br>• Encourage adoption of anaerobic technology based DeWATS in large hospitals and public/ institutional campuses | Low | Medium | Medium | Medium Term Period |
| Prepare Policy and Plan for fecal sludge management (FSM) | • RCC will undertake technical assessment to prepare a city-scale Policy and Plan for developing FSM system | Medium | Low | Medium | Short term period |
| Prepare Master Plan to introduce sewerage system | • RCC in collaboration with RWASA develops a detailed Sewerage Master Plan to guide introduction of centralized sewer network and treatment system in a phased manner | Low | Low | Medium | Medium Term Period |
| Awareness generation activities on hygiene, appropriate sewage disposal alternatives, solid waste disposal | • RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize sewerage and septage dumping in the drains. | Medium | Medium | Medium | Long term period |

## Drainage

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Develop city-wide drainage master plan | RCC in collaboration with other agencies develops a drainage master plan to improve condition of existing drainage network, design and construct new drains with capacity to respond to high intensity rainfall<br>Identify measures to minimize untreated wastewater discharge and clogging due to solid waste disposal. | Low | Medium | Low | Medium Term Period |
| Promote grey water reuse and recycling for non-potable uses such as landscape irrigation, gardening, flushing | RCC in collaboration with other agencies develops a municipal bye-law that promotes and incentives grey water reuse in buildings for landscape irrigation, gardening, and flushing thereby reducing waste water flow in the drainage system. | Medium | Low | Low | Long Term Period |
| Public awareness initiatives on prevention of waste dumping into drains and canals | RCC in collaboration with other stakeholders develops campaigns, stewardship programs to minimize waste dumping (solid waste, sewerage and septage) in the drains. | Medium | High | Medium | Long Term Period |

## Street Lighting

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Replacement of existing Street lighting with LED lights | RCC in collaboration with NESCO replaces 1339 conventional lamp street lights with LEDS lamps. | High | High | High | Short term period |
| Undertake a technical study for design of EE street lighting | • Undertake a detailed technical field survey and investment grade energy audit to ensure proper infrastructure design, up gradation and adoption of well illuminated LED street lighting as per national lighting standards<br>• Study should include identification of primary specifications, delivery model and long-term post-installation maintenance agreements with vendors | High | High | High | Short term period |
| Install EE Street Lighting Control and Management System (Voltage Controller and Timer) | • RCC installs street light control systems of 6 kW size at 15 street lighting feeder panels/ switching points for EE operation (auto on/ off, voltage regulation)<br>• Identify appropriate locations to install control systems with technology providers | High | High | High | Short term period |

## Sector – Transport

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Promote use of bicycles in the city | To replace at least 10% of 2-wheeler trips made in the city with bicycles (public bike sharing through deployment of around 9000 bicycles) | High | High | High | Medium term period |
| Adopt context sensitive street design standards | The city in collaboration with BRTA and other technical agencies develops and adopts context sensitive street design standards that make street construction less expensive and more practical, and biking and walking safer. | Medium | High | High | Medium term period |
| Develop Comprehensive Mobility Plan (CMP) | Rajshahi city in collaboration with BRTA, RDA and other technical agencies develop and adopts a CMP presenting a long-term vision of desirable mobility patterns (people and goods) for the city and provides strategy and policy measures to achieve this vision. Also, list short-, medium-, and long-term investments to improve accessibility and mobility for its residents. | Medium | High | High | Medium term period |
| Introduce public city bus service | Introduce electric-mini-buses on pilot mode based on technical assessments to offer reliable and sustainable public transport system | Medium | High | Medium | Long Term Period |

## Urban Biodiversity and Green Space

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Protecting Rajshahi's biodiversity to build climate resilience | • Offer protection of the natural environment through 'green space stewardship programme'.<br>• Strengthen institutional capacity to develop and maintain urban biodiversity related data and maps.<br>• Develop networks of open spaces to enable migration of flora and fauna.<br>• Identify and designate ecologically important areas as "Heritage spaces." | Medium | High | High | Medium term period |
| Sequester carbon through increased green infrastructure (trees, plants, soil) and natural areas. | The city increases green cover through plantation of fruiting trees on 48 Ha of open space. | Medium | High | High | Short term period |
| Develop a comprehensive Local Biodiversity Strategy and Action Plan (LBSAP) | Rajshahi city develops and adopts a LBSAP detailing a broad strategy, as well as specific actions to implement in order to protect and enhance local biodiversity. | Medium | High | High | Medium term period |
| Implement a programme to promote adoption of rooftop urban farming | RCC develops and implements rooftop urban farming program through which citizens can apply for financial and professional support to set up urban farms. | Medium | High | High | Medium term period |

## Residential Buildings

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Promote use of solar water heaters in place of conventional geysers in HHs | • 100 LPD each in 3% of the total HHs in the city (3243; high-income and upper mid-income homes) | Medium | Low | Medium | Medium term period |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 5 kW each in 5% of high-income and upper mid-income homes (162 HHs)<br>• 10 kW each in 10% of high rise (20 multi-storey) buildings (15 buildings) | Medium | Medium | Low | Medium term period |
| Adopt EE lighting to replace conventional lighting | • 50% of incandescent lamps phased-out and replaced with CFLs and LED lamps<br>• 25% of existing CFLs replaced with LED lamps<br>• 25% of T-8 tube lights replaced with T5 and LED tube lights. | High | High | High | Short term period |
| Adopt EE ceiling fans to replace conventional fans | • Conventional ceiling fans replaced in 25% of homes with Alternating current (AC) type efficient fans and 10% of homes with super-efficient brushless type DC fans | High | High | High | Short term period |
| Encourage use of EE air conditioners | • EE ACs in 10% of high-income and upper mid-income homes | Medium | Low | Low | Long term period |
| Encourage use of EE refrigerators | • EE refrigerators in 10% of high-income and upper mid-income homes | Medium | Medium | Low | Medium term period |
| Adopt LED lights for common area lighting in multi-storey buildings | • 25% of all multi-storey buildings adopt LED lights for common area lighting | High | Medium | Medium | Medium term period |
| Pilot Green/Eco-building design | • Pilot green/eco-building concept in new large residential buildings in Uposhohor and Padma residential area in Wards 15 and 27 and highrise buildings that are planned in Saheb Bazar, New Market, Laxmipur following SREDA's Building Energy Efficiency and Environment Rating (BEEER) standard (Draft), 2020 | Medium | Medium | Low | Medium term period |

## Commercial and Institutional Buildings

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Adopt EE lighting to replace conventional lighting | • 25% of conventional fitting replaced with LED in fully commercial buildings;<br>• 25% of conventional fitting replaced with LED in mixed commercial buildings. | High | Medium | High | Short term period |
| Adopt EE ceiling fans to replace conventional fans | • 25% of conventional ceiling fans replaced with EE fans in fully commercial buildings;<br>• 25% of conventional ceiling fans replaced with EE fans in mixed commercial buildings. | High | Medium | High | Short term period |
| Replacement of Conventional ACs with EE AC in large public office and bank buildings | • 50% of these establishments adopt EE ACs | Medium | Low | Low | Long term period |
| Promote use of solar water heaters in place of conventional geysers in large hospitals | • 20,000 LPD capacity of SWH installed in hospitals | Medium | Low | Medium | Medium term period |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 10 kW each in 10% of commercial and institutional buildings (114kWp cumulative capacity) | High | Medium | Medium | Medium term period |
| Promote building energy efficiency in commercial and institutional buildings through policy and research | • RDA in collaboration with RCC develops and implement a by-law by those mandates and supports all new buildings and existing buildings to adopt EE measure.<br>• Identify pilot neighbourhoods for implementation to develop a replicable, scalable model<br>• Develop an implementation roadmap and guideline document highlighting potential EE actions for new and existing building owners to choose from.<br>• Develop energy saving awareness campaigns to promote behaviour change through marketing of technologies, communication and education programmes<br>• Mandate energy audits to develop Energy Benchmarking of commercial and institutional buildings in Rajshahi | High | Medium | Medium | Medium term period |

## Manufacturing Industries and Construction

| Resilience Interventions | Details of Intervention | Feasibility of the intervention | | | Period of Impact |
|---|---|---|---|---|---|
| | | Technical | Political | Financial | |
| Adopt EE lighting to replace conventional lighting | • 30% of conventional lighting (T8) replaced with LED in small, medium and large industries. | High | Medium | High | Short term period |
| Adopt EE ceiling fans to replace conventional fans | • 30% of conventional ceiling fan with EE ceiling fans in small and medium industries; 20% replacement of conventional ceiling fan with EE ceiling fans and 10% BLDC in large industries | High | Medium | High | Short term period |
| Promote and facilitate installation of rooftop solar PV with net-metering | • 25% of potential rooftop area on utilized for solar rooftop PV system (271kWp cumulative capacity) | High | Low | Medium | Medium term period |

# Annexure V – City profile data

## Ward-wise Area and Population of RCC, 2011

| Ward No. | Area of Ward (sq. km.) | Total Population | No. of Households | Population Density (Persons/sq. km.) |
|---|---|---|---|---|
| 1 | 2.46 | 16,032 | 3,361 | 6,517 |
| 2 | 7.62 | 17,823 | 4,134 | 2,339 |
| 3 | 2.06 | 20,132 | 4,719 | 9,773 |
| 4 | 4.11 | 13,238 | 3,109 | 3,221 |
| 5 | 1.55 | 14,128 | 3,252 | 9,115 |
| 6 | 1.32 | 15,256 | 3,456 | 11,558 |
| 7 | 3.72 | 12,942 | 2311 | 3,479 |
| 8 | 1.07 | 11,011 | 2,227 | 10,291 |
| 9 | 0.95 | 14,232 | 2,671 | 14,981 |
| 10 | 1.44 | 11,057 | 1,986 | 3,622 |
| 11 | 0.54 | 12,294 | 2,264 | 22,767 |
| 12 | 0.91 | 11,349 | 2,107 | 12,471 |
| 13 | 0.94 | 9,845 | 2,218 | 10,473 |
| 14 | 4.82 | 22,070 | 5,122 | 2,289 |
| 15 | 1.51 | 13,700 | 3,369 | 9,073 |
| 16 | 3.20 | 16,610 | 3,775 | 5,191 |
| 17 | 15.02 | 19,951 | 4,730 | 1,328 |
| 18 | 2.75 | 14,547 | 3,516 | 3,328 |
| 19 | 4.36 | 22,929 | 5,482 | 5,259 |
| 20 | 0.81 | 7,857 | 1,725 | 9,700 |
| 21 | 0.84 | 9,927 | 2,274 | 11,818 |
| 22 | 0.68 | 8,414 | 1,855 | 12,374 |
| 23 | 0.97 | 8,654 | 2,064 | 8,922 |
| 24 | 0.65 | 14,513 | 3,489 | 22,328 |
| 25 | 1.25 | 12,752 | 2,912 | 10,202 |
| 26 | 8.73 | 18,586 | 4,346 | 2,129 |
| 27 | 5.01 | 17,856 | 4,249 | 3,564 |
| 28 | 3.37 | 21,697 | 4,990 | 6,438 |
| 29 | 2.86 | 14,239 | 3,150 | 4,979 |
| 30 | 11.66 | 26,236 | 4,234 | 2,250 |
| Total | 97.18 | 449,877 | 99,097 | 241,779 |

## Completed Projects of RWASA[68,69]

| S No. | Project Name | Implementing Agency | Project Duration | Objective of the Project |
|---|---|---|---|---|
| 1 | Rehabilitation of Water Supply System in Rajshahi City | RWASA | January 2016 - December 2018 | • Setting up the 80 km pipeline<br>• Replacing 22 no.s generating tube-wells<br>• ICT related work and installation server<br>• Re-production of 40 no.s tube-wells<br>• Construction work of 1 store room |
| 2 | Frees Water Project Phase – (iii) | Rajshahi WASA | 01 January 2019 - 30 June 2020 | • To Ensure drinking water for slum dwellers through supplying water by pipe line 800 m and 01 nos water point.<br>• To supply drinking water 24 hours for slum dwellers with minimum cost by installing water point |
| 3 | Frees Water Project Phase – (ii) | RWASA | 25 April 2018 - 25 June 2018 | • To ensure drinking water for slum dwellers by supplying water through 450 m pipe line and 03 no.s water point<br>• To supply drinking water 24 hours for slum dwellers with minimum cost by installing water point |
| 4 | Frees Water Project Phase – (i) | RWASA | 05 Oct 2017 - 30 Nov 2017 | • To ensure drinking water for slum dwellers by supplying water through 450 m pipe line and 03 no.s water point<br>• To supply drinking water 24 hours for slum dwellers with minimum cost by installing water point |
| 5 | Feasibility Study of Surface Water Treatment Plant for Rajshahi WASA | RWASA | November 2014 - October 2015 | • The main objective of the study is to conduct detailed feasibility study of Rajshahi water treatment plant and a full scale Environmental and Social Impact Assessment (ESIA) study for this project, to finalize the most sustainable cost effective treatment plant considering all relevant technical, social, environmental, economic and institutional aspects. Cost of the project is BDT 18.9 million. |
| 6 | Development of Water Supply System in Rajshahi City | RWASA | July 2012 - December 2015 | • To ensure customer satisfaction through increasing percentage of population coverage by water supply from 67% to 87%, average daily consumption from 65 LPCD to 100 LPCD and improving water quality<br>• To make the water supply system sustainable through improvement of water resource management, financial management and human resource management by decreasing the operating ratio from 1.3 to 0.90, increasing collection efficiency from 54% to 70%, decreasing NRW from 38% to 23% and decreasing staff/1000 connections from 8.40 to 5.00 |

68 RWASA, https://rajshahiwasa.org.bd/daily-water-production/
69 Physical survey, RWASA, 2020

## Quality and Coverage of Current Water Supply by RWASA (FY Wise)[36,37]

| | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-2019/20 | Unit |
|---|---|---|---|---|---|---|---|
| Number of water pumping stations | 70 | 75 | 80 | 85 | 90 | 103 | Nos. |
| Total daily water supply | 56 | 60 | 64 | 68 | 72 | 95 | MLD |
| Per capita supply of water | 85 | 88 | 91 | 94 | 97 | 205 | LPCD |
| Coverage of water supply connections | 60.2 | 65.4 | 70.3 | 74.3 | 78.2 | 84 | % |
| Existing water treatment plant capacity | 27 | 27 | 27 | 27 | 27 | 27 | MLD |
| Extent of metering of water connections | 0 | 0 | 0 | 0 | 0 | | % |
| Extent of NRW | 41.2 | 38.3 | 36.2 | 35.3 | 33.4 | 33.78 | % |
| Continuity of water supply | 12 | 12 | 12 | 12 | 12 | 12 | hrs/day |
| Daily use of water | | | | | | 135.70 | LPCD |
| Water demand | | | | | | 113.29 | MLD |
| Daily water production | | | | | | 95 | MLD |
| Water supply pipeline network | | | | | | 712.50 | km |

## Existing Pumping Stations and Water Treatment Plants Capacities of RWASA (FY Wise)[36,37]

| | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-2019 | Unit |
|---|---|---|---|---|---|---|---|
| Installed capacity | 27 | 27 | 27 | 27 | 27 | 27 | MLD |
| Operational capacity | 9 | 9 | 9 | 9 | 9 | 9 | MLD |
| No. of pumps installed | 6 | 6 | 6 | 6 | 6 | 6 | number |
| No. of pumps working | 2 | 2 | 2 | 2 | 2 | 2 | number |
| No. of pumps on standby | 4 | 4 | 4 | 4 | 4 | 4 | number |
| Total rating of pumps | 100 | 100 | 100 | 100 | 100 | 100 | kW/hp |

## List of Registered Vehicles in RCC area[70]

| S. No | Type of Vehicle | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| 1 | Truck/Lorries | 1,024 | 1,031 | 1,040 | 1,095 | 1,155 | 1,219 | 1,428 |
| 2 | Mini Truck | 88 | 97 | 108 | 120 | 139 | 159 | 190 |
| 3 | Pick up/Delivery van | 155 | 184 | 225 | 263 | 330 | 397 | 426 |
| 4 | Buses | 293 | 302 | 320 | 343 | 357 | 371 | 398 |
| 5 | Human Hauler | 192 | 192 | 212 | 266 | 324 | 341 | 356 |
| 6 | Cars | 828 | 852 | 874 | 918 | 977 | 1029 | 1203 |
| 7 | Micro Bus | 395 | 403 | 405 | 407 | 410 | 420 | 445 |
| 8 | Mini Bus | 572 | 572 | 575 | 576 | 576 | 576 | 576 |
| 9 | Ambulance | 24 | 27 | 28 | 33 | 33 | 33 | 35 |
| 10 | Three Wheeler (Auto/Tempo) | 443 | 443 | 443 | 443 | 443 | 529 | 531 |
| 11 | Jeep | 265 | 274 | 279 | 290 | 295 | 311 | 311 |
| 12 | Three Wheeler (Auto Rickshaw) | 518 | 518 | 518 | 518 | 518 | 684 | 745 |
| 13 | Motorcycle | 46,339 | 52,238 | 62,135 | 72,183 | 82,433 | 93,722 | 102,075 |
| 14 | Tractor | 425 | 426 | 428 | 428 | 429 | 449 | 446 |
| 15 | Others | 438 | 438 | 438 | 438 | 438 | 439 | 439 |
| Total | | 51,999 | 57,997 | 68,028 | 78,321 | 88,857 | 100,679 | 109,604 |

## Completed Projects in Transportation Sector by RCC[71]

| Project Name | Total cost in BDT (million) | Project duration | | |
|---|---|---|---|---|
| | | Start date | Completion date | Expected completion date |
| Widening and Improvement of Road Starting from Upashahor Mour to Sagorpara Mour through Malopara | 721.6 | July 2011 | December 2017 | December 2019 |
| Construction of East-West Link Road Starting from Rajshahi Naogaon Main Road to Mohanpur at Rajshahi-Natore Road in Rajshahi | 1,229.1 | January 2012 | December 2017 | December 2019 |
| Widening and Improvement of Road from Kalpona Cinema Hall to Talaimary Mour in Rajshahi City | 1,275.0 | July 2015 | December 2017 | December 2020 |
| Improvement of different important roads in RCC | 1,729.8 | January 2017 | December 2019 | June 2021 |

70 Physical survey, BRTA, Rajshahi, 2020
71 Physical Survey, Engineering Section, RCC, 2020

# Annexure VI - Sources of GHG Emissions